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Path Dependency in the Energy Industry: The Case of Long-term Oil-indexed Gas Import Contracts in Continental Europe

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ABSTRACT

This paper seeks to explain the persistence of a business model that was instrumental in creating pan-European natural gas markets but refused to retire when the markets outgrew it. Long-term oil-indexed agreements enabled the emergence of international gas markets in Europe since the early 1960s and they still govern gas imports to the European Union. Yet, they failed to evolve with the changing business environment, resulting in the strategic costs for the companies. A politicized topic, research has thus far focused on national and regional levels, largely ignoring company level processes. This article contributes to the understanding of European gas markets by introducing a company level behavioral explanation of the endurance of an institutionalized but seemingly outdated business model. Path dependence is found to be a major contributing factor of the behavior of agents. Business leaders and governments alike will benefit from learning to identify and avoid path dependent behavior that leads to potentially sub-optimal outcomes.

Keywords: Gas Trade, Gazprom, Path Dependence
JEL Classifications: F, M, Q

1. INTRODUCTION

The "Groningen model"[1] was developed in the Netherlands in 1961 in order to commercialize the newly discovered gas field of Slochteren, later to be known after the nearby city of Groningen. The business model embedded in the Groningen export agreements was instrumental in developing cross-border gas markets in all countries of the then - European Economic Community. Other gas exporters to Europe such as Algeria, Norway and the Union of Soviet Socialist Republics (USSR)/Russia later adopted the business model. Groningen agreements typically have an exceptionally long duration of up to 30 years. The supply volumes are fixed in the agreement throughout the duration period and there is little flexibility to deviate from agreed volumes. The most controversial clause prevailing in the Groningen agreements is that of oil-indexation.[2] Typically, the price of gas is linked to that of competing fuels such as light and heavy fuel oil, with a lag of 3-6 months. Groningen model pricing therefore differs strikingly from that of other major commodities, the price of which is normally discovered on the market according to the supply and demand. Groningen-type agreements still govern most gas imports to the European Union (EU)[3], as well as the majority of global liquefied natural gas (LNG)[4] trade.

The central motivation of this paper is a 25-year track record of false forecasts of an imminent collapse of the Groningen model and failed moves to replace it with liquid traded markets in Continental Europe. These expectations have been inspired by Anglo-Saxon success in transforming their gas markets following the emergence of a broader privatization and liberalization paradigm that has dominated in Organization for Economic Co-operation and Development countries since the 1980s.[5] Such research has been

1 See Chapter 4 on different business models in gas trade in more detail.

2 Much of the policy-related literature focuses on criticizing such oil indexation (see literature review below).

3 In this paper, Norwegian supplies are not treated as "imports" by virtue of that country's membership in EEA.

4 LNG is often the only way to commercialize gas otherwise stranded in remote areas such as Australia or the Middle East. The world's most expensive energy project ever, the Gorgon LNG project in Western Australia, signed another deal in January 2015 with "close" oil linkage, demonstrating the endurance of the Groningen model. (http://www.abc.net.au/news/2015-01-21/chevron-gorgon-deal/6031728).

5 Gas markets were successfully liberalized in both the USA and UK in the 1980s.

proscriptive, focusing on policy recommendations and paying less attention to company drivers and industrial level processes. The legislator, the EU Commission in particular, was a key stakeholder in this process through the introduction of three consecutive energy market deregulation directive packages[6].

In 1986, MIT published a paper that discussed European gas markets and concluded that Groningen-style long-term contracts were necessary for most exporters in order to provide security for investments. Subsequently, in 1989 the World Bank argued that coal would constitute a good alternative for oil. As such, this was one of the earliest authoritative, if implicit, proposals discouraging oil-indexation. Since then, the majority of public debate and policy literature has focused on a general criticism of Groningen agreements and oil-indexation in particular.

Perhaps the most visible and enduring proscription for a likely dismantling of Groningen agreements has come from Oxford-based Jonathan Stern et al. In several publications, Stern et al. have envisioned an evolution away from Groningen agreements. In the early 1990s, a central instigator for this development was expected to be an oversupply of Russian gas (Stern, 1995). More recently, the argument has been that oil is no longer a rational price benchmark for gas due to the latter displacing the former in all end-user segments (Stern, 2009; Stern and Rodgers, 2011; 2013). "Oil indexation is outdated," claimed the French foreign policy think-tank IFRI, quoting Stern (IFRI, 2011). Not to be outdone by Oxford, the Cambridge Electricity Policy Research Group stated that, "the transition away from long-term oil-indexed contracts is unlikely to be reversed" (Noel, 2013). Noel argued that "the rationale for oil-indexation and even long-term contracts was reduced by the commoditization of gas," while such commoditization was "a self-reinforcing process" (self-reinforcing processes are at the core of path dependency theory, and will be discussed later in the theory section of this article). While the Groningen agreements are continually criticized in these papers mentioned above, the causes for their persistence are only passingly explained as simply the vested interests of the companies, or rather ignored.

The legislator has also taken a negative view of the Groningen agreements. The EU Commission was able to gradually coerce gas companies in the EU to unbundle their assets to monopolistic infrastructure and contestable energy trading units, respectively; to open up their grids for third party access; and to auction some gas supplies to new entrants in order to facilitate competition.[7]

Having successfully prohibited so-called "destination clauses[8]" in Gazprom sales contracts, the commission went on to battle what it viewed as prohibitively long contract durations and oil-indexation-Factors at the very essence of the Groningen agreements. However, without sovereignty over ex-EU transactions[9], the commission appeared to have overstretched its powers, finally withdrawing "juridical action against long-term contracts between exporting countries and EU-importers, but remaining cautious, as do many member states" Neuhoff and von Hirschhausen (2005. p. 2). In 2015, the Commission once again raised the case, formally accusing Gazprom of market abuse (Platts). Gas companies continued to push the importance of diversification in their supply portfolios, both regionally and contractually[10]. Yet in 2006, rather than diversify nearly all West European buyers of Russian[11] gas chose to prolong the maturing legacy agreements of the Groningen paradigm well into the 2020s, and in some cases the 2030s, further increasing their dependence both geographically and contractually[12]. Following this a number of major contingent events occurred such as the Great Recession, the shale gas revolution in the USA, radical advances in renewable energies in Europe, which within a short time altered the business environment for European gas and energy companies[13]. Market fundamentals have remained in turmoil ever since[14]. Inflexible Groningen agreements have not responded to these challenges. Being contractually locked in for decades ahead, unwanted gas has continued to enter the market at uncompetitive costs. As a consequence, by 2014 European utilities had written down primarily gas-related assets worth 50 billion euros[15].

Through a primary focus on prescriptive policies or geopolitical and even military analysis, the existing literature has failed to address the potentially deeper structural forces of path dependency that appear to have contributed to the inertia brought about by the contractual set-up of European gas imports[16]. While emphasizing national and regional level developments, existing literature has only lightly touched company level decision-making and yet, organizational and management research has plenty to contribute. The purpose of this article is the effort to illuminate underlying explanations for the unexpected persistence, even ossification, of the Groningen business model. Path dependence (PD) framework

6 The first "energy package" (a co-ordinated set of directives and other EU regulation) in the late 1990s focused on formally opening energy markets for competition, while the second energy package, approved in 2003, went further by mandating "unbundling" (separating activities in order to prevent a unit to subsidize another unit within one conglomerate in order to decrease their market power) energy utilities; the third one, approved in 2007, went still further with these measures.
http://www.euractiv.com/energy/liberalising-eu-energy-sector-linksdossier-188362
http://ec.europa.eu/energy/en/topics/markets-prices-and-consumers/market-legislation

7 The EU Commission was able to legally impose some of the liberalization measures even on non-EU states. For instance, the Commission compelled Norway to dismantle its nationally mandated gas export cartel GFU (EU Commission, 2002).

8 These clauses divided markets into *de facto* regional monopolies; i.e. Company A guaranteed Gazprom that it would not sell gas in Company B's territory; see more in Chapter 4 on Groningen agreements.

9 Russia and Gazprom subsequently gave the sovereignty issue top priority. Numerous presentations and documents refer to the sovereign right to enjoy Hotelling, rather than Ricardian rent in exploiting natural resources (e.g. Barnes et al., 2013).

10 The "diversification" mantra can be found in e.g. annual reports of importing companies.

11 The topic of this paper is the entire set of gas import agreements to the EU/EEA area. For various reasons, Russia's share has been growing - the focus is therefore often-on Russia and Gazprom.

12 See e.g. Gazprom Export and respective counterparties' web sites.

13 Gas companies have not only mandatorily unbundled, but also often changed ownership and/or merged with larger energy groups, thereby moving Groningen portfolios to new owners. While these processes effecting custodianship of agreements are potentially useful in explaining companies' behaviour, they are not the focus of this paper.

14 See e.g. OIES papers on the topic, as well as Chapter 5 in more detail.

15 See Chapter 5 in greater detail.

16 See e.g. OIES and Commission references elsewhere in this article.

will be utilized and the ensuing analysis concerned with the constituent elements of: (1) Contingent events, (2) self-reinforcing processes, and (3) a lock-in, which are all well manifested in the development of the contractual set-up of European gas import agreements. The results will thereby contribute to an understanding of business process inertia in energy industries in general, and within the European gas industry in particular.

2. THE RESEARCH QUESTIONS, METHODOLOGY AND DATA

This paper seeks to explore whether PD theory can contribute to explaining the persistence of the Groningen model in the Continental European gas import agreements[17]. The subsidiary questions are guided by the constituent components of PD theory: (1) What contingent event(s) triggered the non-ergodic process towards opting for the Groningen agreements[18]? (2) how did the self-reinforcing mechanism actually play out with the Groningen agreements? (3) when and where do we observe the total inflexibility that leads to a lock-in for Groningen agreements?

"Persistency" is hard to measure and harder to define. Absolute lack of change hardly exists, so criteria for defining meaningful persistency should be found. In order to validate the research question, the persistence of the Groningen model is therefore quantitatively assessed to verify the claimed existence of the phenomenon researched – has the Groningen model in reality persisted without significant change? A negative answer to this question would render the main research question meaningless. To find out, price and volume data will be utilized in order to estimate how well the key elements of the Groningen agreements have held over time. Correlations between fuel prices are calculated in order to define the best directionalities of annual price movements, while price ratio trends between competing fuels will be used to verify multiannual price linkages. The results of this hybrid approach are then discussed and their meaningfulness qualitatively assessed, as there is ontologically no definitive way to agree on whether a linkage is "good enough" to warrant the "persistence" argument.[19] Epistemologically, the best way to demonstrate the linkage is therefore to show that the correlation between Groningen gas prices and oil prices has remained relatively stronger than that between Groningen gas prices and those of other alternative energy sources.

With the existence of the research phenomenon validated (see Chapter 4.3 for results), the paper then progresses to the core research question: What drivers can be found to explain the phenomenon of the persistence of the Groningen model? The proposed hypothesis of the path dependent behavior of the Groningen paradigm is analyzed in Chapter 5. The kinds of tests conducted in the natural sciences are in general not possible to apply in social research, and in strategy research in particular (Durand and Vaara, 2009). PD scholars appear to converge on the recommendation for counterfactual reasoning as the best research methodology (Durand and Vaara, 2009; Durand and Vergne, 2010; Dobusch and Kapeller, 2013). Other methods proposed such as simulations (Dobusch and Kapeller, 2013) are not feasible in the case of the 50-year industry-creating Groningen paradigm within European gas business history. Counter-factual reasoning is offered by running the research phenomenon longitudinally case-style[20] through the PD framework in order to identify concrete PD hallmark milestones and processes: (1) Contingencies at initial conditions; (2) self-reinforcing processes; and (3) lock-in moments in the history of European natural gas industry.

Durand and Vaara (2009) break this research process down to three steps: (1) Identify critical events; (2) specify causal processes and mechanisms; and (3) use counterfactuals to establish causation. Durand and Vergne (2010) encapsulate the challenges of PD research by warning that: "To claim that something is contingent is not quite like proving it actually is." They caution further by stating that, "it is hard to tell what constitutes acceptable empirical evidence for PD" and conclude that "while all necessary components of PD, taken individually, are common in organizational life, their adequate combination might be less common, so it remains unclear how often PD is likely to manifest itself empirically." This article seeks to demonstrate through counterfactual analysis that events and choices before and during the ascendancy of the Groningen paradigm really were contingencies – alternative choices could have been made and had been proposed; self-reinforcing processes really facilitated displacing alternatives in favor of the Groningen paradigm; that after a certain point in time alternative choices had become by and large unfeasible; and that a subsequent lock-in of the Groningen paradigm therefore represented "at least potentially strategic inefficiency" (Sydow et al., 2009). In other words, the aim of this paper is to show that an adequate combination of PD components is manifested in the research case.

As explained in the methodology section above, price data is used to establish the material persistence of Groningen agreements. Most price data stems from a single source: BP's annually published Statistical Review of World Energy. The review has a wide circulation and is often quoted, a level of consistency between different time series can be assumed, and some of the price data refers to original data not in public domain[21]. The key exception is the crucial Groningen contract price data. Several commercial consultancies attempt to re-engineer the Groningen agreement formulae by tracking Groningen agreement prices directly or indirectly through published data, known legacy price formulae, *ad-hoc* statements by the companies involved etc., but this approach only allows for rough estimates at best. Real price

17 As noted, Groningen type agreements are also common outside of Europe but this paper focuses on their persistent impact on import markets to the EU/EEA area.

18 See Chapter 4.1 for a fuller description of the Groningen model.

19 A 100% fit is not possible for several reasons. The "oil" in question is not crude oil but oil products such as heavy fuel oil and light fuel oil (e.g. Energy Charter Secretariat, 2007). Correlation between these fuels and crude oil is high but obviously not 100%. Moreover, the price opener clauses in the Groningen agreements imply that prices may be renegotiated from time to time, so some divergence from full correlation is expected. The reason for the quantitative check here is to make sure such renegotiations do not materially dilute the oil-indexation principle.

20 The case study approach has been by far the most typical in PD studies (Sydow et al., 2012).

21 For British spot gas prices, BP refers to OTC prices as reported by ICIS Heren Energy Ltd.

formulas and precise data remain a commercial secret. Since the massive divergence of contract and spot gas prices in 2008 and subsequent price renegotiations (see Chapter 5 for further detail), data quality for Groningen prices has deteriorated. This article uses the only publicly available estimate for Groningen gas[22] that is published by Index Mundi. This open and free on-line service obtains data from the International Monetary Fund (IMF), which draws on data taken from World Gas Intelligence[23], a commercial energy consultancy. BP price data points are annual, while Index Mundi monthly data was converted to annual by the author. While the data resolution is somewhat grainy, the simple quantitative analysis employed here is considered to accommodate this as long-term, not intra-annual, correlations and trends are sought after. Price transparency for oil products is poorer than for crude oil and since product prices follow crude reasonably reliably the latter were used as a proxy for the former. The price data used is for 1996-2013 while earlier data is less reliable. These calculations were made in MS Excel. The qualitative data draws on company reports, existing literature and other published material (see Sources).

3. PATH DEPENDENCY THEORY

"History matters" may be the commonest shorthand for path dependency theory. As David (1985), a pioneer of the path dependency (PD) concept put it ironically, "one damn thing leads to another." At best, these comments convey the general idea of PD but fail to represent the concept holistically. At worst, they risk trivializing PD entirely. Other intellectual shortcuts to understanding PD include iconic cases such as the Qwerty keyboard system (David, 1985) and the VHS triumph over Betamax in the operating system wars of the 1980s (Arthur, 1990)[24]. David and Arthur were pioneers in establishing PD as a new conceptual framework with a strong theoretical foundation, one based ultimately on non-ergodic statistics[25]. PD was subsequently adopted within diverse sciences, both natural and social, such as technological history, political history, evolutionary biology and economic geography[26]. What sets PD apart from other theories such as institutional theory in explaining sociological rigidities was perhaps best proposed by Sydow et al. (2011): "There seems to be a broadly shared feeling that we need to understand better how organizations can lose their flexibility and become inert or even locked in."

Despite PD being widely employed in academic literature[27] for a quarter of a century, the concept remains widely debated and no consensus for a definition has emerged (e.g. Sydow et al., 2009; Durand and Vergne, 2010; Dobusch and Capeller, 2013). Such dissonance can be partly attributed to the fact that PD theory has proliferated, diversified and is linked to higher-level frameworks such as complexity economics (Arthur, 2013). Consequently, the deployment of PD has hinged on the theoretical "ocular" used to observe phenomena at different epistemological dimensions. Industrial historians and organizational researchers hold different views on the definitions of central concepts within PD such as inefficiencies, for example.

As noted, PD has been applied to explain the rigidities of technologies, biological creatures, institutions and organizations. This article expands the range to business models. It is imperative to understand that PD is a process (Sydow et al., 2009). The following description (Figure 1) of the PD process draws on Arthur (1989, technologies), Mahoney (2000; institutions) and, in particular, Sydow et al. (2009; organizations) with the aim of adapting PD to business models. The constituent parts of the PD process are, (1) The preformation phase of initial conditions, characterized by a wide range of available options for events or decisions; (2) the formation phase of self-reinforcing process that progressively narrows the range of such options; (3) the lock-in phase where only one option is available; and, possibly, (4) the exit phase from such a state.

In preformation phase, given the initial conditions, decision-making options are unconstrained. Agents are free to choose among any options available within a wide range of alternative actions. The choices taken at this stage are typically small and random (David, 1985) but do not exclude choices that are "not so small, random or innocent" (Sydow et al., 2009). Only a limited number of outliers appear outside the range of available options. Random choices or minor events may amount to critical

22 "Russian gas at German border" – the commonest proxy for contract gas imported into EU/EEA.

23 Confirmed in private correspondence by IMF to the author in September 2014.

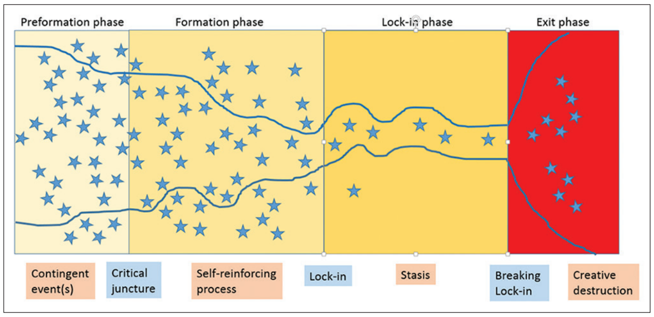
24 The Qwerty system was intentionally made sub-optimal to slow down the typing process in order to prevent the keys getting stuck to each other. As there are obvious benefits in a single standard keyboard system instead of several, Qwerty became the on going norm, even when typewriters gradually became improved to handle fast typing; there was no way back from this standard, which had become locked in despite its inferiority.

25 Coin tossing provides a classic example of ergodicity. An unbiased coin returns both heads and tails with an equal probability of 50%. Any number of consecutive tails does not impact the probability of the next tossing, where the chances are still 50% for both outcomes. Such phenomena are called ergodic. Non-ergodic processes, however, have causalities where the probability distribution of outcomes in event A affects the probability distribution of outcomes in event B that causally follows event A. In a so-called Polya urn process, coloured balls are randomly picked out from an urn, then replaced, and another ball of the same colour ball added. The process will eventually yield an outcome of uniformly coloured balls. Initial conditions, however, are not able to predict the outcome.

26 Acemoğlu and Robinson (2012) argued that England went through a series of successful but contingent political events that at a certain point in time locked in virtuous societal institutions deemed necessary for later development of a modern society. In an on-going project, the late Lensky (2015) and his team have been rerunning the evolution of the coli bacterium for tens of thousands of generations by freezing every 10.000th generation and thawing them at later intervals. They then observe if similar evolution takes place, or, whether a particular evolution is based on a random mutation and can only take place after such mutation occurs in a path dependent way. So far, Lensky and his team have found that contingency has played an important role in building alternative development paths resulting in different outcomes, i.e. deterministic convergence, still a strong theory in evolutionary biology, did not always happen. Mattlin and Nojonen (2014) argue that Chinese development aid in Africa, superficially non-conditional, may nevertheless be on a path towards dependence.

27 Durand and Vergne (2010) counted 6.15% direct references to PD in seven leading management journals published between 1998 and 2002, and no <10.5% published between 2003 and 2007.

Figure 1: Path dependence process



Source: Adapted by author from Sydow et al. (2009)

steps towards a bifurcation point where one option emerges as predominant. Whether small or not so small, such events are contingent and therefore not predictable.

The bifurcation point, or critical juncture, leads to formation phase and kicks off a self-reinforcing process where agents increasingly turn to the emergent preferred option, thereby marginalizing alternative options. The nature and drivers of self-reinforcing process has received much attention. Considering the wide application of PD theory throughout different disciplines these drivers are defined diversely. Arthur (1989) puts increasing returns at the center of the self-reinforcing process. Technological historians identify, (1) Technical interrelatedness; (2) economies of scale; and (3) quasi-irreversibility of investment as increasing return drivers (David, 1985). Organizational research identifies, (1) Coordinating effects; (2) complementary effects; (3) learning effects; and (4) adaptive expectations as self-reinforcing process drivers (Sydow et al., 2009). Depending on the discipline, these elements may be more or less relevant; for example, drivers of biological paths might differ from technological ones. Whatever the driver, the key issue is that the actors' individual choices decline in number in stark contrast with the abundant choices of the first phase. The choice of agents is driven by "increasingly systemic forces, beyond the control of the individual actor" (Sydow et al., 2009).

Once the self-reinforcing process has become irreversible, the number of alternatives spirals down to a terminal, deterministic state a complete inflexibility of choices. A lock-in is the outcome of the process. Such an ossified state not only paralyzes incumbents' decision making, but that of the possible entrants also, who must conform to the pattern. Such total inflexibility "renders a system potentially inefficient, because it loses its capability to adopt to better alternatives" (Sydow et al., 2009).

The final, the exit stage, is paradoxically the antithesis of the very idea of PD, namely the un-locking of PD. Often absent from PD literature, the un-locking of PD is of practical interest in the case of Groningen agreements as there are increasing claims that the Groningen paradigm has finally begun to erode (see Chapters 1, 4, 5 and 6).

As noted, dissonance is prevalent among the approaches of PD theoreticians. While some critique focuses on how to best develop PD theory, other researchers go so far as to question the entire validity of the concept (Liebowitz and Margolis, 1995; 1999). Sydow et al. (2009) develop Arthur's (1989) definition of PD as having four key properties that must exist in a claimed case of PD: (1) Non-predictability; (2) non-ergodicity; (3) inflexibility; and (4) inefficiency. Emphasizing the process nature of PD, Sydow et al. make an important point of the relative, temporary and passing role of these properties, which are sometimes overlooked (Mahoney, 2000. p. 515), thereby further complicating identification of possible PDs.

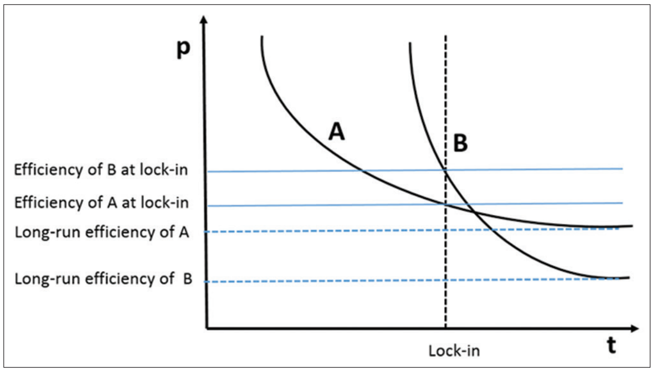
Non-predictability is a central property of PD in the preformation phase and, to a lesser degree, in the formation phase. As alternative options are gradually lost predictability increases until the single remaining option becomes a certainty. "Breakdown of ergodicity gives rise to PD" (Horst, undated) implying the dichotomous existence of both polarities in ergodicity, but again, these polarities are temporally exclusive in the course of the PD process. Initial conditions are assumed to be ergodic, or non-ergodicity to be so weak as to be balanced by contingent events, while at the other end of the PD process, a lock-in outcome is achieved by the very non-ergodicity of the self-reinforcement process. Sydow et al. (2009) define the watershed between ergodic and non-ergodic processes by vesting the past with the ability to "influence" and "determine" the future, respectively. Inflexibility is absent in the preformation phase, only appearing in the formation phase. At the moment of lock-in, inflexibility becomes absolute, and is even used as a synonym for lock-in (Sydow et al., 2009). Inefficiency is among the most debated properties of PD, and Sydow et al. (2009) characterize it with such attributes as "potential" and "strategic," normally manifested only during the lock-in phase, if at all. Figure 2 illustrates schematically such a possible inefficiency. Because of an early lead, whether by accident or design, alternative A gains in efficiency at early stages (due to economies of scale, learning, network effects, etc.), becomes path dependent and succeeds in achieving a lock-in state. At that time B, ultimately a more efficient alternative potentially, remains less efficient and will therefore remain unrealized due to a late entrance into markets.

Finally, it is useful to briefly explain PD within a larger context. Much of the mainstream literature referred to above assumes PD as an isolated phenomenon that emerges from "nowhere" and focuses solely on self-reinforcing sequences while largely ignoring the "prehistory" of PD processes. Perhaps driven by his background in political sciences, Mahoney (2000) introduces a different mechanism from self-reinforcing sequences: "Reactive" sequences. While self-reinforcing sequences reinforce events, reactive sequences transform and potentially even reverse earlier events. Mahoney includes these sequences with a wider PD framework as they set "in motion a chain of tightly linked reactions and counter-reactions[28]." For Mahoney, it is the tight causality that counts as a path dependent process[29]. The rise of industrializing

28 For a Mahonian set of PDs and contingent events in European gas business, see Chapter 6.

29 Acameoglu and Robinson (2012) make an interesting case of the UKs evolution towards the birth of the industrial revolution by identifying a long chain of preceding propitious, contingent events that were reactive, before a self-reinforcing process began. They emphasise the tight causality that produced the outcome.

Figure 2: Lock-in of sub-optimal option



Source: Illustration by author

Britain was such a case, one in which reactive processes finally gave rise to a self-reinforcing process, as noted earlier.

Randomness and lack of agency in the classic definition of PD came to be seen as a point of weakness, particularly by technological history and organizational scholars. "The path dependency theorists made a critical mistake by trading an emphasis on human agency for the impersonal forces of history," complained Pham (2006-2007). Others have taken on the challenge. Sydow et al. (2012) build on Garud et al. (2010) and others by not only finding conscious actions by agents in PD but also introducing other PD derivatives, such as intentional PD, PD extension, unintended path dissolution etc. Finally, Arthur, one of the original scholars on PD, locates PD theory in the dom ain of "complexity economics" (2013). Arthur promotes complexity economics for understanding real world complexities, finding simple neoclassical economic models lacking. All these derived concepts and expansions have much to offer in explaining the complex developments of the European gas industry, as will be seen in the discussion on further studies in the final chapter.

4. ANALYTICAL AND COMPARATIVE DESCRIPTION OF THE GRONINGEN MODEL

4.1. Groningen Model

This paper uses the "Groningen model" or "Groningen agreements" as the name for the business model in question. Generic terms such as "business model," "business paradigm," "business concept" or any combination of them are also occasionally used. Existing policy-oriented literature often refers to "long-term gas supply agreements," a term that does not take into account the key characteristic of oil-indexation and is therefore not used here. The term or concept "Groningen model" is widely used in Russian discourse (e.g. Konoplyanik, 2007) while less so in the Western literature.

First and foremost, the Groningen agreements are long-term and clear commitments for both sellers and buyers[30]. Their specific purpose is to maximize and lock in long-term cash flows in order to minimize the financial risk inherent in massive capital outlays typical to energy investment[31]. Therefore, they should not be primarily understood as a transaction cost minimizing tool in the Coasean sense, but rather as coordinated investments between multiple legal entities bound by the Groningen agreements. The key element is the sunken cost of the commitment: Once signed, the buyer is obliged to honor the contract throughout its lifecycle no matter what. Groningen model agreements are exceptionally long-term, the duration normally between 15 and 35 years[32]. While the typical duration of gas contracts generally decreased from 30 years in 1980 to 15 years in 2004, since then virtually all-major European buyers prolonged their Russian contracts by several decades to the late 2020s and beyond[33]. Long-term contracts are not confined to Russian and other external suppliers to Europe. They also remained prevalent in the USA and UK before these countries liberalized their gas markets. They are still used in most LNG trade. Such lengthy time spans are justified by the huge financial risks that both parties undertake when committing to investments that can amount to tens of billions[34].

Arguably the most contentious current element of the Groningen agreements is the oil price linkage[35]. In the absence of liquid spot gas markets[36] price discovery is difficult and oil linkage provides a practical reference based on a competing commodity. In an oil-indexed gas sales contract the base price of gas is set at parity, or perhaps at a small discount, to oil price[37]. A

30 The description of the standard Groningen model that follows is widely available in reference sources, e.g. Energy Charter Secretariat. (2007).

31 High capital spending and long pay back periods are typical to energy infrastructure projects. E.g. The nuclear industry has conspicuously avoided investing on the back of market fundamentals alone, relying instead on captive customers (USA), regulated markets (most of the existing legacy fleet in most countries), feed-in tariffs (UK in the 2010s) or private risk mitigating solutions such as the Mankala business model (Finland) where the nuclear plant operating company concludes long-term electricity sales agreements with shareholders, thereby shifting the commercial risk from the operating company to the shareholders in smaller, more digestible packages.

32 In practice, things are slightly more complicated than this. Often, additional volumes are attached to an existing contract which is then prolonged; or two or more existing contracts may be combined and prolonged; when exactly an old agreement expires and a new one begins is therefore a relative proposal.

33 Konoplyanik, A. (2013) provides these durations quoting Western sources. However, the majority of the prolonged agreements that Gazprom concluded with its European partners in 2005-7 were extended to the 2030's, and in the case of German WIEH in 2008, by 35 years to 2043.

34 A major LNG development off Western Australia, Gorgon offshore gas field, to be completed in 2015 after delays, is at 54 bn USD "one of the most expensive investments of any kind anywhere" (FT, 2013).

35 See introductory chapter and Stern (2009; 2011; 2013) and Noel (2013) and, quite recently, the EU Commission (Platts, 2015).

36 In Europe, deep and liquid gas markets currently only exist in the UK and the Netherlands ("churn", an index for the turnover of traded gas, exceeds commonly held criterion of 10 for "liquid" markets only on these markets), (Henderson, 2014). The fact that Groningen agreements do not respond well to falls in demand kicks off a self-reinforcing process at hubs whereby increasing gas supply is chasing decreasing gas demand, which is hardly conducive to the stability of gas markets. Such a mechanism that is prone to multiply either deficit or surplus, and therefore price swings and unpredictability, has been one of Gazprom's objections against wider use of spot indexation in the long-term agreements.

37 Japan was paying a premium for LNG throughout much of the 1990's (BP Statistical Review of World Energy).

price formula then makes gas prices follow oil prices at all times – hence, "oil indexation." While oil prices change on a daily basis, the oil-indexed Groningen gas price changes on a quarterly basis, with an oil price reference period of two or three preceding quarters. Therefore, oil indexed gas prices lag behind oil prices and price swings are much more muted as volatility is steeply averaged out. Due to this time lag gas prices can be estimated several months ahead, helping buyers to budget ahead with greater accuracy. In Europe the "oil" in question refers to heavy fuel oil and light fuel oil, both of which are normally included in the formula. In LNG contracts, a mix of crude oil grades is the norm.

"Destination clauses" used to be relevant in Europe. They prohibited the reselling of gas in order to prevent the buyer from profiting on a more expensive market to the detriment of the seller. Being anti-competitive, the EU phased out destination clauses by the early 2000s (EU Commission, 2005). "Price openers," or renegotiation clauses, were introduced in the Groningen agreements in 1986 (Frisch, 2003). Typically, both buyer and seller are entitled to initiate negotiations over price level every 3 years. A successful renegotiation hinges on demonstrating material change in the competitiveness of gas. Pricing transparency is also clouded by possible floor or ceiling prices in order to mitigate risks from "abnormal" behavior on the oil markets.

4.2. Alternative Marketing Models

The International Gas Union (IGU, 2014) has recently compiled a report on global pricing models and their "market shares." The Groningen model roughly compares to IGU's definition of "oil price escalation." Currently, spot pricing ("GOG"), or gas on gas competition, is the dominant pricing principle for domestic and intra-European Economic Area gas production. All US and most UK, Dutch and Norwegian gas is sold for spot prices as these countries liberalized their energy markets in the 1980s.[38] Geographic price differentials are applied in the US[39] in smaller liquid markets - gas is sold at a "virtual trading hub"[40] - while in less liquid markets spot gas is primarily only available at local trading hubs.

Bilateral monopoly ("BIM") refers to one single seller and one single buyer, most typically state-owned companies entering into a supply agreement. The IGU's classification is arbitrary on this type as the massive landmark gas supply deal concluded in 2014 between China and Russia is reported to be a classic Groningen agreement[41], whilst IGU would probably classify it as BIM.

The third major pricing principle is regulation. The IGU identifies three different regulatory regimes, depending on whether the regulator specifically wants to keep prices below cost for social reasons (risk-based capital), cost-based to justly reward the supplier (RCS), or somewhere in between, re-setting the prices for either social or fiscal reasons, as the need or opportunity arises.

The market shares for these marketing paradigms vary hugely depending on whether one looks at domestic production or exports. The regulation-based marketing models still dominate globally, just ahead of spot based markets. Not surprisingly, poorer countries may wish to subsidize energy supplies for their citizens (IEA, 2011), while an energy exporter is more likely to go for hoteling rents or at least manage profitability for massive investments, as is likely to be the case with LNG exports. Figure 3 illustrates these differences.

4.3. Have Groningen Agreements Materially Changed Over Time?

Before actually exploring the credentials of PD theory as a potential contributor to the persistence of the Groningen agreements in Central Europe, this paper analyses the trends and key characteristics in order to verify the persistency claim. As discussed in Chapter 4.1, the Groningen model hinges on the combined characteristics of: (a) Long-term fixed volumes, and (b) oil-indexed prices. Generally speaking, contractual volumes are unambiguously fixed and honored, as well as publicly communicated. Gazprom, the main external supplier, prolonged all main Groningen style contracts (see Chapter 5 in more detail) with its European customers in the early 2000s until the late 2020s and even 2030s. Contractual volumes mostly hover around 140 billion cubic meters (BCM) per annum, which corresponds to the volumes actually delivered during the past few years, until the late 2020s (Konoplyanik, 2014). Groningen agreements are not marginalized or displaced volume-wise and will remain the central gas import paradigm for decades to come.

Such clarity on Groningen agreement volumes contrasts with the ambiguity on their pricing. As noted, pricing is confidential. It is assumed that oil-indexation is followed in the Groningen agreements, but this cannot be directly observed. Price estimates for Russian gas on the German border are calculated by business analysts (for more detail see Chapter 2), and this article treats those prices as a proxy for the Groningen gas price. The behavior of these estimated prices is analyzed in this chapter in order to judge whether claims for the persistence of Groningen agreements have sufficient merit.

At the aggregate level, prices change according to the gross domestic product deflator and are therefore always at least somewhat correlated. Beyond such triviality, commodity prices in general tend to move in cycles, normally in line with macroeconomic cycles. Prices for commodities are therefore expected to move in the same direction, as shown in Figure 4.

Commodity group prices are correlated even more so prices of fuels such as oil, gas and coal tend to be even more correlated

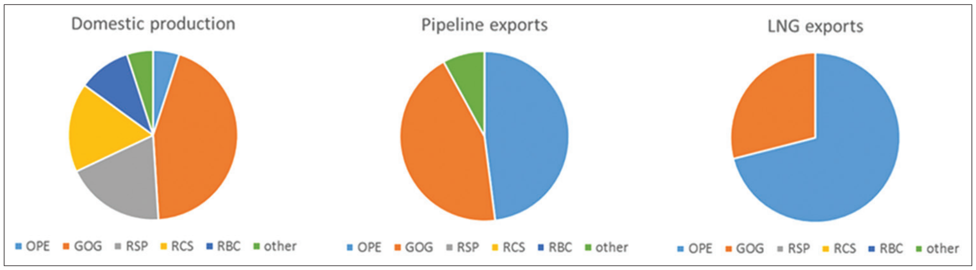
38 From 2010, Norway's main producer Statoil gradually moved to spot pricing (www.statoil.com).

39 In the US, where transmission distances are long, gas is therefore sold with a premium or discount to the "Henry Hub," a traded benchmark based on a physical hub of storages and pipelines in Louisiana.

40 This is the case in the UK and the Netherlands, where gas is freely traded once it has entered the gas grid.

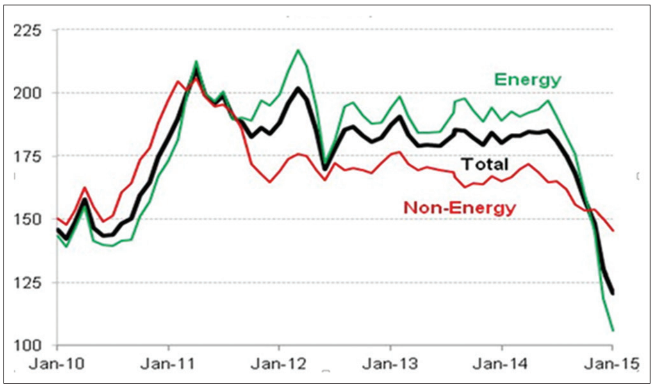
41 Gazprom CEO Aleksey Miller stressed at a press conference that the deal was fully in line with traditional Groningen pricing: "It is tied, like it is envisaged in all our international contracts with Western partners, specifically our partners in Western Europe, to the market price on oil and oil products. It is an absolutely calibrated, general formula for pricing." (BBC, 2014).

Figure 3: Gas pricing paradigms by market



Source: IGU, 2014

Figure 4: International Monetary Fund commodity price indices (2005 = 100)



Source: IMF

than commodities in general. One should not jump to premature conclusions based on such correlations by implying potentially false causalities. In order to make claims about Groningen agreements, it is therefore necessary to demonstrate that the declared oil-linkage causality indeed does produce a correlation between gas and oil prices well in excess of any other correlation between any other pair of fuels. Therefore, Groningen prices are not only compared with crude oil prices but also with prices for UK National Balancing Point (NBP) spot gas[42], US Henry Hub (HH) spot gas, and coal prices, all of which can be assumed to correlate well with Groningen prices. The time-scale is 1994-2013.

As expected, most correlations are rather high. The exceptions to the rule, however, are significant. The shale gas revolution in the US caused a collapse of gas prices there, delinking them from past, higher correlations with oil and gas prices on other markets. The HH correlation with UK spot market is 50%, with the oil price only 30%. While the shale gas revolution was not foreseen, and could be said to be a one-off anomaly, it is exactly these kinds of anomalies that gas exporters seek to avoid by linking gas prices to more predictable oil prices. Indeed, it turns out that HH correlation with Groningen gas is low at 38%. One can therefore conclude that HH gas prices are mostly driven by internal fundamentals, with limited impact from the global drivers that influence European prices more. Internationally traded coal has a better correlation with European gas prices. Against NBP, the correlation jumps to 86%, and against Groningen gas to 90%. A relatively good correlation of coal with both NBP and Groningen gas is expected as they all compete on the European power generation segment. NBP achieves a still better correlation with Groningen gas at 94%, facilitated by two interconnectors between Britain and the Continent. However, by far the highest correlation is achieved with Groningen gas prices and oil prices, with a 97% correlation, corroborating the assumption of persisting oil indexation.

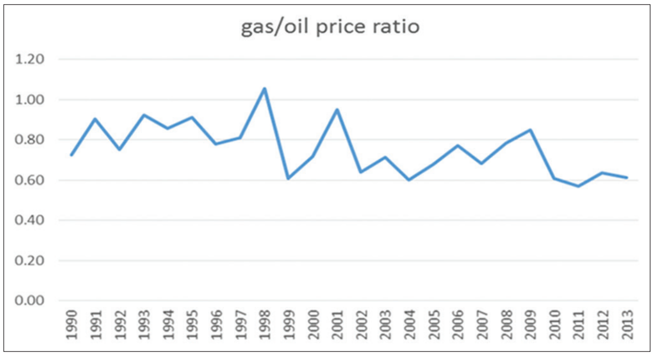
High correlation does not disclose all important drivers in prices. Correlation in shorter-term price movements might be high but there could still be a diverging trend in price ratios, caused by possible major base price changes, eroding true oil-indexation over time. Groningen price as a ratio to crude oil price reveals a relatively stable relationship over the period (Figure 5). Since the late 1990s, the Groningen gas to oil ratio has averaged about 70%. The post-2008 downward correction that resulted from several renegotiations between buyers and Gazprom, Statoil and other producers is visible. However, this correction only returned the ratio back to the level that prevailed at the turn of the millennium, thereby cancelling a creeping appreciation between 2000 and 2008. Considering that both crude oil and Groningen gas prices roughly quadrupled after 2000 Groningen gas from 2-3 USD/million British thermal units (Mbtu) (to over 10 USD/Mbtu), a Groningen price correction of 10-20% is modest in relation. US HH prices, as well as numerous regulated gas prices (e.g. ca 3-4 USD/Mbtu in Russia[43]) produce significantly different outcomes compared to Groningen prices.

These metrics clearly support the purported persistence of the oil price linkage in the Groningen agreements. The interpretation is necessarily subjective – does one put more weight on the noticeable erosion of the recent Groningen prices, or on the ratio that has been reasonably sustained during the longer period? Or rather, perhaps the link was solid until the Great Recession but the renegotiations effectively severed the link? Officially, the Groningen agreements exist far into the future. To claim that they have somehow mutated beyond their original character would require bigger shifts in both prices and volumes. For the purposes of this paper, the quantitative analysis fails to demonstrate any crucial change in the Groningen agreements. Thus, having sufficiently demonstrated the existence of the research phenomenon the article proceeds to seek its explanation.

42 Only UK spot price history extends far enough; Dutch title transfer facility and other continental spot prices are only available after 2000.

43 Korchemkin's web site provides this and other reference material and analysis on Russian gas.

Figure 5: Gas/oil price ratio in European Union contractual gas imports



Source: Author's calculations

5. EUROPEAN GAS IMPORT PARADIGM – LOCKED IN BY PATH DEPENDENCY?

This longitudinal case analysis follows the definition of PD proposed by Sydow et al. (2009) with a brief discussion of the fourth phase, that of the possible dissolution of PD. While these phases represent different states with different dynamics, covering the whole range of ergodic - non-ergodic - deterministic continuum, many of the key events take place at transitions between phases. In this chapter, such states and the transition points to the next state are discussed in one sub-chapter for each phase. Like in most evolutionary processes it is impossible to pin down precise moments that represent a shift from one phase to another[44], and dividing the case into discrete phases is therefore provisional.

5.1. Preformation Phase: Contingent Events

In the late 1950s the European gas industry was local, small and poised for gradual, organic growth[45]. Lack of any substantial gas resources would force agents such as gas producers, consumers and policy makers to focus on premium markets such as industry and cooking. Larger markets such as water heating[46] would continue to be based on coal, oil or the emergent nuclear power. Gas penetration was far lower than in the United States, which was blessed with abundant indigenous gas resources[47]. Booming European economies would require some gas but demand was expected to be met by supplies from small local fields, coal gasification[48], and possibly, limited imports. A couple of years earlier, in 1959, British Gas in the UK had imported a cargo of LNG to its Canvey Island import terminal from Lake Charles export terminal in the US but additional cargos failed to materialize (http://www.bg-group.com). Gas transmission and distribution was mostly local, and cross-border pipelines were virtually non-existent in 1960. As an industry, natural gas was not comparable in size and significance to that of coal or oil. Any paradigmatic growth would likely have had to wait until LNG supply chains had become cheaper and more widely available.

Two separate contingent events, both non-predictable, would change all this. First, the discovery of the Slochteren gas field was a contingent event. Shell and Esso, companies that were exploring the area, were looking for oil, not gas (ExxonMobil and Swiger, 2013). The geologists might as well have been looking elsewhere; or they could just as easily found other, numerous smaller gas fields before making the Slochteren discovery. They would likely have been commercialized in a more localized and organic manner, with resource extraction from small sources obviously marketed locally. The Groningen marketing model is specifically designed to market huge resources with massive capital expenditure and long payback times. Its unique features are too cumbersome to benefit commercializing small fields, so it is likely that a different marketing model would have evolved in the absence of the Slochteren field discovery. Had alternative business models been given time to take firmer root, they would have pulled ahead to become industry formative, preventing the emergence of a competing business model such as Groningen – the latter would have adapted to the incumbent model. Yet, the Slochteren field was far larger than anything else in Europe and was discovered when intra-European gas markets were in their infancy[49]. The sheer size – both relative and absolute - of the field meant that the agents largely held both the cause and means to tailor market design to meet the requirements of Groningen commercialization; cross-border gas trade was nearly non-existent, so the developers had a *tabula rasa* by which to design marketing models.

One could also argue that nature had placed a supergiant gas field in the Netherlands, and that its discovery was therefore deterministically preordained. But the timing of the discovery, a contingent event, is key here (Figure 2). Early discovery of Slochteren was essential for the latitude the stakeholders enjoyed in developing a market model that they eventually agreed upon – The Groningen model. And arguably the location of the then-world's largest gas field at the heart of industrial Europe was a contingency from mankind's point of view, if not from nature's.

In what is a clear example of Mahonian "reactive sequence" (Mahoney, 2000), the second contingent event was causally a direct consequence of the first contingent event. The discovery of the Slochteren field had caused the debate over ways to commercialize the field, with an outcome that could not be foreseen, as the availability of the alternatives in the first stage is formulated by Sydow et al. (2009): "The search for alternatives starts from scratch, and decisions are unconstrained." Esso and Shell were disappointed with the discovery because the potential

44 In other disciplines this would include biological and linguistic speciation.

45 Unlike ubiquitous vehicle fuels and equally flexible coal, gas consumption is still limited in most countries by the absence of nearby gas resources: See the BP Statistic Review of World Energy for such "missing gas users."

46 A Dutch manager for Shell told an Esso manager at a dinner how the Dutch families used gas only for heating water (and not space) due to high cost, implying the premium status of gas - in a speech by an Exxon representative in 2013 at the 50-year jubilee of the Groningen field discovery (Exxon-Mobil, 2013).

47 In 1965, gas demand in the US still exceeded that of the EU by a factor of 11:1. By the early 2000s, the EU had nearly closed this gap (BP Statistical Review of World Energy, 2014).

48 For decades, town gas had been mostly manufactured from coal.

49 A managed long-term production volume of Groningen is about 40 BCM p.a., well under 10% of the current European demand, hardly a paradigm-shaping share. Yet, between only 1970 and 1975, the Dutch share of the then-EU gas production grew on the back of Groningen exports from slightly <50% to nearly 75% (BP, 2014).

market value of gas was not yet fully appreciated (Siegers, 2014). With all optimism directed towards nascent nuclear power, it was widely believed that gas had a limited role to play in wide-scale electricity generation[50]. The key stakeholders considered many options. "3 years after the discovery of the huge Slochteren gas field in 1959, de Pous, the Dutch Minister of Economic Affairs, (Nota de Pous; de Pous, 1962), established the main principles of the Dutch gas policy" – thus describes Gasunie, the Dutch incumbent gas company during the early history of Dutch gas (Siegers, 2014).

It took no <3 years for the stakeholders to come up with a solution in order to commercialize the gas. The main principle was the "market value principle" (Siegers, 2014), i.e. of all possible pricing approaches the oil-indexation would prevail. Another principle was to maximize the markets by selling not only domestically but also to foreign markets under long-term agreements, thereby establishing international gas trade in Europe under the Groningen concept. Alternatives discussed included continued sales on premium markets only, keeping most of it underground for the benefit of future generations (Siegers, 2014). Significantly, producers did not reach end-users directly but via national gas companies with whom they concluded Groningen agreements. Ambivalence towards to best manage national natural resources continued for decades, reflecting prevailing conceptions about the relative sufficiency of gas in the Netherlands. A period of gas conservation policy motivated by the 1970s oil crises again gave way to boosting exports when oil prices collapsed in 1984 - by this time the Groningen business model had been firmly established and the discussion was preoccupied with prolonging existing agreements rather than early termination (Gustafson, 1985).

5.2. Formation Phase: Self-reinforcing Process

At the time, few people comprehended the significance of the Groningen model as a paragon business model. The Dutch had chosen the Groningen model yet there was no conscious tendency to push the model as a universal marketing solution. The tailored Groningen model was considered a one-off measure for at the time there was only one Slochteren supergiant to commercialize – There were no other comparable developments with which to emulate the Groningen model. Smaller gas fields continued to be marketed under traditional models. However, the decision by the Dutch Minister for Economic Affairs on how to commercialize Groningen gas represented the contingent event allowing for a model to be used for other emerging large-scale developments. In 1964, British Gas[51] received the first cargo under a 15-year deal with the Algerian oil and gas producer Sonatrach[52], applying the Groningen concept to international LNG trade. GDF in France followed suit next year[53]. Long duration and full crude oil indexation (Gustafson, 1985) already displayed the key hallmarks of the Groningen model. Some years later, the USSR also adopted the model. The first set of agreements negotiated between Soyuzgazexport[54] and the main Continental European countries in the late 1960s, and subsequently in the early 1980s, were standard applications of the Groningen model[55]. They represented early generations of long-haul imports to Central Europe. They paved the way for the USSR to become the single largest gas exporter to Europe and thereby, to pursue more active path maintenance.

European gas demand had set off on a rapid growth trajectory by the time Soviet deliveries commenced. Increasing imports were called for to meet demand. The Energy Charter Secretariat (2007) summarized supply contract "generations" to Europe as follows: (1) The first Russian gas to Germany, Austria, France and Italy in the early 1970s; (2) Algerian LNG to France and later Belgium, Greece, Spain and also for Algerian pipeline exports to Italy, mostly since the 1970s[56]; (3) the Norwegian gas in the 1970s under the Ekofisk field and Statpipe; (4) additional Russian exports in the early 1980s; (5) the Norwegian Troll fields sales to Germany, the Netherlands, Belgium, France, Austria and Spain; (6) Algerian gas exports to Spain and Portugal via the Maghreb pipeline; (7) Nigerian LNG to Europe; (8) Norwegian exports via the GFU to SEP in the Netherlands, to VNG in East Germany and to the Czech Republic; (9) UK exports to the Continent; and (10) Libyan pipeline exports to Italy.

There was an obvious interplay between active market build-up and the increasingly long-haul Groningen agreements in regard to the supply to those markets – A process with unmistakably self-reinforcing properties. Increasing returns were driving these developments, particularly economies of scale. All major deals included massive investment and long pay-back periods, so therefore the Groningen model was followed. While Europe is, and was, relatively poor in gas resources, it is surrounded by neighbors that control the world's largest gas resources: Maghreb, the Middle East and Russia[57] - Combined hold about 70% of the world's gas proved reserves (BP, 2014)[58]. Likewise, for most of these producers, Europe constituted the nearest large market. The economic viability, however, required sufficient scale in order to cover massive investment costs. To achieve these economies of scale Groningen agreements were instrumental. Smaller fields

50 Siegers (2014). See also Pous on nuclear prospects (1959).

51 The then legal monopoly in Britain for all gas business. Since the 1990s the company has been unbundled. The gas grid is currently owned and operated by a natural monopoly National Grid, while gas exploration and production remains under the control of BG Group.

52 BP web site; energy.ca.gov.

53 GDF (2015) press release.

54 A specialized gas export company under the auspices of the foreign trade ministry of the USSR, merged after the dissolution of the USSR with the former gas ministry; current name Gazprom Export.

55 The latter round was momentous geopolitically as it pitted Western Europe against President Reagan's administration that had embargoed the exports of key equipment from the USA.

56 Although with some major distortions during the "gas battle" in the early 1980s when Algeria imposed FOB crude oil parity on its customers.

57 For long periods of time, the USSR/Russia operated the three largest gas-producing fields in the Eastern Hemisphere (Medvezhye, Urengoi and Yamburg).

58 "Proved reserves" is a definition that refers to gas resources that can be produced economically with today's technology and prices. It is distinct from (and a narrower metric than) "resources" that refer to all resources. As prices and technology change, past decision-making may well have taken place under different technical and economic circumstances. Since the early 2000s, when Russia and its European buyers were negotiating the latest rounds of contractual prolongations, Russia has lost its leadership in global proved gas reserves to Iran, while both Qatar and Turkmenistan have both added 10% points to their global shares.

"piggybacked" on these "anchor fields," thereby moving back on the merit curve, and, potentially, replacing more economical and nearer supplies. Such aggregating may well have chased off local competitive supplies, as well as competition from other fuels such as coal or even nuclear energy. At the Slochteren field itself the cost was a fraction of its market value by virtue of its size, location and the scale of production (ExxonMobil and Swiger, 2013).

Increasing returns were demonstrated elsewhere also. The banks that financed these transactions demonstrated learning and networking effects that had a self-reinforcing impact on the banking community's attitude to Groningen pricing. Such massive investments were normally implemented through syndicated loans. In effect, the entire banking community was steered toward adoption of one single business model and all banks in a syndicate had to conform. As late as 2013, buyers' unwillingness to continue with oil indexation was viewed as preventing gas infrastructure projects going ahead, implying the banking community was still conditioned by the Groningen model, at least with riskier ventures[59]. Finally, the sheer size of the Groningen contracts, when expiring, left buyers with a substantial supply gap that was easily filled with a new, at least equal, or preferably larger, Groningen agreement. In essence, it was a catch-22 situation: To have relied on nascent spot markets to replace Groningen contracts in large amounts was not feasible; and once the base-load demand was met by another long-term Groningen agreement, the incentive for a serious competing market model for gas supplies simply was not there. The Groningen paradigm was rapidly marginalizing alternative market models.

5.3. Lock-in Phase

The bulk of the 1980s "pipes for gas" generation agreements between Gazprom and its main European customers were approaching expiry by the early 2000s. Diversification had been on the agenda for years[60] and importers had already had an opportunity to reach out to alternative suppliers. The continental gas grid was connected to the gas grid of Britain, where deep and liquid traded markets had existed for a decade. Continental Europe held a small number of emerging physical trading hubs, so alternatives did exist both conceptually and actually, if only in an embryonic state. The incumbent buyers could have followed the widely shared advice of diversifying supplies by gradually decreasing the role of the Groningen agreements in their portfolios. Yet, the British model did not travel by pipe to the mainland. Instead, oil-indexed gas prices strongly drove British spot gas prices (as seen in Chapter 4.3).

The onset of a lock-in is often hard to foretell, and only becomes apparent afterwards. In a concerted campaign during 2005-6, Gazprom conducted a round of renegotiations with its European customers seeking to prolong contracts. They were successful and the existing contracts were extended, often with larger volumes, well into the 2020s and in several cases to the 2030s[61]. The contracted total would peak at ca. 180 BCM per annum (about one third of European demand) in 2013, and then stabilize at ca. 140 BCM per annum until 2027. The majority of German supplies were contracted until 2036, with one contract extending to 2043 (Konoplyanik, 2014).

Besides Groningen style agreements, additional elements were added to increase interdependence between the parties. A major new gas transmission pipeline, Nord Stream, was laid at the bottom of the Baltic Sea by a Gazprom-led consortium with several continental buyers as junior partners (www.nord-stream.com). Instead of diversifying geographically and contractually, the gas buyers willingly locked in their positions for decades ahead[62]. While analysts and other stakeholders assumed some growth in gas demand, the prolongation was mostly about replacing the existing but expiring contracts. The infrastructure in question had been financed decades ago - therefore the debt service argument no longer held. Whatever capital expenditure there was, such as the Nordstream sub-sea pipeline, the outlay was quite modest compared to related cash flows. The cost of Nordstream, at 7.4 bn euros, was less than the value of gas it could transmit during 1 single year (www.nord-stream.com). Whatever the ultimate profitability of the export policies which followed during the decades of cheap gas - when the Russian export system was being amortized[63] - securing cash flows was no longer a compelling issue. The importers fell back on the Groningen model as if no viable alternatives remained – or could be considered feasible. Instead of gradually decreasing their dependence on the Groningen agreements, the buyers willingly chose to increase their dependence.

What makes this even more remarkable is the enormous value of the commitments. EON-Ruhrgas alone committed to buy 400 BCM of gas until 2036. With gas prices prevailing at the time of the signing of the contracts (about 250 USD/1000 cubic meters), the value of the deal was 100 billion USD. The total contractual basis of all Gazprom contracts prolonged in around 2006 would equal to several hundred billion USD. Subsequent price developments have increased these figures. Equally remarkable is the fact that EON did not follow this investment with anything approaching similar levels downstream – the gas was not needed to supply, on a long-term basis, any particular new, non-amortized end-user asset. The move really was mostly to prolong the existing wholesale business on the procurement side, with scant regard to the selling side. All the while, the legislator was already far advanced in forcing EON and other incumbents in Germany and elsewhere to open up their markets. Decreasing, rather than expanding, the procurement portfolio would have been risk averse. All in all, the

59 FT (2013).

60 See e.g. Hirschhausen and Neumann (2003), FT (2014), Stern (e.g. 2009, 2013), Noel (2013) and the EU Commission (2015).

61 Konoplyanik (2014) graph for Gazprom's contractual base: Gazprom and European gas company web sites.

62 Technically, the largest single agreement, that with EON Ruhrgas, was prolonged by "only" 15 years. In reality, it was a prolongation of an agreement that was to expire in 2020, so a prolongation that was signed in 2006 and extended to 2035 was effectively a 29-year prolongation.

63 The CIA (a partly declassified document), while acknowledging the methodological and data challenges in estimating profits, does arrive at a conclusion of questionable profit for investment in relation to the 1984 Soviet export agreements. If the project was of questionable economic value during the high oil and gas prices prevailing at the time, then, certainly, economics deteriorated further after the collapse in hydrocarbon prices, a state that lasted for two decades after the commissioning of the system.

prolonging of these long-term commitments manifested a lock-in of the Groningen business model.

5.4. Exit Phase: Breaking the Lock-in?

The Great Recession was global but impacted Europe harder than most. Several countries have repeatedly fallen into recession[64] .As of the time of writing (early 2015), neither electricity nor gas demand has recovered to pre-crisis levels in Europe[65]. During 2009, the deepest year of recession, gas demand plunged by about one tenth in Europe. With their rigidly fixed annual contract quantities, Groningen contracts were not flexible enough to accommodate this fall. Many companies could not off-take gas at the contracted levels[66]. Others took the minimum levels just to resell them on the emergent continental gas trading hubs at substantially lower prices than what they originally paid for them. Therefore, plummeting final demand was not matched by falling supplies, as economic theory would have it, as this was not ingrained within the structure of Groningen agreements and the specific purpose of them, which was to fix volumes irrevocably. Europe went structurally long on gas due to that very Groningen mechanism. The US shale gas revolution kept on redirecting spot LNG cargoes to Europe, adding cheap supply to markets that were already oversupplied.

A "hybrid price" system emerged where Groningen must-run volumes were priced, bought and paid at expensive oil indexation rates, while spot hubs traded at ever-cheaper prices, fuelled by leftover Groningen gas. Perhaps the most problematic element of the hybrid system was the fact that cheaper prices did not decrease supply volumes, which is the central mechanism of correcting prices towards equilibrium in a normally functioning market. At worst, spot prices were barely 50% of the contractual, oil-indexed prices; an identical commodity was sold in one country for two vastly different prices, depending on the business paradigm used. While spot prices recovered gradually from 2009 lows they never caught up with contractual prices, except for some seasonal spikes. Buyers then initiated rounds of renegotiations with Gazprom and other Groningen suppliers. While some discounts were received[67], the hybrid pricing state endures, and utilities have been forced to accept massive gas-asset write-downs. The widely publicized "spot element" appears to have been for extra volumes above the take-or-pay volumes, not for the base load[68].

The Groningen paradigm remains central in all European gas imports, be they from Russia, Algeria or contracted LNG suppliers. Quite clearly, an extremely turbulent market environment was not able to alter the Groningen agreements in substance – at least not at the time of writing. Discounts for the base price of gas were in most arbitration cases achieved, but they neither eliminated the anomalistic hybrid pricing system, nor re-established the competitiveness of gas in European markets. This is in accordance with the findings shown in Chapter 4.3, i.e. that Groningen gas prices have in most part consistently followed oil indexation with little regard to either competitiveness or cost of gas. As predicted by path dependence theory, total inflexibility leading to strategic inefficiency in the lock-in phase is thus well demonstrated.

European Groningen contract gas buyers not only suffered directly - by buying fixed volume oil-indexed gas, the value of which at worst constituted barely 50% of the buying price - they also fell victim to falling asset valuations, caused partly by the Groningen agreements and partly by confounding factors (these will be briefly discussed in the concluding chapter). Assets, many of them gas-related, were written down by European utilities. Six leading European utilities[69] made impairment charges of 40 bn euros in 2012 and 2013 alone[70]. In 2010 and 2011, a set of leading utilities wrote down 17.7 bn euros[71], so a sub-set of Europe's largest utilities that excludes all other utilities wrote down no <60 bn euros during a 4-year period. The assets written down included gas storages and other gas related infrastructure; gas-fired power plants; and goodwill on purchase agreements, including Groningen agreements. EON, for instance, specifically describes the significance of the gas purchase agreements as a long-term financial risk[72].

While mediated by some concessions, in most cases the Groningen agreements formally extend for decades ahead. At the time of writing, there is little to suggest that they would somehow radically transform themselves into something paradigmatically new, either through Schumpeterian creative destruction, or a more managed transition towards a new state. Despite considerable debate, spot pricing appears, as yet, not to have made significant inroads into base-load imports of gas to Continental Europe.

6. CONCLUSIONS AND FURTHER RESEARCH

This article has argued that the Groningen-style gas agreements utilized in European gas imports have persisted relatively unchanged since their inception in the early 1960s and grown increasingly inflexible and strategically inefficient - while also marginalizing alternative marketing paradigms by displacing them on a long-term basis. This article has expanded the widely applied concept of PD and applied it to the unchartered domain of business models to discover that the processes that led to the ossification of the Groningen models do indeed demonstrate

64 According to the IMF October 2014 database, the Euro area had by 2015 still not reached the gross domestic product level of 2007, while the entire EU managed growth of 1.4% over the whole 7-year period.

65 Statistics show that electricity in 2014 in Europe was at 2005 levels (Eurelectric, 2015); parallels in gas are similar, although exceptionally warm weather decreased demand further (Eurogas, 2015).

66 E.g. ENI, press release (2014).

67 While contract gas prices and price dispute settlements are confidential, the common view is that e.g. Gazprom extended an approximately 10% discount to its West European contract buyers. Importantly, EON also went on record regarding adhering to the Groningen model in future: "The basic structure of the long-term contract hasn't changed," said Christian Drepper, an EON spokesman. "Elements with an oil linkage are still in the contract but with a significantly reduced risk." (Bloomberg, 2012).

68 E.g. Reuters (2012).

69 GDF-Suez - 17.3 bn; RWE - 7.7 bn; Enel - 5.1 bn; Vattenfall - 4.3 bn, EON - 4.1 bn; and EDF - 1.8 bn (respective annual reports).

70 Calculated by the author from the financial statements 2011 to 2014 of the named companies.

71 Ernst and Young in a study of 16 major European utilities (2014).

72 EON annual report (2013): "Competition in the gas market and increasing trading volumes at virtual trading points and gas exchanges could result in considerable volume risks for natural gas purchased under long-term take-or-pay contracts."

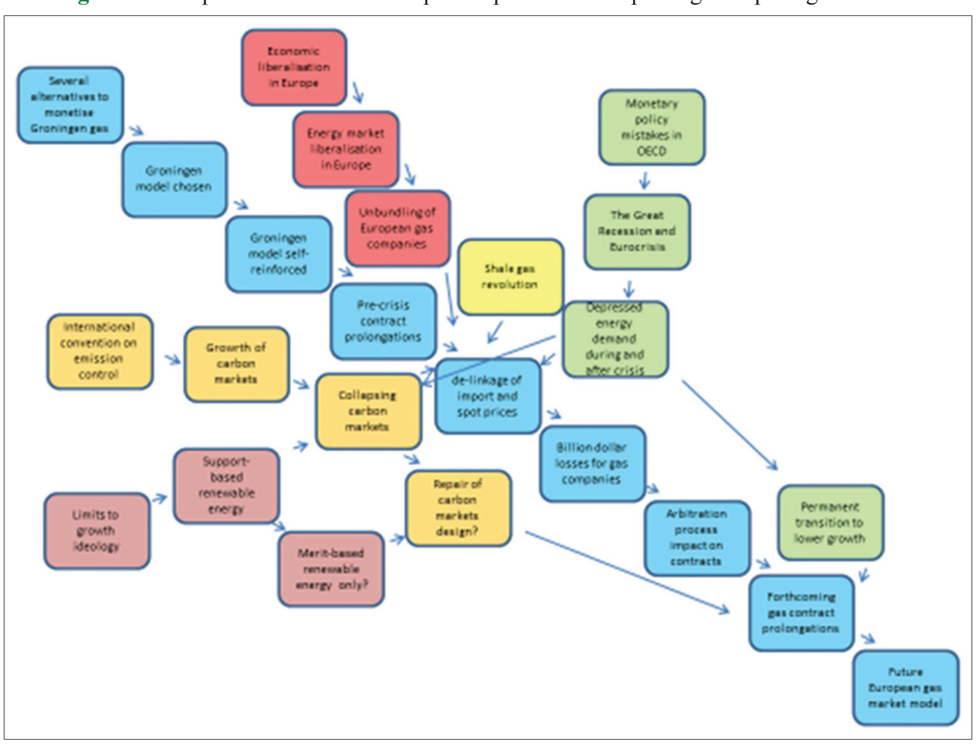
all the constituent phases of PD. The early discovery of the Slochteren gas field was a non-predictable, contingent event, as well as the decision by the Dutch government to market the gas internationally at market value. Alternative models existed. The Groningen model, propelled by a self-reinforcing process driven by economies of scale, as well as learning and network effects, gradually marginalized those alternatives. Smooth transitions to modern traded markets elsewhere, expectations of similar developments in Continental Europe, as well as legislation, failed to encourage such a transition. In retrospect, prolongation of the Russian agreements to the 2020s and 2030s demonstrates a lock-in of the Groningen model in Continental Europe. Unprecedented turbulence and the changing business environment since have not impacted the agreements. Contingent events, self-reinforcing process and lock-in are all found to manifest themselves in the industrial case history of European gas imports. As is the case with many complex phenomena, PD alone may not be a sufficient explanation for the persistence of the Groningen agreement, but it appears to have played an important role.

Further research on the topic is warranted. In retrospect, prolonging the Groningen agreements with Gazprom (on a massive scale during 2005-2006) – with the convincing demonstration of locked-in behavior – appears to have contributed drastically to the financial losses of European gas companies. It also appears that the prolonging of these agreements was made despite the vocal opposition of the EU Commission, consultants and other experts. A wider stakeholder analysis would enlarge the scope of agents and better help to understand the often conflicting interests of different stakeholders. The perspectives could be widened by e.g. including Turkey in the analysis – while not being part of Continental Europe, her potential gateway status has interesting implications for the Groningen model in both geographic regions.

Another line of research would be to take a step towards understanding the deeper complexities of this behavior. As noted, a number of contingent events and independent path dependent-like processes have recently impacted European gas markets[73]. These include: (1) The ongoing Great Recession, now in its 7th year, which has severely weakened gas demand in Europe; (2) the US shale gas revolution that effectively blocked the assumed LNG imports to that country, diverting cargoes mostly to Europe and thereby worsening the oversupply there; (3) the unexpectedly fast build-up of subsidized renewable energies in Europe that negatively impacted some of the most valuable gas market segments; (4) unbundling of gas companies and other measures by the EU Commission, which impacted gas companies' ability to manage their business, and (5) failing carbon markets, compromised by most of the above drivers,

73 Bouoiyour et al., (2014) conducted a meta-analysis of 43 studies made between 1996 and 2013, and found out that "although many factors have been identified to explain the nexus between electricity consumption and economic growth, the empirical evidence is rather mixed." Given that electricity is a final and regional product whereas natural gas may also be an intermediate product competing against alternative energy sources or traded cross-regionally, understanding the nexus between gas markets and economic growth is even more challenging. Likewise, Obadi and Korček (2015) concluded that, contrary to common perception, energy demand in the EU since the crisis was more impacted by efficiency gains than by fall in economic activity as such. Finally, Sohag et al. (2015) find that "environmental Kuznets Curve is a general phenomenon across the world" except for developed countries, once again contributing to confounding the dynamics of European gas markets.

Figure 6: Complexities of events and path dependencies impacting European gas markets



Source: Author's interpretation

and the unwillingness of the rest of the world to adopt climate-mitigation efforts comparable in seriousness to the European carbon markets - through a complex process that potentially mixes more than one PD with Mahonian reactive sequences (Mahoney, 2000). The timing, causalities and complex interactions of all these drivers create a decision-making environment where managing the future is challenging, and developments may spiral out of control. Figure 6 offers a visual representation of the phenomena listed above and the related events, paths and interactions. Assessing Groningen agreement persistence via such a multidimensional lattice could yield interesting insights into industrial inertia in a complex and rapidly changing business environment, and the conflicting drivers may finally provide a break-up of the lock-in of Groningen agreements for European gas imports.

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