Institute of Economic Research and Policy

Chair of Economics of Innovation and Structural Change

Trading Sovereignty for Profit? A Critical Assessment of Corporate Ownership Structures in the German Energy Sector.

A thesis submitted for the degree of

Master of Science

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Program: M. Sc. Business Science and Economics

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Abstract

Complex ownership structures implying secrecy jurisdiction services have become an increasingly relevant topic for research and policy. Predominantly driven by the current Corona recession, questions arise again on how to treat international tax and regulation avoidance on a supernational policy level. This thesis will build on contemporary research advances in data science, network analysis, ownership chains, and secrecy jurisdictions to provide a new contribution to the literature by the example of the German energy sector. In praise of welfare generating forces of free markets, the German energy sector has been continuously liberalized since 1996. I will utilize the sequential character of that transition to add a dynamic research aspect to the economic science fields mentioned above. Applying a novel method of ownership network reconstruction, I will use Orbis data to show how complex ownership structures with secrecy jurisdictions have developed over time in the formerly arguably closed German energy market. My results show that these developments compromise Germany's energy safety, social justice, and national sovereignty to a critical point. Accordingly, a change of policy is of urgent need.

JEL: Keywords:
F12 Models of Trade with Imperfect Competition
G32 Financial Risk and Ownership Structures
H87 International Fiscal Issues
Q43 Energy and the Macroeconomy

Table of Contents

Tables and Figures

Introduction

Motivation

In the last century, complex international ownership structures have become an inevitable tool for large firms to stay competitive in globally accessible markets (Grosskurth 2019b; Garcia-Bernardo et al. 2017; Martin et al. 2020; Reurink and Garcia-Bernardo 2020). They offer benefits like low transaction costs, efficient tax and regulation design, risk diversification, and the combination of multiple countries' location-specific advantages at once (Dunning and Lundan 2008). These competitive advantages often make it nearly impossible for local competitors to keep up with large multinational enterprises' (MNEs') pricing options and quality standards (Backer and Sleuwaegen 2003). Consequently, international companies have become experts in increasingly sophisticated ownership structures, pushing their cost-efficiency to the possible limit (Vitali et al. 2011).

On the consumer side, the effects of international firm structures are a lot more ambiguous. The availability of affordable, high-quality products from highly efficient international firms undoubtedly is a consumer benefit. Moreover, MNEs can "breath new life" into rigid, national markets. Entering as new competitors, they can refresh the allocation efficiency of national markets or introduce technological and organizational innovation (Caves 1974). However, some other objectives of large multinational enterprises using complex ownership models are not necessarily advantageous for everyone. Examples being oligopolistic or predatory pricing policies, corporate tax avoidance, or opaque finance and asset structures (Finér and Ylönen 2017; Clausing 2003; Alabrese and Casella 2020).

Besides, a broader conflict may arise between MNEs' and host nations' interests (Rugman and Kobrin 2009). MNEs' superordinate goals tend to be market power and profit maximization. National governments are responsible for equality, human rights, and social justice among their citizens (Dunning 1991). Conflicts of interest of these kinds can be moderated by appropriate governmental moderation, allowing MNE's to grow and progress as market competitors while setting boundaries for predatory or unethical behavior. Eventually, this is not always an easy task as MNE's often have strong bargaining positions coming with their size, financial strength, innovative potential, and role as employers (Elkins et al. 2006; Fagre and Wells 1982).

When MNEs occupy central positions in essential industries like food, telecommunications, or energy supply, these conflicts become even more delicate. As we know from contemporary research, private ownership concentration has already reached crucial supply sectors in some cases, concentrating corporate ownership in a few groups of internationally investing countries

(Li et al. 2017). We also know that MNEs' ownership structures can be very opaque and hard to comprehend for regulative bodies (Palan and Nesvetailova 2013; Murphy 2009). To supervise and ensure essential supply is part of a nation's sovereignty. This sovereignty can crumble when international ownership becomes complex and opaque in sectors designated to cover basic needs, impeding regulatory oversight by governmental agencies.

Politicians commonly fear that autocratic foreign nations could take charge of essential industry parts for strategic reasons (Simantke 2019), impeding national sovereignty. Indeed, it is questionable how independent a nation can be in times of foreign political unrest if another country ultimately owns a large share of its supply system. However, the authority to ensure and administrate essential supplies on a national level is not solely threatened by the political interests of foreign nations but also by the profit-seeking ambitions of MNEs.

MNEs ownership structures may indirectly threaten national sovereignty by causing financial instability in the essential supply sector. We are still scarred by the events of 2006 when the world witnessed how a bursting housing bubble in the USA sparked a chain reaction of credit defaults leading to a global financial crisis and what we call "the Great Recession" today. International ownership structures usually come hand in hand with highly entangled international financing schemes. International financing, especially if so-called secrecy jurisdictions are involved, can lead to dangerous "off-the-books" liabilities circumventing regulatory boundaries and increasing financial fragility, which becomes particularly threatening in the case of an economic slump (Loomer and Maffini 2009; van Fossen 2003; Lysandrou and Nesvetailova 2015; Bengtsson 2013).

Right now, the events of 2006-2008 are rightly reminding us of the dangers inadequate financial oversight can cause on a global level. The present fear of a recession is unambiguous when looking at the massive difference in scale between fiscal rescue packages in 2008 and 2020 (Cassim et al. 2020). In this light, I want to emphasize the following: International ownership chains frequently involve speculative actors like venture funds, trusts, or similar non-banking financial institutions (NBFIs) (Reurink and Garcia-Bernardo 2020; Murphy 2009). These types of entities are usually heavily enmeshed and reliant on the stability of the international monetary system (McCulley 2009). Moreover, not seldom by using secrecy jurisdiction services, their financial accounting can be very opaque or even outside the range of any regulative body (Shaxson 2011).

Consequently, NBFIs tend to induce financial secrecy, and therefore potential instability to any sector they target as investors. And, as mentioned, this secrecy becomes particularly dangerous in times of economic downscaling. Global foreign direct investment (FDI) volume has risen

sharply and continuously throughout the last centuries (figure 1), and international assets concurrently concentrate in microscopic states specialized in financial services (figure 2).To ask how safe even national basic supply systems will eventually be in the prospect of global economic instability appears to be an unpleasant but urgent question.

Besides increasing essential sectors' exposure to political and economic stability issues, internationally internalized business operations (ergo: ownership chains) impede national sovereignty from at least one more direction: Fiscal authority. The exclusive right to collect and reallocate tax is the financial foundation of every nation's public household. It enables their political representatives to offer public goods and services to inhabitants and reallocate wealth when it seems in favor of social fairness. Complex ownership chains are a standard instrument to avoid not only regulations but also taxes. For essential supply sectors, this looks particularly delicate as these sectors regularly receive subsidies of state money.

Currently, there is solid research about ownership chains (Grosskurth 2019b; Mihir A. Desai et al. 2003) and ownership participation in essential supply sectors (Li et al. 2017). The problem of tax avoidance and financial instability is well researched, too (Tørsløv et al. 2020; Huizinga and Laeven 2008; van Fossen 2003; Bengtsson 2013). Furthermore, there is a vivid and ongoing discussion about the impact of MNEs on national sovereignty (Rugman and Kobrin 2009; Vernon 1971; Elkins et al. 2006). However, the literature lacks a comprehensive assessment of the development, causes, and socioeconomic implications of complex international ownership chains and secrecy jurisdiction involvement in essential supply sectors. Furthermore, there is a literature gap regarding evaluating a government's ability to moderate these implications for the public good. More precisely: To prevent the public from the discussed risk factors concerning justice, security, and sovereignty. This thesis aims to fill that gap using the German energy sector as an illustrative example.

Subject

The German energy sector is an interesting case study for showing and discussing the complications discussed above, coming with MNEs' involvement and complex ownership chains in the essential supply system of a national economy. Germany has (in part to comply with European Union directives) progressively liberalized and privatized its energy sector since 1996 (Brandt 2006). This liberalization has allowed new international competitors to access the German energy infrastructure, formerly occupied by a relatively static system of territorial monopolies (Lohmann 2006; Dickhaus and Dietz 2004). This trend gathered even more pace due to the "Energiewende," Germanys' transition to green energy. Renewable energy assets

offer investment options of a way lower volume than traditional energy investments. A wind farm, a single wind turbine, or even small amounts of solar cells on the top of one's residential building imply considerably less “sunk costs” than coal or nuclear power plant (Hall et al. 2016).

Of course, the liberalization of the German energy sector came with benefits like weaker market entry barriers and (temporarily) lower end-consumer prices. It also made the energy market more dynamic by cracking oligopolistic structures. Structural changes like the Energiewende, which brings many positive externalities, are likely to profit from active markets with weaker barriers and lower concentrations of market power (Schumpeter 2017). On the other hand, the German energy market has gotten far more complex and, in many spots, less transparent since 1996. This lack of transparency comes with all the previously discussed issues. Because the sector's liberalization happened stepwise, I can examine impacts on social justice, energy safety, and national sovereignty through a solid referential timeline.

Eventually, the purpose of this thesis is to thoroughly **unveil, describe and discuss the development and scale of today’s ownership structures in the German energy sector and estimate their impact on Germany as a national economy with a particular focus on social justice, energy security, and national sovereignty.** I will then use these results to elaborate a sound **policy recommendation to reap the benefits and restrict the costs of foreign investment in the German energy sector**.

Research Questions

I will elaborate on this subject with the guidance of four overarching research questions.

1. **How have the current ownership structures in the German energy sector developed over time, particularly concerning secrecy jurisdictions?**

As already mentioned, ownership chains tend to develop “hubs,” meaning that some countries take particular roles and therefore occur more often in the ownership chains of specific industries. Researchers have found this kind of ownership aggregations or fragmentations concerning MNEs in Europe (Grosskurth 2019b; Reurink and Garcia-Bernardo 2020) and the energy sector overall (Li et al. 2017). I will examine the development and current relevance of these hubs in the German energy sector. Furthermore, I will show how Germany’s position within the ownership chains of its energy sector has changed over time and discuss the possible consequences of that shift.

2. **What factors or events could have driven or hindered the building of international ownership structures?**

Even though the scale of this thesis does unfortunately not allow for comprehensive economic regression analysis, I will at least point out periods of rapid change to allow for further research to find a starting point. Some political decisions made since (and including) the initial liberalization of the German energy sector in 1996 should have significantly impacted the overall market environment and its participants. A detailed analysis considering economic and political factors like growth differentials, tax differentials, political decisions about information exchange (Hanlon et al. 2015), or even data leaks (O'Donovan et al. 2019) would be required to pinpoint which decisions mattered the most. As said, an analysis of that depth does not fit into the space of this thesis, which is majorly descriptive. Still, I hope to at least show how fundamentally the German energy market has changed during and after times of political intervention, indicate the present relevance of these changes, and therefore, in the best case, motivate for further research.

3. **How do international ownership chains impact energy safety, social justice, and national sovereignty, and what consequences does this impact imply for German citizens, employees, market competitors?**

Like mentioned, some forms of ownership chains and their functions for MNEs can be controversial to the public interest. Question one and two will give us information about the shape of the ownership network behind the German energy sector and indicate which influence factors could have influenced its building process. To answer question three, I will use this information to estimate to which degree MNEs use ownership structures for purposes that contradict one of the three factors:

Financial instability: As said, secrecy jurisdictions can be and are frequently used as an instrument to avoid regulations and thereby cause financial instability. (Loomer and Maffini 2009; van Fossen 2003). How significant is the involvement of secrecy jurisdictions in the German energy sector? How ample is the unregulated space behind the financing of investment in the German energy sector? Can the lack of transparency and regulation induced by the involvement of secrecy jurisdictions be a thread to the systemic financial stability of the German energy sector and, therefore, ultimately endanger energy security (the uninterrupted availability of energy sources at an affordable price)?

Tax avoidance and social justice: To what extend is the German energy sector exposed to the problem of tax avoidance? Do German consumers and employees benefit from large Energy

corporates' tax savings and overall cost efficiency by receiving higher loans or cheaper energy supply? Is this an extreme case of tax injustice because of the subsidies the energy sector (particularly in renewable energy) receives?

National sovereignty: "The hierarchical or Fordist structure of the traditional MNE reinforces the core values of the modern international political system: state sovereignty and mutually exclusive territoriality" (Rugman and Kobrin 2009). How do hierarchical MNE structures influence the energy sector? Are state sovereignty and mutually exclusive territoriality endangered by the ownership structure of the energy supply sector as it is?

4. **Which political measures are available to foster the positive effects and diminish the harmful effects of international investment and an internationally open energy market?**

Question three will provide a new view on the costs and consequences of different stakeholder parties due to economic and political developments in the German energy sector within the last 25 to 30 years. Going by these insights, I will deduce recommendations regarding political directions for the future to the best of my ability.

That politicians take transparency and safety concerns seriously is currently shown by the ongoing dispute about Chinese investments in German infrastructure or the German-Russian Nord-Stream 2 project over the last years (Simantke 2019; Meiritz 2021). Politicians of different countries fear those investments might compromise energy security. Moreover, the fiscal restrains national economies around the globe are currently suffering due to the corona crisis have tracked new attention towards a fairer international tax distribution (OECD 2020).

Still, German politicians have taken ambiguous political positions regarding its energy sector throughout the last decade. This indecisiveness indicates difficulties to please the interests of large multinational firms, maintain fiscal functionality, keep up with political targets, preserve market efficiency, and staying fair and generous towards the public altogether. Big political decisions have been fundamentally changed or entirely revoked after short periods causing significant shifts in the market (appendix I table 5). In renewable policy, for example, there has been a lot of back and forth regarding market regulations and public subsidization to keep consumer energy prices stable while still allowing small competitors or self-producers to survive economically.

Moreover, Germany is a country that offers a lot of location-specific advantages (e.g., good infrastructure, asset protection, reliable legal institutions, and skilled labor) to MNEs. On the other hand, it collects relatively high corporate tax and demands a certain base level of financial

regulation. The co-occurrence of these characteristics can motivate MNEs to use opportunistic tax options and misalign profits by including secrecy jurisdictions in their ownership chains (Garcia-Bernardo et al. 2021). This *modus operandi* of some MNEs adds another layer of political complexity to the challenge of stakeholder moderation. Such fiscal exploits are only possible because of jurisdictional asymmetries between countries (Huesecken and Overesch 2015), and some countries profit from this status quo (Tørsløv et al. 2020). Consequently, the German government gets challenged to represent national interests where diplomatic instruments are often the only way to influence. With my recommendations, I aim to assist in this problematic area of political decision-making.

Method and Structure

Considering the aims of my research, the methodological starting point of this thesis will be a comprehensive and dynamic network analysis (including historical reconstructions) of the German energy sector up to its early beginnings, but with a particular focus on the last 30 years[1]. Network analysis, which originates in social science, has become increasingly popular in economics over the previous decades (Garcia-Bernardo et al. 2017; Grosskurth 2019b; Vitali et al. 2011), including some significant attempts to recreate historical networks by the use of sophisticated data management (Grosskurth 2019a; Jaraitė et al. 2014). By displaying individual entities (in our case countries) as nodes and their relations (in our case foreign ownership links) as edges, one can get information about an entities' position and role in a complex network. Researchers use the strength and direction of these links to apply measures of centrality, identifying nodes as hubs or gateways. This approach suites very well to answer research questions one and two.

Bureau van Dijk's Orbis, known as one of the most reliable and sophisticated providers of historical ownership data, serves as the primary source of ownership data. Unfortunately, high-quality ownership information is not easy to come by, especially regarding periods lying further in the past. In this thesis, I will therefore introduce a novel merging algorithm using today's snapshot of Orbis company data on the one hand and another database of Bureau van Dijk listing merger and acquisition events. Even though some gaps will always remain in historical datasets due to lower data quality and digitalization in the past global economy, I will show how to reduce these gaps to a practicable minimum by using efficient and sophisticated data management tools.

[1] This is the time range which I see as both most relevant to nowadays conditions and most interesting in terms of its economic dynamics, as I will later illustrate in more detail.

Based on this network analysis, I will provide a detailed description of selected indicators regarding sovereignty, stability (often close or equal to secrecy in my case). Furthermore, I will show how these quantities[2] differ between domestic energy companies and companies owned by foreign investors of different jurisdictions, including groups of jurisdictions known as *secrecy jurisdictions.* As said, most of this part will be descriptive. Nevertheless, some statistical tests (t-tests) will be applied to check the statistical significance of notable differences between firms dependent on their owner. Moreover, I will use a logarithmic regression model close to the Cobb-Douglas production function to estimate the difference between firms' reported profits and potential profits as determined by the sector-typical factor profitability of work and capital. Complementing Orbis data, I will use several other data sources. Namely data from the UCDAT, Eurostat, the German "Bundesnetzagentur" (BNA), and the Federal Statistical Office (Statistisches Bundesamt) for illustrative purposes in the introductory and discussion chapters, as well as to check for robustness regarding some models using Orbis data.

The chapters of this thesis will be structured as follows. Chapter two will dive deeper into literature about FDI and ownership structures, their uses and exploitation possibilities for MNEs, the resulting risks and opportunities for national economies, and the role of involved secrecy jurisdictions. The chapter will also introduce the reader to the characteristics of poorly regulated NBFIs and explain why they occur particularly often in secrecy jurisdictions. Furthermore, I will describe the history and unique features of the German energy sector, providing the reader with a comprehensive picture of this unique economic environment as a reference framework to interpret and embed the results of the following chapter's models. I will explain how stepwise political decisions liberalized and privatized the sector and how the Energiewende furtherly fueled this trend. In chapter three, I conduct my research hypotheses. Chapter four describes data selection and refinement in more detail and presents the methodology of all research methods/models used in this thesis. In this chapter, I will also describe how my merging algorithm to reconstruct historical ownership chains works. Chapter five contains the results of the models of chapter four and preliminary points out some observations I value as particularly relevant. Chapter six picks up these findings and includes an in-depth discussion of their relevance and implications regarding energy safety, social justice, and sovereignty. The chapter also elaborates on possible political countermeasures regarding some unfavorable indications of chapter five. Chapter seven concludes this thesis and

[2] tax burden/rates or share of poorly regulated business forms just to name some feasible examples. A detailed description and the justification of their selection as being relevant for the present topic will follow in the respective chapter of the main part.

discusses its contribution to science. Moreover, I will point out the limitations of my results and give an opinion about what I see as promising subjects or starting points for further research.

Literature Review

Ownership Structures

"The motive of business is pecuniary gain, the method is essentially purchase and sale. The aim and usual outcome is an accumulation of wealth." – Thorstein Veblen, 1904[3]

The assumption that businesses in general aim to maximize their profits and individuals aim to maximize their utility is a central premise in neoclassical economics (Weintraub 2002). Even though we nowadays know that neoclassical theory at its very beginnings suffered a lot of shortcomings, this fundamental hypothesis has transitioned over to what we call "mainstream economics" today, which builds the principal basis for academic teaching in both business science and economics (Mankiw 2014; Dunning and Lundan 2008). There is a meaningful critique that profit does not always mean an increase in personal, monetary wealth but can also occur in the form of a psychological reward of entrepreneurial success (Scitovszky 1943). Still, a firm operating in a competitive market must compete for and consequently maximize (or at least optimize) its monetary profits to preserve itself from extinction. This necessity remains despite the potential presence of other, non-profitable goals (Jensen and Meckling 1976). In this thesis, I will therefore assume that the German energy sector is a competitive market. Thus, profit maximization is a central (direct or indirect) goal of the firms competing in it, and ownership structures are accordingly an instrument to reach that goal.

Unlike these expositions, which might appear self-evident to many and which I mention primarily for the sake of argumentative integrity and, the question of *how* MNEs use ownership structures to maximize profits requires a more thorough examination. It was until the 1970s that business research and economic science provided a general theory to explain FDI, the behavior of MNEs to acquire, accumulate, and, most importantly, *control* value-generating capital beyond their home country borders (Buckley 2011). Following neoclassical logic, international *trade* was formerly explained mainly by factor-cost models stating that various countries produce their commodities at different labor and capital costs. Because businesses of these countries offer similar or substitutable goods and compete with one another on an international market, companies with access to price-efficient production factors outperform their competitors as soon as their cost savings extend accruing transaction costs. In the long run, this

[3] Veblen 1904, first page of chapter two

systematic inevitably results in a spatial specialization of each trading nation depending on which goods it can produce at the most favorable factor costs (Samuelson 1948). Some authors, even in those early stages of international trade theory, did consider not only commodity, but also capital movement between nations. (Ohlin 1935), who was a general proponent of the factor-cost theory, explained the relocation of business capital from one country to another mainly by differences in interest rates. These differences, so Ohlin, motivate multinational corporates (and banks) to transfer money (or even borrow it) from countries with low interest rates to those with high interest rates to maximize the rate of return. [4]

By all means, these theories incorporate a solid and plausible logic, and their basic concepts still underpin influential ideas of international and interregional trade (Krugman 1991). However, factor and transaction costs (or transaction costs in the broader sense) or differences in interest rates alone cannot explain why businesses would undergo the managerial risk of acquiring a majority stake in off-border capital. It appears more reasonable to trade with foreign companies or invest in a minority share under the prospect of monetary returns. The sheer occurrence of FDI was an empirical phenomenon contradicting basic neoclassical principles. Therefore, most past established scholars categorically ignored the growing number of FDI events in their theories about international business. (Williams 1929).

The critical turnaround of early FDI theory was the assumption of imperfect markets, primarily driven by the contributions of Stephen Hymer. As it is widely accepted today, Hymer assumed that most market environments are far from perfect. On the contrary, oligopolistic structures, entry barriers, and applications of market power[5] by large competitors distort the allocation mechanism of the market as neoclassical theorists understood it. To adapt to or even exploit these market imperfections, international corporations aim to build market power themselves to reap the maximum possible benefit from business operations abroad (Hymer 1976).

As FDI skyrocketed since the 1980s (figure 1), explanatory literature became more copious and precise. Today's scholarly consensus assesses the motivations behind FDI as diverse but systematic. Dunning's eclectic paradigm (Dunning 2000) is arguably one of the most widely accepted, though not undisputed, theories of FDI in current times. Dunning refers to the assumptions of Hymer and converges them with other notable ideas to explain FDI. He

[4] In fact, Ohlin even mentioned single cases of companies holding controlling shares in foreign branches to ensure constant supply of foreign raw materials (Ohlin 1935 Those considerations can be interpreted one of the first recognitions of internalization motives. The author, however, did not systematically define foreign direct investment (controlling shares) from portfolio investment (minority, yield driven share), neither did he attempt to generalize a theory of foreign direct investment.

[5] In this case competitive market power such as predatory pricing, control over recourse channels or bargaining power towards governments or industry partners resulting in favorable or privileging regulations.

concludes and augments a large number of heterogeneous theories that were previously not necessarily seen as connected (Vernon 1966; Lessard 1976; Johanson and Vahlne 1977; Penrose 1956; Aliber 1970) to what he calls an "envelope for economic and business theories of MNE activity" (Dunning 1977, 2000).

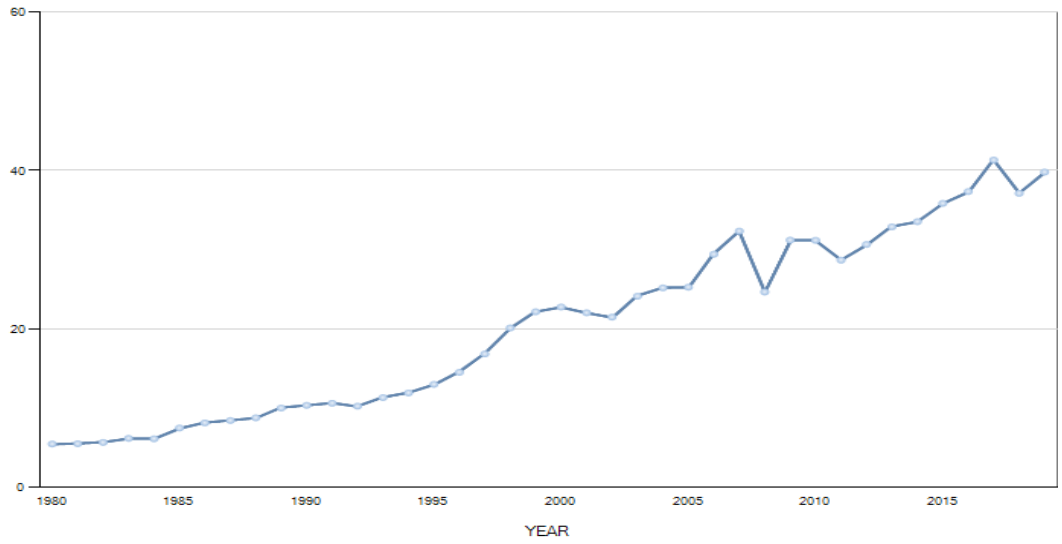

Figure 1: World outward FDI stock as a percentage of GDP from 1980 to 2020. Source: UNCTAD

According to Dunning, composition and priority FDI incentives differ case-specific but can be categorized in[6]:

Ownership-specific advantages are advantages of subsidiaries owned by larger enterprises and MNEs' benefits holding diverse international assets. These advantages include property rights, intangible assets (know-how, intellectual property, etc.), organizational advantages (efficiency gains caused by joint corporate governance, knowledge transfer, minimization of intra-firm transaction costs, risk reduction through diversification), and institutional assets (incentive systems, corporate culture).

Location-specific advantages are accessible by firms or their subsidiaries through the environmental conditions of geographic locations. These include access to factor and recourse markets, infrastructure (also education), knowledge spillovers, and jurisdictional benefits (investor protection, property protection, etc.).

Internalization advantages primarily result from imperfect markets and can roughly be described as the capability to circumvent or exploit market failure by internalizing and controlling what would otherwise source (firm-)externally. Examples include avoiding search

[6] Based on Dunning and Lundan 2008 p. 101 f.

and negotiation costs, controlling recourse supply channels and market outlets, or preventing price discrimination.[7]

It should be apparent that these advantages, especially in their combination, offer exceptional value to multinational corporations. In line with that reasoning, geographical and transnational ownership configurations (complex ownership chains) constitute an almost inevitable consequence. As of 2011, (Vitali et al. 2011) conclude that 737 *top holders* control the lion share (roughly 80%) of MNEs' worldwide value via a complex configuration of entangled, multilevel ownership relations. Of this 80%, the top 147 holders alone control nearly half.

The consequences of the growing influence of MNEs are highly diverse and cannot fit into a black and white scheme. From a market perspective, researchers have shown that the impact of international firms can positively influence productivity and technological process on host country markets due to empowering competition and transferring knowledge (Caves 1974). On the other hand, international investment, especially FDI, can also lead to capital concentration and market exits of domestic firms (crowding out effects) (Backer and Sleuwaegen 2003; Kosová 2010).

However, MNEs' influence due to their size, power, and often strictly hierarchical structures go beyond market conditions. As already discussed, the financial integration of large, entangled MNEs enables them to diversify their *downward* risk, meaning that the success of one affiliate can compensate for the failure of another. On the other hand, dense financial relations in corporate ownership structures can be fatal in systemic shock scenarios (e.g., an economic or natural crisis). Such a scenario could fatally impact corporate network structures due to a lack of *circuit breakers* within their intra-firm financial dependencies (Stiglitz 2010a, 2010b). In terms of public finance: MNEs are less vulnerable to *unsystematic* risks by entertaining a diverse asset portfolio. They are more susceptible to *systemic risks* because of strong interdependencies within their corporate structure (Allen et al. 2010; Allen and Gale 2000).

As said, there is no black and white about the impact of MNEs on market economies. MNEs are certainly not monsters that only thrive when overtaking markets, crushing local firms, looting natural recourses, and putting whole nations at systemic financial risk. Neither are they saviors, bringing wealth without cons, pushing technology and organizational finesse, and providing a role model in terms of social responsibility, stakeholder service, and the creation of positive externalities. Commonly, we expect national governments to moderate and adjust MCSs' impact for the good of their citizens. Conceptionally, it is much rather the state's role to

[7] Tax avoidance strategies, especially transfer pricing, mainly fall into this category but will be discussed later.

ensure fairness, justice, security, and democratic authority to its people as MNEs arguably care preliminary for their own profitability. Realistically, however, national states are not closed universes. Politicians are often conflicted by trade-off considerations between potential welfare generation by international business activity and exclusive territorial sovereignty of governments acting as representatives of their people (Kobrin 1999; Strange 1992).

Concerningly, as of today, there are strong indications that governments, given the prosperity FDI *can* bring to their nation, find themselves *bidding* for FDI by offering special concessions or privileges to MNEs (Oxelheim 1993). Especially when offering unique advantages (like sophisticated technology or knowledge) to an economy, MNEs recurrently hold strong bargaining positions towards their host country governments (Fagre and Wells 1982; Kobrin 1987; Charlton 2003). On many occasions, national governments are eventually willing to give up a considerable share of their sovereignty to ensure long-term contractual rights for international investors. These can include proprietary rights over natural resources, exclusive licensing, or loss of profit compensation assurance in political interventions. More often than not, it is not easily possible to revoke these contracts in the case of a subsequent disagreement (Elkins et al. 2006).

Some authors argue that many nation-states, from an economic perspective, became so exposed to the influences of MNEs that they became "*once more as in the past, just one source of authority among several, with limited powers and resources*." [8]. In the later sections, I will discuss why this development is of particular concern for the (German) energy supply industry. But before, the following part assesses the role of secrecy jurisdictions as a specific vehicle to circumvent aspects of border-bound national authority by exploiting the international maneuverability of MNEs, affecting not only national sovereignty but also financial stability and social justice in a crucial way.

Secrecy Jurisdictions

A lot of it is legal, but that's exactly the problem. It's not that they're breaking the laws, it's that the laws are so poorly designed that they allow people, if they've got enough lawyers and enough accountants, to wiggle out of responsibilities that ordinary citizens are having to abide by. – Barrack Obama, 2016[9]

[8] From Strange 1996 p. 73
[9] The White House, Remarks by the President on the Economy, available at: https://obamawhitehouse.archives.gov/the-press-office/2016/04/05/remarks-president-economy-0

At the beginning of this chapter, it is imperative to differentiate between *healthy* or *natural* and *harmful*, unsustainable tax competition. The first naturally occurs through market mechanisms when nations states entertain international companies with mobile capital. The second occurs mainly because of certain market imperfections. Even though secrecy jurisdictions provide more services than just tax optimization, this is still one of their central functions. I will, therefore, briefly discuss this issue.

I am mentioning free markets again because defenders of tax haven regimes regularly bring up the positive effect of free-market mechanisms (Hodge 2018; Edwards and Mitchell 2008; Baldwin and Forslid 2002; Teather 2006). Now, in my opinion, this argumentation oversees or ignores a crucial flaw. Charles Tiebout first argued a free-market view on tax competition (Tiebout 1956). He states that nation-states in an international economy compete similarly to private companies on open markets. Just as buyers naturally prefer private companies with the best input/output efficiencies, states with the best input/output efficiency are naturally the preferred location choice for private individuals and corporates. As private companies use work, labor, and capital and produce commodities, nation-states use tax revenue to offer public goods and services. Those nations with low taxes but good public deliverables are more efficient and the natural location choice for people to live and do business. Tiebout called this *voting by feet*, a market mechanism driving states to strive for an efficient state body (Tiebout 1956).

If one observes the current reality of tax competition, Tiebout has been proven right in the matter that nation-states do tend to compete for international capital by offering low tax rates (Devereux et al. 2008). On the other hand, the current reality also shows how the automatisms identified by Tiebout manifest in a world where markets are not perfect, unlike what he presumed. There are mainly two conditions in today's global economy that were unforeseen by the early tax competition theory. First, MNEs pay taxes when booking profits, not necessarily when generating economic value (Tørsløv et al. 2020). Second, not all forms of capital (or workers) have the same degree of mobility (Sinn 1990), and not all market competitors have the same access to tax-lowering instruments. Especially multinational corporations and very wealthy individuals seem to have exclusive or at least preferential access to secrecy jurisdictions services (Slemrod 2007; Wilson 2009; Trautman 2017; Alstadsæter et al. 2019; Palan et al. 2010). Even though the complete portfolio of tax optimizing instruments secrecy jurisdictions offer is hard to estimate for researchers, especially three significant types have been identified by research as *standard practices,* primarily referring to MNEs (Gumpert et al. 2016).

Transfer pricing (Clausing 2003; Vicard 2015) is a term for the strategic mispricing of intra-firm trading objects to either create revenue in the selling country and expense in the buying country (overpricing) or vice versa (underpricing).

Debt shifting (Egger et al. 2010; Buettner and Wamser 2013) exploits intra-firm loans to shift profits in the form of interest revenue (or expense on the opposite site).

Strategically locating intangible assets and intellectual property (Dischinger and Riedel 2011; Karkinsky and Riedel 2012) works through tax-deductible royalty payments. These payments flow from a business unit in a high-tax country to another business unit in a low-tax country (which holds the ownership rights).

Now preferential tax avoidance schemes distort the allocation function of a market in two significant ways. First, because of higher tax burdens, market competitors without access to these schemes can hardly compete with those having access. Consequently, a firm's factor efficiency (cost of input factors to price and quality of the output factors, meaning mainly consumer goods and services) is no longer the determining factor whether a business survives or succeeds. Hence, there is a weaker competitive motivation to improve quality and reduce production costs, market entry barriers heighten, and oligopolistic structures can evolve easier (Goerke and Runkel 2011; Martin et al. 2020). Second, on the fiscal level, especially nations that primarily serve as locations for economic value creation (production, extraction, R&D etc.), struggle to refinance public goods that MNEs utilize but do not pay for (Radu 2012). The second factor can consequently increase the tax burden of the middle-class. Eventually, middle-income earners may pay for public goods primarily exploited by MNEs to compensate for fiscal wholes (Harrington 2017). This odd reverse reallocation of wealth further amplifies unequal competition on national markets, leading again to a higher market share of large MNEs who have more extensive options to avoid tax and so on. In the long term, this cycle can lead to a fiscal dilemma in which state administrations and the working class eventually do not profit from the *welfare* which international capital is supposed to bring (OECD 2013; Crivelli et al. 2015; Avi-Yonah 2000).

Because taxes are eventually necessary for governmental spending, small economies have the best chances to profit from undercutting other countries' tax rates (figure 2). That is for two reasons. Due to the small size of their economies, they naturally have "less to lose but more to gain" when competing with larger economies that consequently have larger tax bases (Wilson 1999). Even a small share of international business revenue taxed at low rates can be enough to let a tiny economy thrive. On the other hand, large economies could hardly attract enough foreign capital to ensure a necessary level of government spending while suffering low tax

revenue caused by inefficiently low tax rates within their borders (Genschel and Schwarz 2011). In cases of small countries that turned into financial *shelter* states before their economies had developed independently[10], another factor comes into play. These states do not have to spend tax revenues on public goods that are beneficial or even necessary to entertain an industrial sector[11].

Thus, some larger economies opt for special legislation to profit from taxing misallocated revenues despite their disadvantages towards smaller countries (Huesecken and Overesch 2015; Garcia-Bernardo et al. 2017). For example, jurisdictions can assign exclusive privileges to foreign shell companies while domestic firms must comply with different rulesets. (Palan et al. 2010). Later parts of this thesis will provide empirical evidence of both types' function and interplay in the German energy sector.

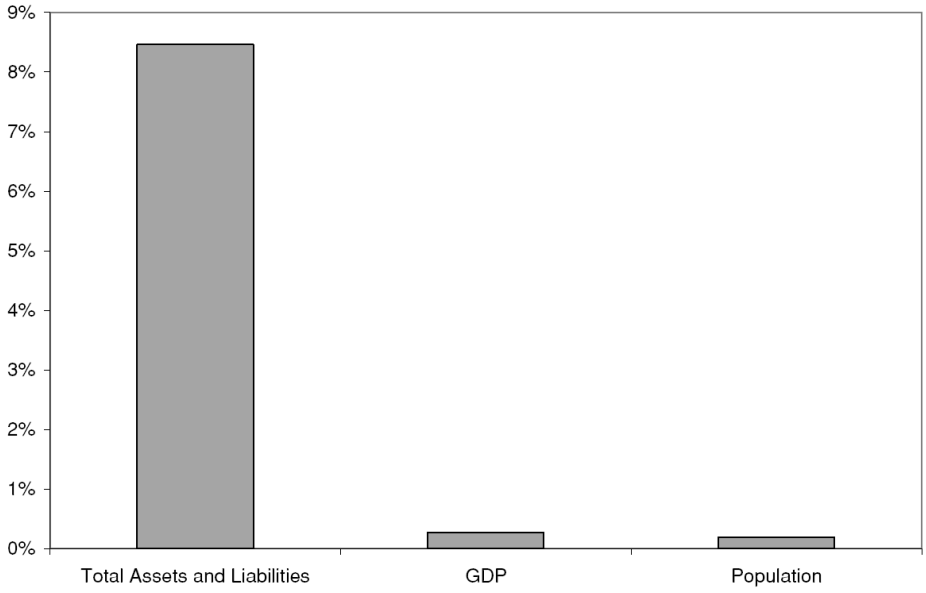

Figure 2: Total worldwide share of assets, liabilities, GDP, and population of a selected group of small states specialized in financial services in 2007. Source: (Lane and Milesi-Ferretti 2011)

The terms *secrecy jurisdictions* and *tax havens* are often synonymous in literature. In this thesis, I stick to the definition of both by Thomas Rixen: "states or dependent territories that intentionally create regulations and tax rules for the primary benefit and use of those not resident in their geographical domain."[12] Though, I purposely use the term *secrecy jurisdictions* instead of *tax havens*. That is because taxation heavily relates to this thesis's central concerns regarding both social justice and national (at this stage, particularly fiscal) sovereignty.

[10] Most British Overseas Territories fall into this category, see Shaxson 2011.)
[11] Research has indicated that regions with larger primary and secondary sectors tend to overtax those sectors in the attempt to compete for low taxation tertiary sector at the cost of overall welfare (Stöwhase 2005).
[12] From Rixen 2013p 437-438

However, another notable characteristic of secrecy jurisdictions is their ability and willingness to hide economic activity that could spark much concern among international politicians if regulative institutions revealed it (Shaxson 2011; Palan and Nesvetailova 2013; O'Donovan et al. 2019). As I shall elaborate, financial secrecy can induce supranational financial instability at arguably the same scale as tax avoidance instruments induce social and economic discrepancies.

When wanting to finance a car, a house, or some costly asset, most people's natural choice will probably be to go to a bank and ask for a loan. As of 2020, banks were still the most represented lenders of capital in most large industrialized and developing economies worldwide (FSB 2020). However, besides a slight dip resulting from the global financial crisis in 2008, we are experiencing a continuous growth of so-called *non-bank financial institutions* (NBFI), which today hold a larger share of global financial assets than traditional banks (FSB 2020). The crucial distinction between conventional banks and NBFIs is that first must oblige to a supervising system regularly assessing their asset structures and evaluating their risks (Barth et al. 2008). They also integrate with a central bank regulation system using (central bank) money reserves. That means that banks have to *back* their deposit liabilities with central bank reserves to a set percentage. In return, traditional commercial banks can access additional funds from the central bank in the case of a liquidity drain (basically a bank running out of money) (Gray 2011).

This system allows monitoring institutions like central banks or finance ministries to track how much funds are circulating and how well the reserve system backs this money. NBFIs, as they are not *banking* in a traditional sense, do not comply with these control measures. Now not all NBFIs are shadow banks. Pension funds and insurance companies, e.g., also fall into this category. Authors use the term *shadow bank* when an NBFI acts like a traditional commercial bank by getting involved in intermediary financial activities and participating in significant transformation or leverage of liquidity (like lending, credit intermediation, or the setup of investment vehicles) (FSB 2017, 2020).

Now, as said, the share of NBFIs in the financial industry of most large economies is smaller than that of traditional banks. This proportionality reverses when measuring globally because NBFI activity highly concentrates in very few national economies[13] (FSB 2020). Multiple scholars classify almost every one of these economies as secrecy jurisdictions (Hines 2010; Tørsløv et al. 2020; Philips et al. 2017). Now there is logical reasoning for locating shadow

[13] Most of these economies also show the highest activity of shadow banking withing the NBFI sector, FSB 2020.

banking activities inside the borders of secrecy jurisdictions. The lax regulations of these jurisdictions give NFBI ample freedom and thus a much larger playground for financial asset management and speculation (Rixen 2013). Moreover, banks and institutes supervised by regulative bodies can dodge or impede the assessment of risk-exposed balance sheet items by relocating and repacking them via offshore jurisdictions to which national regulators have no access. This repackaging can be convenient for a bank since risky activities can be very profitable, and instead of missing potential profits, those activities can be pushed *off the books* (Chick 2008).

One could say that the foundation of secrecy jurisdictions' role in shadow banking is identical to its most significant danger. The concept of *elsewhere*, meaning someone letting something happen out of the reach of regulating institutions to avoid their involvement, remains the core reasoning and a fatal consequence of offshore finance. This concept would explain some extremely complex, multilevel ownership models behind business entities of my data sample. I will later pick this up again when interpreting the results. Many scholars now think that a considerable share of international wealth and financial assets lies behind a cloak of special purpose vehicles (SPV). These vehicles are untraceable, unlocatable and certainly unregulatable by any central governance (Zucman and Fagan 2015; Shaxson 2011; Palan et al. 2010). Rhetorically speaking, somewhere between the international stages of such an ownership chain, elsewhere becomes nowhere (Murphy 2009; Palan and Nesvetailova 2013) since none of the individual entities within a chain isolates as responsible in case of an unpleasant event.

Scholars are not entirely consensus about the precise extent to which offshore finance increases financial instability or the risks and impact of financial crises. Still, a large camp assumes that it substantially influenced the build-up process and amplitude of the international financial crisis and the subsequent great recession of 2007-2008 (McCulley 2009; Nesvetailova 2017; Sharman 2010; Chick 2008; Loomer and Maffini 2009; Bengtsson 2013; Lysandrou and Nesvetailova 2015)[14]. Although progress in terms of financial regulation has happened since the crisis, offshore finance remains a risky vague space for every country's financial and

[14] Loomer and Maffini differentiate between offshore finance and tax havens arguing that many onshore off-balance banking is equally dangerous. As examples for non-offshore banking centres, they name London and New York. I agree to this differentiation but still argue that this does not diminish the risk secrecy jurisdictions bear. Moreover, in this work, at least the City of London will be treated as if it was a tax haven. (This will be justified later).

economic stability directly or indirectly involved[15]. I will therefore take the entanglement with secrecy jurisdictions and NBFIs as an (in)stability measure in my model.

Network analysis and its application on ownership configurations

The origins of today's applied network analysis arguably trace back to the early works of Georg Simmel, who started to speak about humans' connections to different social circles (soziale Kreise) and the resulting potentials of attraction and mediation between groups by individuals. The terms he uses to describe the social dynamics of individuals mediating different groups they belong to come astonishingly close to modernly used terms in network analysis. E.g., what Simmel calls "soziale Fäden" would arguably be "edges" in today's vocabulary (Simmel 1890). Simmel's ideas were later conceptualized and visualized by the psychologist Moreno (figure 3, left), who observed group dynamics in a girls' hospital (Moreno 1934). Levine, who studied *interlocked* boards between large banks and central industrials (Levine 1977), adopted network analysis on an economic topic as one of the first (figure 3, right). Further sophistication and mathematization (Harper and Coleman 1965; Freeman 1978) of network metrics and a steady increase in computation power and data availability fostered network analysis to become a reliable empirical research tool with wide multidisciplinary applications.[16]

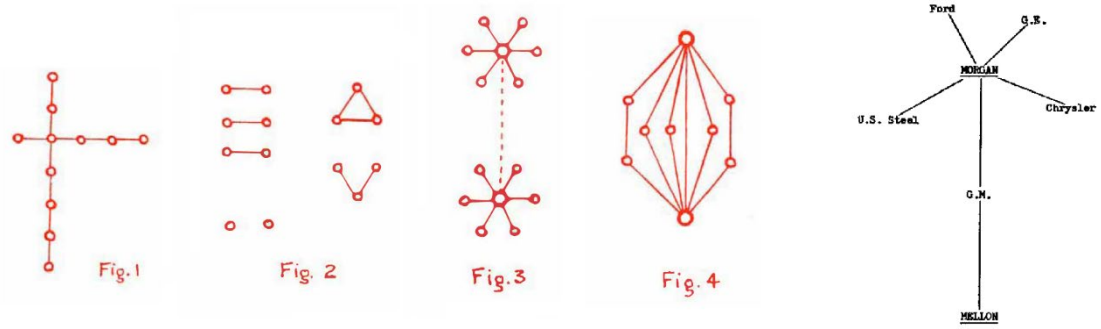

Figure 3: Pioneering attempts of network analysis. Left (red): Social group formations within dormitories of a girls' hospital, from: Moreno (1954). Right: "Interlockings" of the General Electric board with other industrials and banks, from Levin (1977).

One of the most sophisticated and recent research applications of economic network analysis comes from CORPNET. The researchers of CORPNET use the instruments of network analysis to reveal dependencies, positions, and functions of corporates, financial institutions, and host nations within a profoundly and complexly enmeshed web of control relations (figure 4 and 5)

[15] An assessment of the political progress and its impacts would exceed the scope of this thesis. For empirical data about the ongoing relevance of offshore finance see FSB 2020 A political reflection of countermeasures is brought by Helleiner 2014.
[16] An exemplary assortment of applications in different fields of science can be found in Fu et al. 2017.

(Garcia-Bernardo et al. 2017; Vitali et al. 2011; Reurink and Garcia-Bernardo 2020). This thesis is heavily inspired by and builds on this pioneering accomplishment.

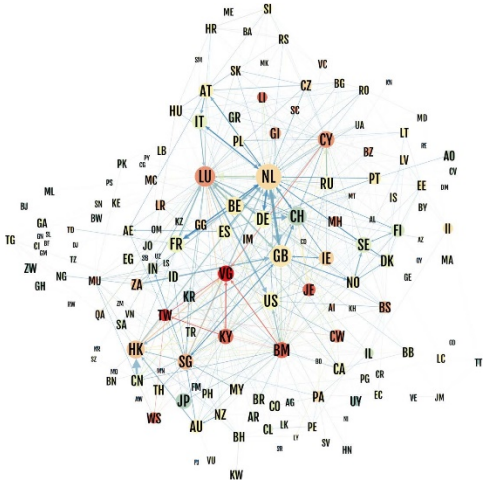

Figure 4: "conduit" and "sink" OFCs in the global ownership network in 2015. Size displays relevance as a conduit. The red color stands for significance as a sink. Source and detailed description: Garci-Bernardo et al. (2017)

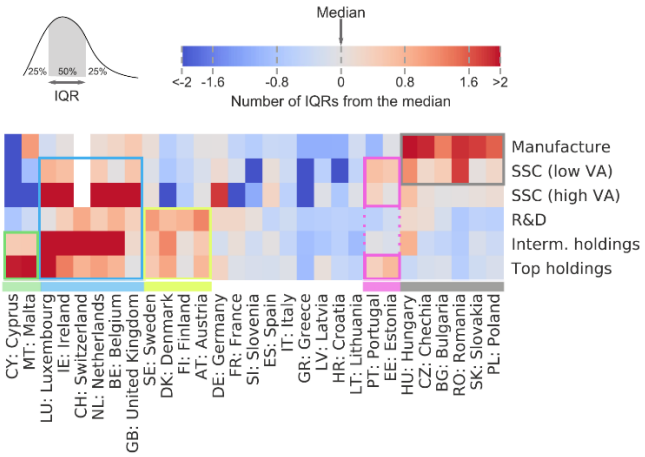

Figure 5: European states by their main function for businesses between 2007 and 2017. IRQ = interquartile range, SSC = shared service centre, VA = value-added. Red cells = successful, blue cells = unsuccessful. Profit centers (green), Coordination centers (blue), Innovation centers (yellow), Back-office centers (magenta), and Manufacturing centers (Gray). Source: Reurink & Garcia-Bernardo (2020)

Network analysis adds a new ability to research the avoidance of regulation and tax through complex corporate structures. Instead of just revealing their scale, researchers can allocate the specific *functions* complex ownership models require to work and pay off to particular firms or specialized host countries (Reurink and Garcia-Bernardo 2020). Now there were attempts to classify different kinds of secrecy jurisdictions before. (Kudrle and Eden 2003) assume that secrecy jurisdictions can be classified in *production havens, headquarter havens, sham havens,* and *secrecy havens*. Other authors found some theoretical logic and empirical indication MNEs locate intermediate subsidiaries strategically in certain states to circumvent repatriation tax (Mihir A. Desai et al. 2003; Altshuler and Grubert 2003).

In very recent literature, researchers strongly confirm the assumption of different roles of host countries in complex ownership chains by large-scale empirical evidence. (Garcia-Bernardo et al. 2017) show that there are *sinks* and *conduits* in the global ownership network. Conduit states identify by passing large amounts of income and capital from the source of their creation unto reaching their *sinks*, jurisdictions in which ownership chains and profit flows end. (Reurink and Garcia-Bernardo 2020) detect specific *attraction profiles* of states that attract international

firms. Depending on the case, these states aim to attract strategic intermediates or global headquarters by offering regulation (e.g., investor protection, withholding tax) or factor-driven (e.g., knowledge, specialized labor, infrastructure) advantages. Several authors have furtherly confirmed the relevance and increasing usage of intermediate affiliates ("in-betweeners") (Phillips et al. 2021; Nakamoto et al. 2019).

The Case of the Energy Sector in Germany

When politicians or scholars discuss opaque and complex ownership chains, tax avoidance, and secrecy, we often intuitively associate these topics with large high-tech or finance companies. However, specialized research indicates that similar practices impact essential supply sectors (Li et al. 2017; Finér and Ylönen 2017)[17]. In my opinion, the energy sector is an interesting case in terms of tax and regulation avoidance exposure. Firstly, a financial collapse of the energy sector would presumably lead to a powerful motivation to set up burdensome governmental rescuing schemes to prevent widespread and potentially long-term load shedding. Secondly, as part of the essential supply sector, the energy sector recurringly receives special privileges or subsidies from the government, increasing the sharpness of debates about social justice. [18]

I picked Germany as an exemplary case for several reasons. The liberalization of the German energy sector is in its exact form a rare occurrence in economic history. Many European states have implemented measures of liberalization in their energy sector during the last 25 years. However, before the initial liberalization in 1996, Germany was not predominantly dominated by a public monopoly like France or Great Britain (Dickhaus and Dietz 2004). Instead, a relatively oligopolistic group of sizeable private energy suppliers (e.g., E.on, RWE, EnBW) occupied the energy market on a supra-regional level, generated the lion share of electricity (around 80%), and held control over strategic infrastructure and the distribution network.

These eight in total energy "giants" were almost exclusively active within regionally restricted territories. The generated electricity was distributed to the local levels by around 80 companies, which furtherly allocated it to about 900 municipal utilities which were partly private and partly public (e.g., municipal energy suppliers called "Stadtwerke") (Brandt 2006). This system was, though oligopolistic for sure, relatively stable and profitable for many years. This consistency

[17] Li et al show reoccurring chain patterns in minority stock investments regarding to global energy investments. Finér and Ylönen demonstrate how Finnish corporates use multilevel ownership models to lower their tax burden.
[18] This, as of today and in the German context, applies for both conventional and renewable energies. See Zerzawy et al. 2021 or IEA 2020.

was probably one of the main reasons Germany's liberalization took place as a reaction to pressure from EU initiatives.

In most formerly monopolistic markets in Europe, predominantly national intentions pushed the progress of liberalization (Dickhaus and Dietz 2004). Interestingly, the natural gas sector's structure had a very similar shape—one of few exceptions being those supra-regional companies were about half *importers* and half *generators*. Moreover, other companies occupied the supra-regional oligopoly of Gas (with an overall of 16 regional monopolies). RWE was the only company taking a spot at the supra-regional level in both markets. Nevertheless, the distribution system with its long-term, contract-bound structure and mixed private and public entities was similar (Mez 2003; Lohmann 2006).

Before I discuss the impact of the political adoption of progressive EU liberalization goals in the German energy sector from 1996, it is also essential to mention the political process of the clean energy transition (Energiewende). Since around 1990, policy measures targeting market liberalization on the one hand and green energy transition on the other hand have been somewhat entangled. I shall discuss them as a parallel, partly interdependent process.[19] The oil crisis of 1973 and the Chernobyl accident of 1986 sparked first greater ambitions to move from fossil and nuclear energy to renewables (Lauber and Mez 2006). However, since these early politics mainly consisted of subsidies for research and stock investment in renewable energies, they had little impact on a national scale (Hake et al. 2015; Rechsteiner 2020). I will therefore take 1990 as the "start" of the Energiewende. In 1990, the Act on Supply of Electricity from Renewable Sources into the Grid (Stromeinspeisungsgesetz – StrEG) obliged electricity distributers to prioritize renewable energy over conventional energy at a minimum price. This price was, at that time, bound to the average cost of electricity, including non-renewable sources. Even though the impact of the StrEG on the electricity market was marginal, it embodied a first considerable step to promote the transition through obligatory prioritization of renewable energy sources (Hake et al. 2015).[20]

At the end of the 1990s, several crucial policy changes happened at roughly the same time. The EU directive 96/92/EC (first EU energy act, sometimes also called "package") and the transition into German law by the National Energy Act (Energiewirtschaftsgesetz, EnWG) invalidated the legal base of formerly existing territorial monopolies in favor of an open, liberal market.

[19] Appendix 1 gives an overview of political actions regarding both market liberalization and clean transition. The table contains both EU directives German policies. In this section, I will only comment on a smaller selection of most the impactful measures.

[20] Appendix 2 shows two diagrams about the growth of renewable energy generation absolute and in relation to other sources. It can be used as a reference to evaluate the impact of historic energy policy and the content of this chapter.

Ironically, after a short phase of an enhanced competition (around 1996-2003 in the electricity market, around 1996 to 2000 in the natural gas market), the break-up of the territorial monopolies led to an even stronger market concentration towards large, supra-regional firms (Brandt 2006; Lenz et al. 2019; Lohmann 2006). However, the desired effect of lowering electricity/natural gas prices failed to materialize in both markets (figure 7 and 17 in appendix I-3).

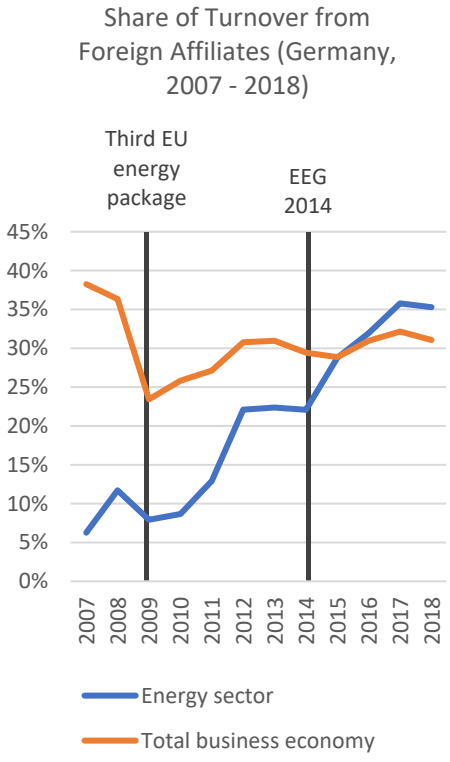

Figure 6: Source: Eurostat

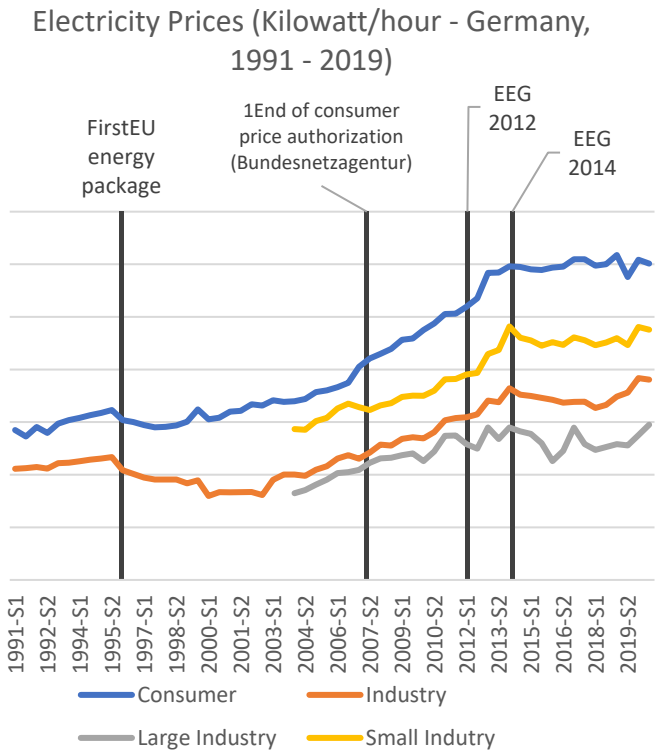

Figure 7: Source: Eurostat. See Appendix I-3

In 2000, the first version of the Renewable Energy Recourses Act (Erneuerbare Energien Gesetz – EEG 2000) decoupled the minimum price of renewable energy from the overall average energy price. This decision (in contrast to the StrEG of 1990) caused the market share of renewable energies to increase sharply for the first time (Lenz et al. 2019) (figure 15 and 16 in appendix I-2). The law furtherly obliged electricity distributors to prioritize electricity from renewable sources at fixed feed-in tariffs (Einspeisevergütung) (Hake et al. 2015; Rechsteiner 2020). While the effect on the electricity prices was marginal, the natural gas prices (potentially adding to the previously described market concentration effects) sharply inclined this year[21]

[21] It is generally difficult to pinpoint these price developments to one or two specific events. This is especially relevant for the natural gas price, which was until 2010 bound to the oil price and therefore highly sensitive on external factors. This chapter is therefore best taken as a description of the circumstances of the research model

(Eurostat 2021a). The prices in both sectors continued to increase steadily in the following years. In the natural gas sector, another sharp incline happened in 2005, potentially caused by the EnWG 2005, which introduced regulation of third-party access to the distribution network through a legal authority (Bundesnetzagentur). Both sectors then experienced another sharp incline in 2007. From that year on, public regulators (Bundesnetzagentur) stopped authorizing consumer prices on the base supply cost (Brandt 2006). Instead, energy prices cap at a set maximum profit margin of supplier companies (Rimmler 2015).

In 2009, the EU directives 2009/72-73/EC (Third Energy Package) sparked an immense surge of foreign affiliates (Eurostat 2021b) (figure 6). The directive introduced a EU agency to ensure fair competition among EU member states and support national regulatory agencies to cooperate and communicate (Agency for the Cooperation of Energy Regulators - ACER) (Rimmler 2015). Additionally, the EU directive 2009/28/EC (Renewable Energy Directive) followed by the Renewable Energy Sources Act 2009 (EEG 2009) set new goals for renewable energy generation and caused the respective sector to accelerate its growth (Rechsteiner 2020; Lenz et al. 2019). Whereas the natural gas market got hit hard by the financial crisis of 2008 and prices therefore declined, the political decisions of 2009 did not counteract the ongoing price increase in the electricity sector. However, as mentioned, those decisions had a tremendous effect on the clean energy transition and can, from that view, be taken as an achievement.

For the natural gas market, the year 2011 was the beginning of a rather turbulent time. After the decoupling of gas and oil prices in 2010, the accident of Fukushima in 2011[22], the Russia/Ukraine conflict in 2014, and an unusually mild winter in the same year caused the gas prices to fluctuate heavily (Bukold 2015). On the electricity market, the 2012 novelle of the Renewable Energy Sources Act 2012 (EEG 2012) introduced market premiums (Energieumlage) for renewable energies as an optional sales channel to feed-in tariffs. These premiums ensured that price-efficient renewable energy producers that use free marketing instead of feed-in tariffs to sell their electricity receive a bonus payment equaling the difference between their sale price and an ex-post assessed average electricity price (Rimmler 2015). Since distributors were still obliged to prioritize renewable energies, higher end-consumer prices financed the costs for the market premium. Subsequently, energy prices sharply increased from

later on. Nevertheless, I wanted to at least add some possibilities about political causes behind these price developments. For a detailed overview of the natural gas prices in Germany see Appendix 3.

[22] The accident forced Japan to import large amounts of liquified natural gas, see Bukold 2015.

2012 to 2014. At the same time, this premium system stopped the foreign affiliate "boom" and furtherly increased the market share of renewable energies (Eurostat 2021b; Rimmler 2015).

Potentially as a response to the skyrocketing energy prices and some "overfinancing" problems, especially regarding the photovoltaic sector (Getachew 2019), the EEG 2012 was amended in 2014 by another novelle of the Renewable Energy Sources Act (EEG 2014). The EEG 2014 revoked the whole system of guaranteed returns in the form of feed-in tariffs and exposed the renewable energy sector to market forces (while maintaining the set renewable energy market share targets) (Getachew 2019; Brunn and Sprenger 2014). These measures immediately stopped electricity prices from rising and simultaneously caused a second boom in foreign affiliate activity (Eurostat 2021a, 2021b).

Hypothesis Development

The previous chapters discussed current scientific work and informational data to build an appropriate starting point for my research. I will quickly sum up the most central insights before deriving my hypotheses:

- MNEs usually look for competitive advantages.
- Ownership structures are an instrument to increase cost-efficiency and set MNEs ahead of their competitors.
- Some ownership "configurations" include exploiting tax and regulation advantages by utilizing secrecy jurisdictions, a competitive advantage that domestic firms cannot use to the same extend. These complex ownership chains regularly occur on open markets.
- Policy measures progressively enhanced international competition and market liberalization in the German energy sector over the last centuries. A stepwise reduction of subsidies and funds in favor of market forces furtherly promoted this competition.
- These measures have increased the turnover share of foreign energy affiliates in Germany.

From these premises, I derive my hypotheses:

H1: Due to the rising share of foreign affiliates in the German energy market, **Germany's average position in international ownership chains in the energy sector has moved from "top to central" since 1996**.

H2: Because of fierce competition and MNEs looking for an edge, tax and regulation avoiding ownership structures have developed in Germany since 1996. Therefore**, countries specializing in taxation and regulation avoiding ownership chains have increasingly entered the German energy market since 1996.** And accordingly:

H2.1: *States with a reputation to entertain "conduit firms" show an increasingly high measure of centrality in the ownership network of the German energy sector since 1996.*

H2.2: *States with a reputation to entertain "sink firms" mostly take top positions of ownership chains in the network.*

H3: By the nature of their function, **conduit jurisdictions connect more often to sink jurisdictions than to the average country in the network and vice versa.**

H4: **Foreign affiliates with upward ownership links to secrecy jurisdictions comply with significantly lower effective tax rates than their domestic (German) counterparts**.

H5: **Foreign affiliates with upward ownership links to secrecy jurisdictions report significantly fewer profits when compared to the average factor profitability of the overall sector than their German counterparts**.

H6: **Since 1996, the share of German energy firms owned by NBFIs has increased continuously.**

H6.1: *The share of NBFI owners is exceptionally high within owners located in secrecy jurisdictions.*

To account for the substantial structural changes green energy transition policy has caused within the German energy market, I add another hypothesis:

H7: Because of lower investment volumes and easy accessibility of energy generation units, **renewable energy generation is significantly affected by ownership models involving NBFIs or secrecy jurisdictions.**

H7 assumes that renewable energy generation units require a much lower investment volume than conventional energy generation units. Unfortunately, there is little literature dealing with that topic. However, it seems intuitive that rent-seeking investor groups that are not necessarily established players in the energy sector would be keener to purchase controlling shares with lower investment volumes. Consequently, a wind turbine at the cost of 5 million euros would be more attractive than a nuclear power plant at the expense of 15 billion euros. I will therefore add H7 for explorative purposes and a potential starting point for further research.

Data & Methodology

General Description

My primary data source for firm data is Orbis. As mentioned in the introduction chapter, the Orbis database from Burau van Dijk is considered one of the most complete and accurate micro-

level databases available to researchers and suits well for my purpose. I need to apply some adjustments to the Orbis list exports before conducting the models that can be appropriate to test my hypotheses. The reader can retrace a detailed description of some main steps can be retraced in appendix II[23]. However, due to the novelty of this method, I will briefly explain every step I applied to the dataset for the sake of transparency and reproducibility.

I exported the original dataset from Orbis on the 13th of March, 2021. After completely writing the code for all algorithms I used, and everything worked the way it should, I again downloaded a complete Orbis dataset on the 1st of August. I did this is for two reasons. First, because I needed some time to get everything working methodically, some datasets (e.g., those considering ownership on the one hand and taxable income on the other hand) were of different Orbis versions. In this final version of the thesis, *all* Orbis data comes from Orbis data update number 213001. Second, due to the topicality of this thesis' subject, I want to present results based on data as recent as possible.

The search scheme identifies all (active and inactive) companies available on Orbis located in Germany. Furthermore, I include only companies categorizing in the Statistical Classification of Economic Activities in the European Community ("nomenclature statistique des activités économiques dans la Communauté européenne" – NACE) space 35xx (electricity, gas, steam and air conditioning supply). Additionally, I add all subsidiaries owned by these companies by at least 50.01% and all shareholders controlling them (also defined by a held share of at least 50.01%).

Construction of the Dataset

The evolution of the German energy ownership network is a substantial part of my research. Furthermore, other authors have shown that unrecognized ownership changes can significantly distort research regarding firm characteristics like tax burden (Grosskurth 2019a). Therefore, it is not sufficient for my study to use a static ownership dataset (snapshot). However, dynamic ownership chains' (re)creation is not an easy task and a relatively new approach in economic network analysis. Orbis, by standard, only supports current snapshots of ownership links in list format (detailed historical ownership information is only available on the individual firm profile pages).

There are a handful of approaches to solving this problem. Those with access to "Orbis Historical" can recreate historical ownership information by merging a current Orbis snapshot with historical snapshots exportable from Orbis historical year by year (Kalemli-Ozcan et al.

[23] Full R-code available at https://github.com/MaxmlGz/Masterthesis

2015). Though an improvement towards assuming ownership has not changed over time, this method has two significant drawbacks. First, Orbis historical is a costly extra package of the already fee-based Orbis access license. Accordingly, Orbis Historical is only available to a tiny group of researchers, making Orbis Historical based models hardly reproducible to a reasonably large researcher base. Second, and this is particularly important for research focusing on ownership, Orbis coverage of ownership links has significantly improved over time, making Orbis Historical-based models vulnerable to being skewed" towards the present (Bajgar et al. 2020).

In my opinion, the currently second-best practice to recreate historical ownership data with Orbis is to merge a current Orbis snapshot with mergers and acquisition (M&A) datasets. Even though it is not perfect, the OECD recommends this approach (Bajgar et al. 2020). In their paper, Bajgar et al. particularly recommend the Zephyr database of Bureau van Dijk. Other researchers have achieved good accuracy by merging Orbis with the EU Emissions Trading System (EU ETS) transaction database (Jaraitė et al. 2014; Jaraitė et al. 2016). In this thesis, I will apply a similar approach. However, there is one approach that would arguably have a more accurate outcome:

To use a web scraper program (a program that can retrieve information from an Html page) to extract historical ownership from each firm's Orbis report sheet individually and apply a bottom-up ownership merging algorithm to the resulting data (Alabrese and Casella 2020). This procedure would probably overcome two significant limitations of my method. However, it would need enormous amounts of bandwidth and processing power that are both not available to me at the moment. I will therefore settle with the M&A data method as the *best possible* approach in this work, complemented by careful analysis and discussion of its limitations.

Instead of Zephyr (which I currently do not have access to), I use a light version of the same available through my Orbis access. Though some details (mostly not relevant to my model) are missing, this light version still contains the essential M&A information. It covers deal type, acquirer ID and country, vendor ID and country, target ID and country, deal structure, and competition date. After exporting all available deals in which the companies from the initial dataset are included (as the acquirer, vendor, or target), I pre-filter these deals to exclude all those not containing transfers of controlling shares by a series of string-detections (appendix II – 4). Next, I apply a matching algorithm between the company set and the M&A data. I found this to be necessary since Orbis does not always reliably classify if controlling shares were transferred or not by its deal structure information. E.g., some deals are classified as "Patent

sales" and imply a transfer of ownership, whereas other deals with the same classification do not.

The reconstruction algorithm roughly works as follows[24] : Starting from the company list snapshot of 2021, I check for each deal of 2021 whether the respective *acquirer* is the owner of the associated *target* in the company dataset of 2021. If that is the case, I assume a transfer of ownership since companies rarely "acquire" their own companies. Even if they do (stock increase, share buyback), these cases can be assumed to be reliably pre-filtered by the previously described string detection. When a deal gets validated, the vendor of 2021 replaces the owner of 2021 in the (recreated) dataset of 2020. The exact process repeats from a vendor's perspective. I check again for each deal that happened in 2021 whether the *vendor* is still the owner in 2021. If that is the case, the deal is assumed to be invalid, and no modifications are applied. If the deals' vendor is not the owner in 2021, I presume that those vendors must own their companies before selling them. The deal, therefore, is assumed valid. Again, I expect the string-detections mentioned above already filtered out exceptions (stock increase, share buyback). If a deal is validated, the vendor of 2021 replaces the owner in 2021 in the modified 2020 dataset. This method also captures takeovers of companies that were previously not owned by another shareholder. In such cases, Orbis' deals list's vendor ID is not available. Since the merger algorithm still inserts this ID as the previous owner, this previous owner (in the reconstructed company list) will also show as not existent.

This method, unfortunately, has two weaknesses. For the case of public takeovers, no string filter can apply. The filter does not work since listed public takeovers do not separate into transfers of controlling shares from one shareholder to another and cases of several minority holders selling a *summed-up* controlling stake to the new controlling shareholder. Unfortunately, the Orbis M&A database I use does not contain vendors' formerly held share percentages. I had to choose between excluding all public takeovers or assuming the previously largest shareholder of a deal[25] as the past controlling shareholder.

Regarding my hypotheses, I chose the second method since it rather overestimates the count of past shareholders than underestimates it, which would, if at all, somewhat weaken my results instead of falsely empowering it. Even though it inarguably is an inaccuracy, this approach also works as a measure to increase robustness. However, for the 50 deals I validated manually by looking up respective Orbis individual company reports, I did not find a single error of the

[24] Detailed description in Appendix II - 5
[25] always on top of the list of all former shareholders at Orbis

applied merging algorithm. Nevertheless, I cannot guarantee for a hundred percent that the reconstructed datasets are entirely free of errors of the described kind.

Moreover, the algorithm always merges the company list with the deals list *by the target*. Even though the algorithm checks vendors *and* acquirers, an ID match of the target is always required. Resultingly, the algorithm is much more accurate for *upward* ownership changes than for *downward* changes. Since I included all active and inactive German energy companies in the original set, this is not a problem for changes in their upward ownership chains. However, in the case of subsidiaries owned by German energy companies, there is a blind spot. The algorithm will only track transactions if the target of these transactions is still in the dataset. That means that it will unveil whenever a German energy company *has bought* a subsidiary *still in the dataset*.

On the other hand, it will not unveil *past sellings* of subsidiary units. That flaw is, by all means, limiting my research results. Nevertheless, there is a more significant problem occurring if I wanted to apply downward merging. Unlike an upward merge, downward merges would add new ownership chains (new rows) to the dataset instead of altering existing ones. The lowest subsidiary level is always the starting point for every chain in the dataset.[26] I would then have to recheck these rows for upward ownership changes and so on. A combined downward/upward merging approach might serve well for data samples without geographical or sectoral boundaries. In my case, however, such an approach would potentially result in a giant dataset full of ownership chains not containing any German energy companies. In an even worse case, I could end up with a dataset including all companies in the world. Today's global corporate network is heavily entangled. Continues downward and upward merges through time could conceivably let the dataset grow up to its natural limit. That limit is the entire global ownership network. Because this thesis majorly focuses on the consequences of upward ownership relations, I evaluate this as an unnecessary risk.

Maybe the resulting dataset of an upward *and* downward reconstruction would even result in a limited dataset. I could then probably filter this dataset only to include ownership chains containing German energy companies. Still, the sheer complexity of the process would increase the chance of failure (referring to both human mistakes and poor Orbis data quality or search accuracy) by a considerable amount. To avoid this, I decided to stick with an upward-focused merging algorithm. The only hypothesis affected by this method's weaknesses would be H1

[26] This is primarily caused by the Orbis search I used, which starts with identifying German energy companies and then adds all subsidiaries of these companies to the result list. Controlling shareholders of all levels are then displayed in another column in order to avoid double counts.

(since it concerns Germany's average position inside ownership chains). Still, this behaves widely similar to the limitation I mentioned about public takeovers. Since my hypothesis states that Germany's role within ownership chains changed from *top* to *central,* this methodological flaw would more likely weaken the chance to accept the hypothesis than falsely increasing it. That is because subsidiaries German energy companies have sold in the past do not appear in reconstructed datasets. Germany's *past* average position within ownership chains would, therefore, if at all, be estimated as falsely higher than falsely lower.

I apply this merging algorithm to reconstruct datasets for all years until the earliest noted deal in Orbis in 1996, which covers the essential range for my research's core objectives. Afterward, I export a list of owners of the years before 2021 not appearing in the initial 2021 dataset from Orbis. This list contains the same information about companies as the initial company list of 2021, including their current ownership chains. I then attach these chains to the respective companies in all years before 2021. Since I do not know if these *ownership levels also changed in the past, I repeat all steps* described in this chapter until the algorithm applies no further changes to the datasets in any year. Next, in all datasets (including 2021), I delete all companies that were not founded before the respective year or withdrew from the market until that year from the set going by Orbis information about the founding and exit dates. If a deleted company is positioned centrally in an ownership chain, I split this chain into the two parts formerly adjacent to the deleted company. Afterward, I remove all ownership chains without at least one German energy company *with a known date of incorporation* from the sets.[27]

To my regret, there is not much literature that I could use to verify or add robustness to my model. Still, I compared the historical datasets resulting after these steps with those of another recent research paper. This paper uses a different reconstruction method (Grosskurth 2019b). The reader can find this comparison in appendix II-6.

I furtherly apply adjustments to the location information of all companies and their controlling shareholders. The leading location indicator used in this thesis is the ISO country code. Problematically, some secrecy jurisdictions are not entirely politically independent and therefore have no unique ISO. Instead, they share the ISO code of their superordinate sovereign.

[27] I thought a lot about this step. But after some trial-and-error, I found this to be the best method to create a consistent and comparable dataset. Since I use date of incorporation as a filter criterion, it only makes sense to kick out companies with no available incorporation date. By expanding this filter to German energy companies, I prevent to filter out GUOs that are for example located in secrecy jurisdictions and do not reveal their company details. I also filter out branches that are, for whatever reason, not assigned to their owner by Orbis while keeping those that are correctly assigned. This is because correctly assigned branches are now part of the same chain as their owning non-branch company, which in almost every case has a valid date of incorporation. This also prevents double-counting of branches.

However, since many of these "non-nation" jurisdictions have significantly different laws and embody quite different positions and roles in the ownership networks (I will later discuss this in more detail), I must separate them for my research purpose. In my sample, these "non-nation" jurisdictions are the City of London (local government district of the United Kingdom), Jersey, Guernsey, the Isle of Man (all three are British Crown Dependencies), and the US state of Delaware. Last embodies a special political zone inside the USA since its corporation law differs substantially from other US states (State of Delaware 1897; Strine, Jr. 2015). I identify every legal entity within these special law zones by a combined string-search of postcodes, city names, and company names (appendix II – 7). I then change these entities' ISO code to differ from the ISO code of their superordinate sovereign.

At this stage, the preparation of the datasets is complete. From 1599 to 2021 (the earlier years mainly serve illustrative purposes), each dataset consists of unique firms and their entire upward ownership chains starting at the lowest subsidiary level. Each of these chains, as said, contains at least one German energy company with a known date of incorporation. I share the conviction of many researchers that a lucid and appealing visualization of complex and extensive quantitative data is the most effective way to transfer information (Tufte 1983). Therefore, I geo-map all companies and their ownership links throughout all datasets and create an interactive web interface that displays the ownership networks over time. The reader can access this interface at https://maxmlgz.github.io/Masterthesis/. Even though these visualizations alone cannot provide "tangible" research results like numeric results attempt to, visual appeal is a particular strength of network analysis. It gives whoever perceives it an additional, more intuitive angle to interpret the results of this thesis.[28]

Network Indicators Considered

To check H1, H2, and H3, I use two network indicators. The first one is *betweenness centrality*. Betweenness centrality is a network metric that measures to which degree a network node falls on the shortest path between two other nodes (Freeman 1977). In mathematical terms, betweenness centrality g defines as:

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

With v being any given node in the network, σ_{st} being the number of shortest paths from node s to node t and $\sigma_{st}(v)$ the number of shortest paths between s and t running through v. In my

[28] For detailed information about the network graphics and the reasoning behind shape and color-code can be found in appendix II-9

case, network nodes represent the host countries of the companies in my dataset. Paths are edges (the connection between two nodes, in my case, ownership links) or a chain of edges connecting one node to another.[29] *The shortest path*, in this context, does not mean the geographically shortest path but the path with the minimum number of nodes on its way. Betweenness centrality is an accurate measure to identify central intermediaries (or proxies) within a network. It is, therefore, appropriate to evaluate the *conduit* activity of firms or jurisdictions in my dataset.

To measure the characteristic of a host country (node) to be on top of (long) ownership chains, I use an indicator originating from my own thoughts. I define h (ownership score) as:

$$h(v) = \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{pos\ (v_i)}{length(v_i)}$$

With n being all ownership chains of which a host country *v* is part. *pos* is the position of *v* in an ownership chain *i* (starting at 1 = global ultimate owner, GUO). *length* is the total number of entities that are part of the chain *i*. This indicator may be straightforward from a mathematical perspective. Nevertheless, it expresses very well the tendency of a country (node) to host entities at a high level of long ownership chains.

Defining Sinks and Conduits

Before I describe further models in detail, I shall briefly explain how I determine *sink* and *conduit* jurisdictions as this categorization is of central relevance for the following. The first step is elementary. I list all unique jurisdictions that appear in a dataset of any year. Next, I look up some of the most renowned contemporary research papers regarding secrecy jurisdictions (Hines and Rice 1994; Hines 2010; Philips et al. 2017; Garcia-Bernardo et al. 2017). If one of these papers categorizes a jurisdiction as a secrecy jurisdiction[30], I include it as a *sink* or *conduit* jurisdiction[31]. To distinguish between conduits and sinks takes a little more effort.

At this point, I want to state that the distinction between sinks and conduits among secrecy jurisdictions is a relatively new concept and has arguably reached a global audience since researchers have applied measures of network analysis to the topic. Many (especially older) research papers, including some highly influential pieces (Hines and Rice 1994) do not

[29] I use the normalized version of betweenness centrality defined as $\frac{g(v)-\min(g)}{\max(g)-\min(g)}$ in order to ensure comparability within the networks of different years which have different amounts of nodes and edges.
[30] As mentioned, the terms secrecy jurisdiction and tax haven is commonly used synonomously in literature. Some papers therefore use the term tax haven, but essentially mean the same.
[31] The only exception being UK and the City of London, which I will later comment on.

distinguish these two kinds. The contribution of CORPNET (Garcia-Bernardo et al. 2017) was one of the first attempts of more extensive reach categorizing between the classical sort of a secrecy jurisdiction, primarily small countries with opaque regulations, meager tax rates, and lots of foreign deposits (sinks) and another, more recently establishing kind of secrecy jurisdiction. This second kind (the conduit) features a legal system specializing in intermediary positions within ownership chains (e.g., low capital transfer tax) (Garcia-Bernardo et al. 2017).[32]

I take the categorization of CORPNET as a starting point for my categorization. But, I adjust it slightly to fit the conditions of my data. The reader can view the complete categorization in appendix II-8. In most cases, the categorization of CORPNET fits with my observations (CORPNETS sinks show a high GUO score, conduits a high betweenness centrality). Consequently, I categorize four of the six jurisdictions as conduits CORPNET categorizes alike. The two exceptions are Luxembourg and the City of London. Due to the observations in my dataset (see figure 26, 27, 29, and 30 in appendix I-5), Luxembourg recurrently serves as a conduit *or* sink jurisdiction (CORPNET's observed the same in their data). In CORPNET's research, the categorization depends on the thresholds they set. In my data, I find that Luxembourg's function as a conduit is more protruding than its function as a sink. It is the only country besides the Netherlands maintaining a constant high betweenness centrality throughout the last 20 years. Concerning the United Kingdom, I did somewhat include it as a conduit, represented partly by the City of London as a separate jurisdiction. That is for two reasons. First, the City of London occasionally builds a "junction" between British Crown dependencies (Jersey, Guernsey, Isle of Man) or British Overseas Territories (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Gibraltar, etc.) on the one hand and Europe and other industrialized nations on the other hand (Cobham et al. 2020; Shaxson 2011). Second, the City of London's network indicators differ more significantly to those of the average jurisdiction in my data than the network indicators of the United Kingdom. Namely, betweenness centrality and GUO scores have been considerably higher throughout the last 20 years, especially concerning the small size of the jurisdiction.

When it comes to sink jurisdictions, my categorization differs from CORPNET's in three cases. Singapore[33] and Guernsey are, in my models, categorized as sink jurisdictions since both do

[32] To give an example of these "highly developed legal systems" see Huesecken and Overesch 2015 and their analysis of ATRs (advanced tax rulings) and their exploitation by large multinational firms in Luxembourg.
[33] Singapore is one of the major conduits in CORPNETS categorization. However, this difference could be of geographic nature. In my sample, I find that those countries with high betweenness centralities tend to lie geographically close to Germany. Singapore, on the other hand, is found by CORPNET to be a conduit mainly connecting Asian countries to Hong Kong, the British Virgin Islands, the Cayman Islands or Bermuda.

not show an apparent function as conduits (no significantly high betweenness centrality or abnormally high count of intermediary position). Additionally, I add the state of Delaware as another sink jurisdiction. Delaware is, as previously mentioned, a state with special laws that offers large corporates unique advantages. It thereby competes with other secrecy jurisdictions. In a way, this is a "better a small share than no share" attempt by the US to reap tax income the country would otherwise likely lose entirely to other secrecy jurisdictions (Dyreng et al. 2011). Even though non-US-American MNEs primarily use Delaware, namely as a location for foreign subsidiaries operating in the US, a few observations of Delaware-owned firms in Germany significantly differ from the German energy firm in my data. What that means precisely will be in the content of the later chapters.

Estimation of Effective Tax Rates

Orbis data is unfortunately not ideal for checking H4 and H5. Orbis' financial statements generally comply with the International Financial Reporting Standards (IFRS) or locally depended General Accepted Accounting Principles (GAAP). Since I use unconsolidated German accounts, the format is German GAAP (HGB[34] standard). However, German authorities determine tax burdens by using a separate financial statement solely designated for tax (Steuerbilanz). Regardless, since these statements are not publicly available, I will again follow the best available approach to test my hypotheses.

There are several differences between HGB reporting and tax reporting (Steuerbilanz) in Germany. Fortunately, by German standards, the fiscal year of both statements share the same period (fiscal year - Geschäftsjahr = calendar year - Kalenderjahr). However, exceptions to this rule exist under the permission of the German tax authority (Finanzamt). Since I will use ten-year averages for my model, this is a relatively minor problem. Additionally, deprecation rules differ between HGB and tax statements. Since deprecations are tax-relevant, this constitutes a more significant problem.

On the other hand, my primary purpose is to evaluate tax justice between domestic firms and those using complex international ownership structures. Since depreciation-related tax strategies are available to every company, this should also have a limited impact on the comparability between these two. Still, it could, e.g., be possible that wealthier companies have better access to tax experts and, therefore, better chances to benefit from sophisticated depreciation strategies. However, since I generally conduct all tax-related models in a weighted

[34] Handelsgesetzbuch

(by taxable income in this case) and an unweighted (average taken by the number of companies) version, the potential drawbacks of inaccurate depreciation should be of marginal impact.

However, two other drawbacks occur when using Orbis (here HGB) data to evaluate tax rates. These are particularly relevant for my model. Germany participates in many complex double-taxation arrangements with other jurisdictions (Ernst & Young 2020). These arrangements usually differ in detail and contain several tax exemptions or adjustments for dividends, royalties, and interest expenses between contracting countries to avoid double taxation of the same income base. The ZEW particularly criticized this factor in response to an ETR-based tax research paper (Bräutigam et al. 2019).

There are two things to say about this critique in regards to my research. First, my model does not compare between countries. I only go by German, unconsolidated accounts. The discussion mentioned above happened about a research paper comparing companies in different countries (Janský 2019). The scholars of the ZEW argue that a large share of, e.g., Luxembourgish companies' income result from receiving dividends. These receivings would invalidate the observation of apparently low tax rates since the country of their origin had usually taxed respective dividends already. Because of that, countries receiving dividends would not again collect tax on the related income at the headquarter level to avoid double taxation (Bräutigam et al. 2019).

In my case, I exclusively compare companies located in Germany but *owned* by companies located in different foreign countries. Furthermore, these companies are *net borrowers* in their vast majority. In Orbis (HGB) data, dividends, royalties, or interests paid always reduce the EBT (earnings before tax). There are two ways in which double taxation agreements could matter here. One case being double taxation arrangements determining agreeing jurisdictions to tax corporate income at the headquarter level. In this case, Orbis data should accurately display the impact of dividends, royalties, or interests paid on effective tax rates (ETRs).

Nonetheless, my models ignore that receiving countries might still tax these payments as income by their means. However, current research (Garcia-Bernardo et al. 2020) indicates that the effective tax rates of countries still differ significantly even when considering dividends, royalties, or interest arrangements and ETRs in Germany are nevertheless far above the European average. Therefore, the overall impact of these effects might not be as heavy as expected by the ZEW.

The other (opposite) case would be double taxation arrangements determining agreeing jurisdictions to tax corporate income at the subsidiary level. In that case, dividends, royalties,

or interests paid could potentially falsely *deflate*, not *inflate,* ETRs. In the second case, my models would once more rather falsely reject my hypotheses instead of falsely accepting them. Nevertheless, I deal with this potential inaccuracy by adding to my models an aggregate group of *all foreign energy affiliates* in Germany, ignoring the specific country of their owner.

The arguably sharpest limitation of Orbis-based effective tax rates connects to but reaches far beyond discussed accuracy problems of double taxation agreements. Orbis does not give exact information about the proportions of net interest paid, net dividends paid, or net royalties paid. Instead, all of these positions are thrown together as *net financial profit*. My first model uses once the operative result and once the combined operative and financial result (Earnings before Tax, EBT) as a tax base to calculate effective tax rates. Orbis calls the operative result EBIT (Earnings Before Interest and Tax). This designation is not entirely accurate since the Orbis EBIT is the operative result before net interest *and* before other financial positions like dividends or royalties (Garcia-Bernardo et al. 2020). I use the Orbis EBT and the Orbis EBIT as tax bases since tax authorities often treat financial positions (like dividends, royalties or interests) differently. Dividends can, e.g., be taxed differently than interest, interest differently than royalties, and so on (Garcia-Bernardo et al. 2020). Orbis, as said, unfortunately, does not provide detailed information about the composition of financial income or expenses. Therefore, there are possible cases in which both calculations are not accurate. I will illustrate this problem and why I think using two different tax bases solves it by the following example:

A German company cannot deduct dividend expenses from taxable income, but it can deduct interest expenses. If the company pays large amounts of interest, the Orbis EBT will be an almost accurate tax base, but the Orbis EBIT as a tax base will lead to falsely low tax rates. If the company pays high dividends but low interest, the EBIT will be an almost accurate tax base since it still contains those taxable dividend payments. The EBT, on the other hand, will measure falsely high tax rates. Considering that the company also has financial income from investing positions, the case becomes even more complex. If the company only receives dividends that were already taxed on the subsidiary level and therefore did not higher the tax burden in Germany, but at the same time only pays interest, that lower the tax burden in Germany, both measures are distorted. However, a case like that would already be a full-fledged tax avoidance strategy through debt-shifting (see chapter 2) since such behavior, from an economic standpoint, only makes sense when there is some kind of arbitrage to gain.[35]

[35] Equity and debt can be seen as substitutable ways to help-out a subsidiary financially. Even if we take OLI advantages into account (chapter 2) and assume that a parent company does not have the liquidity do directly fund its subsidiary, the question remains why a loan is then not raised directly on the subsidiary level instead of channeling it through the parent and transforming it to equity funds.

One must therefore read the results of this model considering this limitation. Under the premise of widely similar financing structures and costs among the dataset[36], the EBT-ETR and the EBIT-ETR are comparable between different companies. If we drop that premise, it should still be reliable to compare the EBT-ETR and the EBIT-ETR on a cross-company level (EBT-ETR of firm A lower than EBIT-ETR of firm B represents the minimum real effective tax rate difference).

From a logical point of view, financial revenues should not considerably influence the results of this model. As non-financial companies, the vast majority in my sample consists of net borrowers. Furthermore, as described, significant compositional differences between financial assets and liabilities usually follow economic considerations. In other words: The arbitrage opportunities of differing tax rates. Therefore, I will not consider the strategic configuration of net financial payments influencing effective tax rates as a pure data error. In my opinion, this practice is just one of the several tax-reducing instruments of MNEs that small or domestic market competitors cannot utilize to the same extend.

The results of this model should be reasonably representative after applying the described adjustments[37]. Still, the difference between Orbis data (HGB) and the actual taxable income base in Germany (Steuerbilanz) can lead to distortions since both statements generally follow differing purposes (Hanlon and Heitzman 2010). Therefore, I will apply a mixed model with two additional approaches estimating effective tax rates and profit shifting to ensure the best available robustness to my tests. At the end of this chapter, I will discuss the discrete application of all models to the dataset. Even though all models differ in theory and data selection, the final application follows a widely similar approach and can therefore be described together for the sake of conciseness.

Effective Average Tax Rates

The second model approaches effective tax rates from a slightly different understanding.[38] It bases on the interpretation of value-generating companies as potential investment choices (Devereux and Griffith 1998). Accountants occasionally calculate the present value of a firm

[36] Unfortunately this can hardly be controlled for regarding the mentioned weaknesses of Orbis data. At least not without accepting considerable error margins and inconsistencies, which would furtherly complicate my model and reduce the already small sample size of companies with valid data. However, with a larger dataset or better data density, a model with reference to capital/financing structure of firms seems an approach worth trying.
[37] A complete description of all data cleaning measures can be found in appendix X.
[38] Since cash flows are not taken as a tax base from the fiscus, not all data-cleaning measures of model one make sense here. However, at least step four (drop companies with less than three observations) and an adjusted version of step five (drop companies with negative *cash flow* sum throughout the entire observation period) are applied to this model, too.

by the sum of generated cash within a specific future period discounted by the return rate of a low-risk investment alternative in the same period:

$$R = \sum_{t=1}^{n} \frac{net\ CF_t}{(1+i)^t}$$

With *R* being the net present value of a firm in t=1, *n* the total number of business periods, *net CF* being the net cash inflow, and *i* being the interest rate of low-risk investment. To estimate the average effective tax rate during a given period, this model calculates how its tax burden reduces the value of a firm from an investor's perspective. Therefore, the same formula is again applied to add the total tax paid:

$$R^* = \sum_{t=1}^{n} \frac{net\ CF_t + tax_t}{(1+i)^t}$$

With *R** being the firm value without tax burden and tax being tax paid during period *t*. One can now estimate the effective tax rate can by the amount to which tax reduces the firm's value.

$$\frac{R^* - R}{R^*}$$

The advantage of this approach is that it does not suffer the same problems as the first model regarding which shares of profits are taxable and which are not. From an investor's point of view, which expenses or revenues are tax-relevant is of minor importance. How successful a firm is as a *cash-generating organization* is in the center of investor interest when evaluating it compared to alternative investment options. And, considering my research aim, to what extent Germany's tax burden diminishes these cash gains.

Unfortunately, Orbis data availability also limits this approach, though differently from previous models. Orbis itself provides only an elementary version of cash flow, defining as profit/loss plus depreciation. Still, with a little bit of additional effort, one can calculate the *operative* cash flow more precisely. But, Orbis does not contain data at the same detail level for investing activities like purchase or sales of production capital, which I would require to calculate an accurate overall cash-flow value. I have to use net profit/loss values as a proxy for the investing and financing cash flow. Hence, this is again an *estimate*. The formula I use to estimate firms' cash flows looks the following:

(overall) profit/loss for the period
+ deprecation
+ net changes in stock/inventory (as unrealized profit)
+ accounts receivable
- accounts payable

On the one hand, this estimate widely overcomes the limitations of method one[39]. On the other hand, it comes with its other imprecisions. Following the overall motivation of this mixed model approach to get the *best available estimate* of unequal taxation treatment between firms, all models must therefore be seen as a bigger picture, having the most significant explanatory power when considered all together.

Estimating "True" Profits

The first and second models use the reported profits of a firm as a starting point to calculate effective tax rates. The following reaches beyond this stage of accounting. Some measures of tax avoidance affect a firm's reported profits at very early levels. For instance, transfer (miss)pricing, as described in chapter two, artificially ramps up the operative expenses and consequently distorts the operative result directly. Debt shifting and licensing fees (as for intellectual property) at least influence the financial result[40].

In economic terms, firms use input factors (labor and capital) and add value to these factors (by some kind of transformation) to generate profit. Therefore, several researchers use production functions to estimate "true" profits and unveil potential tax avoidance practices reducing reported profits (Huizinga and Laeven 2008; Hines and Rice 1994; Wier and Reynolds 2018). I add this approach as a last component of the mixed model. In the first step, I run a regression to estimate the average transformation rate of assets and labor into profits. By using a logarithmic regression, I got a high R^2 of over 80 percent[41]. The regression has the following formula:

$$\log(P) = a * \log(K) + b * (L)$$

[39] Another advantage of the EATR model is that the German GAAP's (HGB) main purpose is the assessment of shareholder demands (*Anspruchsbemessung*, see Zimmermann et al. 2014), while tax accounting focusses on fiscal demands. Orbis data should therefore report the financial result of a given period relevant to shareholder demands (which are part of the cashflow) widely accurate. To therefore look directly at the cashflow available to shareholders/business partners as it is reduced by taxation could circumvent the inaccuracies described in the previous model, which result mainly from the Orbis (HGB) EBIT/EBT as a calculation base where we would actually need the tax accounting EBT.

[40] Depending on the particular use of e.g. loans or licenses these expenses can be accounted at either the operative level or the financial level.

[41] 0.8123 and 0.8121 when adjusted to the number of explanatory variables.

The difference between expected profits going by the average factor productivity of the energy sector and reported profits in the Orbis data can estimate profits potentially shifted out of the reach of German tax authorities. Of course, low factor profitability can also be the result of poor management or technology. Nevertheless, this is unlikely for large firms that operate over long periods without dropping out of the market.

Model Application

I will now explain how I apply all three models to the dataset. At the start, I export all of the required variables (each described previously) for all German energy firms in the dataset and each model from Orbis. Unfortunately, Orbis financial data is not as dense as data about ownership. Therefore, I suffered a significant loss in sample sizes at this point. To pay tribute to this deficiency, I will apply a t-test with degrees of freedom adjusted by *n* to test my hypotheses whenever possible. Financial data in Orbis covers the last ten years. I export all available financial data of that period. As a next step, I check for each of the ten years in which host countries are included in every company's ownership chain (at a higher position than the German firm)[42].

In contrast to just going by the year 2021, assuming ownership has not changed in the past, companies in my model only influence the statistics of host countries for as long as another company in that host country owns it. I see this is as a strong point of combining dynamic ownership reconstruction and economic research. It improves the overall accuracy of all three models. E.g., I can account for tax-motivated acquisitions like the intention to "acquire" the current losses of a firm to benefit from offsets (Hanlon and Heitzman 2010).

For model one (for special adjustments see appendix II-10), I sum up EBT and EBIT for every firm during the last ten years and divide it by their ten-year sum of tax paid. Next, I calculate the unweighted averages of these sums for each host country represented in my dataset (e.g., the Belgian sample includes all German energy firms owned by a Belgian entity at *any* level). The process is repeated with a weighted average, weighted by reported profits.

For model two, I calculate the net present value of every firm through all available years[43] (with a threshold of 3 available years to be included in the set). In a second step, I calculate the net present with the tax-added version of cashflows. I again allocate the results to owning host

[42] I first tried to differentiate this by creating different datasets depending on host countries of the global ultimate owner, direct controlling shareholder and intermediary positions but had to drop this idea because the sample sizes got too small to serve for quantitative research.
[43] Assuming t-10 is the initial year of investment.

countries and calculate weighted and unweighted averages. I weigh the averages by the net present value after-tax.

For the third model, I divide the difference between estimated real profits and reported profits by estimated real profits for every firm in each host-country sample. Again, I calculate both a weighted and an unweighted average for each host-country sample. This time, I use the absolute amount of estimated profits to apply the weighting. The result indicates what percentage of the estimated real profits have been artificially reduced by tax avoidance measurements.

Identifying NBFIs and Renewable Energy Companies

To check H6, I define NBFIs as entities whose NACE core codes start with 64 or 66 but are not banks (going by Orbis entity type classification). Theoretically, companies within the NACE code range 65XX (insurance companies) would also count as NBFIs. However, since insurances are mostly (like banks) financially regulated somehow, they do not necessarily fall in the category of financial market participants increasing systemic risk considerably (see chapter 2). For H6, I then check how the share of NBFIs has developed over time. For H6.1, I check if NBFIs as controlling shareholders appear particularly often in secrecy jurisdictions.

To check H7, I first have to identify renewable energy companies within the dataset. Unfortunately, Orbis' NACE classification is not fine-grained enough to identify those. I, therefore, compare all companies in the Orbis dataset with companies in another energy firm date set of the BNA, the *Marktstammdatenregister*[44]. The dataset of the BNA lists all power generating units in Germany categorized by energy source. Moreover, it also lists the tax identification number (VAT) according to owners. I match these VAT numbers with the VAT numbers of the companies in the Orbis data and thereby identify which companies generate renewable energy. Unfortunately, not all firms in the Orbis dataset list with VAT numbers. Therefore, I additionally apply a string search for the terms "WIND," "SOLAR," "BIO," "HYDRO," "WASSER," "RENEW," "ERNEUER," "GEOTHERM," "PHOTO," "WATER," "NATURGAS," "NATURE," "NATURAL" and "SUSTAIN" to all firms' names in the sample. Last, I check to what degree NBFIs, non-holding-NBFIs, and entities located in secrecy jurisdictions include firms identified by this method in their FDI portfolios.

Results

After applying the reconstruction algorithm to the dataset of 2021, I got 154 unique historical versions of it, reaching 1599 to 2021. Of course, the number of firms considerably increased

[44] Available at https://www.marktstammdatenregister.de/MaStR/Datendownload

over that period. Most probably, an actual increase of firms over time *and* improving coverage rates of the Orbis database are responsible for this expansion. Because it is hard to estimate each factor's exact contribution, this thesis preferably works with proportions rather than absolute numbers whenever possible. The reader can find detailed information about the difference in the size of the samples in appendix I-5. The tables and diagrams following appendix I-5 furtherly cover all the information the text of the current chapter contains. The oldest firm included in any reconstructed sample is a hydropower station founded in 1599 that is still in operation, the "Ramsauer Talmühle KG". In those early years, sample sizes stayed small, resulting in six energy firms in 1847. From that year on, potentially caused by the first industrial revolution, firms increased more than tenfold to a count of 81 in 1886. After a short period of slow growth, electrical firms again almost triple their count from 104 in 1896 to 298 in 1914.

From 1914 until the year of the German reunification in 1990, I observe a long period of slow, steady firm count increase up to some 1412 firms in 1990. It is the following period that is particularly interesting for this thesis. The German energy market has substantially changed its shape at least once since 1990. To analyze the details and consequences of these changes is of central interest to my research, which is why most models focus particularly on the years after 1990. The count of German energy firms has increased to 40244 in 2021 (with a rapid growth phase from 1990 to 2012 and a steadily continuing growth rate until today). Despite this growth probably being influenced by an increasing coverage rate of the Orbis database, a growth rate of almost 300% over 30 years still sharply contrasts to any other 30-year period since 1599. Data asymmetries have unlikely caused this increase on their own or even the larger share of it.

Moreover, the average length of ownership chains containing German energy companies has risen significantly since 1991. This increase is even more significant when considering international companies exclusively. In 1991, the average ownership chain of internationally involved German energy companies was about 2.25 (1.89 in the overall sample). That value has risen to 4.22 (2.12 in the overall sample) in 2021. Almost 50 percent of this increase happened between 1998 and 1999 when the first version of the EnWG realized the EU guidelines of the first market liberalization act of 1996 in Germany. Ownership chains during that period not only became longer on average, but they also became more international. In 1991, about 5.5% of all ownership chains in the dataset (including single German energy firms with no subsidiaries or controlling shareholders) contained connections to foreign countries. This share has risen to about 9.3% in 2021.

However, during this internationalization process, inward and outward subsidiaries in the German energy sector have not increased equally. In 1991, German energy companies had 84 subsidiaries in other countries, whereas foreign companies owned 16 subsidiaries in the German energy sector. These values changed to 90 (German subsidiaries) and 42 (foreign subsidiaries in Germany) in 1996. In 2021, German energy companies have 1398 subsidiaries in other countries, whereas foreign companies own 2367 subsidiaries in the German energy sector. Considering not only the count of subsidiaries but also the position and length of international ownership chains (using the GUO indicator of chapter 4), the average GUO score of German energy companies within international ownership chains has "dropped"[45] from around 0.59 in 1991 over 0.66 in 1996 to approximately 0.68 in 2021. The average GUO score of all countries in the sample rose from 0.77 (1991) to 0.635 (1996) to 0.632 (2021) (unweighted average of all countries, two-digit rounded values). Using a sample average with each country weighted by the number of ownership chains it is involved in, this rise was even sharper, starting at about 0,89 in 1991 over 0.78 in 1996 to about 0.57 in 2021.[46] Due to these results, I accept H1.

Within the ownership chains containing firms located in foreign countries, I also observe the rising participation of firms located in both sink and conduit secrecy jurisdictions. In 1991, about 1% of all international ownership chains contained countries from sink or conduit secrecy jurisdictions. In 1996, 0.07% of all international ownership chains included sink jurisdictions, and 0.74% contained conduit jurisdictions. In 2021, the share of sink jurisdictions in international ownership chains rose to about 7.4%, whereas conduit jurisdictions' share rose to about 31.9%. Therefore, I accept H2.

Additionally, I observe an increase in normalized betweenness centrality of conduit nations from zero in 1991 to 0.0085639 (0.0085639 weighted by the number of ownership chains every country is involved in) in 1996 and to 0.01036 (0.01664) in 2021. These numbers are hard to interpret by themselves[47]. However, compared to the average betweenness centrality score of all foreign jurisdictions, one can see that these "special" jurisdictions are utilized as conduits within ownership chains significantly more often than other countries. I accept H2.1.

[45] I use dropped in exclamation marks since a low indicator value actually means a high GUO score, see chapter 4.

[46] One must note here that my sample does not include foreign energy companies owned by German non-energy companies, but German energy companies owned by foreign non-energy companies. It could therefore indeed be that the rise in international inward subsidiaries gets equaled out by outward energy subsidiaries of German non-energy firms. However, this thesis does not focus on financial balances between countries. The main objects are questions concerning the energy sector internally (meaning nationally in this case). Outward subsidiary count of German energy companies is therefore an indicator reflecting size and/or influence within the sector in relation to inward international influence and should not be taken as a measure to reflect inequalities in the payment/investment balance between countries.

[47] Mathematical reasoning in chapter 4-

I also observe that sink jurisdictions categorically show a higher[48] GUO score than other countries. In both 1991 and 1996, the GUO score of sink jurisdictions was 0.5, this value rose up to 0.46345 (0.40995 weighted) in 2021. These numbers indicate that firms located in sink jurisdictions averagely take much higher positions in ownership chains than both German firms and the average international firm. Due to these results, I accept H2.2.

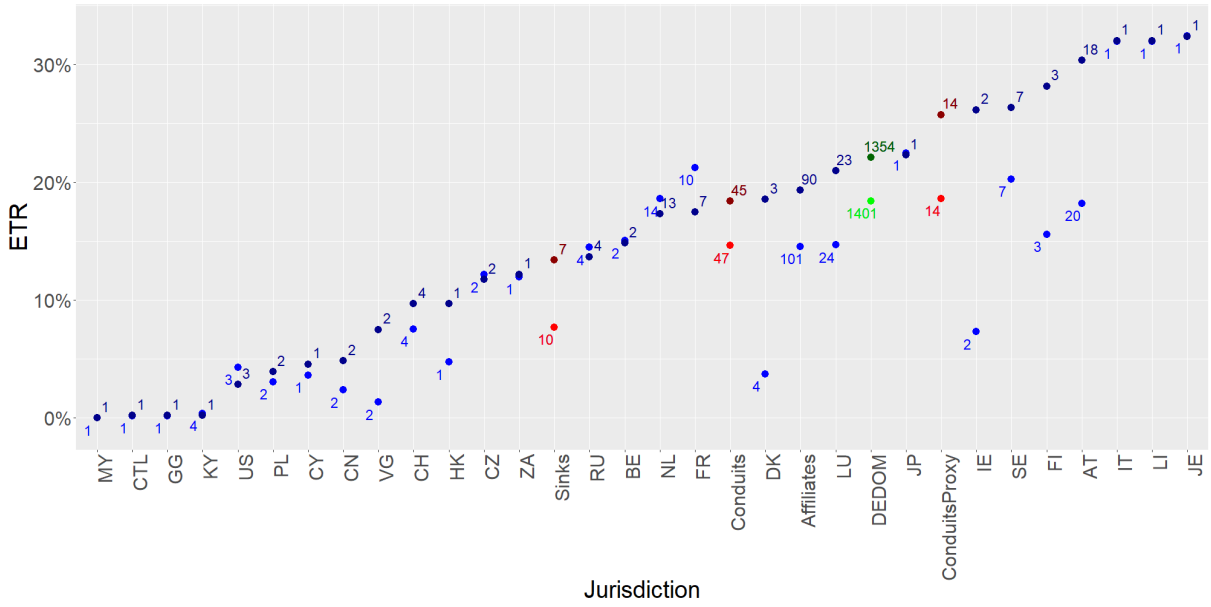

Figure 8: Unweighted effective tax rates of energy firms located in Germany and owned by entities from different jurisdictions at any level from 2013 to 2020. Light colours represent EBIT-ETRs, dark colours represent EBT-ETRs. Sample sizes are displayed as small numbers next to the dots in matching colours.

Looking at the interplay between the conduit and sink jurisdictions, the data shows that in both 1991 and 1996, there were no ownership chains involving both sink and conduit jurisdictions. This changed in 2001 when about 12.2% of all international ownership chains involving conduits also involved sink jurisdictions. The overall share of sink jurisdictions within all international ownership chains amounted to about 2.5% in the same year. Interestingly, this value sank over time until, in 2011, the overall share of sinks within international ownership chains (about 3.7%) surpassed the share of sinks within chains containing conduits (about 3.6%). In 2021, the share of sinks within conduit involving chains is about 5%, while the overall share within international chains is 7.4%. These numbers alone could indicate that conduits and sinks have become two independent systems. However, this perception changes when looking at ownership chains with higher complexity (length). Suppose, e.g., we consider chains of a length of at least seven involved entities. In that case, the share of conduits within sink-

[48] Higher in this case means lower in numbers, as stated on the previous page

containing chains (about 12.5%) remains higher than that of sink-containing chains within all international ownership chains (9.5%).

When switching the perspective and checking for the share of conduit jurisdictions within chains containing sink jurisdictions, I found 55.6% in 2001 compared to an overall share of conduit jurisdictions involving chains of 11.3% within all international ownership chains. In 2021, 21.6% of all ownership chains containing sink jurisdictions also contained sink jurisdictions compared to a share of conduit jurisdictions within all international ownership chains of 31.9%. Again, this proportionality changes with ownership chains becoming more complex. In a subsample of chains of a length of at least seven, 94% of all chains containing sinks also contain conduits. Even in the overall sample of international ownership chains with a minimum length of seven, this share of chains involving conduits is very high, at 71.2%. I can therefore accept H3 only under the premise of long ownership chains (length of five or more).

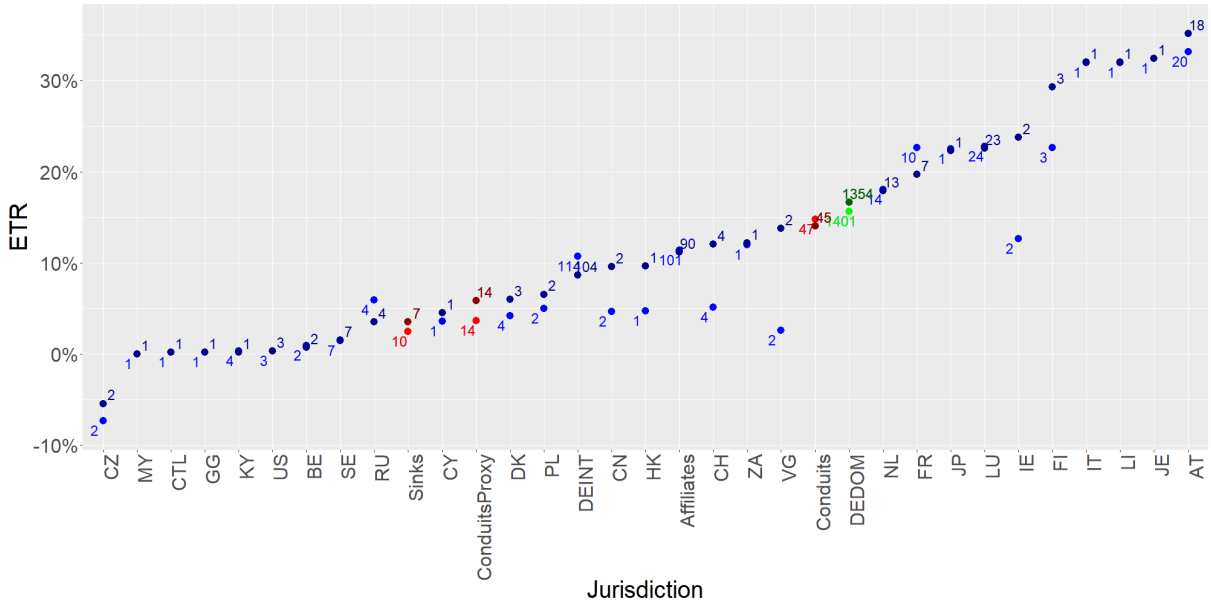

Figure 9: Weighted effective tax rates of energy firms located in Germany and owned by entities from different jurisdictions at any level from 2013 to 2020. Light colours represent EBIT-ETRs, dark colours represent EBT-ETRs. Sample sizes are displayed as small numbers next to the dots in matching colours.

The results for the ETR model (figure 8 and 9) show that looking at an unweighted average, firms owned by sink jurisdictions at an upward level in their ownership chain paid an average of 13.4% tax on their (Orbis) earnings before tax throughout the last ten years. Going by the (Orbis) EBIT, the average tax rate amounted to 7.7% throughout the same years. Regarding conduit jurisdictions, the EBT-ETR is 18.4%, whereas the EBIT-ETR shows at 14.6%. The average EBT-ETR of all foreign affiliates is 19.3% and their EBIT-ETR 14.5%. Wholly domestic German firms (no international firms within the ownership chain or independent

firms) paid an average of 22.1% tax on their EBT and 18.4% on their EBIT. Firms owned by foreign countries *through* conduit jurisdictions (conduit jurisdictions taking an upper position in the chain but are not the GUO) paid 25.7% tax on their EBT and 18.6% on their EBIT. Once I weigh the average ETRs by the firms' profit (EBT, EBIT), the statistics change significantly. Firms owned by sink jurisdictions now paid a (weighted) average of 3.5% tax on their EBT and 2.5% on their EBIT. Firms owned by conduit jurisdictions paid an average of 14.1% on their EBT and 14.8% on their EBIT. Affiliates paid an average of 11.2% tax on their EBT and 11.4% on their EBIT. Wholly domestic firms paid an average of 16.6% on their EBT and 15.7% on their EBIT. Lastly, firms owned *through* conduit jurisdictions paid an average of 5.9% tax on their EBT and 3.7% on their EBIT.

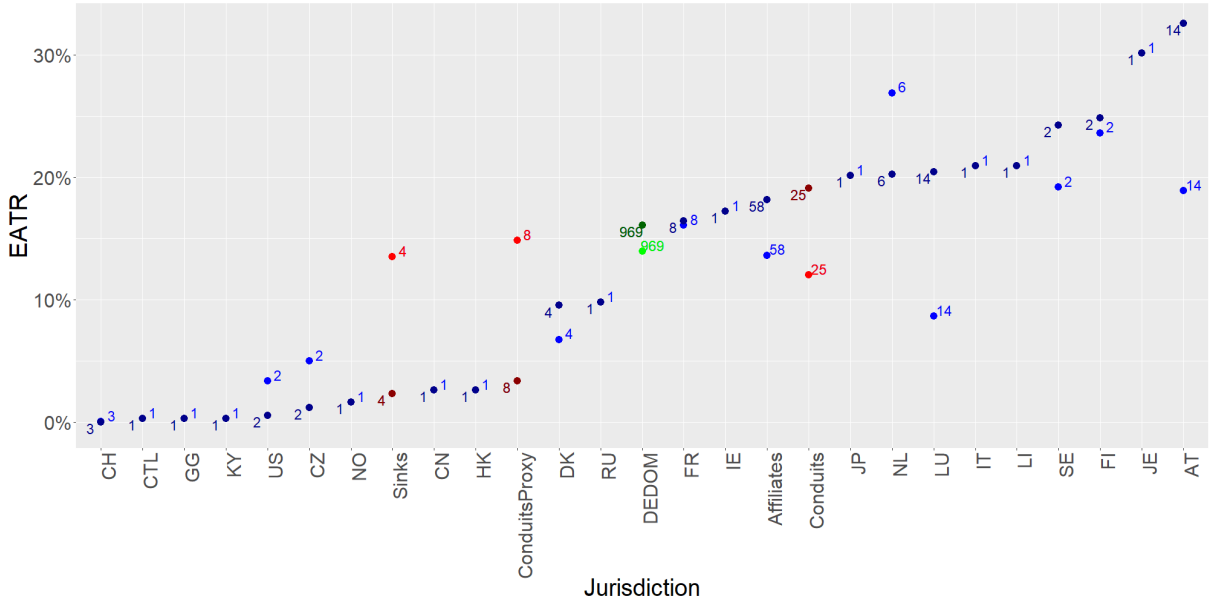

Figure 10: Effective tax rates of energy firms located in Germany and owned by entities from different jurisdictions at any level from 2013 to 2020. Light colours represent the unweighted EATR, dark colours represent the weighted EATR. Sample sizes are displayed as small numbers next to the dots in matching colours.

The EATR model (figure 10) gives the following results: The unweighted EATR over the last ten years amounted to 13.5% for firms owned by sink jurisdictions. For firms owned by conduit jurisdictions, the EATR amounts to 12%. Affiliates paid an average EATR of 13.6%. The EATR for domestic German firms amounted to 14%. Firms owned *through* intermediates located in conduit jurisdictions were affected by an EATR of 14.8%. If applying weights (by NPV before tax), the average EATR of firms owned by sink jurisdictions changes to 2.3%. Firms owned by conduit jurisdictions show weighted averages of 19.1%. Affiliates were subject to an average 18.2% EATR. The weighted average of domestically German firms' EATR amounted to 16.1%. Firms owned by intermediaries in conduit jurisdictions showed a weighted

average EATR of 3.3%. Taken together (Table1), the models show a very strong indication of sink jurisdictions as tax-avoiding instruments. Concerning conduits, I only find convincing significance when these conduits take intermediate positions, and the profit of included firms weights the sample's average. I generally accept H4 for sink jurisdictions and restricted to the case of a profit-weighted average when conduits are used for indirect ownership models.

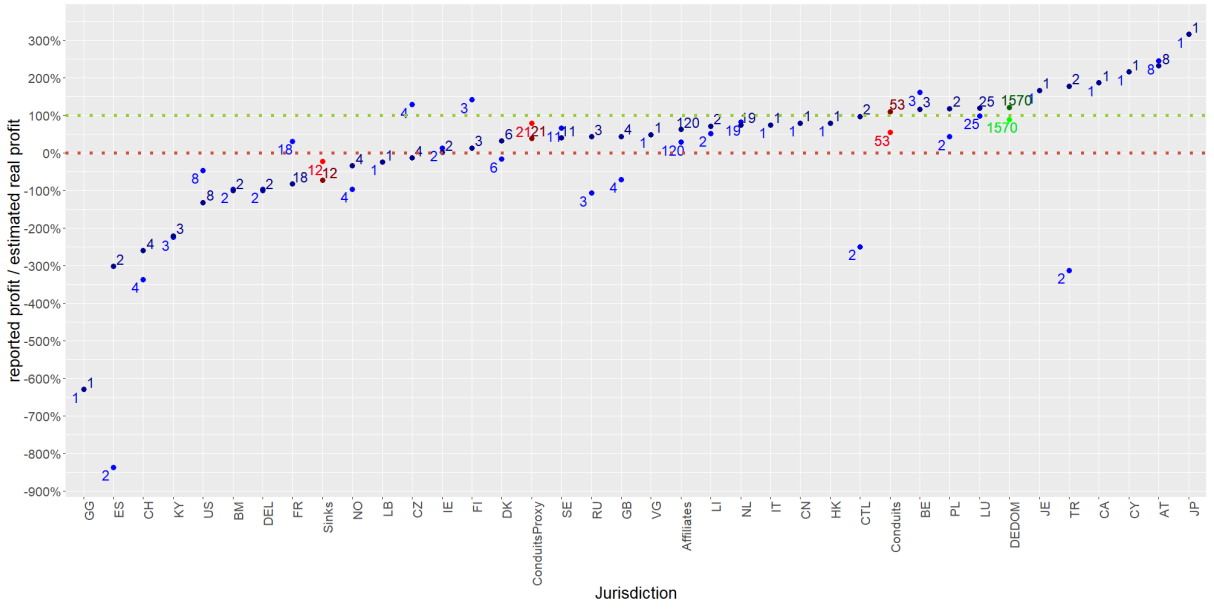

Figure 11: Share of reported profits of estimated real profits of energy firms located in Germany and owned by entities from different jurisdictions at any level between 2012 and 2020. Light colors represent the unweighted percentage, dark colors represent the unweighted percentage. Sample sizes are displayed as small numbers next to the dots in matching colours.

One last model (figure 11) concerning tax was applied using a profitability function to estimate "real" profits (chapter 4). In this sample, firms owned by sink jurisdictions averagely reported -23.5% of their estimated real profits. When this average is weighted by the estimated real profit of respective firms, it amounts to -72.3%. Firms owned by conduit jurisdictions averagely report 53.8% on average and 109.6% when weights are applied. Affiliates in general averagely report 28% of their estimated real profits and 62.2% respectively when weighed by their reported profits. Domestic German firms averagely report 88.9% of their estimated real profits; the weighted average is 120.7%. Firms owned *through* intermediary firms located in conduit jurisdictions averagely report 78% of their estimated real profits and 38.7% when the average is weighted. Table 1 shows the results of all models. A red-to-green color space is applied to the table from low to high separately for each row. Since some firm groups in this sample are rather small, a series of T-tests are applied to all models concerning tax. Those groups showing significantly lower tax rates compared to domestic German firms are marked.

One can see very clearly that especially firms that are owned by sink jurisdictions regularly seem to pay the lowest tax rates of all groups. Another interesting occurrence is that firms owned by conduit jurisdictions often seem to score very low tax rates on an unweighted average. In contrast, the weighted averages of this sample group do not appear to differ much from affiliates or domestic German firms. This observation reverses when looking at firms that are indirectly owned *through* conduit jurisdictions.

	Sinks	Conduits	Conduits indirect	Affiliates	German
EBT-ETR_UW	**13.4%±**	**18.4%±**	25.7%	19.3%	22.1%
EBT-ETR_W	**3.5%**(**)**	**14.1%**(±)**	**5.9%**(**)**	11.2%	16.6%
EBIT-ETR_UW	**7.7%***	**14.6%±**	18.6%	14.5%	18.4%
EBIT-ETR_W	**2.5%****	14.8%	**3.7%****	11.4%	15.6%
EATR_UW	13.5%	12.0%	14.8%	13.6%	14.0%
EATR_W	**2.3%***	19.1%	**3.4%*****	18.2%	16.1%
CD_Model_UW	**-23.5%±**	53.8%	78.0%	28.0%	88.9%
CD_Model_W	**-72.3%*****	109.5%	**38.7%****	62.2%	120.7%

*Table 1: Summary of models one, two and three. T-Tests applied in comparison to domestic German firms: *** 99.9%, ** 99%, * 95%, ± 90%. Signs within brackets show cross-ETR T-Tests (EBT-ETR lower than EBIT-ETR of domestic German firms)*

These firms do not stick out of the other sample groups when looking at unweighted averages. However, when weights are applied to the sample averages, these firms show significantly lower tax rates than domestic German firms in three of five (weighted) models. This finding could indicate that mainly large companies use complex, multilevel ownership constructions to optimize tax burdens, whereas small firms prefer simpler ownership models. I list affiliates as an aggregate group since (as discussed in chapter 4) at least some share of the difference in tax rates likely appears legitimately through interest or dividend payments not accurately depictured by Orbis data. However, there are various models in which sink or conduit jurisdiction-owned firms' tax rates differ from domestic firms and the average tax rates applied to affiliates. I strongly assume a systematic use of these jurisdictions for tax optimization measures instead of data or observation errors. I accept H5 for sinks. I furtherly accept it for conduits in the estimated real profit weighted sample when used for indirect ownership.

I will report the results concerning the involvement of NBFI firms in ownership chains in two versions. The first version defines NBFIs as financial businesses that are neither banks nor insurance companies (figure 12). The second version excludes holdings, too (figure 13). Even though there might be exploitation cases in terms of tax advantages or regulation avoidance, holdings are a standard vehicle to manage subsidiary portfolios. They offer various administrative efficiency and risk diversification advantages that cannot categorically be judged as offering “unfair” advantages or resulting from maliciously rent-seeking motives.

Nevertheless, they are financial businesses that are not regulated in the same way as banks or even insurances. Therefore, they must be included when discussing systemic financial risk, especially when estimating exposure to the financial instability that regulatory institutions do not catch. However, those NBFIs remaining after excluding insurances and holdings are either associated with extremely high amounts of investor protection, ergo secrecy, or unregulated financial intermediation (shadow banking). Businesses falling in the first category are primarily trusts or similar instruments. The second category includes financial brokerage, leasing, or fund management.[49] A differentiation between NBFIs (including holdings) and non-holding NBFIs accordingly appears appropriate to distinguish between ownership structures that can be expected to expose the energy market to different intensities of systemic financial risks. (NBFIs – "medium" financial risk, non-holding NBFI – high financial risk).

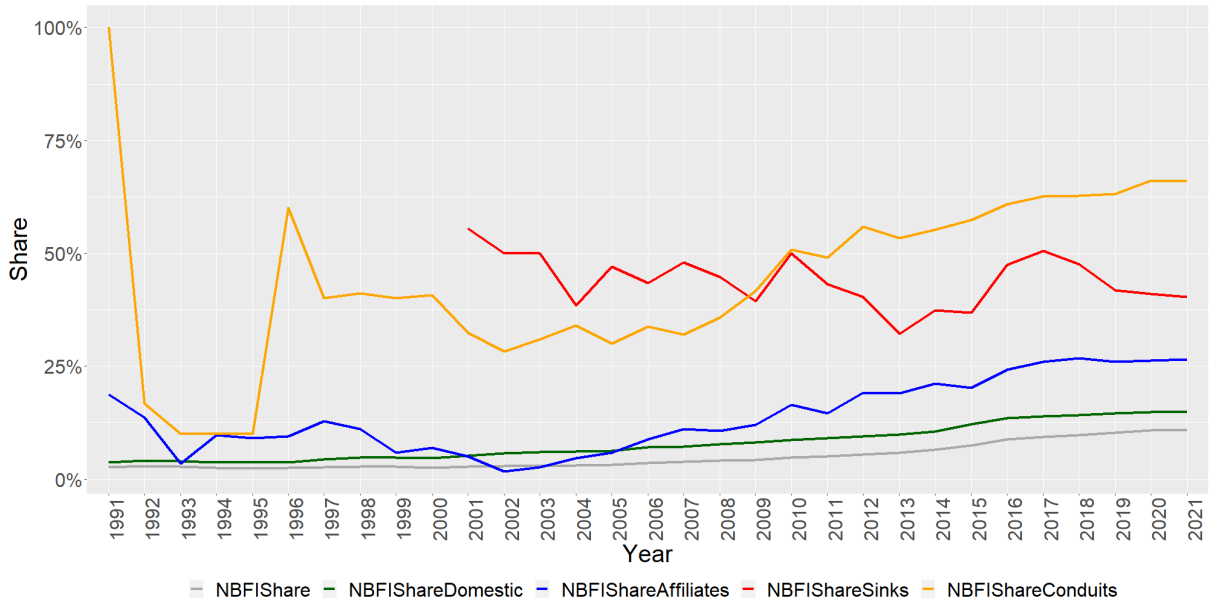

Figure 12: Share of NBFI-owned energy firms located in Germany within different samples between 1991 and 2021. Gray represents the overall sample.

The results show in the overall sample (including independent companies), NBFIs owned 2.6% of German energy companies in 1991, 2.5% in 1996, and 11% in 2021. Concerning non-holding NBFIs, the respective shares amounted 0.4% in 1991, 0.3% in 1996 and 3.4% in 2021. As always, a sample including all inward affiliates of foreign companies is included as a second control group. In this sample, the NBFI ownership share amounted to 18.8% in 1991, 9.5% in 1996, and 26.5% in 2021. The non-holding NBFI ownership share amounted to 0% in 1991 and 1996 and 10% in 2021. Within companies owned by sink jurisdictions, the share of NBFI-owned companies was 0% until 2000, 55,6% in 2001, and 40.3% in 2021. Concerning no-

[49] For a detailed overview see NACE rev.2

holding NBFIs, these shares amount 0% until 2004, 17.6% in 2005 and 27% in 2021. NBFIs owned firms owned by conduit jurisdictions at a share of 100% in 1991, 60% in 1996, and 66% in 2021. Excluding holding companies, these values change to 0% until 2003, 1.9% in 2004, and 32% in 2021.

To compare these values to a wholly domestic reference group, I create a subsample of ownership chains with a minimum length of two that include no non-German entities. I do this to prevent independent firms from distorting comparability. The overall dataset includes many independent firms ("chains" with a length of one) located in Germany, but not a single independent foreign firm as these are not selected by the initial Orbis search scheme (see chapter three). In this sample, the NBFI share among controlling shareholders was 3.7% in 1991 and 1996 and 15% in 2021. No holding NBFIs accounted for a share of 0.6% in 1991 and 1996 and 3.5% in 2021. I accept H6, including H6.1.

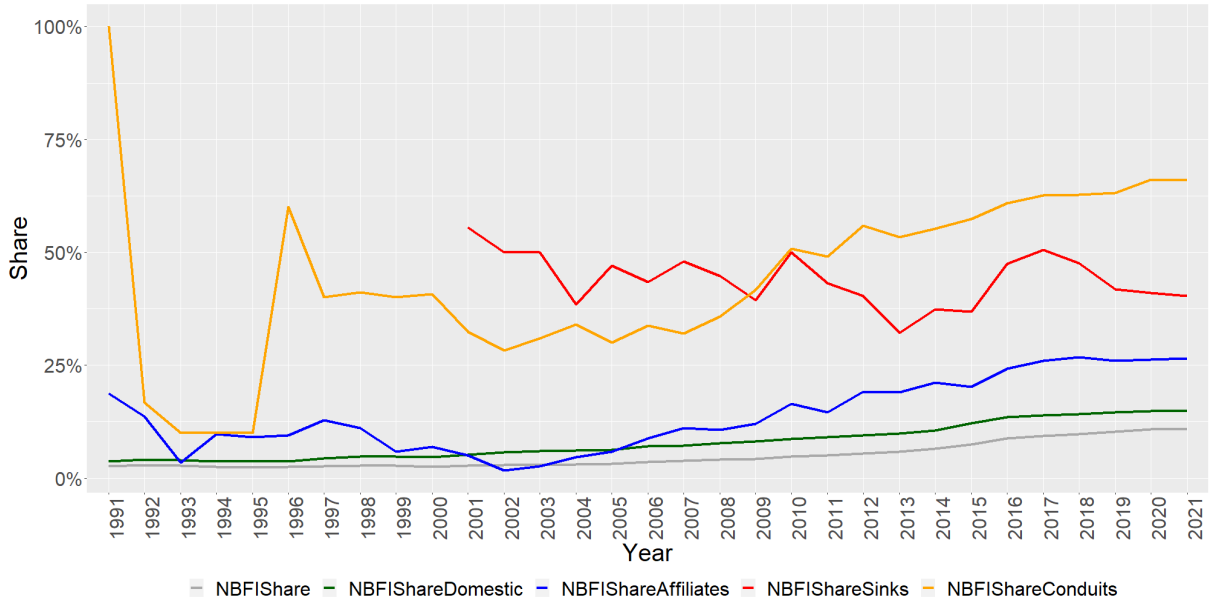

Figure 13: Share of NBFI-owned energy firms located in Germany within different samples between 1991 and 2021. Gray represents the overall sample.

Looking at the portfolio of firms owned by NBFIs, I observe a focus on renewable energy in 2021. For the case of non-holding NBFIs, this focus appears to be even stronger (figure 14). Besides two exceptions (domestic German firms with a non-holding NBFI owner and conduit-owned firms with an NBFI owner[50]), NBFI-owned and non-holding-NBFI-owned firms are more often renewable energy firms compared to their equivalent samples not filtered by owner

[50] Note that from this point on, independent firms are included in the domestic sample again.

entity type[51]. The highest share of renewable energy companies is held by non-holding-NBFIs located in sink jurisdictions. In 2021, non-holding-NBFIs own 71 firms, of which 60 are primarily active in renewable energy production, investment, or distribution. This results in a share of 84.5%. The prevalence of NBFI-firms for renewable energy investment, however, appears to be a recent phenomenon. Until 2000, the highest share of renewable energy firms throughout all samples included in the comparison of this section is observed in the domestic German sample. I accept H7 judging by the observed prevalence of NBFI firms and firms located in secrecy jurisdictions for renewable energies regarding their investment choice.

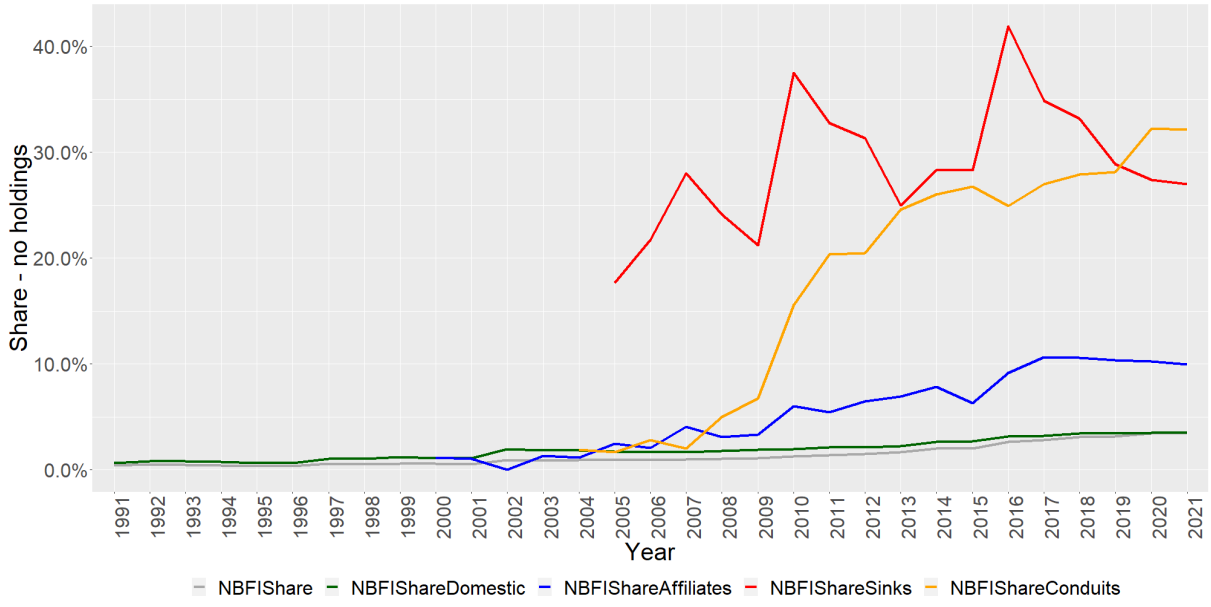

Figure 14: Share of non-holding-NBFI-owned energy firms located in Germany within different samples from 1991 to 2021. Gray represents the overall sample.

Discussion

Development of the German Energy Sector

These results show, without a doubt, that the ownership network of the German energy sector has immensely evolved within the last 25-30 years. New competitors have been continuously entering the market, and the share of trans-border ownership has significantly risen. Alongside this internationalization, the role of Germany within trans-border ownership relations concerning its energy sector is slowly transitioning from *net proprietor* to *net property* as an increasing number of German energy firms become owned by international investors. In contrast, the increase of foreign subsidiaries owned by German energy companies does not rise at the same rate. Compared to both 1990 and 1996, ownership models (particularly the

[51] e.g. the overall affiliate sample includes less renewable energy firms than the NBFI/non-holding-NBFI affiliate sample etc.

international type) have become increasingly complex if assessed by their chain length. Over the last 25-30 years, the German energy sector has increasingly become subject to these complex ownership chains in which it averagely takes relatively low positions.

Today, the German energy sector maintains several international ownership relations with other jurisdictions in both directions (as owner and as a location for subsidiaries). However, not all relations between Germany and other jurisdictions are of the same kind. In 2021, German energy companies have the most subsidiaries in Italy (223) and Spain (203), while most impactful foreign investors usually locate in different jurisdictions (Table 2). In this thesis, I have shown that the participation of secrecy jurisdictions in the German energy sector has considerably increased since 1991 and 1996. These jurisdictions (full list at appendix II-6) are not known for hosting large energy companies that "conventionally" expand their business operations to Germany like Sweden (Vattenfall), Russia (Gazprom) or Norway (Statkraft). Instead, they have a reputation for offering advantages of financial efficiency when acting as either intermediate owner (*conduit*) or ultimate owner (*sink*) - (mainly through tax and regulation reduction, chapter 2).

ISO	Turnover	Sample Share	n	per Firm	n All	Estimate	Share Estimate
DEDOM	276402515	70.91%	4078	67778.9395	41158	2789645592	70.69%
Conduits	85457808.9	21.92%	132	647407.643	1265	818970668	20.75%
SE	42565109.9	10.92%	18	2364728.33	98	231743376	5.87%
ConduitsProxy	30210848.8	7.75%	47	642784.017	544	349674505	8.86%
NL	26396888.9	6.77%	36	733246.914	288	211175111	5.35%
CTL	21702794.6	5.57%	5	4340558.91	25	108513973	2.75%
LU	21228096.4	5.45%	57	372422.744	445	165728121	4.20%
NO	19618334.2	5.03%	5	3923666.84	15	58855002.7	1.49%
RU	18432522.6	4.73%	5	3686504.53	18	66357081.5	1.68%
Sinks	14078035.3	3.61%	40	351950.882	291	102417707	2.60%
US	12993294.9	3.33%	9	1443699.43	30	43310983	1.10%
KY	12649771.5	3.25%	5	2529954.31	13	32889406	0.83%
GG	12237410	3.14%	1	12237410	1	12237410	0.31%
BE	9922953.1	2.55%	11	902086.645	72	64950238.4	1.65%
FI	6263096.52	1.61%	7	894728.074	51	45631131.8	1.16%
IE	6253896.9	1.60%	5	1250779.38	74	92557674.1	2.35%
FR	4571625.89	1.17%	22	207801.177	137	28468761.2	0.72%

Table 2: Turnover statistics of energy firms located in Germany and owned by entities located in different jurisdictions between 2012 and 2020.

Both the proportion of ownership chains containing today's most prominent conduits and their focus on intermediary ownership positions have risen considerably since 1991 and 1996. Two conduits are particularly noteworthy in the case of the German energy sector. The Netherlands and Luxembourg are the only jurisdictions in my sample to consistently maintain a high number

of representations and a high betweenness centrality[52]. There is a similar tendency for the case of sinks as both representation number and GUO focus of these jurisdictions have risen since 1991 and 1996. Liechtenstein, Malta, and British Overseas Territories (particularly Bermuda, the Cayman Islands, and the British Virgin Islands) being the most noteworthy sinks. Another interesting and unexpected observation is that Spain, since 2016, has appeared as a popular conduit for German *outward* investment as it connects German energy firms to their subsidiaries in America (Argentina, Brazil, Chile, Honduras, Mexico, Peru, USA), in Asia (China and India) and in eastern European states (Croatia). Those connections seem odd as they do not include any secrecy jurisdictions but connect German GUOs to countries with less geographical distance to Germany than Spain. Even though Spain is not typically known for offering preferential legal options to corporates on a large scale, MNEs could certainly take advantage of some conditions in Spain (untaxed capital gains, favorable tax system for patent royalties). Spain's emerging role within the international energy sector would be an interesting subject for further examination. If aiming to describe every detail of the development of the German energy sector since 1991/1996, this text would become very extensive. However, the appendix' figures 26,27,29 and 30 and the interactive network graphics (https://maxmlgz.github.io/Masterthesis/) give a good outline of the proportions, positions, and relations of the jurisdictions included in my dataset through time.

Periods of rapid change and potentially connected factors

As already mentioned, this thesis does not include a comprehensive model of explanatory kind. However, I will mention some of the most significant irregularities in the development process of international ownership chains within the German energy sector to open up new questions and offer subjective suggestions about possible underlying reasons. There are some periods of rapid change within the observation range of this thesis. First up, as figures 21 and 22 show, there was a massive jump in length of international ownership chains on the one hand and share of international ownership chains among all German energy firms on the other hand from 1999 to 2000. There were two major political decisions in and right before that years: The EnWG of 1998 and the EEG of 2000. Both decisions (for details, see chapter 2) introduced a substantial change to the market conditions in the German energy sector. Having a closer look at this period and these political initiatives could certainly shed more light on driving factors behind (particularly) complex ownership chains, especially considering that the two policy packages

[52] „consistent" needs to be understood as a relative term as both jurisdictions have shown a high value in both representation number and betweenness centrality compared to other jurisdictions in the sample throughout the complete time range of observation. Nevertheless, both values still have risen furtherly through the years.

are very different from the EnWG especially focusing on liberalization and free access to the market and the EEG especially focusing on the funding and prioritization of renewable energies.

Additionally, I noticed a drastic decrease in average betweenness centrality of conduit jurisdictions from 2014 to 2015, which is to a major share caused by a decrease of the betweenness centrality of Switzerland. 2015 was the year of the "Swiss Leaks", a major data leak of the Swiss bank HSBC which unveiled confidential information about a tax evasion scheme involving tens of billions of Euros from international accounts all around the world (Naheem 2015, 2018). Even though previously (before 2015) existing connections with Switzerland in my dataset were not cut in 2015, it could be possible that subsequent international investors prefer other conduits for their foreign investment from that point on. Notably rising in betweenness centrality between 2014 and 2015 is Honk Kong. It can be that those jurisdictions just got more prominent as conduits due to general economic growth and rising demand for cost-effective foreign investment schemes in Asia. In favor of that theory is that other major data leaks like the "Lux Leaks" in 2014, the "Panama Papers" in 2015 as well as the "Paradise Papers" in 2017 did not cause major shifts in the network structure. However, this difference could also occur because the Swiss Leaks shed light on *illegal* activities of *corporates* (Naheem 2015, 2018) in contrast to other leaks primarily containing data about private persons (Panama Papers - (Obermayer and Obermaier 2017)) or client-exclusive, but eventually legal data about corporates (Lux Leaks, Paradise Papers - (Huesecken and Overesch 2015; Crabb 2017)). I want to point out the connection between data leaks and shifts in ownership networks as an interesting case for further research.

As the last thing about periods of considerable change within the ownership network, I want to mention the rapid growth of conduit jurisdictions since 2007. There were (certainly among other factors with potential impact) two major events in this year that can be expected to be strongly related to this occurrence. One is the end of cost-based electricity price regulation by German authorities in 2007 and the change to fixed maximum profit margins as regulatory price caps for energy generators (chapter 2). The other event is the global financial crisis of 2007-2008, which indisputably had a substantial impact on international business practice in every sector. Both events could be plausible for the following reasons: The end of cost-based energy prices put more pressure on market competitors, which could have served as an access point for large multinationals using conduit jurisdictions for cost-efficient finance and tax management to outcompete domestic firms or those without access to ownership structures of similar efficiency. From an economic view, this argument makes a lot of sense since a switch to market-based price regulation policy inevitably enhances competition and cracks open past established

structures, particularly if these are not equally cost-efficient. However, there is another factor going along with the increase of conduit participation within international ownership chains since 2007, which is the synchronous rise of non-holding NBFIs among firms located in conduit jurisdictions and owning German energy companies. This share has risen ten-fold in just four years from 2% in 2007 to 20% in 2011 and then again to 32% in 2021. I discussed in chapter 2 that the financial crisis of 2007 caused a lot of *alerts* among politicians and central banks, and measures were introduced rewarding banks with economic benefits in case their balance sheets do not contain too many "venturous" items.

	NBFI	NBFI (no holding)	NBFI Conduits	NBFI Conduits (no holding)	NBFI Sinks	NBFI Sinks (no holding)
Turnover (10-year average)	119687896.9	39379133.59	61169085.97	16054261.94	581899.6272	123640.2279
Sample Share	30.71%	*10.10%*	*15.69%*	*4.12%*	0.15%	0.03%
n	578	204	78	30	17	10
per Firm	207072.486	193034.9686	784219.0509	535142.0647	34229.38983	12364.02279
N All (2021)	4800	1507	766	373	106	71
Turnover Estimate	993947932.6	290903697.7	600711793	199607990.1	3628315.322	877845.6182
Share Estimate	25.19%	7.37%	15.22%	5.06%	0.09%	0.02%

Table 3: Turnover statistics of NBFI-owned energy firms located in Germany between 2012 and 2020.

Ironically, this might be a regulation NBFIs can profit from. First, they can serve as venture capital lenders to substitute regulated banks that were *called to caution* by their authorities. Second, as discussed in chapter 2 as well, banks or other regulated (but profit-seeking) organizations (e.g., insurances) can instrumentalize NBFIs to cloak (or repack) their venture investments behind an "investor protection wall" of the legal system of a secrecy jurisdiction. Eventually, it is most likely that both discussed factors have influenced the rise of conduits *and* non-holding NBFIs located in conduits as owners of German energy companies, while the increase of overall international involvement (Figure 22) apparently got impeded between 2008 and 2011. However, this development is as striking as it is strange and, moreover, could potentially be dangerous, as I will discuss now.

Impact on energy safety, social justice, and national sovereignty

I already pointed out the rising number of NBFIs, particularly among firms located in secrecy jurisdictions, in the results chapter. Table 3 shows an overview of the ten-year average turnover share of NBFIs among all firms in my sample. Even though these numbers do not seem shocking at first, I want to particularly highlight the following thought: Taken together, energy firms that make up for over fifth (22.17%) of the turnover in the overall sector are either owned

by non-holding NBFIs or by NBFIs located in secrecy jurisdictions[53]. Since non-holding NBFIs are (as discussed in chapter two), poorly regulated and secrecy jurisdictions "standardly"[54] offer very opaque instruments of investor (including identity) protection, it is questionable if regulatory authorities are still able to correctly evaluate the financial stability, including the extent of exposure to systemic financial risk

Moreover, the market liberalization of the German energy sector apparently was and is weakly administered in terms of preventing abuse by MNEs to create tax advantages by including secrecy jurisdictions in their ownership chains. It also exposed the sector to an increased level of financial instability due to NBFI and shadow banking activities. But the motive behind the liberalization was to increase the efficiency of the energy sector by fostering free-market competition, resulting in reduced monopolistic profit margins (producer surplus) and therefore fostering economic welfare. In chapter two, I have discussed that energy prices have roughly doubled since the initial liberalization in 1996. Figure 14 shows that this increase cannot nearly be equaled out by increasing wages for employees of the energy sector. In fact, when subtracting the overall growth of the German economy from 1996 to 2020 (real GDP growth rate), wages even decreased by 0.53% relatively[55].

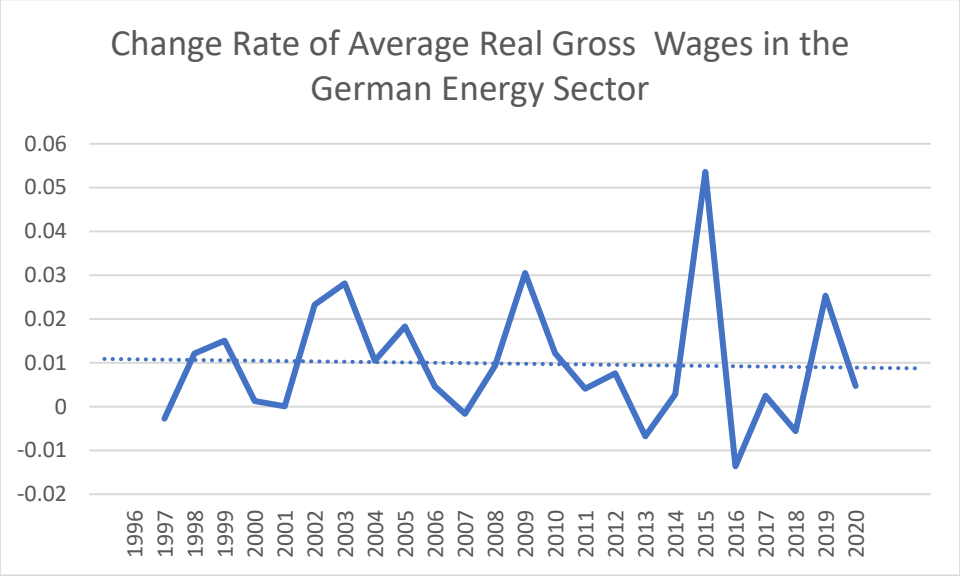

Figure 15: Change Rate of Average Real Gross Wages in the German Energy Sector from 1996 to 2020. Source: Statistisches Bundesamt

[53] Non- holding NBFIs (10.1%) + Conduit NBFIs (15.69%) – non-holding Conduit NBFIS (4.12% since those are included in both of the former and must thereby be subtracted once)
[54] In fact the three most impactful conduits in this sample (the Netherlands, Luxembourg and the City of London), as well as Switzerland are ranked exceptionally high on the *financial secrecy index 2020* of the Tax Justice Network, link: https://fsi.taxjustice.net/en/introduction/fsi-results
[55] arithmetic mean, 0.55% by geometric mean

So, in the end, we must ask the question of who really benefited from the liberalization yet. After all, the energy sector should be under particular supervision by regulation agencies. Not only because it embodies an essential part of the basic supply for German citizens but also because it regularly receives public subsidies that are funded by tax income. The fact that these funds are then partly exploited to *avoid* tax, creating market inefficiencies and unfair competition towards small and medium-sized as well as domestic competitors in the process, must be taken as a governmental failure in many ways. First, tax money is invested in projects that will not pay off from a fiscal point of view since they do not pay a lot of taxes (back). Second, the domestic economy cannot thrive in terms of profitability, efficiency, or innovativeness since they are simply outperformed by competitors having access to tax avoidance vehicles, mainly under the use of secrecy jurisdictions. Now, this outperformance does not necessarily happen because those competitors are more efficient (in terms of productivity) or innovative; we must also consider the possibility that their main competitive advantage and the reason for higher profitability of their business is *financial* efficiency by strategic reduction of tax burdens. Once this happens, a free market cannot sufficiently reward productivity differences among competitors anymore. Consequently, the prosperity free-markets can potentially create does not happen. Whether this is really the main reason why the liberalization of the energy market did not yet have the effects wished for cannot finally be answered by this thesis. International markets are highly complex, and uneven taxation is just one of many factors that can hinder welfare creation.

However, **I want to emphasize that tax avoidance and fragile financing have become an increasingly impactful reality in the German energy sector.**

So let us come back to the initial question of this thesis. Do the international structures that have evolved in the German energy sector throughout the last thirty years compromise national sovereignty? In my perception, the short answer is "yes." The long answer, however, depends on what we understand as sovereignty. The arguably most narrow definition of national sovereignty under the premise of multiple coexisting nation-states could be the ability to "reserve the monopoly of violence to those wielding legitimate authority" (Bartelson 1995). Now I do not think that MNEs could harm this "ground-level" of sovereignty now or in the foreseeable future. There are certain parts of the German legislation (Art. 14 (3) of the GG 1949; Art 115c (2) of the GG 1949)[56] that ensure total control over defense relevant assets within Germany's territorial borders in the case of a real foreign political crisis. Nevertheless, the preservation of territorial exclusiveness in the narrow sense of a state's ability to retain

[56] For comparison: https://www.bundestag.de/gg

ultimate territorial control when it is utterly necessary is arguably the most defining function of a nation-state. If this function started to crumble, I would dare to argue that states could justify their existence at all anymore.

However, a wider definition of sovereignty not only implies the ability to *preserve* territorial authority but also to *use* this authority for the good of those legitimating democratic governance, after all, its national citizens. Kofi Annan, former Secretary-General of the UN and Nobel Peace Prize recipient, put this understanding in the following words: "State sovereignty, in its most basic sense, is being redefined—not least by the forces of globalization and international co-operation. States are now widely understood to be instruments at the service of their peoples, and not vice versa […] In the context of many of the challenges facing humanity today, the collective interest *is* the national interest."[57] (Annan 1999)

When understood in this manner, I conclude that, regarding the energy sector, the sovereignty of the German government is indeed strongly offended by international business interests. When judged by its effectiveness to serve its people through political or administrative action, the German government performed poorly in some regards. The liberalization of the energy sector could not be converted into welfare by means of lower consumer prices or through higher employee wages. Instead, the sector has gotten exposed to a preferential tax regime heavily compromising competitive fairness on the domestic market. Moreover, the underlying finance behind energy-generating assets in Germany has gotten increasingly opaque and is nowadays not accessible to regulative authorities, to a considerable part.

Contrarily, the pace and consistency at which the government committed to the green energy transition must, in my view, be granted as a major accomplishment. The outcomes of the climate crisis are an imminent threat not only for Germany but for world citizens. The determination and effectiveness of the German government to pioneer sustainable energy sourcing is a splendid example of good governance. Unfortunately, instead of using this transition as a chance for a "clean slate" not only ecologically but economically, I observe in this thesis that the green energy market in Germany does not overcome any of the aforementioned crucial flaws. Though this statement shall not diminish the importance of the green transition and the consequent significance of the underlying political success, I argue that discussed problems of

[57] Annan actually uses these words to discuss the justification of international intervention in national actions/decisions in the prospect of humanitarian crises. These considerations go far beyond my context in their sharpness and urgency. To me, however, they give a good example of how serious the discussion about the sovereignty of nations in the meaning of responsibility for their people can and should become, even considering "milder" cases of injustice.

fairness, justice, and security are no inevitable consequences but rather a hindrance for this important progress.

Policy recommendations

In my view, there are multiple conflicts between nations and MNEs as well as between multiple nations interlinked by MNE activity. First off, the supreme goal of multinationals is usually (as discussed in chapter two) to maximize profits by seeking market share and increasing profitability. As previously discussed, the central goal of a (functioning) national government is the promotion of social and economic welfare for its citizens (Dunning 1991). Though these interests *can* be complementary to one another, they might as well conflict. In case of a conflict, the situation becomes even more difficult when the interest of two nations in which an MNE is an active conflict as well. In contrary to nation-states, MNEs are organized *across* borders. There is no state-like sovereign that politically covers the geographical range of MNEs (Vernon 1971). The existing cross-border political organizations (e.g., the European Union, the World Trade Organization, or the Organization for Economic Co-operation and Development) can more often than not either not represent a joint, unanimous aggregate of the interest of member nations or do not have the same legislative authority of nation-states. MNEs can therefore enjoy *cherry-picking* between different jurisdictions they operate in on many occasions while these jurisdictions must witness getting *played off* against each other.

The present case of international ownership structures is a perfect example of this dilemma. Tax and regulation avoidance through secrecy jurisdictions is exclusively possible under the presence of asymmetric and weakly aligned legislations among different nations. While secrecy jurisdictions usually profit from this asymmetry by attracting foreign capital, most industrialized and developing countries usually suffer by losing tax revenue, losing control over the financial entanglements of their domestic economies, and seeing their local markets losing their reward mechanisms to pseudo-efficient MNEs utilizing the financial benefits international ownership chains. This conflict of interest is clearly reflected in the categorical failure of all political attempts purposing a harmonization of tax systems internationally or even in the EU up to the present day. We can take one of the contemporary European attempts, the Common Consolidated Corporate Tax Base (CCCTB) proposal, as an example, which repeatedly failed because several European states (including Luxembourg, the Netherlands, Ireland, and Belgium – which are all evaluated as conduits in this thesis) refused to consent (Marini and Stoev 2017). In the end, though, it is questionable how sustainable the benefits of secrecy jurisdictions in this game of hide-and-seek are. There are several negative factors to consider for nations or jurisdictions that are or aim to become secrecy jurisdictions.

First, the attraction and financial reaping of foreign capital are eventually still heavily dependent on the legislation of the country that is the source of the capital. In that sense, economic growth caused by secrecy jurisdiction activity is not self-sustaining but reliant on the tolerance of foreign countries. At the moment, it indeed seems like most countries are not determined and/or competent enough to confront secrecy jurisdictions with firm protective countermeasures within their own national legislation. However, once this changes, secrecy jurisdictions that rely so much on "cashing" foreign assets will end up with an economy unable to provide its citizens with real productive value in the form of tangible commodities and goods. Second, there are indications that "too much finance" can ironically become financially inefficient for a host nation. Reasons for that are, among others, the oversupply of skilled labor in the finance sector, going in line with an undersupply in other sectors of the economy ("brain drain"). Additionally, the consumption of government time needed to deal with the regulation and control of an irrationally high amount of financial activity within the economy can put a burden on naturally limited fiscal resources (Shaxson 2018). In the end, it might therefore be of mutual interest to transition from a system of exploitive multilateral trade relations to a common legal basis building a foundational framework for fair and transparent trade of mutual acceptance. Initiatives like country-by-country reporting (note) are certainly a step in the right direction.

But relying on international legal bodies might be a brave decision when the condition of a nation's basic supply system is at stake. There are with no doubt possible improvements of the German national law that would, with a good chance, effectively counter the risks and flaws of the energy sector as it is now. For example, the requirements international investors have to comply with in order to invest in German energy firms are rather laissez-faire. While investors do have to prove that they have the necessary expertise to act as energy providers (§55a of the AWV 2013), detailed information about finance and ownership structures must be unveiled only *on spec*. The reasons for suspicion in this context stated in the legal text (§60 (2) of the AWV 2013) are rather bonafide and include criteria like "the direct acquirer does not maintain any significant business operations of his own" or "does not have any permanent establishment of his own including offices, staff, and equipment in Germany." The standard requirements only include criteria like ID, address, and share of all direct and indirect acquirers. Respecting the fact that the executives (e.g., specialist lawyers and consultants) of secrecy jurisdiction activity are highly professional (Otusanya et al. 2011), these guidelines cannot be expected to prevent "sketchy" investments at all. A *compulsory* check-up of *every* planned investment, including detailed financial information of every direct and indirect acquirer involved, seems,

in my opinion, a lot more appropriate to ensure fairness and financial stability of the energy supply sector in Germany.

Of course, such a measure would certainly include a rise in governmental spending for wages and infrastructure of regulative agencies. But that, in my view, is part of a greater misunderstanding. When the financial crisis of 2007-2008 hit Europe, austerity became one of the most prominent countermeasures to make states work more efficiently. In a European context, this includes both a cut-back of government workers and a reduction of funding for renewable energies (Skovgaard 2014). In Germany, governmental investment in renewable energy has not played a major role in the economic recovery packages following the crisis (Altvater 2011). Instead, as discussed, Germany relied on market forces and a switch from cost-based to profit-margin-based price regulation in the renewable energy market. But private competition, especially following the philosophy of the German social market economy (Soziale Marktwirtschaft), needs regulation in order to prevent social costs resulting from the profit-seeking behavior of free-market competitors. In my opinion, financial secrecy and preferential taxation schemes belong to these social costs. In discrepancy to this logic, however, the German government did not only ignore green energy in its economic recovery packages *and* increased competitive forces on the renewable energy market, it also continuously cut funds for the public sector, resulting in a reduction of 4000 full-time equivalents in already understaffed and underequipped fiscal authorities between 2009 and 2018 (Ryglewski 2019). In 2020, 160 foreign takeovers of German companies were checked by the Federal Ministry for Economic Affairs and Energy (BMWi[58]). This number is up against an overall of 372 registered foreign takeovers plus 1684 newly established foreign companies (GTAI 2021). As a last factor adding to this problem, many aspects of political decision-making in Germany are not transparent. In 2020, a significant share of German businesses is still exempt from compulsory public reporting of their balance sheets. Furthermore, court decisions about taxation cases or international investment are usually not accessible by the public (TJN 2020).

To sum up this section, I see a combination of several measures is advisable to ensure a thriving, fair, and sustainable energy economy in Germany. First, on a European and international level, Germany should insistently emphasize the importance of international policy agreements focusing on an improvement of taxation, competition, and transparency in international business. Agreements of this kind are repeatedly discussed on an EU and global level. Their success, however, depends on the determination of involved nations to turn promising concepts into binding legal frameworks. In fact, there are currently two major attempts on an EU level

[58] Bundesministerium für Wirtschaft und Energie

(BEFIT - (Álvares-Martínez et al. 2021)) and a global level (OECD minimum tax rate agreement - (Federal Ministry of Finance 2021)) to increase regulatory fairness among nations. However, the outcome and range of these agreements are yet vague, and Germany, as a large and influential industrialized country, could make a significant impact in the right direction.

On a national level, Germany must adapt to the regulative necessities of international business operations rising in volume and complexity by the year. This includes investments in the infrastructure, employee count, and the skill set of regulative bodies. The fiscal loss of the German state due to tax abuse is estimated by different sources to lie somewhere around 25 (in 2018 - (Tørsløv et al. 2020)) and 35 billion US dollars (in 2020 - (TJN 2021)) in contemporary years. The costs of financial opaqueness or instability are hardly estimated and could be tremendous in the case of a crisis. If only a minor share of these costs could be effectively prevented, the administrative costs should pay off manyfold. Even though there are ongoing attempts to make investment control more effective and transparent (BMWi 2020), and even if they will be as effective as intended, my personal recommendation is to expand regulative efforts by far and particularly stop the divestment in tax regulation immediately.

Conclusion

In this thesis, I have used modern research instruments of network analysis and data management to give insights on the development and current impact of complex ownership models in the German energy sector. My results show that despite the well-meant aims of continuous market liberalization in Germany since 1996, political and economic changes have induced significant extents of financial opacity, and thereby potentially unseen instability, to the energy sector in Germany. Furthermore, insufficient administration of foreign investment results in the application of preferential instruments of international tax avoidance, compromising free-market competition. This outcome is contrary to the initial aim of liberalization, which was to *foster* market competition and *prevent* the accumulation of market power. On top of this, the liberalization of the sector since 1996 neither resulted in higher wages nor in lower energy prices. These factors combined indicate that German politicians are hardly "in charge of the situation" since they are unable to execute a structured liberalization for the sake of the welfare of its people. Concluding, Germany is steadily losing its *energy sovereignty* as it can no longer guarantee a financially stable energy industry that creates fairly divided prosperity among citizens, customers, and employees.

Limitations

This thesis suffers its biggest limitations by insufficient data availability. Even though I made my best possible effort to get as much intelligence as possible out of the data available, there is

a remaining possibility of data-voids or errors, e.g., in the M&A database of Orbis as well as in the Orbis company database, particularly in regard to funding or discontinuation dates of firms. Furthermore, certain limitations occur from the merging algorithm I applied (chapter 4.2). The most central probably being the focus on upward ownership relations while accepting certain inaccuracies in downward relations. Additionally, I could only work with what I had in terms of financial data. As chapter 4.5 describes, Orbis data can never be a perfect source for tax-rate-related research. Another central limitation is the undifferentiated character of some of my models. For example, even though I achieve to indicate that some ownership models result in lower tax burdens, NBFI impact in the German energy sector rises, and this happens particularly in connection with conduit jurisdictions, and secrecy jurisdictions developed an investment preference for renewable energy, all of these models are widely distinct from each other. Unfortunately, I cannot give information in terms of, e.g., how NBFI ownership impacts tax burdens or whether renewable energy firms with secrecy jurisdictional ownership have lower tax burdens than domestic renewable energy firms. Furthermore, most of my samples are not uniformly categorized by firm size. Even though I do address this by providing a weighted and unweighted version of some models, a comparable size classification would for a certain give result with better comparability. These limitations are unavoidable in the present thesis because I already have to deal with small sample sizes due to bad data availability. Further differentiation of the sample would have reduced sample sizes to a point where statistical representability could hardly be achieved at all. Lastly, it is hard to estimate an alternative scenario to the liberalization of the German energy sector. The results of this thesis show certain unfortunate and unintended outcomes of the liberalization process, but we do not know if "things would be better" if the German energy sector stayed in its past form of territorial monopolies. In other words: The external, "out of the scope" of this thesis, the related impact on the German energy sector can be seen as a black box I do not have information about.

Contribution to Literature and Outlook

This work closes an important research gap in the field of complex controlling ownership models in a restricted sectoral and territorial framework. I present a new approach to reconstruct historical ownership data with a special focus on the aforementioned case. However, due to the infancy of this subject in both methodical and interpretational means, additional verification is required to guarantee the validity of my results. Especially the aforementioned limitations give ample´, fruitful ground for further research. E.g., the model I introduced could be applied to larger economies like the US or the European Union. With a larger dataset, a finer categorization (e.g., size, firm type, etc.) could be added to comparable models as they were applied in this thesis. Additionally, the use of other datasets in relation to the current topic

would add additional robustness to these results. Some researchers do have exclusive access to tax and ownership-related databases that could potentially be a better foundation for this kind of research. In the end, the application of network analysis and data management on the subject of tax fairness, secrecy, and market (competition) conditions is still in its beginnings. But that is exactly the point why we need more researchers to contribute to knowledge creation in this field. Complex ownership chains are an uprising phenomenon. Due to their opacity and complexity, as well as the fact that they are mostly not monitored by a central regulative or political body matching their geographical range puts researchers in a particular responsibility to "jump in" and provide both public and policymaking with the insides they need in a field that increasingly affects them.

Acknowledgment

This thesis is the result of almost a year of extensive literature research, self-education, and data analysis.[59] Even though I know that I am exceeding the maximum page number for a master thesis at the assessing chair, I simply did not have the heart to leave out the information I found important to maintain a straight and completive narrative about the present subject. After this thesis is assessed, I will make my git-repository public[60]. I hope that I can genuinely contribute to the methodical advancements in economic science in terms of data reconstruction and network analysis. If anyone has questions about my work, wants to review or replicate it, the best way to get in touch with me is through my git-profile. I would be happy about any kind of interaction, even if this implies unveiling flaws or imperfections about my thoughts or methods. In the end, I want to take this opportunity to pay tribute and gratitude to Dr. Gunnar Leymann, who got me in touch with the topic and motivated me for the field of international business research through his informative and intriguing lectures, Mr. Matheus Leusin, for supervising this thesis as well as preceding thoughts for such a long period and always treating me with professionality and kindness, and lastly, Mr. Javier Garcia-Bernardo and the researchers of CORPNET and the Tax-Justice-Network, which I have never met in person but who have in my eyes opened up the overarching subject of network analysis in regards to questions about economic and social fairness and security to both researchers and public.

[59] I want to clarify that I did not violate the University of Bremens guidelines. I did not start working on this thesis before it was registered. Preliminary research to find the right topic and practice of very general methodological skills in data science contribute to this number.
[60] This self explainingly only relates to the parts I am allowed to publish.

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Appendix I – Additional Tables and Diagrams

1. Chronological overview of energy policy in Europe and Germany [61]

1990	The Act on the Supply of Electricity from Renewable Energy Sources into the Grid (Stromeinspeisungsgesetz): - Electrical power generated from renewable sources were granted priority on the energy market - Distributors were obliged to prefer renewable energies whenever possible at a minimum price - Minimum price as percentage on average electricity price (including conventional generation)	StrEG
1996	EU directive 96/92/EC: -Free entry to the transport segment must be assured and regulated for all energy supply companies -Different regulation modes of access to the transport segment are possible (e.g., regulated or negotiated third party access).	First Act
1997	First mergers and acquisitions of large energy supply companies	
1998	National Energy Act of 1998: - Complete seamless liberalisation; - Access to the transport net had been regulated by the "negotiated access" though "association agreements between energy producers and industrial consumers" (without a special regulatory agency); - Unbundling from production- and supply segments from the network segment through "separation of accounts"	EnWG 1998
1999	New electricity provider appeared; electricity prices declined	
2000	Strong increase of market concentration due to mergers and acquisitions of energy supply companies	
2000	Renewable Energy Sources Act 2000: - Introduction of independent feed-in tariffs (Einspeisevergütung) - Obligatory acceptation of renewable energy by grid operators at fixed prices (not bound to conventional energy prices anymore)	EEG 2000
2001	Further merger waves; new electricity provider disappeared due to low energy prices	
2001	EU Directive 2001/77/EC - overall renewable energy source target set to 10% by 2010	RES 2001
2002	Electricity prices increase	
2003	EU acceleration directive (2003/54/EC): - Obligation for "regulated third party access" through a regulatory agency - "legal unbundling" of electricity production and supply from the network segment until 1 July 2004	Second Act

[61] Own composition, used sources: Brunn and Sprenger 2014; Lenz et al. 2019; Getachew 2019; Brandt 2006; Elspas et al. 2016; Rimmler 2015; Meeus and Nouicer 2018 Green = focus on renewables, orange = focus on market policy, light tint = EU policy, dark tint = German policy

2004	Renewable Energy Sources Act 2004: - Reduction of feed-in tariffs for wind turbines - Adjustment to European legal requirements	EEG 2004
2005	National Energy Act of 2005: - "regulated third party access", - a regulatory agency for the network segment and - legal unbundling have been enacted delayed	EnWG 2005
2006	First electricity net price reductions, nevertheless (end) electricity prices for private households increased considerably	
2007	Price authorisation of end consumer prices will end in July 2007	
2008	Start of net price regulation, based on incentive regulation	
2009	EU directive 2009/72-73/EC: - Unbundling of generation and supply - Regulators must now be independent from both industry and government - Founding of ACER (Agency of the Cooperation of Energy Regulators) - Further enforcement of EU energy markets and discrimination-free markets - Transfer of national legislative power in favour of EU-authorities	Third Act
2009	EU directive 2009/28/EC (Renewable Energy Directive): -overall renewable energy source target set to 20% by 2020	RED 2009
2009	Renewable Energy Sources Act 2004: - New target of 30% of overall power generation should be generated by using renewable energies until 2020 - Improved cost control if photovoltaic power plants	EEG 2009
2010-2012	Massive increase in foreign affiliates	
2011-2012	National Energy Act of 2011: - Enhanced market transparency guidelines - Prohibition of insider trade - Introduction of new consumer rights (mediation institutions, poverty protection)	EnWG 2011
2012	Renewable Energy Sources Act 2012: - Acceleration of nuclear phase-out, setup of new renewable supply percentage targets, - Market premium ("EEG Umlage") for renewable energy sales below an ex-post assessed "average electricity price"	EEG 2012
2012-2013	Energy prices rise sharply again	
2014	Renewable Energy Sources Act 2014: - Invocation of guaranteed returns (feed in tariffs) - Overall decrease of public funding options, especially in biomass and offshore-wind power plants	EEG 2014
2017	Renewable Energy Sources Act 2017: - Introduction of competitive bidding system for public funds - Regulated "sector linking" (Sektorkopplung) to equal out generation fluctuations by conventional power plants	EEG 2017

2018	Revised renewable energy directive 2018/2001/EU: - Overall renewable energy source target set to 32% by 2030	RED II 2018
2020	EU directive 2018/844,2001,2002,1999,943,944,941,942 - aims at insuring fully competitive supply prices without public intervention - full opening of national energy markets (including access of distribution infrastructure) in favour of a joint, European energy market	Fourth Act

Table 4: Overview of major political decisions targeting the German energy sector between 1990 and 2020. Light colours represent EU-level decisions. Dark colours represent decisions by the German government. Yellow represents decisions primarily concerning liberalization. Green represents decisions majorly concerning green energy transition.

2. Growth of the renewable energy sector from 1990 to 2019

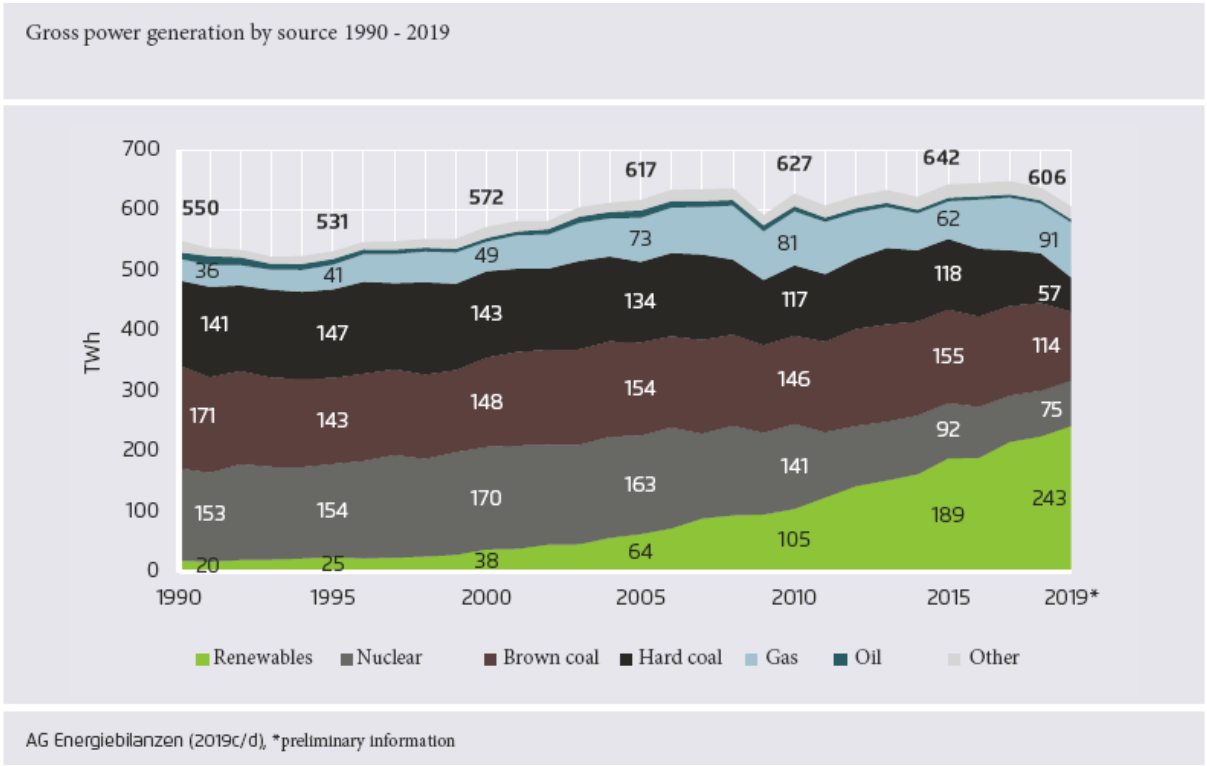

Figure 16:Gross power generation by source (Germany) 1990-2019 source: (Lenz et al. 2019)

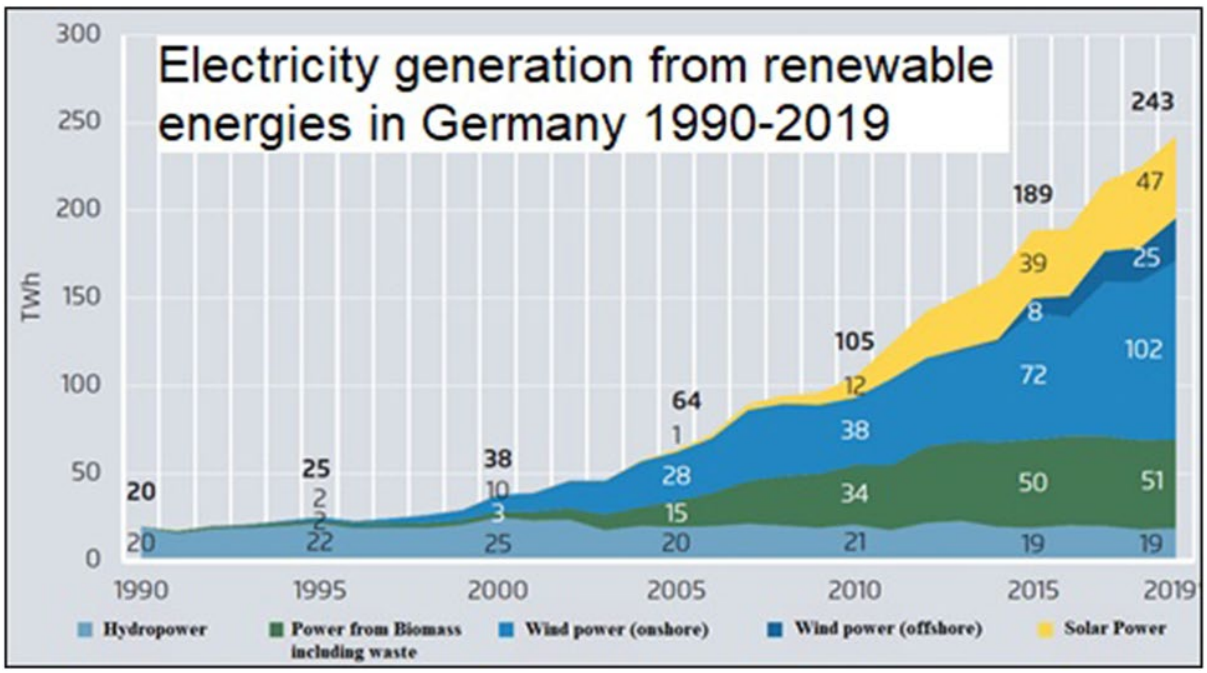

Figure 17: Electricity generation from renewable energies in Germany 1990-2019. Source: (Rechsteiner 2020)

3. Development of natural gas prices

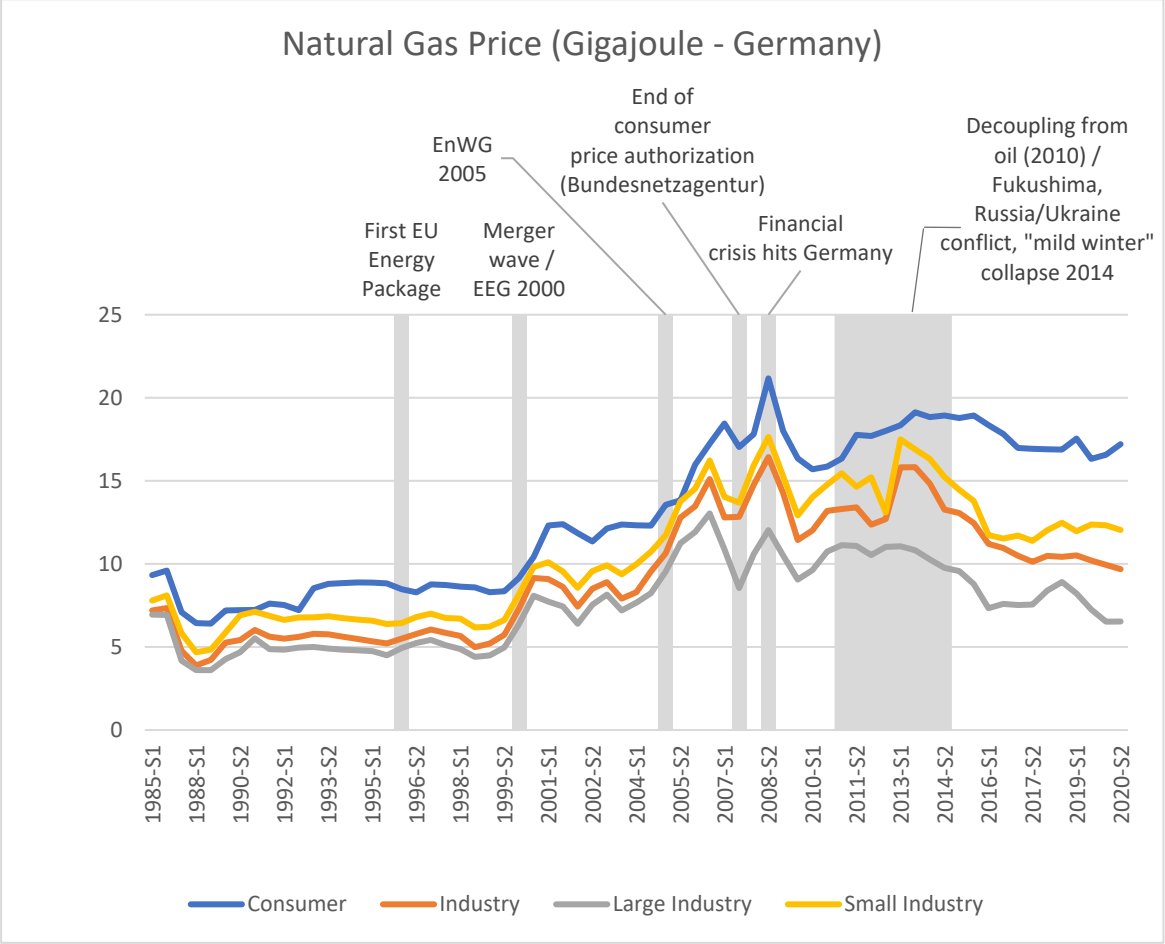

Figure 18: Natural gas price development in Germany between 1985 and 2020. Source: Eurostat

For electricity prices:
Consumer: 1991 – 2006 = 3500 – 7500kWh / year; 2007 – 2020 = 2500 – 5000kWh/year
Industry: 1991 – 2006 = 2000 – 10000MWh/year; 2006 – 2020 = 2000-20000MWh/year
Small Industry: 2004 – 2006 = 160 – 1250MWh/year; 2006 – 2020 = 20 – 500MWh/year
Large Industry: 2004 – 2006 = over 70000MWh/year; 2006 – 2020 = 70000 – 150000MWh/year

For gas prices:
Consumer: 1985 – 2007 S1 = all consumers (single tariff); 2007 S2 – 2020 = 20 – 200 GJ/year
Industry: 1985 – 2007 S1 = 41860 – 418600GJ/year; 2007 S2 – 2020 = 10000 – 100000GJ/year
Small Industry: 1985 – 2007 S1 = 4186 – 41860GJ/year; 2007 S2 – 2020 = 1000 – 10000GJ/year
Large Industry: 1985 – 2007 S1 = 418600 – 4186000GJ/year; 2007 S2 – 2020 = 1000000-4000000 GJ/year

5. Details of sample sizes

Year	Chains	Firms	Firms_Ger_Energy
2021	45396	57361	40244
2020	45182	57059	40083
2019	43958	55335	39114
2018	42684	53602	38132
2017	41533	51983	37253
2016	40221	50201	36169
2015	38866	48335	35098
2014	37513	46536	34067
2013	36079	44585	32925
2012	33816	41735	30921
2011	30579	37720	27982
2010	26478	32610	24171
2009	22401	27402	20398
2008	18871	22964	17099
2007	16770	20348	15212
2006	14349	17375	12999
2005	12317	14884	11120
2004	10756	12992	9665
2003	9752	11760	8738
2002	8765	10585	7851
2001	7555	9189	6730
2000	6445	7859	5698
1999	5299	6523	4781
1998	4560	5645	4098
1997	3864	4824	3482
1996	3356	4227	3019
1995	3035	3822	2723
1994	2706	3418	2427
1993	2403	3045	2141
1992	2092	2632	1852
1991	1868	2336	1652
1990	1609	1985	1412
1989	1438	1763	1264
1988	1397	1706	1227
1987	1361	1660	1193
1986	1325	1608	1161
1985	1297	1575	1133
1984	1261	1522	1101
1983	1230	1477	1072
1982	1198	1438	1044
1981	1175	1409	1022
1980	1150	1373	1000
1979	1117	1332	972
1978	1089	1297	945
1977	1047	1240	906
1976	1033	1222	892
1975	1011	1191	870
1974	983	1157	845
1973	883	1050	827
1972	863	1026	810
1971	802	950	751
1970	762	900	714
1969	733	859	688
1968	711	830	669
1967	703	821	664
1966	692	809	656
1965	684	798	648
1964	675	786	639
1963	658	768	625
1962	647	754	614
1961	608	710	579

1960	595	696	567
1959	581	679	555
1958	574	671	548
1957	565	659	540
1956	561	653	536
1955	551	643	526
1954	542	634	517
1953	539	630	514
1952	522	613	500
1951	510	596	490
1950	506	592	486
1949	501	585	481
1948	495	579	477
1947	490	572	472
1946	489	570	471
1945	487	567	469
1943	484	562	466
1940	474	552	456
1939	469	546	451
1938	464	540	447
1937	459	534	442
1936	456	531	439
1935	455	530	438
1934	453	527	436
1933	451	525	435
1932	450	524	434
1931	446	520	430
1930	444	518	428
1929	440	514	424
1928	430	502	414
1927	419	488	404
1926	406	474	391
1925	397	464	383
1924	392	458	379
1923	386	451	374
1922	372	433	361
1921	366	426	356
1920	353	413	343
1919	332	390	322
1918	318	375	308
1916	310	366	301
1915	309	365	300
1914	307	362	298
1913	302	355	293
1912	295	347	287
1911	268	318	260
1910	256	304	248
1909	245	289	237
1908	223	265	215
1907	209	251	201
1906	201	241	193
1905	175	212	170
1903	173	208	168
1902	170	205	165
1901	164	198	160
1900	161	195	157
1899	143	169	140
1898	142	168	139
1897	112	138	109
1896	107	130	104
1895	100	119	97
1894	97	115	94
1893	95	113	92
1892	93	111	90
1890	91	108	88

1888	88	104	85
1887	85	100	82
1886	84	99	81
1885	65	78	62
1884	61	73	58
1880	57	67	54
1875	56	66	53
1873	54	63	51
1872	53	61	50
1871	51	59	48
1870	44	52	45
1869	42	49	43
1866	39	45	40
1864	38	43	39
1863	37	42	38
1860	36	41	37
1858	34	38	35
1857	33	37	34
1856	27	30	28
1855	23	25	23
1854	22	24	22
1847	20	21	20
1834	6	7	6
1820	5	6	5
1806	4	5	4
1803	3	3	3
1800	2	2	2
1599	1	1	1

Table 5: Quantities of the reconstructed samples

Year	Firms	Year	Firms	Year	Firms	Year	Firms	Year	Firms	Year	Firms	Year	Firms
2021	159214	1989	1676	1957	901	1925	619	1893	70	1861	25	1829	7
2020	146102	1988	1638	1956	884	1924	599	1892	66	1860	24	1828	7
2019	137512	1987	1599	1955	874	1923	577	1891	64	1859	24	1827	7
2018	130264	1986	1553	1954	865	1922	553	1890	63	1858	24	1826	6
2017	124079	1985	1519	1953	851	1921	510	1889	63	1857	19	1825	6
2016	118388	1984	1483	1952	845	1920	471	1888	61	1856	19	1824	6
2015	110167	1983	1446	1951	818	1919	326	1887	59	1855	14	1823	5
2014	101092	1982	1415	1950	805	1918	320	1886	57	1854	13	1822	5
2013	89400	1981	1374	1949	793	1917	320	1885	56	1853	13	1821	4
2012	72265	1980	1352	1948	792	1916	312	1884	55	1852	13	1820	4
2011	53184	1979	1319	1947	784	1915	302	1883	53	1851	12	1819	4
2010	40080	1978	1302	1946	784	1914	293	1882	52	1850	12	1818	4
2009	32264	1977	1282	1945	784	1913	283	1881	51	1849	10	1817	4
2008	26423	1976	1261	1944	783	1912	273	1880	49	1848	10	1816	4
2007	21402	1975	1237	1943	782	1911	257	1879	46	1847	10	1815	4
2006	16255	1974	1208	1942	779	1910	243	1878	46	1846	10	1814	4
2005	12692	1973	1170	1941	766	1909	233	1877	45	1845	10	1813	4
2004	10935	1972	1140	1940	758	1908	218	1876	44	1844	10	1812	4
2003	8783	1971	1101	1939	749	1907	212	1875	44	1843	10	1811	4
2002	6555	1970	1092	1938	741	1906	200	1874	43	1842	10	1810	4
2001	5128	1969	1077	1937	731	1905	193	1873	41	1841	10	1809	4
2000	4486	1968	1051	1936	721	1904	182	1872	39	1840	9	1808	4
1999	3949	1967	1033	1935	718	1903	173	1871	39	1839	9	1807	4
1998	3519	1966	1016	1934	712	1902	169	1870	38	1838	8	1806	3
1997	3161	1965	1007	1933	706	1901	121	1869	37	1837	8	1805	3
1996	2802	1964	998	1932	701	1900	111	1868	36	1836	8	1804	3
1995	2506	1963	981	1931	685	1899	108	1867	33	1835	8	1803	3
1994	2277	1962	970	1930	679	1898	100	1866	31	1834	8	1802	3
1993	2104	1961	948	1929	661	1897	91	1865	31	1833	8	1801	3
1992	1942	1960	938	1928	648	1896	85	1864	28	1832	8	1800	3
1991	1786	1959	926	1927	641	1895	78	1863	26	1831	8	1799	3
1990	1719	1958	912	1926	630	1894	74	1862	26	1830	7	1798	3

Table 6: Sample quantities of the BNA dataset, retrieved on 11th August 2021.

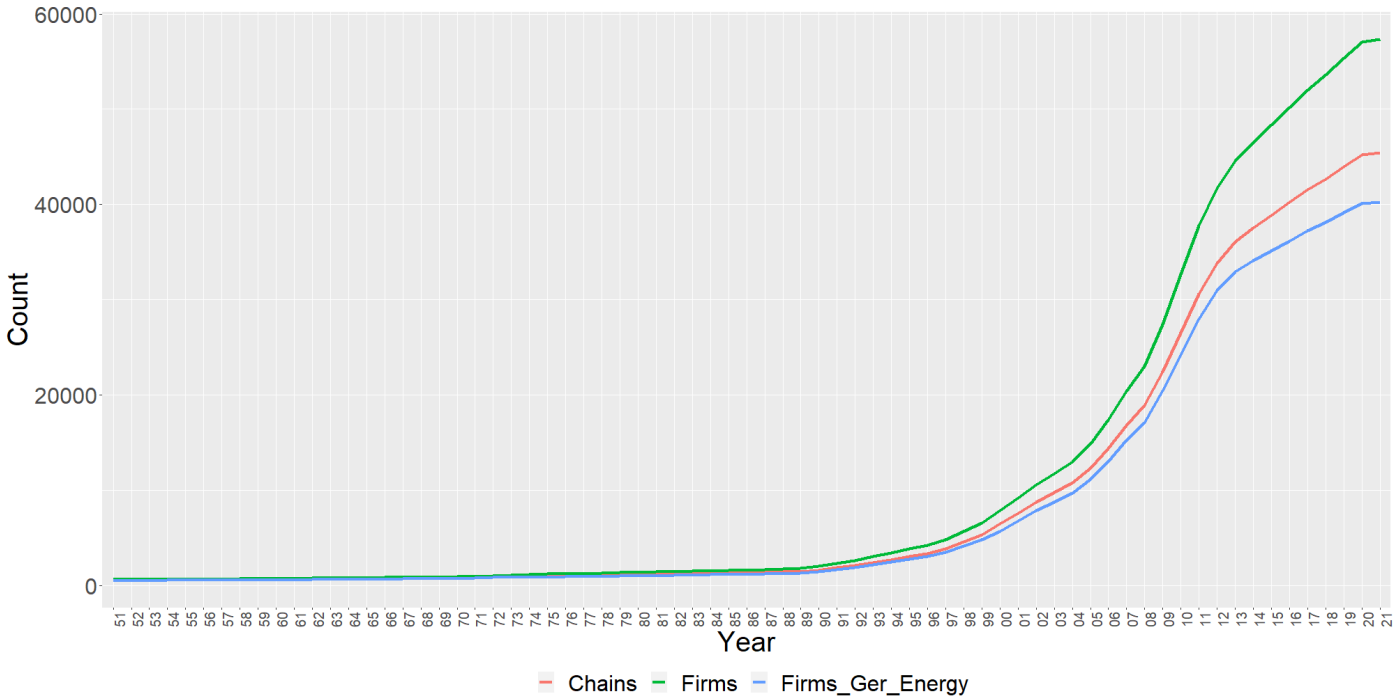

Figure 19: Quantities of the reconstructed samples visualized. Number of unique ownership chains, firms and German energy firms in the reconstructed samples from 1951 to 2021.

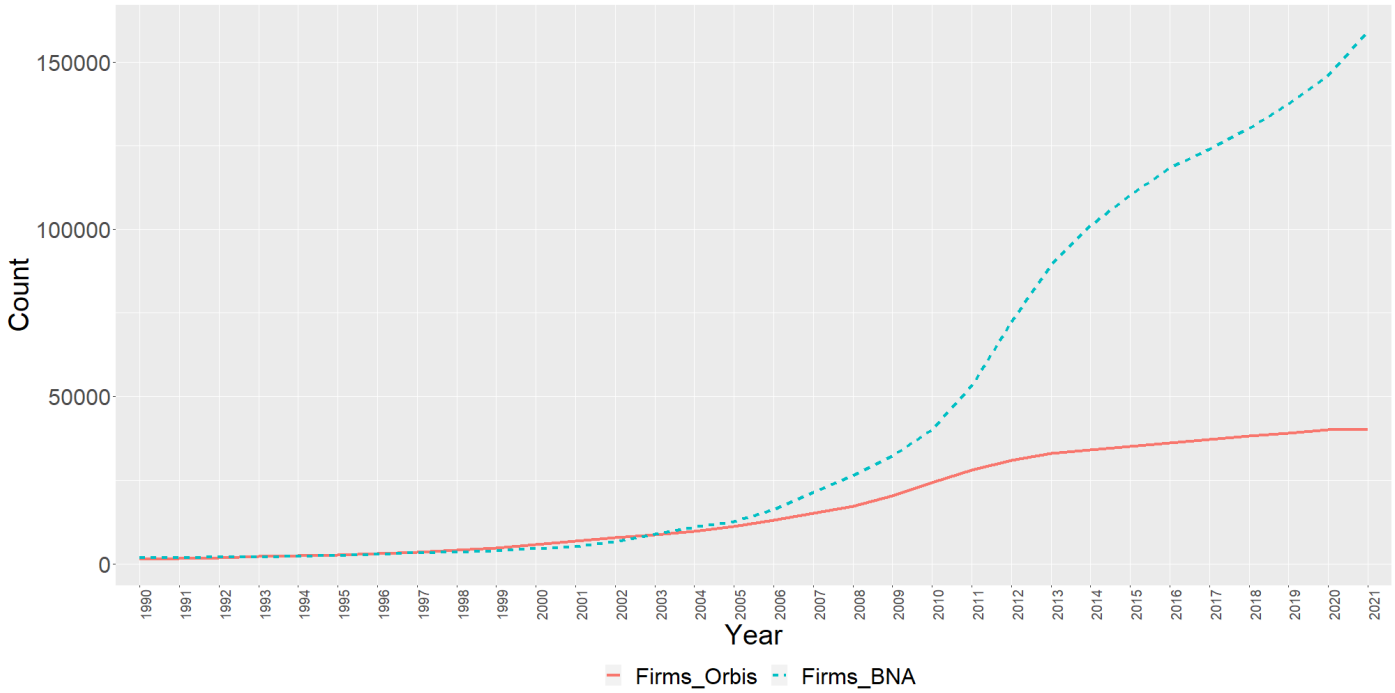

Figure 21: Comparison of Orbis sample and BNA sample. Number of unique firms participating in the German energy sector.

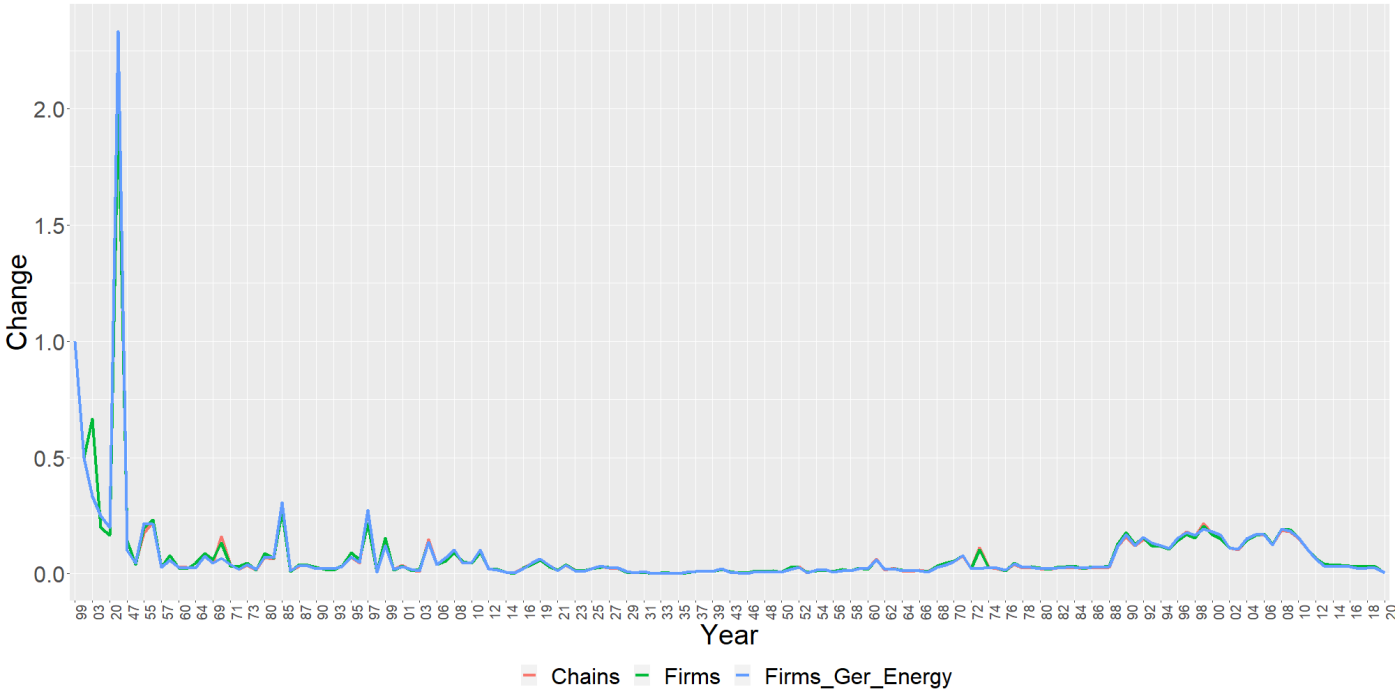

Figure 20: Growth rates of chains, firms, and German energy firms in the reconstructed Orbis samples. 1599 to 2021.

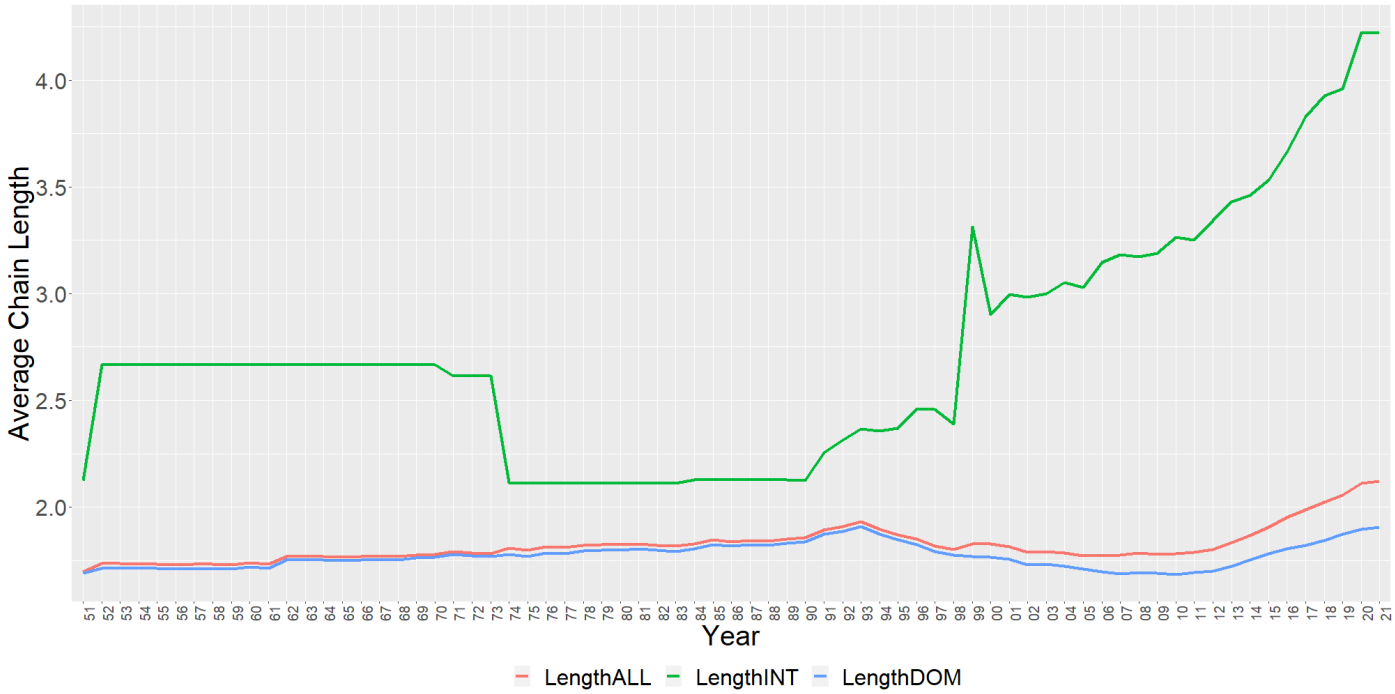

Figure 23: Average ownership chain length of chains involving German energy firms through time. 1951 to 2021.

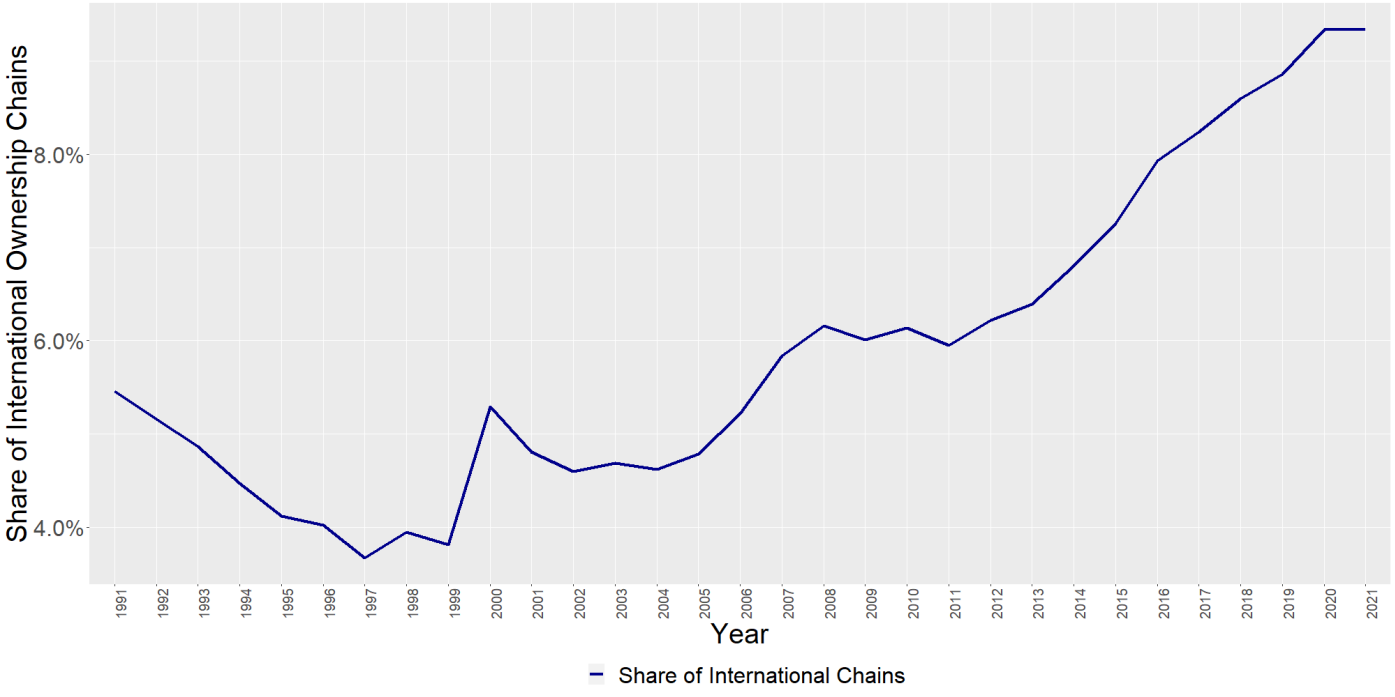

Figure 22: Share of international ownership chains in the whole reconstructed samples (including independent firms). 1991 to 2021

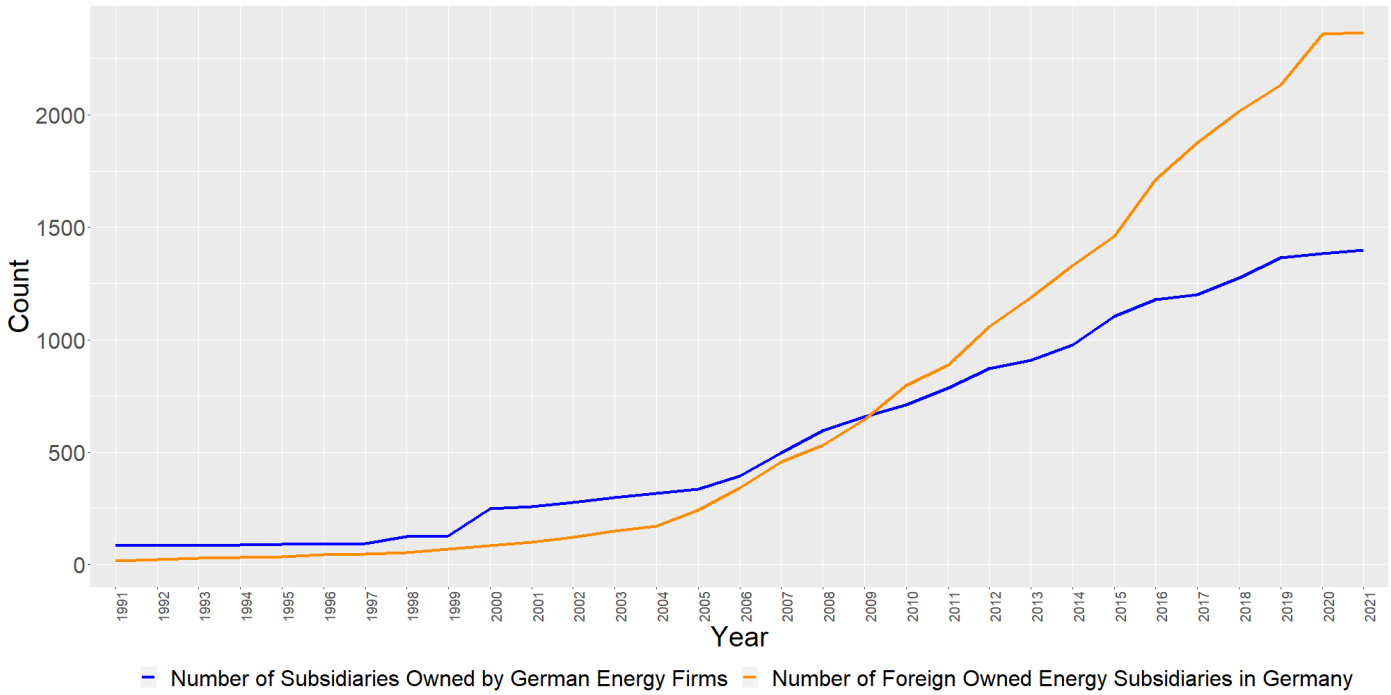

Figure 25: Comparison of subsidiaries ultimately owned by German energy firms that are located in foreign countries and foreign-owned energy firms located in Germany.1991 to 2021.

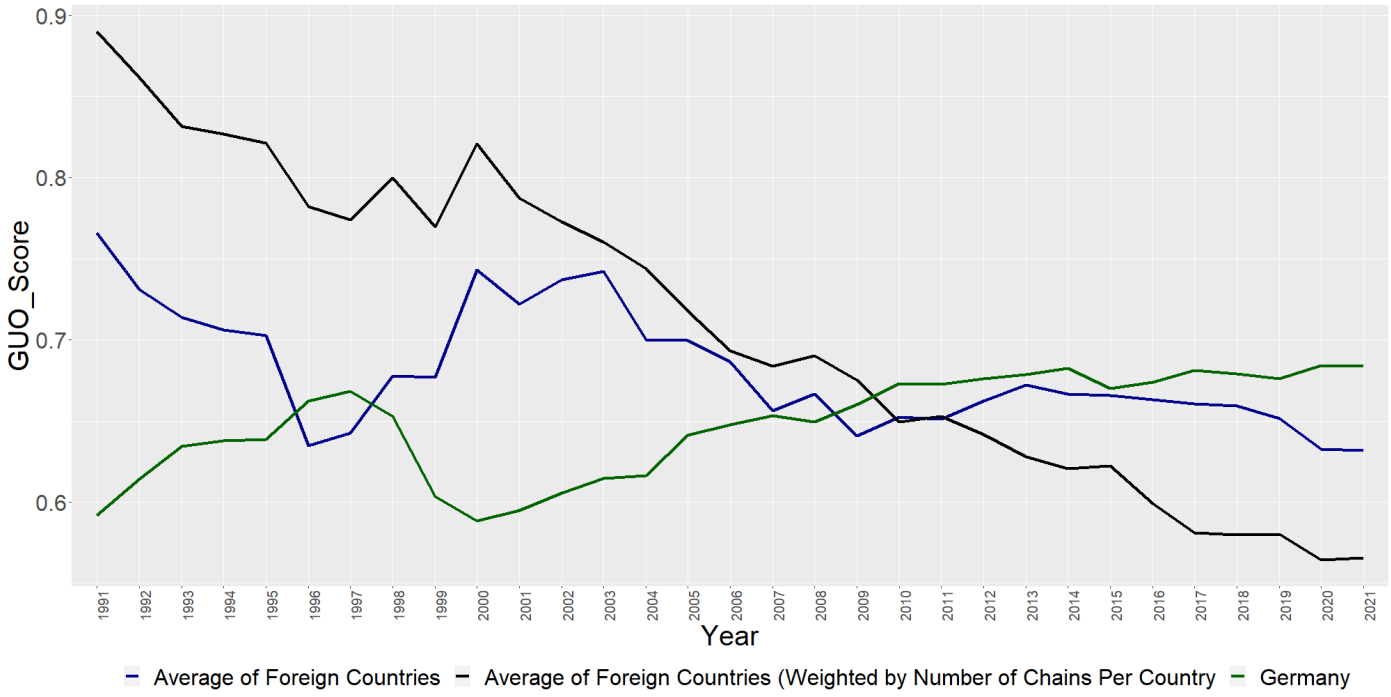

Figure 24: Comparison of Germany's GUO score to sample average. 1991 to 2021.

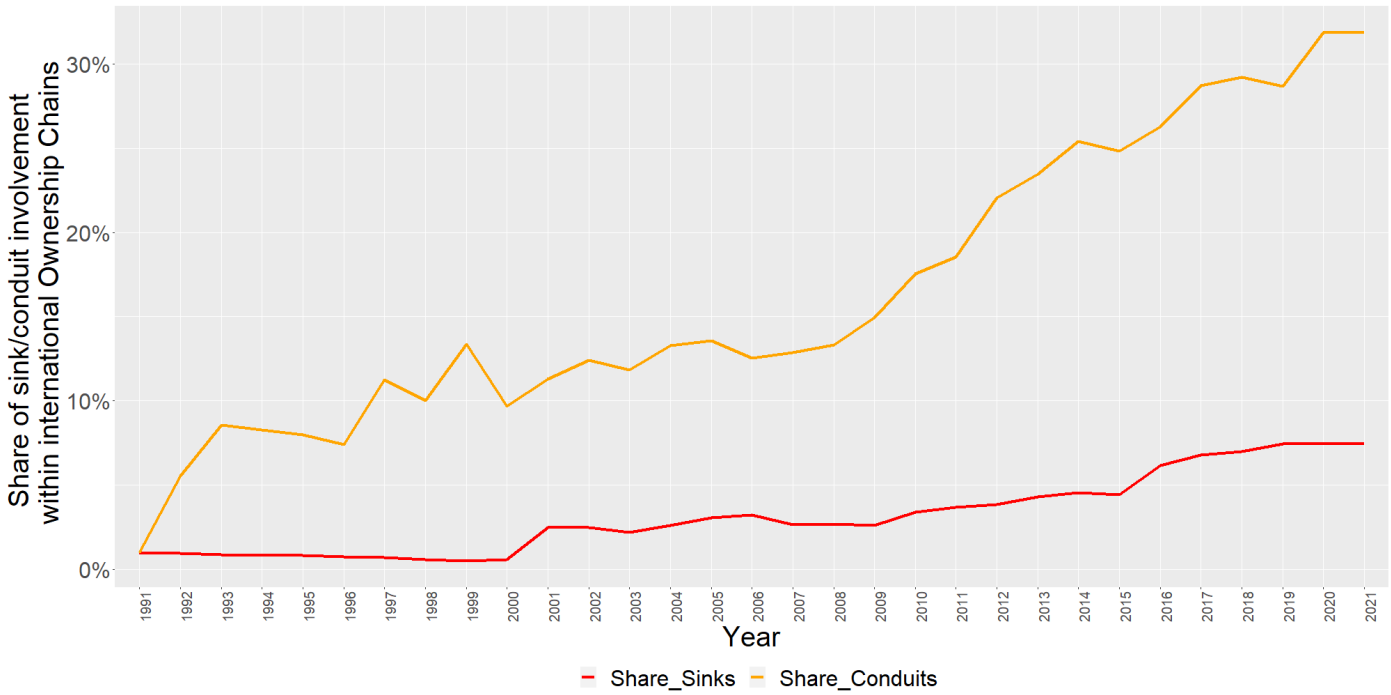

Figure 27: Share of chains containing sinks / conduits within all international ownership chains over time. 1991 to 2021.

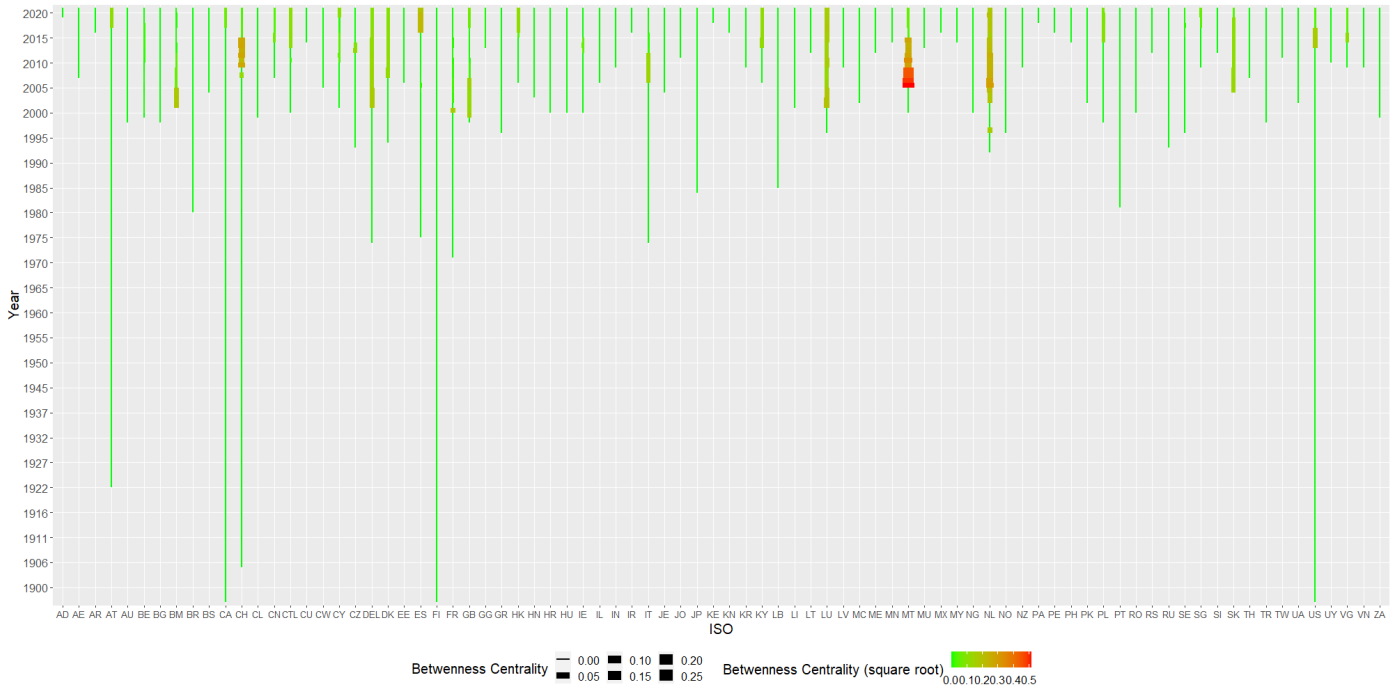

Figure 26: Betweenness centrality statistics of all countries participating in the German energy sector over time. 1900 to 2021.

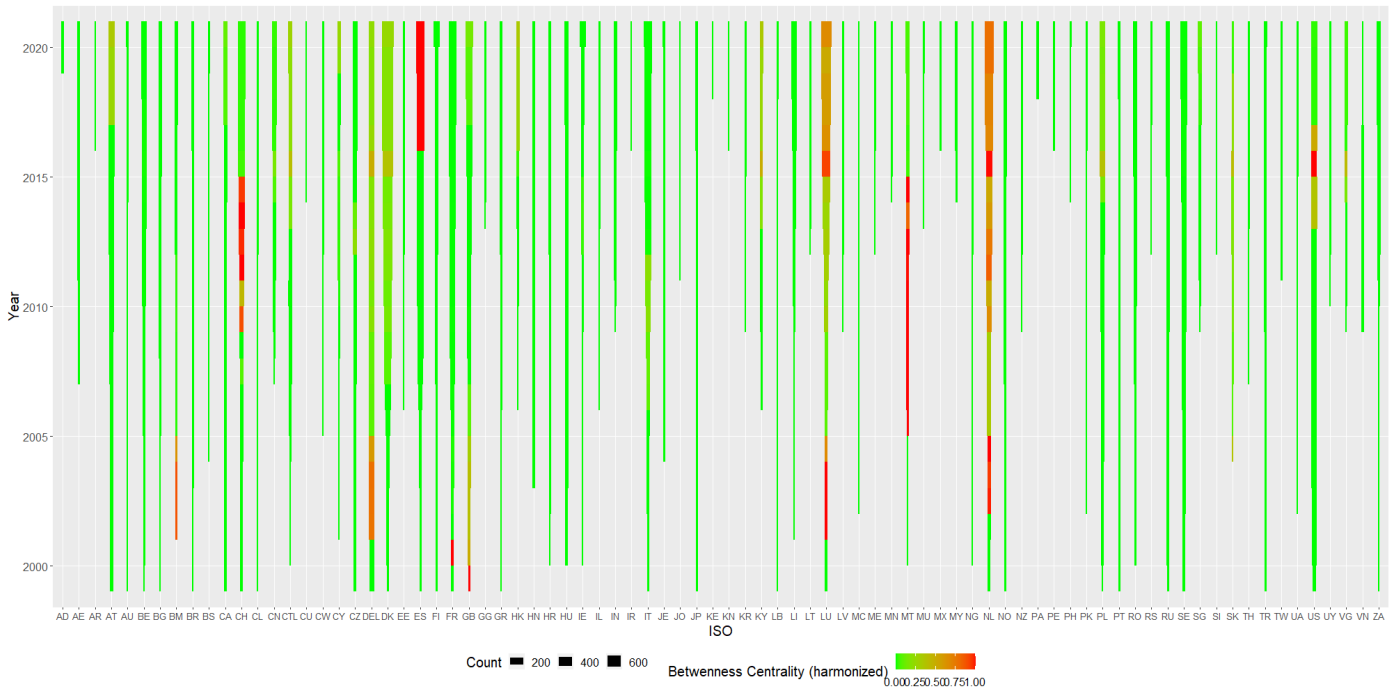

Figure 29: Harmonized betweenness centrality statistics over time with respect to number of chains included. Germany excluded. Harmonization applied equal to GUO-score harmonization as described in appendix II-9. 1996 to 2021.

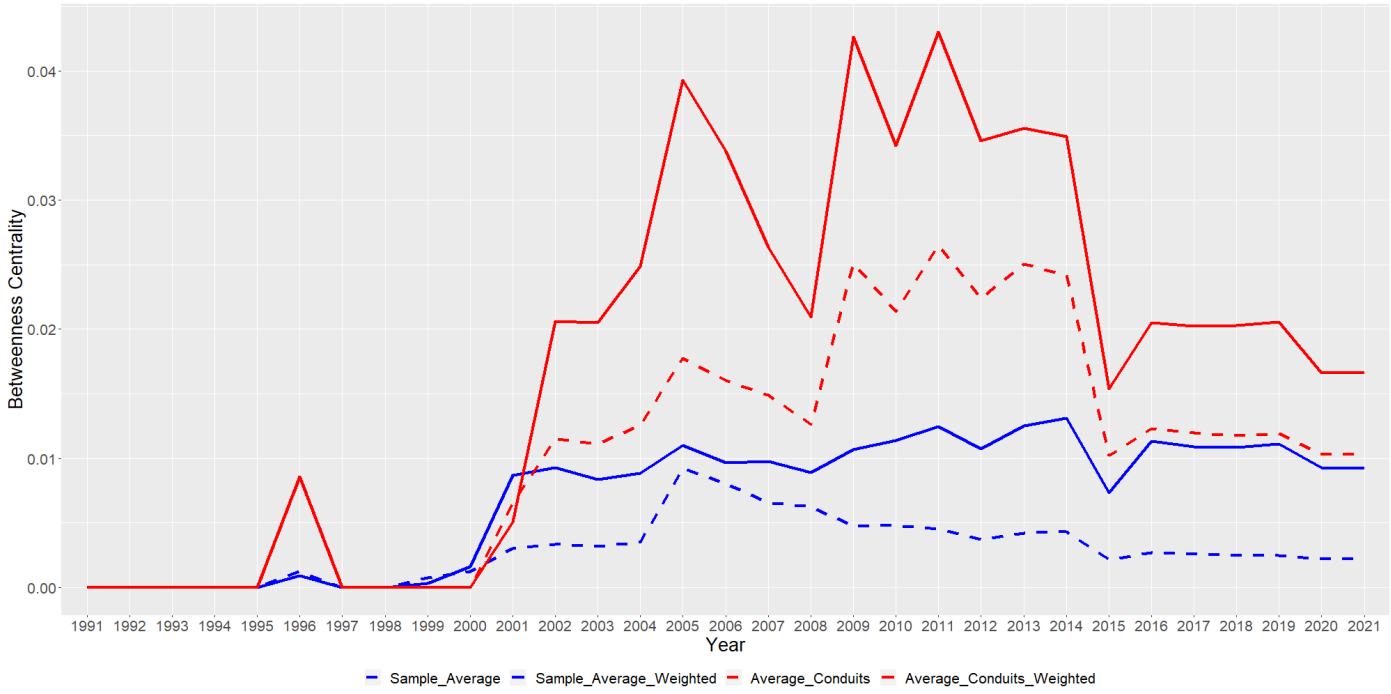

Figure 28: Betweenness centrality comparison between sample average and conduits over time. 1991 to 2021.

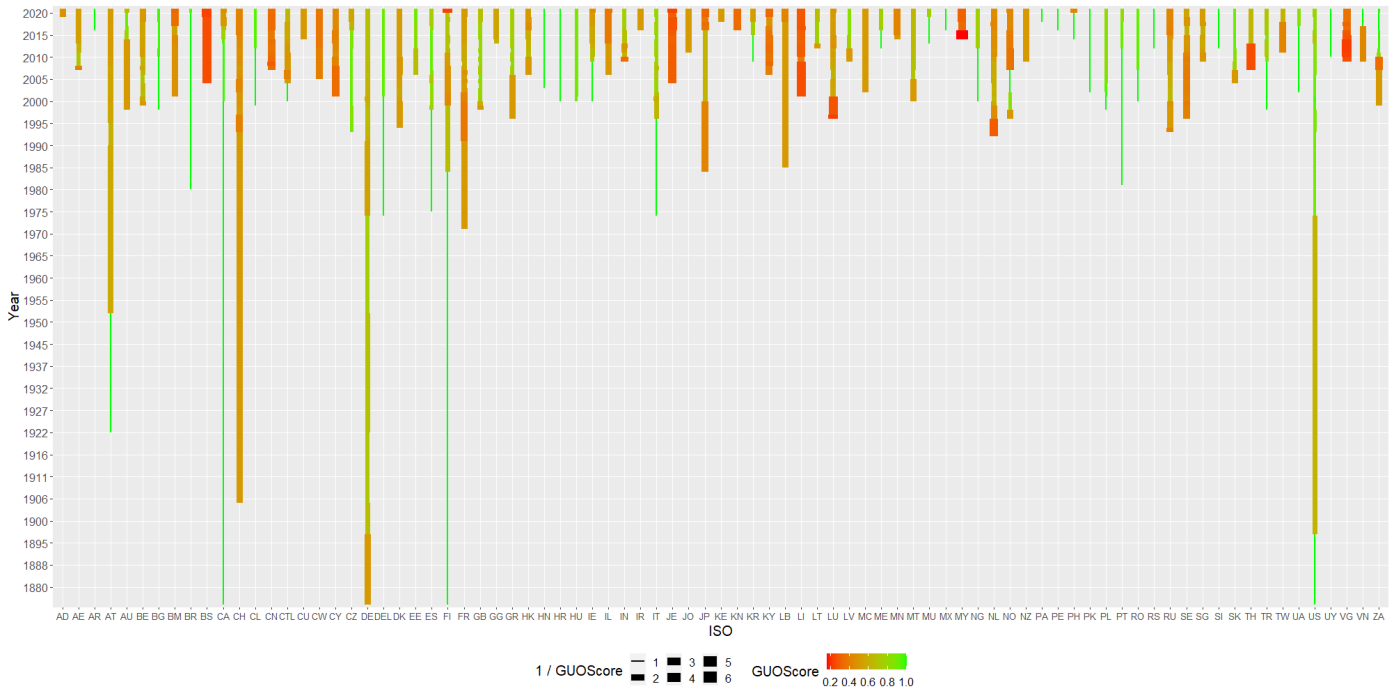

Figure 31: GUO score statistics over time. 1880 to 2021.

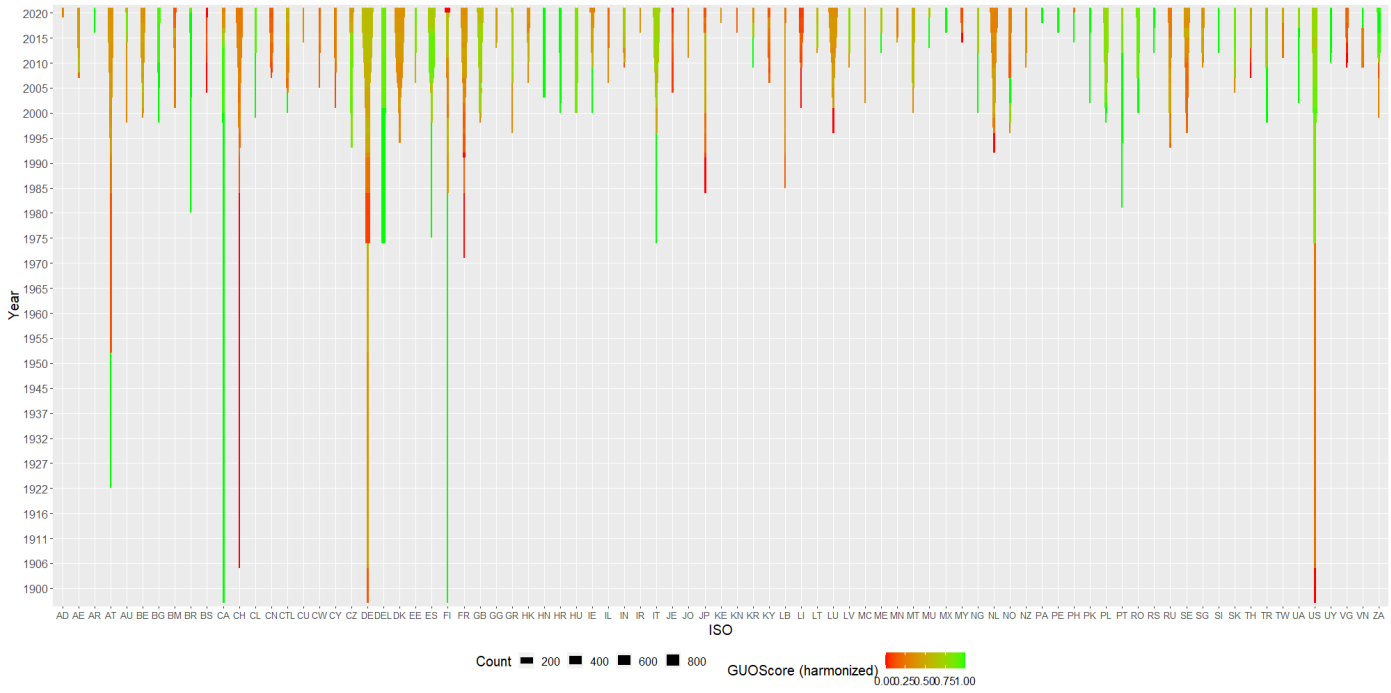

Figure 30: Harmonized GUO score statistics over time with respect to number of chains included. Number of German firms capped at 130% of the next highest value in each year. Harmonization applied equal to GUO-score harmonization as described in appendix II-9. 1900 to 2021.

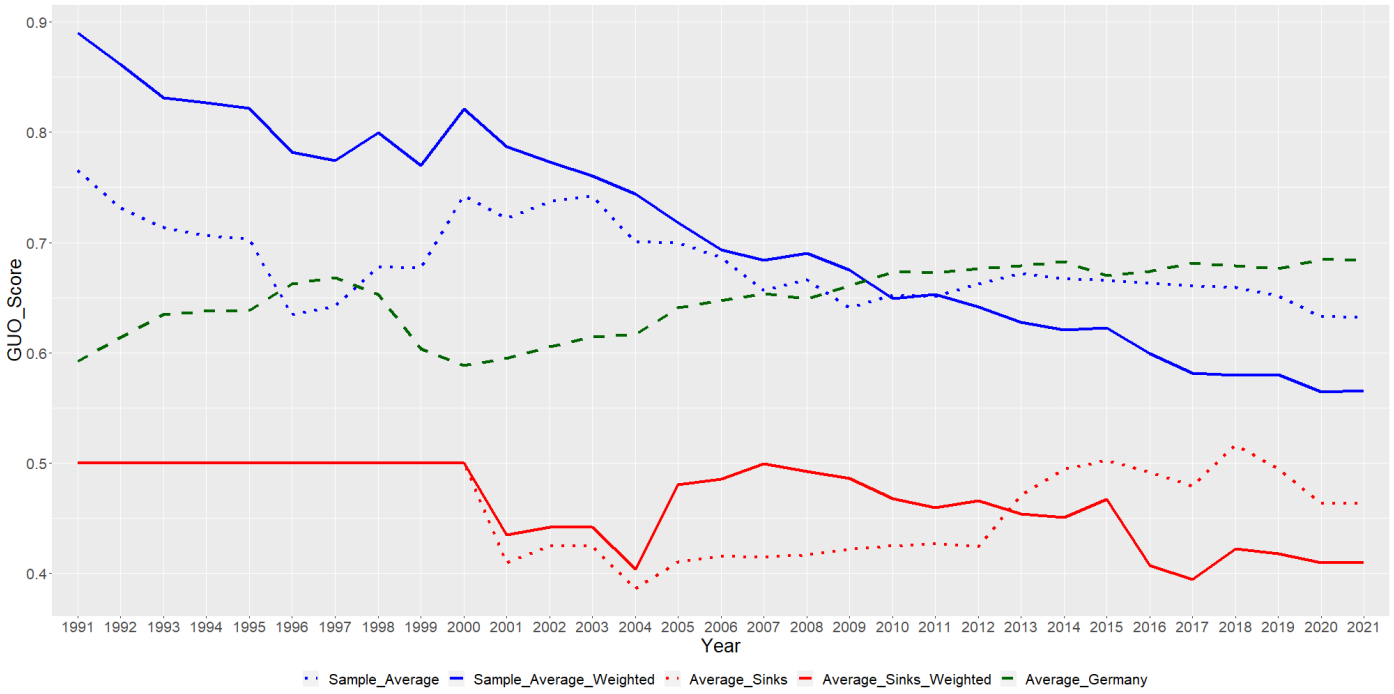

Figure 33: Comparison of GUO scores between the sample average, sink jurisdictions and Germany. 1991 to 2021.

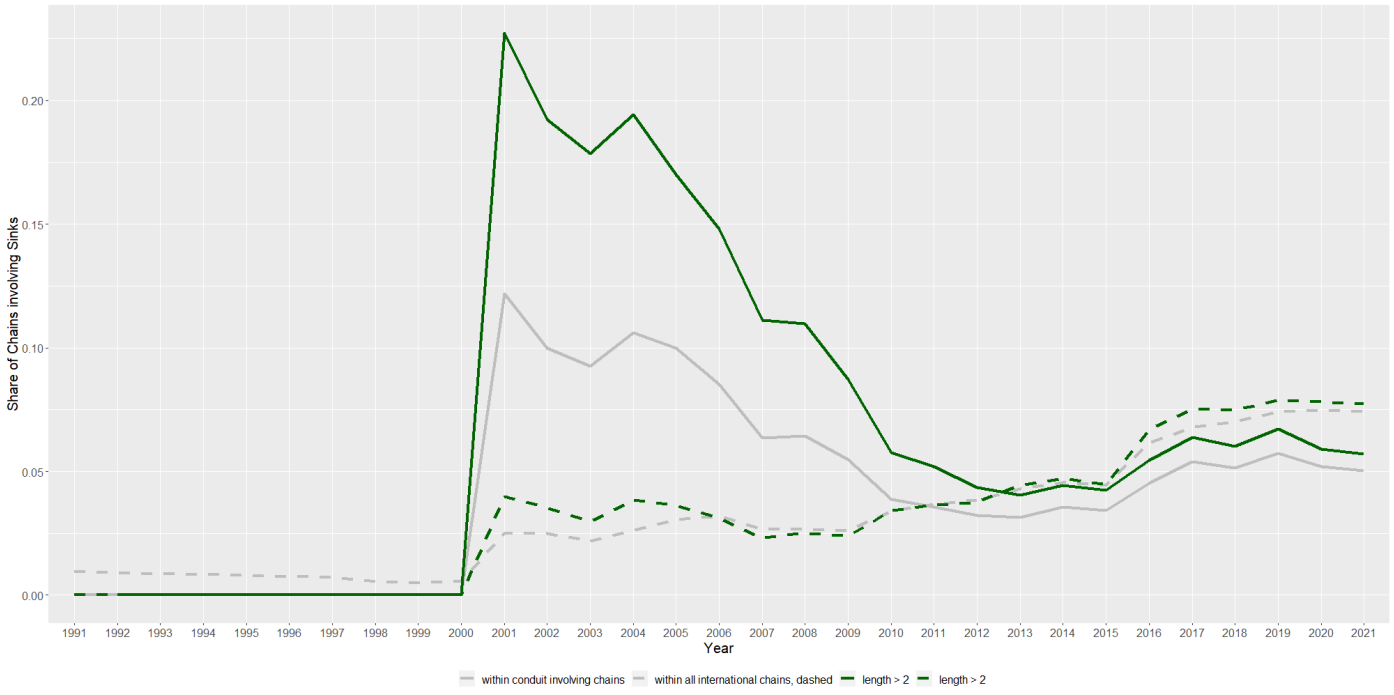

Figure 32: History of interconnectedness between sinks and conduits in comparison to the overall sample. 1991 to 2021.

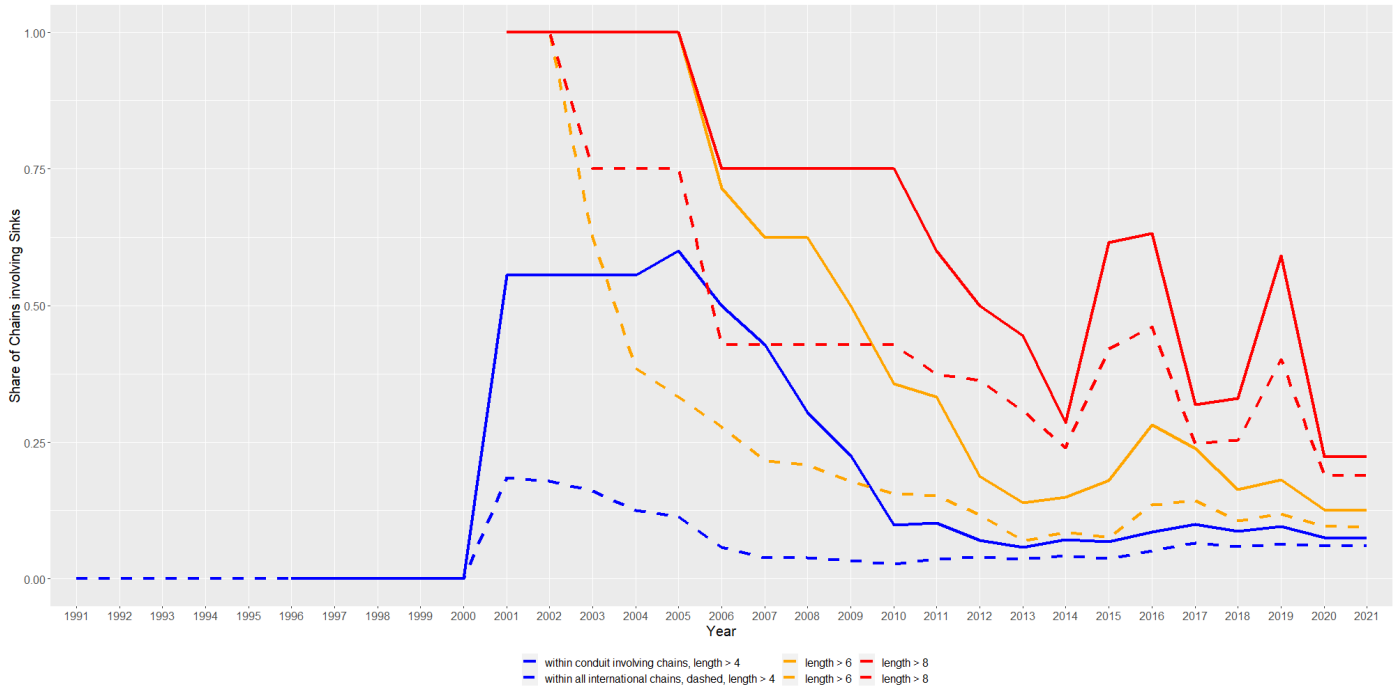

Figure 35: History of interconnectedness between sinks and conduits in comparison to the overall sample. Minimum length > 4. 1991 to 2021.

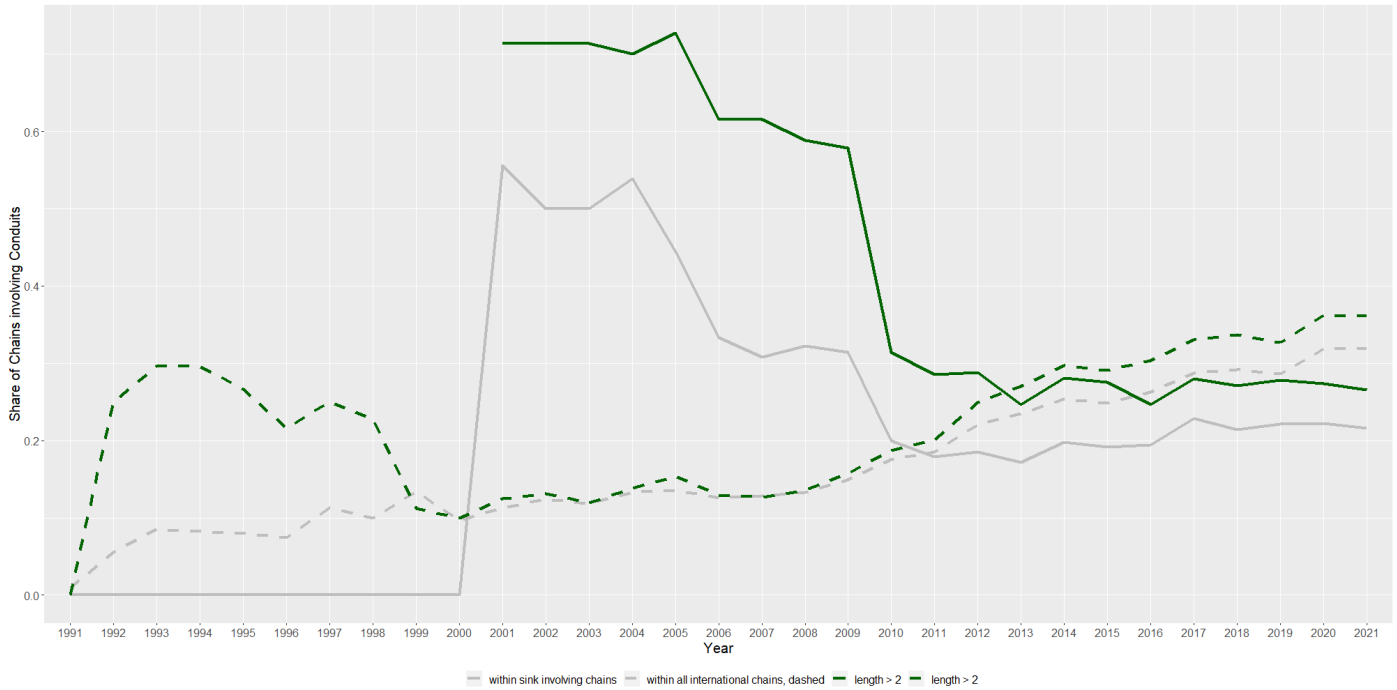

Figure 34: History of interconnectedness between conduits and sinks in comparison to the overall sample. 1991 to 2021.

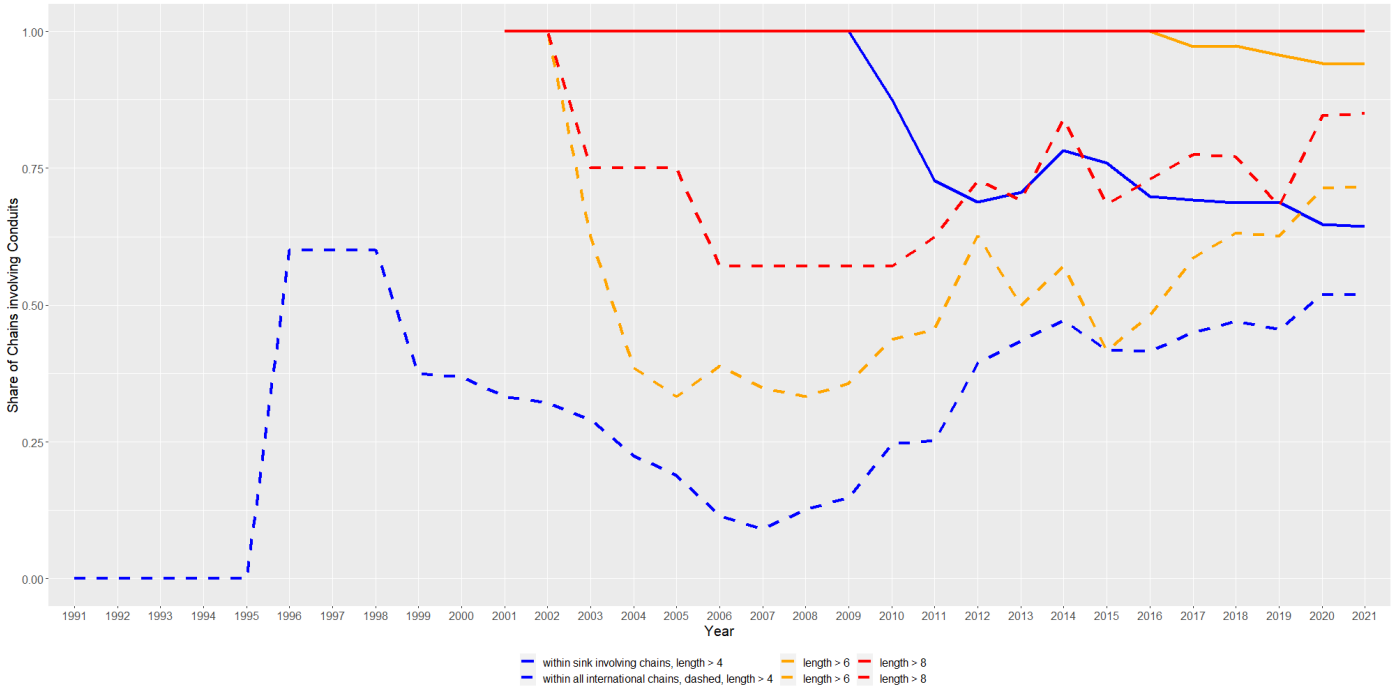

Figure 36: History of interconnectedness between conduits and sinks in comparison to the overall sample. Minimum length > 4. 1991 to 2021.

Appendix II – Technical details of the model

4. Filter scheme for M&A dataset

First, I filter out minority stakes and share buybacks. Minority stakes are irrelevant for my purpose since this thesis is about controlling shareholders. Share-buybacks are irrelevant as well since they are defined as buying back "own" shares, which means that the company is already controlled by a shareholder buying back more shares. Those procedures therefore do not change the controlling shareholder. The R code for this filter is as follows:

```
Deals.List.Byyear<-pblapply(1:length(Deals.List.Byyear),function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, "Minority") == FALSE)))
```

```
Deals.List.Byyear<-pblapply(1:length(Deals.List.Byyear),function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, "Share buyback") == FALSE)))
```

I use the Orbis "Deal type" field to apply a string-detection-based filter. Deals.List.Byyear being a two-level nested list sorted by year of competition on the first level and Orbis' unique deal ID on the second level.

Next, I filter out capital increases and deals of unknown type. Capital increases are irrelevant since they just higher the amount of shares, not the controlling shareholder identity. Of course, there can be capital increases combined with public takeovers. However, the “takeover part” would in such a case be classified as “public takeover” and be listed separately by Orbis. Deals of unknown type would just add unnecessary inaccuracy to the model. The according R code lines are:

```
Deals.List.Byyear<-pblapply(1:length(Deals.List.Byyear),function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, "Capital Increase") == FALSE)))

Deals.List.Byyear<-pblapply(1:length(Deals.List.Byyear),function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, "Capital increase") == FALSE)))

Deals.List.Byyear<-pblapply(1:length(Deals.List.Byyear),function(x)
list.filter(Deals.List.Byyear[[x]], all(is.na(`Deal type`)) == FALSE))
```

The next step is a bit more complicated but very necessary. The deal type “acquisition” can both contain controlling ownership transfers (“crossing” the 50% mark) and minority share transfers (not crossing the 50% mark). I therefore filter out all deals with the deal type of “Acquisition increased from [over 50] to [something]” and “Acquisition increased from [something] to [over 50]”. In order to do this, I use a loop function combined with a string match. The code is:

```
for(i in 50:100) {

Deals.List.Byyear <- pblapply(1:length(Deals.List.Byyear), function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, paste0("Acquisition increased
from ",i,".*")) == FALSE)))

}


for(i in 0:49) {

   Deals.List.Byyear <- pblapply(1:length(Deals.List.Byyear), function(x)
list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, paste0("Acquisition increased .*
to",i,"\\.*")) == FALSE)))

}
```

Finally, initial acquisitions (acquirer did not hold any ownership share before) are labelled simply as “Acquisition [percentage]”. I therefore filter out all deals with an acquisition of under 50% (acquisitions of exactly 50% but not 50.01% will be handled in the next step to avoid rounding errors at this point). The code is:

```
for (i in 0:49) {

Deals.List.Byyear <- pblapply(1:length(Deals.List.Byyear), function(x) list.filter(Deals.List.Byyear[[x]], any(str_detect(`Deal type`, paste0("Acquisition ",i,"\\.")) == FALSE)))

}
```

5. Detailed description of the matching algorithm

To verify each pre-filtered deal, I first control if the acquirer of a deal happening in the year of the current year of the company list is still listed as the owner in the company list. If that is not the case, the deal is ignored. If it is the case, the owner of the previous year is replaced by the top-row vendor of the respective deal and the chain is marked with an "APPEND" marker on the left end in order to connect the owner of the vendor at a later stage. This procedure is performed every time two firms that are adjacent in an ownership chain are as well found in a deal of the according year as "acquirer" (adjacent to the target on the left side) and "target" (adjacent to the acquirer on the right side).

An example:

Company list of 2020:

Company A	Company B	Company C	Company D	Company E
Company 1	Company 2	Company 3	Company 4	
Company I	Company II	Company III		

Check for adjacent companies in deals list of 2020:

	found as acquirer in deal X	found as target in deal X		
Company A	Company B	Company C	Company D	Company E
Company 1	Company 2	Company 3	Company 4	
Company I	Company II	Company III		

Lookup deals list:

Acquirer	Target	Vendor
Company B	Company C	Company H
Company F	Company G	

New company list of 2019:

APPEND	Company H	Company C	Company D	Company E
Company 1	Company 2	Company 3	Company 4	
Company I	Company II	Company III		

This process is repeated for every year deals are available in. Afterwards, a second merge algorithm is applied going by vendor and target ID instead of acquirer and target ID. This time, a deal gets verified whenever a company within a company list of any year is found in the deals list of the same year, but the vendor of that respective deal is *not* adjacent to the left of the target in the company list. Example:

Company list of 2020:

		not listed as vendor of deal X	found as target in deal X	
Company A	Company B	Company C	Company D	Company E
Company 1	Company 2	Company 3	Company 4	
Company I	Company II	Company III		

Lookup deals list:

Acquirer	Target	Vendor
NA	Company D	Company J
	Company F	

New company list of 2019:

	APPPEND	Company J	Company D	Company E
Company 1	Company 2	Company 3	Company 4	
Company I	Company II	Company III		

Of course, this is the same thing applied from two different sides. However, it can be seen as a double-check approach to account for data voids or inaccuracies. To make sure, I applied both algorithms in the opposite order (vendor match first, acquirer match second). I got the same results.

When this "first order" matching is done, I extract all companies adjacent to APPEND markers. For the resulting company list, I also extract from Orbis all deals these companies were involved in. Then, I apply the matching algorithm again to the new company list (only containing companies adjacent to APPEND markers). This is repeated until no relevant deals can be identified anymore. At that point, all company lists are merged *backwards* for every year until the earliest year a relevant deal is found in. Example:

1. Original company list of 2021
2. First application of merger algorithms
3. New company lists for 1996 – 2021
4. Download APPEND adjacent companies and respective deals from Orbis (Merge list 1)

1. Merge list 1 of 2021
2. Application of merger algorithms
3. New Merge lists 1 1996-2021
4. Download APPEND adjacent companies and respective deals from Orbis (Merge list 2)

1. Merge list 2 of 2021
2. Application of merger algorithms
3. New Merge list 2 1996-2021
4. Merge list 1996 – 2021 do not differ! The algorithm therefore finds no relevant deals anymore.

Backward merging:

5. Append Merge lists 2 1996 – 2021 to Merge lists 1 1996-2021 according to year and APPEND markers.
6. Append "merged" Merge lists 1 1996-2021 to primary company lists 1996 – 2021 according to year and APPEND markers.

Example:

Ownership chain in 2021:

Company A	Company B	Company C	Company D	Company E

Ownership chain in 2010:

	Owner changed through merging algorithm	
APPEND	Company F	Company E

Ownership chain in 1996:

	Owner changed through merging algorithm	
APPEND	Company F	Company E

Merge 1 chain in 2010

Company H	Company G	Company F

Merge 1 chain in 1996

APPEND	Company I	Company F

Merge 2 chain in 1996

Company J	Company I

Backward merging:

Merge 1 chain in 1996

Company J	Company I	Company F

Ownership chain in 2010

Company H	Company G	Company F	Company E

Ownership chain in 1996

Company J	Company I	Company F	Company E

6. Validity/robustness check of the reconstructed datasets

For the sake of the best possible integrity verification of my reconstructed ownership chains, I compare the reconstructed ownership network with the results of Großkurth (2019b). In his paper, he reconstructs historical ownership by a bottom up approach also used by other contemporary research (Alabrese and Casella 2020; Jaraitė et al. 2014; Moore et al. 2019). Instead of merging current ownership data with M&A data, he directly uses historical ownership information from Orbis. It is not a hundred percent clear to me if he uses shareholder information in list format or uses a web scraping application to access each firm's information sheet individually. Either of these approaches would not fit my needs.

Historic shareholder data in list format is only available at the first (direct) shareholder level and data quality/density becomes very bad for years further in the past. The first fact would make an application to my dataset very time consuming. If historic shareholder information is only available on the first level, that would mean that the GUO can only be found after a number of "search circles" copying the BvDID of the first level shareholder, search again for its direct shareholders and so on. To repeat this procedure for all years until 1996 or even 1990 would consume more time than I have. Moreover, the decreasing data quality for those years further in the past (like 1996) is an obvious problem to the accuracy of my research results that stem from reconstructed ownership data. Großkurth's research focusses on the years from 2000 to 2018, which makes this approach more appropriate.

Historic shareholder data extracted from each firm's individual Orbis information sheet could potentially improve data integrity but would certainly make the reconstruction process even more time and recourse consuming. Nevertheless, the approach of Großkurth is well accepted in contemporary research and was used in a number of papers from well-established researchers and journals (cited above). It should therefore serve as a reference point to validate my own reconstruction algorithm. In the appendix, Großkurth defines four different kinds of ownership structures:

"Cases where both the top shareholder and the GUO are located in the same foreign country are classified as plain foreign. If both the top shareholder and the GUO are each located in different countries than the firm itself, the construction is identified as a conduit structure. If both the GUO and the firm are in the same country but the top shareholder is in a different one this is labelled as round tripping. If both the top shareholder and the firm are in the same country, but the GUO is in another one, the structure is identified as a domestic hub." – Großkurth 2019b p.41

Even though this is not the main object of his own research, he uses the proportions of these structures in his dataset to compare his historical reconstructions with past research about ownership structures using Orbis data. In this way, he validates that the reconstructed networks come close to "original" past datasets from Orbis.[62] What is interesting for my case is that Großkurth also depicts the historical proportions of these four ownership models from 2010 to 2018.

[62] Note that these comparisons are applied to historical versions of Orbis in the younger past (2015). The data quality limitations of historical Orbis versions mentioned in the methodology chapter should therefore be minimal.

I saw this as an opportunity to check my dataset for the same four ownership types and compare these graphics to mine. At this stage it should be mentioned that Großkurth uses MNE data of all corporate companies in Europe that is not filtered by countries or industrial sectors. Differences between his proportions and mine should therefore be natural. Nevertheless, I think that the approach of Großkurth and mine deliver widely similar reconstruction results. The diagrams of Großkurth can be seen on the next page. For comparison, I rebuilt a same kind of diagrams but with my own reconstructed datasets. One can clearly see that there are differences. The most noticeable probably is the higher share of domestic hubs in my datasets. This could, however, be a characteristic of energy companies as they are naturally dependent on some kind of distribution structure.

	A. & C.	Own Sample	Diff
Plain foreign	59	59.56	-0.56
Conduit Structure	10.9	5.08	5.82
Round Tripping	1.1	4.79	-3.69
Domestic Hub	29	30.57	-1.57
Sum of differences			**11.64**

Table 7: Comparison of sample proportions of different ownership chain kinds in 2015. A.&C. represents the sample proportions of Alabrese and Casella (2020) which use an Orbis static data snapshot of 2015. The "Own Sample" column shows the proportions of these same kinds of ownership chains in my own, reconstructed sample of 2015.

	A. & C.	Großkurth	Diff
Plain foreign	59	66.2	-7.2
Conduit Structure	10.9	11	-0.1
Round Tripping	1.1	0.9	0.2
Domestic Hub	29	22	7
Sum of differences			**14.5**

Table 8: Comparison of sample proportions of different ownership chain kinds in 2015. A.&C. represents the sample proportions of Alabrese and Casella (2020) which use an Orbis static data snapshot of 2015. The "Großkurth" column shows the proportions of these same kinds of ownership chains in the reconstructed 2015 sample of Großkurth (2019b) who uses a different reconstruction apporach than mine.

There are, however, also clear similarities despite the fundamentally different initial data selection. To start with the absolute numbers, both datasets show an s-curve-like increasement of plain-foreign type ownership structures. Moreover, there is a little "growth spike" in number of firms between 2006 and 2007 in both datasets. Looking at the relative proportions, both versions of the diagram show that conduit structures started to have a considerable impact in the early 2000s.

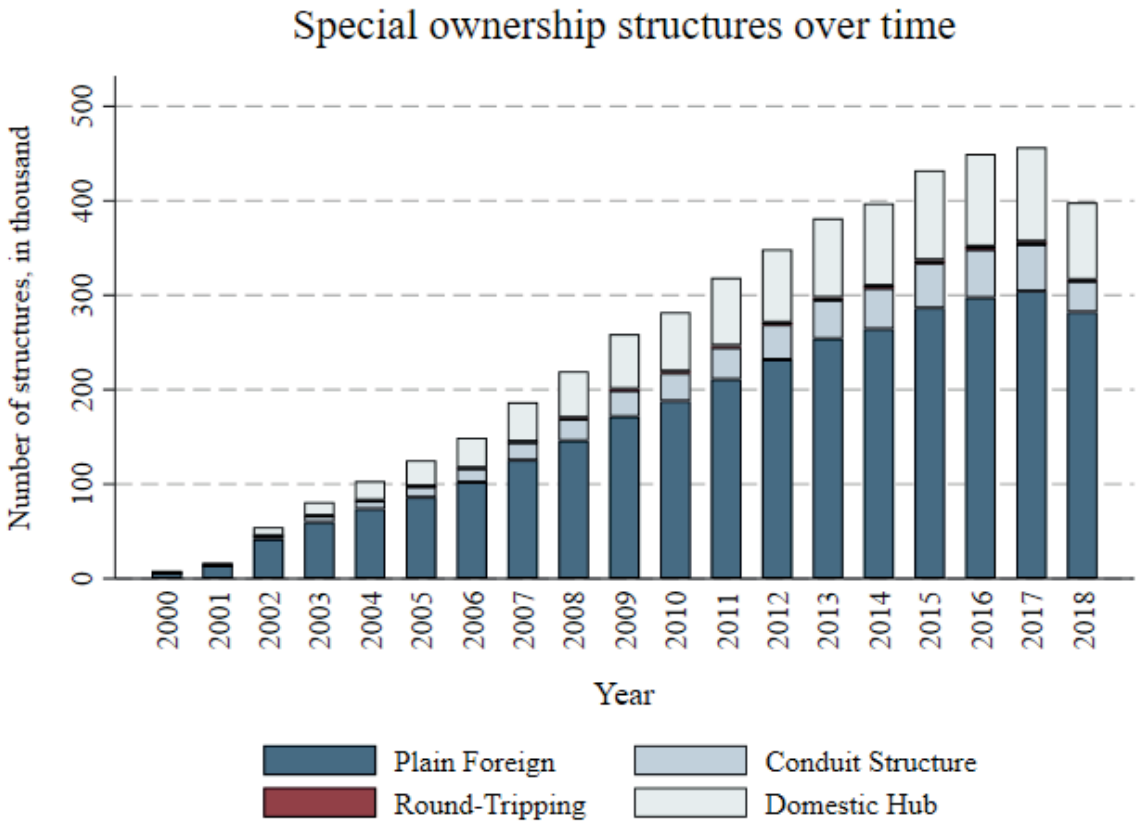

Figure 37: Special ownership structures in absolute numbers between 2000 and 2018 in Großkurth (2019b).

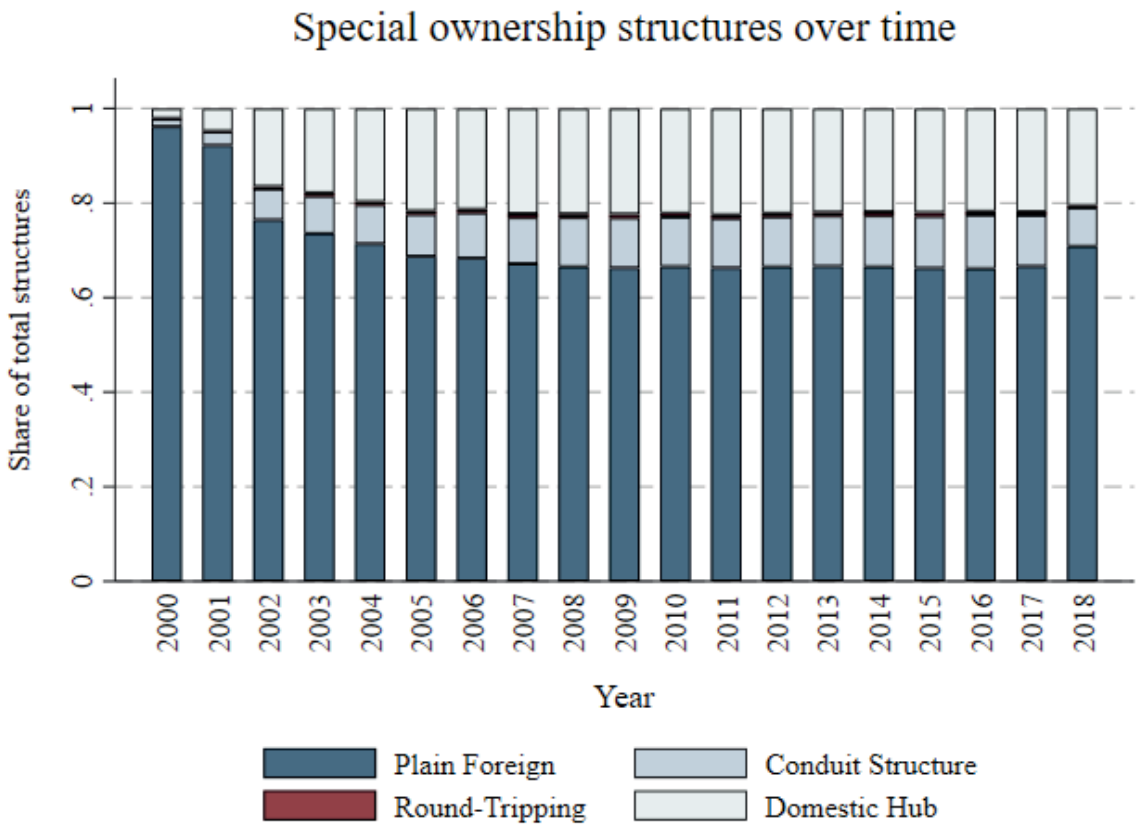

Figure 38: Special ownership structures in proportions between 2000 and 2018 in Großkurth (2019b).

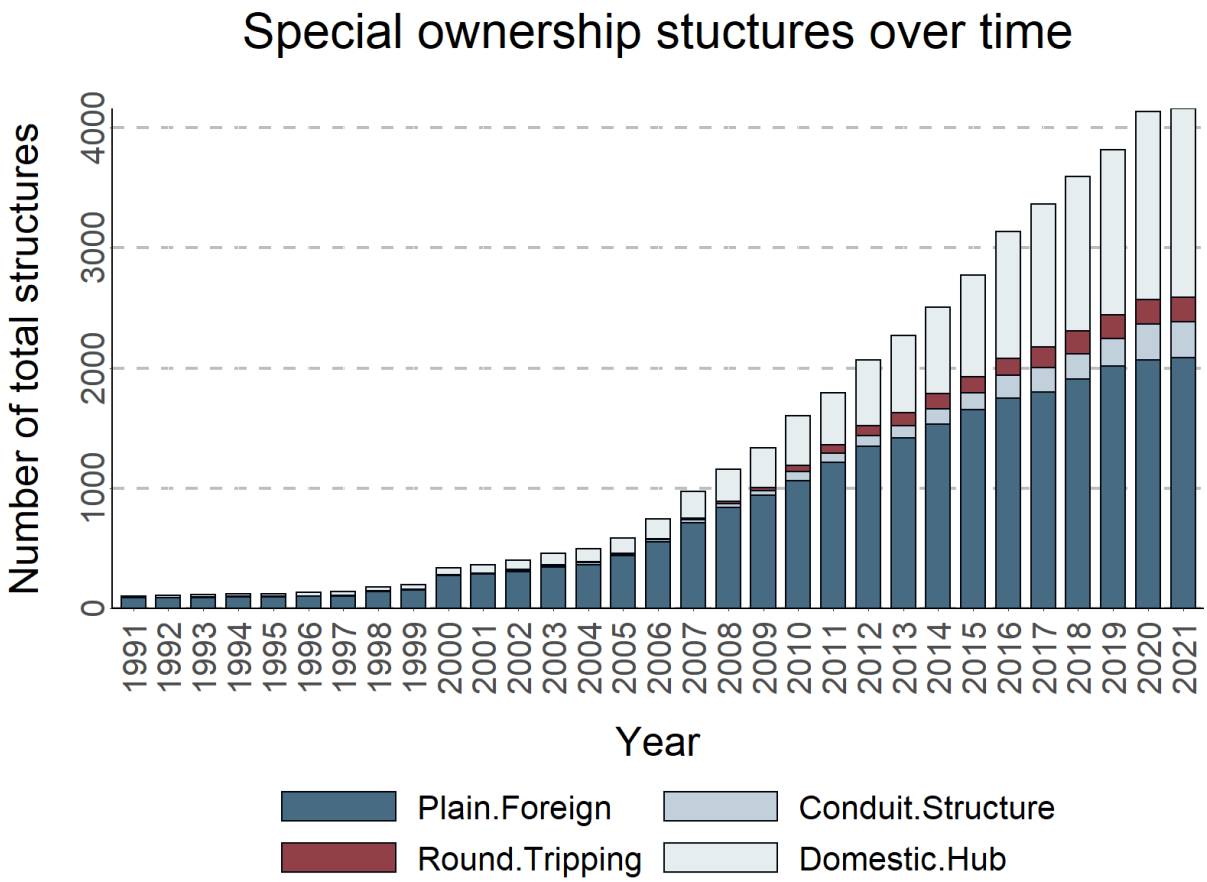

Figure 39: Replication of Großkurth's robustness check with own samples between 1991 and 2021. Absolute numbers.

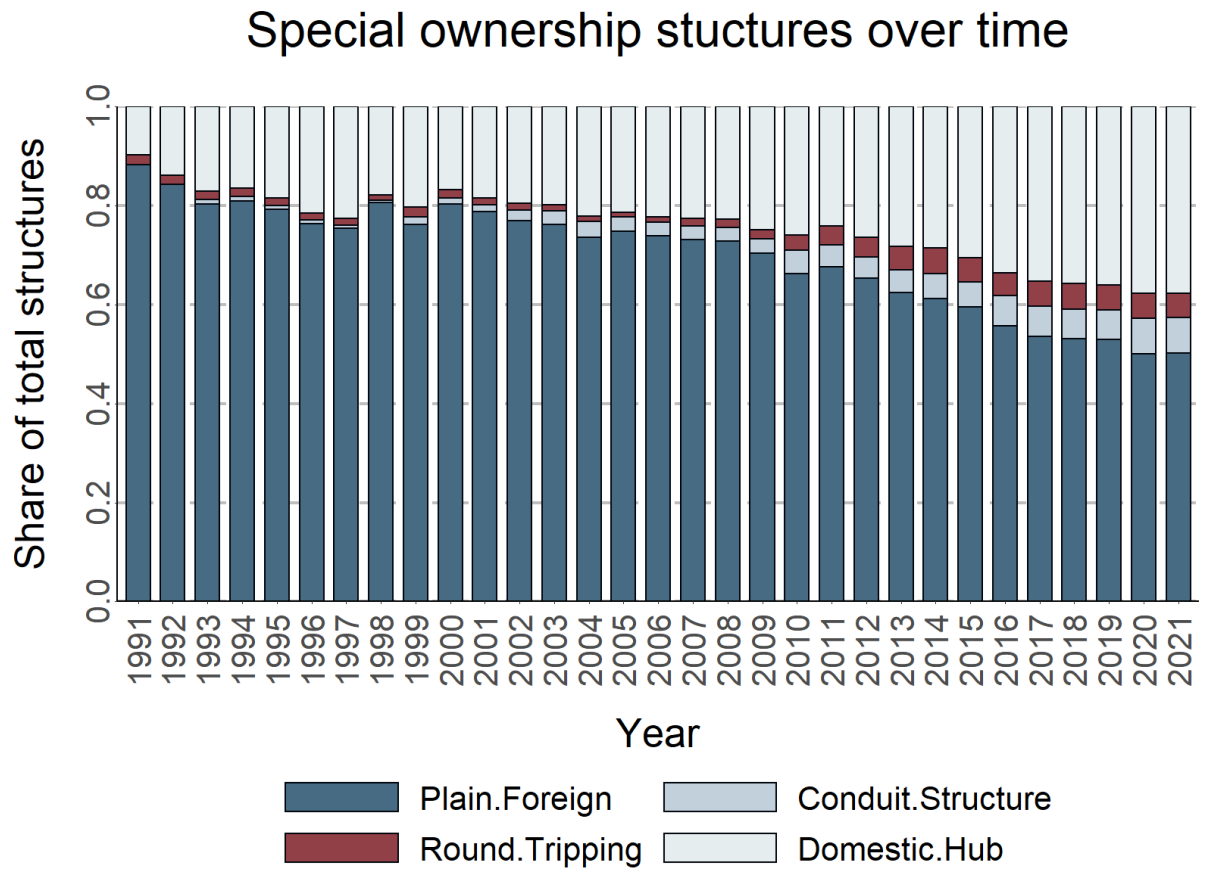

Figure 40: Replication of Großkurth's robustness check with own samples between 1991 and 2021. Proportions.

In my view, these similarities are remarkable respecting the two generally different initial datasets. I have furtherly replicated Großkurth's comparison with Alabrese and Casella (2020), who used no reconstruction but worked with a "original" Orbis dataset retrieved in 2015. Surprisingly, my reconstructed dataset shows an even lower sum of differences than the one of Großkurth (Table 8-9). However, due to the differences in data collection, these comparisons cannot be taken as quantitative quality measures. They are much rather proof of the overall functionality of both algorithms. The similarities between all three papers (mine, Großkurth 2019b, Alabrese and Casella 2020) indicate two things. Firstly, we can expect that my merging algorithm works as it is supposed to. Secondly, the German energy sector is tightly enmeshed in the overall ownership network in Europe.

7. Detailed description of special law zone string match

Jersey

All postcodes within the territory of Jersey start with JE. A simple string match could therefore be applied to find all entities that are located the postcode area JE* with * meaning a *wild card* for any alphanumeric digit following. Furthermore, another string match was applied to identify for companies located in cities and towns which are themselves located in jersey. This string match searched *within* all entities listed under the ISO code of GB (Great Britain) for city/town names containing the following strings:

JERSEY|HELIER|CLEMENT|SAVIOUR|MARTIN|GROUVILLE|MARY|JOHN|TRINITY|OUEN|LAWRENCE

Note that some of those strings do not represent the full name of cities/towns. That is because some locations can be written slightly different. E.g. HELIER, which stands for Saint Helier, can be written as STHELIER, ST. HELIER, ST.HELIER, SAINT HELIER and so on. To avoid mismatches, I therefore checked all city/town names *that resulted in matches* whether there is another city/town in Great Britain containing the string HELIER. If not, the string match was conducted. If yes, the string match was refined to add more accuracy.[63] Last, I also checked for all companies with the string "JERSEY" in their name.

[63] This "safety measure" was applied to all following string matches by town/city name

Isle of Man

The process was widely similar to Jersey. The postcode string match searched for IM* in the postcode field of the Orbis dataset. The city/town names where:

PATRICK|DOUGLAS|RAMSEY|CASTLETOWN|ONCHAN|PEEL|BRADDAN|ERIN|BALLASALLA|MARY|LAXEY|SAINT|KIRK|SANTON|MARLEY|ARBORY|ERIN|BRADDAN|FOXDALE|SODERICK|ANDREAS|BALLAUGH|BRIDE|JURBY|LEZAYRE|JOHNS|JOHN|GREEBA|BALDRINE|LONAN|SULBY|MAUGHOLD

Again, all city/town matches under the premise that the company ISO code is "GB". A company name string match for names including "ISLE OF MAN" is also applied.

Guernsey

Postcode search was GY*. City/town names:

GUERNSEY|ALDERNEY|SARK|HERM|JETHOU|BRECQHOU|LIHOU|BURHOU|CASQUETS|BRECHOU|PIERRE|VALE|TORTEVAL|FOREST|ANDREW|MARTIN|SAMPSON|SAVIOUR|CASTEL

Likewise, all city/town matches under the premise that the company ISO code is "GB". A company name string match for names including "GUERNSEY" is also applied.

Delaware

The postcode space of Delaware starts with 19. Therefore, a similar string match as previously explained was applied for the postcode field of the Orbis company list, searching for entities whose postcode starts with 19*. City/town names searched for were:

DELAWARE|DOVER|HARRINGTON|LEWES|METROPOLIS|MILFORD|NEW CASTLE|NEWARK|REHOBOTH|SEAFORD|WILMINGTON

The City of London

The identification of entities located in the City of London is a bit more difficult. The area does not have a special postcode space starting with certain letters or digits. Neither could I use city/town name string matches as all companies of the City are listed as being located in London. I therefore used a postcode list I retrieved from https://www.doogal.co.uk/ on the 15th of May 2015. The site seems trustworthy and was already used by a number of data workers and scientists. I furthermore checked a few postcodes by hand (using Google® Maps) and found that there were all valid. The list contains 6802 unique postcodes and will therefore not be included in this appendix. However, it can be accessed in my GitHub repository on https://github.com/MaxmlGz/Masterthesis.

8. Secrecy Jurisdiction List

		Hines and Rice 1994	Hines 2010	Philips et al. (ITEP) 2017	Garcia-Bernardo et al. 2017	Included as sink	included as conduit
AD	Andorra	X	X			**X**	
AE	United Arab Emirates						
AR	Argentina						
AT	Austria						
AU	Australia						
BE	Belgium				X		**X**
BG	Bulgaria						
BM	Bermuda	X	X	X	X	**X**	
BR	Brazil						
BS	Bahamas	X	X	X	X	**X**	
CA	Canada						
CH	Switzerland	X	X	X	X		**X**
CL	Chile						
CN	China						
CTL	City of London						**X**
CU	Cuba						
CW	Curacao	X (as Netherland Antilles)	X (as Netherland Antilles)	X (as Netherland Antilles)	X	**X**	
CY	Cyprus	X	X	X	X	**X**	

CZ	Czech Republic						
DE	Germany						
DEL	Delaware						
DK	Denmark						
EE	Estonia						
ES	Spain						
FI	Finland						
FR	France						
GB	United Kingdom				X		(City of London)
GG	Guernsey	X as Channel Islands	X	X as Channel Islands		**X**	
GR	Greece						
HK	Hong Kong	X	X	X	X	**X**	
HN	Honduras						
HR	Croatia						
HU	Hungary						
IE	Ireland	X	X	X	X		**X**
IL	Israel						
IM	Isle of Man	X	X			**X**	
IN	India						
IR	Iran						
IS	Iceland						
IT	Italy						
JE	Jersey	X as Channel Islands	X	X as Channel Islands	X	**X**	
JO	Jordan	X	X			**X**	
JP	Japan						
KE	Kenya						
KN	Saint Kitts and Nevis	X	X			**X**	
KR	South Korea						
KY	Cayman Islands	X	X	X	X	**X**	
LB	Lebanon	X	X			**X**	
LI	Liechtenstein	X	X		X	**X**	
LT	Lithuania						
LU	Luxembourg	X	X	X	X		**X**
LV	Latvia						
MC	Monaco	X	X		X	**X**	

ME	Montenegro						
MG	Madagascar						
MN	Mongolia						
MT	Malta	X	X	X	X	**X**	
MU	Mauritius		X	X	X	**X**	
MX	Mexico						
MY	Malaysia						
NG	Nigeria						
NL	Netherlands			X	X		**X**
NO	Norway						
NZ	New Zealand						
PA	Panama	X	X	X		**X**	
PE	Peru						
PH	Philippines						
PK	Pakistan						
PL	Poland						
PT	Portugal						
PY	Paraguay						
RO	Romania						
RS	Serbia						
RU	Russia						
SE	Sweden						
SG	Singapore	X	X	X	X	**X**	
SI	Slovenia						
SK	Slovakia						
TH	Thailand						
TR	Turkey						
TW	Taiwan				X	**X**	
UA	Ukraine						
US	United States						
UY	Uruguay						
VG	British Virgin Islands	X	X	X	X	**X**	
VN	Vietnam						
ZA	South Africa						

Table 9: Definition of sinks and conduits and comparison to other literature.

9. About the Ownership Network Graphics

As described in the main text, all countries occurring in the network are projected on a world map by geo coding. Since these graphics are mainly for the purpose of a lucid visualization, a few modifications are applied to the scaling of nodes (countries) and edges (ownership links).

Since Germany will naturally be overrepresented in the dataset as it is a central selection criterium for the dataset that a German energy company is involved in an ownership chain, the observation frequency (total number of German companies within all ownership chains of a given year) of Germany is fixed at 1.3 times the observation frequency of the next most represented country (or jurisdiction). If there are for example 5000 observations of German firms within ownership chains in 2018 and 550 observations of Luxembourgish firms, the size scaling of Germany will be as if there were 715 (550 times 1.3) observations. This measure was applied because the representation of jurisdictions other than Germany would be hardly visible otherwise as Germany would appear extremely large on the map.

The rest of the node scaling follows the formular $\frac{\log(number\ of\ obersvations)}{4}$. Again, these adjustments are applied for the sake of comparability and lucidity within the graphics. For a one-to-one quantitative comparison, the data tables of this thesis are a better option. It should just be said that small differences in size between nodes that are large on the graphics are in reality much larger than differences between small nodes that e.g., represent countries with just one and two observations for a given year. A similar adjustment is done to the edge size. Here, the formula for size scaling is $\frac{\log(number\ of\ obersvations)}{10}$, but no cap is applied to edges directly connected to Germany.

The colouring of the nodes is based on the GUO indicator score but is harmonized for each network separately. The harmonization follows the formular $\frac{GUOscore_i - \min(GUOscore)}{\max(GUOScore) - \min(GUOscore)}$ with i being the respective node (country/jurisdiction) and min/max GUO score the minimum/maximum observed GUO score throughout all countries within the respective year. This is, as all of these adjustments, a measure to improve visual relatability between the nodes.

The edges are coloured according to their *origin* node, which means by the country of the *owner* side of the link between two countries. If there are relations in both directions between two countries, those are pictured as overlaying edges.

10. Adjustments to ETR model one

The adjustments to the EBT-ETR and the EBIT-ETR model follow the thoughts of a very recently published paper (Garcia-Bernardo et al. 2020) that works with Orbis data to estimate ETRs and applies some adjustments to its models partly in response to critics about tax-rate estimation by Orbis data (Bräutigam et al. 2019; Hanlon and Heitzman 2010). The basic idea is to estimate both EBT and EBIT based versions of an ETR indicator to avoid inaccuracies that can be caused by differences in taxation of international capital flows (see main text). Furthermore, the authors apply an additional number of refinements to their data to prevent invalid comparisons between different companies. I will quickly outline those adjustments I adopted for my model. These adjustments are applied in the same order they are reviewed in this section.

1. Drop all companies that show negative income (loss) in the first latest before the observation period (2012)

This is done to prevent ETR distortions of losses carried forward. If a company suffered negative income in the year before the observation period begins, this can lead to positive taxation (tax "refunds", meaning tax is *added* to the income rather than subtracted). Even though this is a normal practice in fiscal policy, it can be problematic if the losses happened in the year before the observation period and therefore only the loss-carry-forward tax refund gets recorded, but the losses of the previous period are not. In these cases, ETRs would be falsely reduced.

2. Keep 2013 to 2020

Orbis data for the current year often shows poor coverage, incompleteness, or inconsistency. The last year of observation (2021) is therefore removed entirely from the set for the sake of comparability and data integrity.

3. Drop last year of observation (dependant on data availability) if companies show negative profits in that year.

This is in some way the counterpart to step one. It is applied to avoid the inclusion of negative income without catching loss-carry-forward tax refunds potentially neutralizing these losses in terms of the average ETR within multiple years.

4. Drop companies with less than three observations.

This is another data robustness measure. Since taxation is a complex construct, it can always happen (despite previously discussed adjustments) that companies show one or two years of "odd" tax related observations. However, these anomalies should equal out over several years. To prevent companies with one or two *out of the ordinary* taxation years (and these years being the only ones observed) distorting the results, at least three observations must exist within the year range from 2013 to 2020 for companies to be included.

5. Drop companies with a negative income sum at the end of the observation period and those with an ETR of more than one

Companies with an overall negative income at the end of the observation period are deleted for the following reason. This thesis deals with equality between profitable companies to judge economic and social fairness between market competitors. Following this thought, companies with negative income would lower average tax rates in a way that is not beneficial for this intended comparison[64]. ETRs of over one on the other hand do not make good economic sense and are most probably either the result of data flaws or complex restructuring procedures that cannot reliably be captured with the data and methods available for this thesis.

Lastly, it should be noted that I *keep* companies with negative tax rates as long as they have positive profits summed up over the whole observation period. These effects can be caused by takeover deals including an unprofitable target which can offer investors the chance to benefit from loss-carry-forward tax refunds. As this thesis, unlike the paper I am referring to (Garcia-Bernardo et al. 2020), does account for ownership changes and this is furthermore a particular strongpoint of my methodology, those companies will remain in the dataset.

[64] Companies with suspectedly "false" negative profits will be respected in the "true profit" model.