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Does Regulatory Independence Translate into a Higher Degree of Liberalization? - Evidence from EU Energy Regulators*

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Abstract: Independent regulatory authorities are a basic prerequisite for a successful liberalization process. However, contrary to what is expected, both graphical analyses and OLS regressions for a small sample of electricity and gas regulators operating in 16 European countries reveal a negative relationship between the authorities' formal autonomy from politicians and the scope of market reforms. These findings might suffer from endogeneity, though, so we draw on political scientists' explanations for diverging independence levels to construct appropriate instruments. The 2SLS-IV results then confirm conventional wisdom: the higher the degree of regulatory autonomy, the higher the level of liberalization.

JEL-classification: L50, L94, L95, L98

Keywords: Independent Regulatory Authorities, Energy Market Liberalization, Formal Independence.

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1 Introduction

The liberalization process initiated by the European Union in electricity and gas markets in the mid-1990s has aimed at achieving a single internal energy market (European Communities 1996, 1998). It was accompanied by the establishment of national independent regulatory authorities (IRAs) which foster reform by fulfilling three different tasks: first, they allow protection of investors from arbitrary government interferences with regulation that would otherwise occur due to short-term political pressures. Second, they monitor the natural monopolies that exist in both industries (i.e., transmission and distribution in both sectors as well as gas storage) to avoid competition-hampering impacts on the liberalized activities (i.e., generation/production, wholesale and retail); this prevents the monopolists from abusing their market power at the expense of consumers. Finally, IRAs are commissioned to enhance economic efficiency (Smith, 1997; OECD/IEA, 2001), which especially implies the enforcement of prices for monopoly services that eliminate excess profits, but still both ensure costs coverage and provide incentives for cost reductions and adequate, timely investments (Small, 1999; Joskow, 2007).

A proper fulfillment of these tasks requires that neither politicians nor regulatees are able to affect agency decisions in any way. An authority's independence from both politics and stakeholders backed by an adequate endowment with financial and personal resources is therefore rated as essential for an effective regulation (Smith, 1997; OECD/IEA, 2001). This notion, however, is challenged by the scatterplots shown in Figures 1 and 2: the diagrams contrast the degree of regulatory independence with the liberalization level realized in European energy markets; they include three (for electricity) and two (for gas) years, respectively, of the early

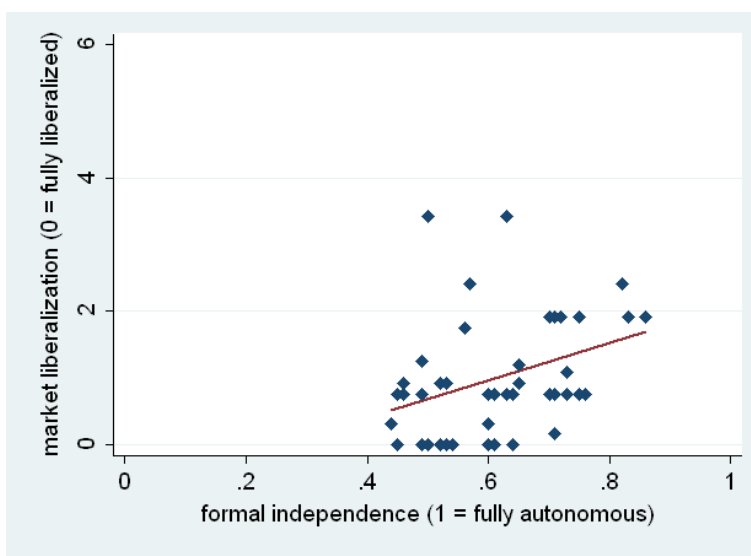


FIGURE 1: REGULATORY INDEPENDENCE AND ELECTRICITY MARKET LIBERALIZATION

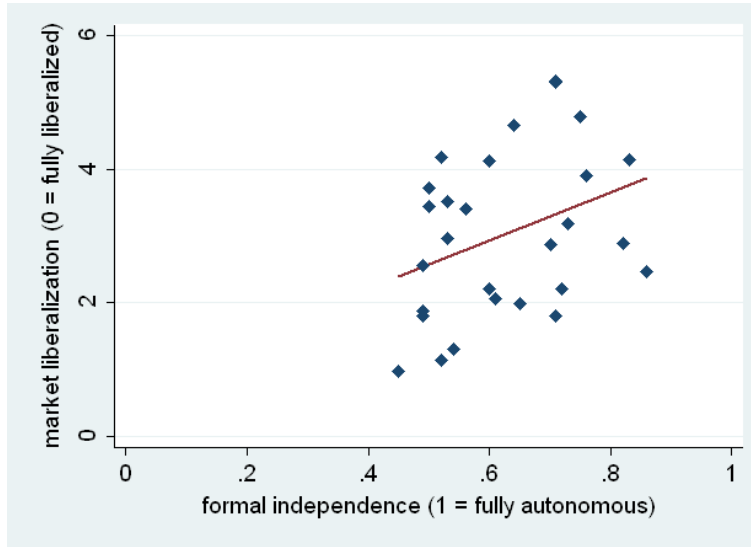


FIGURE 2: REGULATORY INDEPENDENCE AND GAS MARKET LIBERALIZATION

2000s as well as 16 countries (EU-15 plus Norway). The regulators’ autonomy is measured by an index developed by Gilardi (2002) that ranges from 0 to 1 and increases with higher degrees of formal (i.e., statutory) independence. Liberalization is operationalized by averaging OECD measures that evaluate market entry regulation, vertical separation provisions (in both sectors) and market structure (only in the gas sector) by assigning values between 6 (precluding competition) and 0 (fostering competition) (Conway and Nicoletti, 2006; OECD, 2011)¹. Contrary to what is expected, the fitted regression lines in the plots suggest lower reform efforts in energy markets supervised by more autonomous authorities; the higher slope in Figure 2 indicates that the negative relationship seems to be even more pronounced in the gas sector.

These observations are at odds with the conventional wisdom of competition-enhancing independent regulators. They rather emphasize the relevance of the warning to be found repeatedly in research on IRAs (Thatcher, 2002a; Maggetti, 2007; Gilardi and Maggetti, 2011): despite the substantial role that regulatory authorities (are supposed to) play during reform processes, a comprehensive analysis of their functioning and particularly their actual impact on liberalization is still missing.

Our paper now aims at narrowing this research gap: it empirically analyzes the effect of regulatory formal independence on the intensity of electricity and gas market reforms in Europe. At the same time, this study takes the first steps to overcome an issue identified as significantly impeding the empirical assessment of IRAs: the problem of lacking long-term data on the agencies’ degree of statutory autonomy (Gilardi and Maggetti, 2011) is tackled by the construction of a small panel sample that captures the formal independence of the *same* European energy

¹Methods and data sources used to construct both the independence and the liberalization index are described in detail in Section 2.1.

regulators in *different* years.

An agreed-upon measure of statutory agency autonomy does not exist in economics. Autonomy data for the first sample year are therefore borrowed from Gilardi's (2002) index of regulatory formal independence which was originally developed to verify two explanations for diverging degrees of agency autonomy prevailing in political science: the credibility and the uncertainty hypothesis.

The credibility hypothesis states that governments delegate decision-making powers in the area of market regulation to *agencies* detached from cabinets so as to be able to credibly display the ruling parties' commitment to regulatory provisions (Gatsios and Seabright, 1989). The giving up of power on the part of politicians is seen as necessary due to the governments' ongoing propensity to optimally adapt their policies to actual circumstances and their political discretion empowering them to do so (Kydland and Prescott, 1977): only an institutional arrangement eliminating decisional leeway allows cabinets to credibly rule out future changes in regulations (Shepsle, 1991). Agencies *fully independent* from government are expected to fulfill this requirement most effectively (Majone, 1997a, 1997b).

The uncertainty hypothesis claims that ruling politicians set up autonomous authorities to shield their political beliefs from opposing successors in case they lose majority: established with objectives that reflect the government's ends, their institutional structures durably resistant against any interference secure an adamant policy in the agencies' jurisdictions (Moe, 1989).

The employment of Gilardi's (2002) index requires a closer consideration of two of its properties, though. First and as mentioned above, the measure merely depicts "a snapshot of the formal independence of regulatory agencies" (Gilardi and Maggetti, 2011: 206): it covers only a single observation point in time, the first panel year. This makes the intended analysis of the long-term effects of agency autonomy on electricity and gas market liberalization impossible, so we extend the sample period: we use two surveys on European energy regulators (Johannsen et al., 2004; CEER, 2005) along with Gilardi's (2002) method of calculation to compute comparable values of the autonomy index for further years.

Second, Gilardi's (2002) measure only considers how "prescriptions, enshrined in the constitutions of agencies, [...] guarantee their independence from elected politicians" (Gilardi and Maggetti, 2011: 202); the results of *regulatory capture* theory are hence neglected. Based on Stigler's (1971) seminal paper claiming that politically influential industries are able to abuse state institutions to maximize the incumbents' profits, different strands of the *capture* approach solely blame the regulatees for welfare detrimental regulations: agency members are assumed to act in the interest of firms due to bribes (Laffont and Tirole, 1991), post-tenure job prospects in the industry (Che, 1995) or by intentionally applying biased information provided by the regulatees as a basis for regulatory decisions (Agrell and Gautier, 2010, 2012a, 2012b), while governments are expected to strive for welfare maximization only. However, despite the definite

source of adverse regulations suggested by *capture* theory, focusing on political instead of industry interference by applying Gilardi's (2002) index should provide reliable results: at variance with the theoretical predictions, Wilks and Bartle (2002) argue that especially the prevention of political influence is crucial for obtaining effective regulators; regulatees try to interfere with authorities mostly only indirectly via politicians who are prone to yield to political pressures and are therefore exploited by suppliers as well as industrial lobbyists.

We start our empirical analysis by running OLS regressions that control for several factors that might affect the degree of energy market liberalization besides regulatory formal independence (including those that have been identified to influence a country's reform efforts in previous studies). In these estimations, the sign of the coefficients on statutory agency autonomy turns out to be in line with the negative relationship between regulatory independence and liberalization suggested by the scatterplots, but the estimates cannot reach statistical significance.

However, the common notion that authority independence fosters liberalization might induce a government facing a poor reform progress in the energy sector to extend the responsible regulator's autonomy; in this case, our OLS estimates would be biased because of reverse causality. We cope with this problem by re-running our regressions, using 2SLS IV as the estimation method. To select the instrumental variables, we draw on the research on the determinants of formal regulatory independence: proxies for political uncertainty and for political credibility are employed. The instruments should accordingly be correlated with statutory agency autonomy and fulfill the first requirement to be valid. We furthermore argue that also the second condition for instrument validity, a lacking direct effect on liberalization, is met by the credibility and the uncertainty measure: in particular due to the high level of expertise needed for today's utility regulation, we expect that solely IRAs (are able to) determine the scope of energy market reforms. Their regulatory decisions, in turn, should be unaffected by both a feature of a country's polity (as a government's risk of losing office to a successor with a different ideology, captured by the uncertainty proxy) and the degree of an economy's globalization (applied as credibility proxy).

In line with the uncertainty hypothesis, first stage IV results reveal the formal regulatory independence to increase with a higher risk for governments to be replaced by warring politicians. Moreover, higher levels of statutory autonomy are suggested for less globalized economies. This contradicts expectations, though: an outstanding importance for cabinets to credibly commit to regulations is conjectured to exist especially in open countries where foreign investors have to be attracted and retained. We provide the following possible explanation for this inconsistent finding: evidence from EU member states indicates that, due the energy sector's importance for an economy, governments favor national energy suppliers to be controlled by domestic shareholders. The European Union, though, counteracts this tendency by all means to enforce the EC Treaty rules on the free movement of capital and the freedom of establishment. The only

remaining possibility for politicians to influence the energy sector in their interest is therefore to interfere with the regulator; higher foreign investments should then induce governments to keep a foot in the authority's door, reflected by a limitation of formal regulatory independence. In the second stage of the IV regression, a considerable liberalization-enhancing effect of an authority's formal independence is suggested by the respective estimate. Supporting conventional wisdom in contrast to its OLS counterpart, it indicates that an interaction between the scope of reform and the statutory level of regulatory autonomy (and hence an endogeneity problem) indeed exists.

The remainder of the paper is organized as follows: The next section illustrates the data used to test the hypothesis of a liberalization-enhancing effect of IRAs empirically and elaborates on our controls. Section 3 reports and discusses OLS regression results. Section 4 takes account of potential reverse causality problems. It introduces appropriate instruments for regulatory independence and substantiates their selection; then, the section presents and discusses IV regression results. Section 5 concludes.

2 Data and Variables

2.1 Liberalization and Regulatory Independence

To capture the degree of liberalization in national electricity and gas markets, we draw on the OECD's ETCR (*E*nergy, *T*ransport and *C*ommunications *R*egulation) index (OECD, 2011). It provides a comparative measure for the overall liberalization level in seven non-manufacturing sectors (electricity, gas, airlines, railways, road transport, post, telecommunications) by assessing how regulatory provisions impede competition in the (potentially) competitive stages of the industries' value chains. The comprehensive measure is composed of (equally weighted) sector indicator values. These, in turn, are the averaged scores of two to four sub-indicators, capturing the regulatory design in areas that are crucial for realizing a competitive market in the industry considered. They are chosen from the following: barriers to entry, public ownership, market structure, vertical integration, and price controls. Two or three main aspects of the structural arrangements in each selected field are then evaluated on the basis of data included in OECD and other institutions' official publications as well as on information on policy settings and regulatory rules gathered from OECD member states by a questionnaire (Conway and Nicoletti, 2006).

Since we are interested in a possible relationship between regulatory independence and liberalization in the *energy* sector, we concentrate on the indicators for the electricity and the gas sector. The sub-indicators originally included are entry regulation, public ownership and vertical integration (both sectors) as well as the market structure (only for the gas sector) (Conway and Nicoletti, 2006). Due to concerns about reverse causality, however, we disregard the ownership

situation: according to Majone (1996), the market power of natural monopolies existing in European energy markets has been curbed for a long time by nationalization. The nationalization of natural monopolies aimed at ensuring an appropriate consideration of the public interest in the companies' production and pricing decisions, but was increasingly perceived as failing to meet this objective: apart from the insufficient supervision of the firms' leaders due to a lack of specialist knowledge and information on the side of politicians, both vague responsibilities and managerial objectives prevented clear-cut performance ratings and enabled executives either to excessively expand corporate activities or to preserve convenient conditions. In the recent past, independent authorities have therefore taken over the regulatory function from public ownership.

To measure the liberalization levels in gas and electricity markets, we calculate the respective mean of the sub-indicators for each sector. The following major aspects are evaluated: the electricity entry regulation sub-indicator captures the conditions of third party access, the existence of a wholesale market and restrictions in the consumers' choice of supplier; the vertical integration sub-indicator considers the level of vertical separation between transmission and generation as well as the overall degree of vertical integration in the sector. The gas entry regulation sub-indicator analyzes the terms of third party access, the extent of consumer choice and provisions curtailing market entry in the production/import stage; the vertical integration sub-indicator assesses the degree of vertical separation between production/import and all residual stages, between supply and all residual stages and separately between supply and distribution. The sub-indicator for the market structure in the gas sector additionally evaluates the largest companies' market shares in the production/import, in the transmission and in the supply stage. Evaluation scores assigned to each of these issues range from 0 to 6 and increase with the anti-competitiveness of regulatory provisions. A weighting scheme adding up to 100 percent is then applied to all scores belonging to one sub-indicator, yielding index values between 0 and 6 for both the latter (Conway and Nicoletti, 2006) and our liberalization measure.

To measure the autonomy of energy regulators, an index of formal independence developed by Gilardi (2002) is applied as a benchmark. An authority's *formal* independence determines the degree of autonomy conceded to an IRA by statutes and laws that prohibit political interventions (Gilardi, 2002). It has to be distinguished from an agency's *de facto* independence (Gilardi and Maggetti, 2011) which captures the non-interference in an authority's day-to-day operations and is conceptualized and operationalized in Maggetti (2007). Unlike the formal independence concept, the *de facto* approach considers autonomy from both politicians and regulatees. Gilardi's (2002) index comprises five dimensions determining a regulator's formal autonomy: the agency head's status, the management board members' status, the authority's relationship with government and parliament, the regulator's financial and organizational autonomy and the regulatory competencies. The degree of independence in these areas is assessed by a questionnaire answered by regulators (Gilardi, 2002, 2005a, 2008, ch. 8). It assigns values between 0 and 1 to

predefined answering possibilities to questions that capture the statutory provisions governing the respective aspect surveyed. The values increase when political interference is impeded by the relevant laws. The dimension indices are the average values of all questions composing a dimension; the overall autonomy values used in our paper are calculated as the means of the dimensions. Figures for the total formal independence of electricity regulators are reported in detail in Gilardi (2008, ch. 8) and reflect the situation in one year of the 2001-2003 period that differs for the agencies included in the sample.

Since we are particularly interested in possible effects of regulatory independence on liberalization over time, we draw on the surveys by Johannsen et al. (2004) and the Council of European Energy Regulators (CEER) (2005) to add observations from additional years. Both reports use similar questionnaires as Gilardi (2002) to picture the formal autonomy of IRAs, so that constructing a small sample that captures the formal independence of energy regulators in 16 European countries (EU-15 plus Norway) in the recent past becomes possible: all answers were coded according to Gilardi's (2002) scale, so as to generate a comparable measure for the independence dimensions and the overall IRA autonomy. Unlike Gilardi (2002, 2005a, 2008, ch. 8), who explicitly refers to *electricity* regulators, both Johannsen et al. (2004) and CEER (2005) sent their questions to the CEER member authorities responsible for *energy* regulation. For the periods covered by these two studies (Johannsen et al. (2004): 2003/2004 and CEER (2005): 2005) we therefore consider both the *electricity and the gas* sector. As the regulator in Norway is not responsible for governing the gas market (International Energy Regulation Network, 2012), only the Norwegian electricity sector is included in our analysis².

2.2 Control Variables

Next to the impact independent regulators are expected to have on energy market liberalization, several other explanations for diverging reform efforts exist. We outline the associated theoretical approaches as well as related empirical evidence in the following and add appropriate control variables to our estimations. Furthermore, this section introduces additional covariates we include in the regressions and briefly substantiates their selection. Detailed descriptions of the controls as well as summary statistics for all variables can be found in Tables 4 and 5 in the Appendix, respectively.

First, we distinguish between regulatory activities in the electricity and the gas industry.

²Lacking data on regulatory independence further reduce the number of observations: the survey by Johannsen et al. (2004) does not include information about the Belgian and the German electricity and gas regulators, while Gilardi (2008, ch. 8) does not provide an index value for the Luxembourgian electricity agency. In addition, Gilardi (2008, ch. 8) assigns an index value of 0 to the German electricity authority for our first year of observation: an energy sector regulator autonomous from the government had not yet existed there in 2002. Since we want to assess the relationship between the formal independence of IRAs and the scope of energy market reform, we exclude this observation from our sample.

Compared to electricity markets, reform efforts in the gas branch were smaller in the early years of liberalization (Conway and Nicoletti, 2006), so we take account of the distinct initial situations newly established regulators had to face in both these sectors when they started their work.

Furthermore, the duration of a regulator's activity most likely plays an important role for the fulfillment of its (economic) task to eliminate anti-competitive behavior: determination, implementation and enforcement of reform measures as well as potentially necessary adjustments to improve their efficiency require a long time period. Besides, authorities organized in networks (as, e.g., the Council of European Energy Regulators) might, over time, benefit from a transfer of knowledge and best practices between member agencies (Maggetti, 2007) that facilitates their mission. We therefore control for the number of years that have passed by since an authority has started its operation.

Moreover, the so-called "crisis hypothesis" asserts that a (severely) deteriorating economy is a prerequisite for reform: only the distress occurring in such a situation can induce politicians to implement necessary changes and, above all, enable them to force through these adjustments against the resistance of the losing group every reform inevitably creates (Drazen and Grilli, 1993; Krueger, 1993; Rodrik, 1996; Drazen and Easterly, 2001); at this point, the costs of the crisis unacceptably exceed the advantages of its few, albeit often well-organized, beneficiaries (who, beyond that, are expected to reduce opposition as they get negatively affected by the pervasive economic problems as well (Rodrik, 1996)). The hypothesis is substantiated with respect to high inflation by Drazen and Grilli (1993) theoretically as well as by Drazen and Easterly (2001) and Pitlik and Wirth (2003) empirically. With regard to growth crises, Pitlik (2008), examining the joint effect of a country's economic performance and its political regime type, provides empirical evidence for negative growth to foster reforms in democracies, but not in autocratic polities. Pitlik and Wirth (2003) find that - compared to a situation without a crisis - liberalization efforts are higher in countries suffering from a deep growth crisis, whereas a medium crisis delays steps of reform³. Drazen and Easterly's (2001) and Pitlik's (2007) results point in the direction of a growth crisis effect as well, but are (mostly) not statistically significant. To check for a possible relationship between the state of an economy and its degree of liberalization, we include a control for potential economic downturns in the previous year. Based on Pitlik and Wirth's (2003) findings, rather a reform-hampering effect of a crisis should show up, since in

³Pitlik and Wirth (2003) define the two types of crisis as follows: They assign a value of 1 to every year with a non-positive growth rate being higher than -1%; years with a rate equal to or smaller than -1% receive a value of 2. Then, a five year period with a sum between 3 and 5 is classified as a medium growth crisis, a five year period with a total value greater than 5 constitutes a deep crisis. Their finding that at least medium crises hamper liberalization is in line with Bean's (1998) conjecture: contradicting the "crisis hypothesis", he argues that policy changes are more likely in times of growth, since a good economic performance allows to better alleviate the disadvantages of the losers of reform.

the period considered a deep recession did not emerge in European states. Pitlik's (2008) (and, within limits, also Drazen and Easterly's (2001) and Pitlik's (2007)) results, however, suggest exactly the opposite. We refrain from additionally controlling for currency devaluation, since the inflation rates identified as inducing reform are way beyond those observable in Europe during our sample period⁴.

We also account for a country's energy efficiency in production. Since the desire for cheap energy is stronger in economies with energy-intensive manufacturing processes, a high energy intensity probably fosters competitive market structures in the national electricity and gas industry. Far-reaching reforms should thus mainly take place in countries where the total amount of primary energy necessary to produce one thousand US\$ of GDP - a common proxy for energy efficiency (OECD, 2010) - was high in the preceding year.

The intensity of liberalization might likewise be affected by the government's ideology: typically, left-wing parties are expected to favor state interventions and, thus, rather comprehensive regulatory regimes, while right-wing policies are associated with an unobtrusive state, trusting the market and fostering deregulation (Benoit and Laver, 2006, ch. 6). The propensity to liberalize the energy sector should hence be lower in countries governed by left-wing parties, which would also be in line with Pitlik's (2007) and Potrafke's (2010) empirical studies: both find general reform efforts to be higher in countries with right-wing governments. The revealed relationship, however, might not only be caused by direct governmental decisions and actions, as suggested by the plain theory; given the key role assigned to regulators in the liberalization process, it might also reflect the political orientation prevailing in authorities not (yet) fully politically independent: Gilardi (2005b) argues that "IRAs need not be ideologically neutral" (Gilardi, 2005b: 92), and his view is in line with Thatcher's (2002b) remarks on the establishment process of agencies, indicating the consideration of all influential (political) interests during their creation. Finally - although with reference to general competition authorities - also a comment in Wilks and Bartle (2002) points into the same direction: such agencies are suggested to allow for the ruling politicians' views and objectives when taking decisions and to adjust to potential shifts therein. Descriptive statistics from Thatcher (2002a) substantiate the conjecture of ideological influences on regulatory decisions: for a sample of IRAs active in

⁴As in the case of growth (compare footnote 3), Pitlik and Wirth (2003) differentiate between medium and deep crises also for inflation: a year with an inflation rate higher than or equal to 10% and smaller than 40% scores with a value of 1, a year with an inflation rate equal to 40% or smaller than 100% with a value of 2 and a year with an inflation rate exceeding 100% with a value of 3. Values are then added for five year periods. A period with an aggregated score between 2 and 10 is classified as a medium inflation crisis, while a period with a total value greater than 10 constitutes a deep crisis. Drazen and Easterly (2001), dividing their sample into percentiles subject to the inflation rate, find a positive effect on reform only for the groups with a median annual rate of 68% or more. When they use another classification method, even an annual inflation of at least 100% was necessary for countries to benefit.

four EU countries and eight domains⁵, the paper shows that 73 (ITA), 46 (FRA) and 36 (GER) percent of the authorities' senior members have been affiliated to a political party⁶, and that 32 (ITA), 15 (GER), 9 (FRA) and 3 (UK) percent of them have even held or run for a political office at the local, national or European level before or after their agency job. The control for the ruling parties' orientation hence captures ideologically-tinged changes in the regulatory environment induced by either the government or politically sympathetic regulators.

Finally, we take account of the level of corruption prevailing in the sample countries. Venal public servants are expected to use the various actions at their disposal - as, e.g., the implementation of different regulatory measures - to their own benefit by affecting the bribers' ability and inclination to pay kickbacks (Tanzi, 1994; Ades and Di Tella, 1997a; Treisman, 2000): rents enjoyed by firms due to malfeasance enable officials to extract part of these illegitimate profits via bribes (Ades and Di Tella, 1997a, 1997b, 1999; Treisman, 2000). Since such rents emerge in particular in non-competitive environments (Mauro, 1996; Ades and Di Tella, 1997a, 1999), corruption is seen as a serious obstacle to the removal of market imperfections (Tanzi, 1994): civil servants aiming at high kickbacks are suspected to curb competition in their own interest (Ades and Di Tella, 1997a; Treisman, 2000). Consequently, we expect a negative relationship between the degree of liberalization and the perceived susceptibility to bribery of a country's public sector, captured by the last control we add. This would also be in line with previous theoretical and empirical findings: Emerson (2006), employing a Cournot model with a competitive fringe, shows that a low number of Cournot competitors corresponds to large kickbacks and is hence optimal from a venal official's point of view. Attached estimations furthermore reveal a strong negative effect of corruption on a country's overall level of competition. Van Koten and Ortman's (2008) study shows that in the EU-15 the degree of vertical separation between electricity transmission and generation - an essential condition to realize fully liberalized markets (European Commission, 2007a) - is higher in less corrupt member states⁷.

However, it might also be possible that the direction of effect runs exactly opposite and a low level of competition induced by only modest previous liberalization efforts increases corruption: the excessive rents firms generate in a strictly regulated, non-competitive market constitute a strong temptation for agency employees to demand bribes from the companies that are interested in maintaining their profitable situation (Mauro, 1996; Ades and Di Tella, 1999); a higher degree of state interference might therefore be associated with officials becoming more corrupt

⁵The domains are: general competition, telecommunications, energy, water, railways, postal services, media and stock exchange/shares; in some of the countries surveyed independent regulators did not exist in all of these areas. See Thatcher (2002a) for details.

⁶The corresponding percentage in the UK has been zero.

⁷Although not linked to bribery by the author, also Duso's (2002) results for the *mobile telecommunications sector* seem to further substantiate the above considerations: he finds that the higher the market share of the incumbent (and thus the rents it enjoys), the lower is the intensity of industry deregulation.

(Tanzi, 1994; Mauro, 1996; Treisman, 2000). A general negative effect of non-competitive rents on the officials’ integrity is suggested both theoretically and empirically: Ades and Di Tella’s (1997a) model shows that the proportion of corrupt bureaucrats increases in the profits of the regulated firms. And Ades and Di Tella’s (1997a, 1997b, 1999) and Treisman’s (2000) estimations reveal a higher susceptibility to bribery in countries where domestic companies enjoy higher rents due to the following reasons: a low trade openness (Ades and Di Tella, 1997a, 1997b, 1999; Treisman, 2000), a market dominance of few firms (Ades and Di Tella, 1999), regulatory interventions (Treisman, 2000), subsidies, fiscal discrimination or the exclusion of foreign firms from public procurement procedures (Ades and Di Tella, 1997b); Ades and Di Tella’s (1999) and Treisman’s (2000) results, however, are not statistically significant throughout. In our case, it would probably be reasonable to argue that the non-competitive profits companies earn in the partially still regulated energy markets do not crucially affect the measure of overall perceived public sector corruption employed as a control; but to entirely rule out results biased by endogeneity, we re-estimate all regressions by lagging the corruption proxy by one year. We briefly address the outcomes of these robustness checks after the findings of our main estimations are discussed.

3 OLS Estimations

To test for the relationship between an IRA’s formal autonomy and the degree of energy market liberalization, we start with estimating the equation

$$lib_{it} = \alpha + \beta \cdot formind_{it} + \boldsymbol{\gamma} \cdot \mathbf{X}_{it} + \epsilon_{it}.$$

The dependent variable lib_{it} denotes the liberalization level of electricity and gas markets. Our main explanatory variable is the regulator’s formal independence $formind_{it}$. The vector \mathbf{X}_{it} includes all factors that might also affect reform efforts, outlined in Section 2.2. Finally, ϵ_{it} describes the usual error term.

Table 1 reports the results from a fixed-effects OLS regression with robust standard errors being clustered at the country level. Basically, the estimation outcome suggests the relationship already revealed in Figures 1 and 2: the coefficient of the independence measure has a positive sign, indicating less competitive energy sectors in countries with thoroughly independent regulatory authorities; statistical significance, however, is lacking. The widespread notion of a liberalization-enhancing effect of autonomous regulators is hence further challenged at this point; findings are rather in line with the accusation that IRAs have not been able to overcome the often industry-friendly climate prevailing in regulation prior to their establishment (Thatcher, 2002a).

TABLE 1: FIXED-EFFECTS OLS

dependent variable: lib		
	coef.	std.err.
formind	.2922	.8851
gas dum	2.1625***	.2935
IRA age	-.2458***	.0581
lag GDPcap crisis dum	.4492	.3360
lag ensupGDPunit	-.0145	.0115
ideopotr	.1478	.1650
corruption	-.0928	.4598
constant	4.4831	4.1180
<i>N</i>		72
<i>R</i> ² <i>within</i>		.7314

Note: Table 1 shows estimation results of a fixed-effects OLS regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. *** denotes statistical significance at the 1% level.

The statistically significant coefficients of the control variables reveal a slower liberalization pace in gas compared to electricity markets as well as a positive relationship between long-lasting IRA activities and the intensity of competition in energy sectors. According to their size, the modest reform efforts in the gas sector earlier in time entail a liberalization divergence which is equivalent to approximately two OECD index units. Furthermore, about every four years of regulatory surveillance reduce the liberalization measure by one unit.

The other controls show the expected signs as well. Our conjecture of a more competitive energy sector in case of an energy-intense economy seems to be reasonable, but the relationship is not statistically significant. Besides, the findings hint at more comprehensive reform processes in countries with a good economic performance, right-wing governments and a low corruption level. However, unlike in the studies explaining diverging reform efforts by these three aspects, their coefficients do not reach statistical significance in our estimations.

Lagging the corruption proxy by one period leaves the regression outcome almost unaffected (see Table 6 in the Appendix for detailed results): the estimate on regulatory formal independence takes a value of 0.2848 and remains statistically insignificant. The coefficients on the gas dummy and the regulator's age reach statistical significance at the 1% level again and change their size by less than 0.005 units compared to the estimates reported in Table 1. And the regression outcome still indicates a lacking effect of a country's energy intensity, the government's ideology and the level of perceived corruption (even if lagged by one year this time) on liberal-

ization. The only deviation in the findings worth mentioning is that the lagged crisis dummy reaches statistical significance at the 10% level and suggests reform efforts to be lower after an economic downturn: in case of a negative GDP per capita growth rate in the previous year, liberalization measures corresponding to an index reduction of about 0.5 units are postponed. Pitlik and Wirth's (2003) finding of the reform-hampering effect of medium growth crises might explain this result.

4 IV Estimations

4.1 The Endogeneity Problem

The estimations in the previous section are based on the assumption of an unambiguous direction of effect: the degree of formal independence (co-)determines the scope of energy market reforms in Europe. This requires that a regulatory institution's autonomy is specified before the authority takes up its work; an order that also Albon (2012) states when he describes what he calls the *regulatory supply chain*. According to this sequence, the definition of the regulator's independence level from regulatees and politicians stands at the beginning (together with setting the objectives), whereas regulatory activities are located at the end of the chain, only followed by potential appeals of the authority's decisions. The power autonomous agencies established in such an environment furthermore need to alter the sectoral structures according to their intentions obviously exists as well: they are identified as "powerful participants in policy making" (Thatcher and Stone Sweet, 2002: 15 et seq.) that "are proactive and involved in market design" (Levi-Faur, 2004: 9). Since, after all, the advancement of market-oriented reforms is one of the broad goals of independent regulators and the establishment of the latter is perceived to be vital for the development and preservation of competitive energy markets (OECD/IEA, 2001), assuming that liberalization efforts are influenced by the degree of institutional autonomy seems to be reasonable. This conjecture is substantiated by Thatcher and Stone Sweet, pointing out that "regulatory agencies have vigorously promoted liberalisation" (Thatcher and Stone Sweet, 2002: 17) in the recent past.

However, some statements in OECD/IEA (2001) also allow for a different conclusion, suggesting an opposite direction of effect: they postulate that institutions responsible for market regulation are modified over time so as to enable them to meet the changing challenges that arise when liberalization measures continually alter the structure of the regulated industry. The establishment of independent regulatory bodies is accordingly seen as a necessity in the course of reform: due to the associated increase in competition, an impartial decision-maker not discriminating against any of the market players is considered to be essential for the functioning of the market. Thatcher (2002b) argues in quite the same direction: he rates autonomous utility regulators only as a concomitant feature of the sectors' liberalization process. Finally, one of

the reasons adduced at the beginnings of the Third Electricity (European Union, 2009a) and the Third Gas Directive (European Union, 2009b) for repealing the preceding rulings creates the impression that insufficient progress of liberalization triggers increases in regulatory independence:

”Directive 2003/54/EC [2003/55/EC] introduced a requirement for Member States to establish regulators with specific competences. However, experience shows that the effectiveness of regulation is frequently hampered through a lack of independence of regulators from government, and insufficient powers and discretion. For that reason, [...] the European Council invited the Commission to develop legislative proposals providing for further harmonisation of the powers and strengthening of the independence of national energy regulators. [...]” (European Union, 2009a: 58, No. 33, 2009b: 97, No. 29 (with reference to Directive 2003/55/EC))

According to this argument, the EU’s main reason for demanding more autonomous energy regulators was their inefficient functioning, probably manifesting itself in only modest market reforms. One could thus also argue that growing liberalization efforts induce an increasing autonomy of energy regulators rather than vice versa.

Consequently, we cannot rule out that our OLS results suffer seriously from endogeneity caused by reverse causality. One can tackle this problem by applying an instrumental variable approach which, however, generates estimates being significantly less precise than their OLS counterparts; the conjecture of endogeneity should thus be verified (Cameron and Trivedi, 2005, chs. 4.9 and 8.4.3). To this end, we run a robustified Durbin-Wu-Hausman test (Durbin, 1954; Wu, 1974; Hausman, 1978) that analyzes whether the debatable explanatory variable is indeed endogenous, making the use of instrumental variables necessary. The null hypothesis is that our regressor of the regulators’ formal independence is exogenous (Cameron and Trivedi, 2005, chs. 8.3.2 and 8.4.3). For our sample, it is rejected at the 1%-level ($p = 0.0093$), fully justifying an application of the IV approach at this point. Consequently, we estimate the following equations:

$$formind_{it} = \nu + \boldsymbol{\rho} \cdot \mathbf{Z}_{it} + \boldsymbol{\mu} \cdot \mathbf{X}_{it} + \eta_{it} \quad (1.1)$$

$$lib_{it} = \alpha + \beta \cdot formind_{it} + \boldsymbol{\gamma} \cdot \mathbf{X}_{it} + \epsilon_{it} \quad (1.2)$$

Equation (1.1) describes the first-stage estimation, where the formal independence of regulators is regressed on the instruments, \mathbf{Z}_{it} . Equation (1.2) captures the second stage, estimating the effect of formal independence on the degree of liberalization. The vector of covariates, \mathbf{X}_{it} , includes all controls already used in Section 3.

We will discuss the instrumental variables included in \mathbf{Z}_{it} as well as to what extent they fulfill the standard statistical requirements for instrument validity in the following section. Section 4.3 then elaborates on two of the covariates (the agency’s age and government ideology) that might,

besides the instruments, have an effect on the regulator’s formal independence in the first stage, before Section 4.4 reports and discusses the regression results.

4.2 Instrumental Variables

For instrumental variables to be valid, they have to fulfill two statistical requirements (Wooldridge, ch. 5.1.1): first, they need to be correlated with the endogenous regressor, i.e., the variables we choose as instruments have to have an effect on formal regulatory independence. Second, the only channel through which valid instruments are allowed to affect the (second-stage) dependent variable is their influence on the instrumented regressor; put simply, this means that our instrumental variables need to be uncorrelated with the degree of liberalization (and, precisely, that they have to be uncorrelated with the second-stage error term). The remainder of this section provides arguments substantiating that our instruments meet both these conditions; the discussions are preceded by a brief introduction of the respective instrumental variable and a description of the data that are taken over one-to-one as an instrument or employed to construct one, respectively.

4.2.1 Political Uncertainty

The first instrument we employ to tackle the endogeneity problem between formal regulatory independence and liberalization is a proxy measuring the degree of political uncertainty, *uncert*. It captures two aspects that basically determine whether a governing cabinet will be able to pursue its agenda in the same (or at least a similar) way also after the next election or whether different political ideas will then be dominant, instead: both a government’s hazard of losing office and the ruling party’s ideological deviation from its successor are considered by the measure.

To create the proxy, we draw on three variables (*gov_new*, *elec* and *gov_gap*) from the Comparative Political Data Set I from Armingeon et al. (2011, 2012); the calculation of annual values is carried out as follows: first, a cabinet’s probability of having a successor with a different political agenda is computed. To this end, the number of ideology changes in government induced by variations in the parties holding office (*gov_new*) in the last 25 years (i.e., 24 years back) is divided by the total number of elections (addition of all entries for *elec*) in the same period of time. Ideology changes are identified on the basis of an index that assigns integral values according to the political orientation of governing parties: a value of 1 is assigned when only right-wing or centre politicians are in the government, a value of 2 when less than 33% of the cabinet members are from left-wing parties, and a value of 3 when the left-wing share further increases up to less than 66%; values of 4 and 5 describe the opposite to values of 2 and 1 with an analogous dominance of left-wing parties. Whenever the index value switches compared to

the previous year, an ideology change has occurred. The second step, then, captures the overall scope of the ruling governments' ideology changes in the last 25 years by summing up the absolute values of *gov_gap*; *gov_gap* draws on the outlined ideology index as well and calculates the governments' ideology difference by subtracting the pre- from the post-replacement index value. Eventually, the sum of the moduli is multiplied by the fraction generated in the first step to obtain our political uncertainty proxy. Since the values of both components of the *uncert* index increase with higher threats of an ideological turnaround, also the overall measure used as an instrument in the following does so.

The calculation of our *uncert* proxy basically resembles the method Gilardi (2005a) applies to construct an indicator of political uncertainty: both a cabinet's replacement risk and the extent of post-election ideology shifts are combined also in his measure⁸. In line with the uncertainty hypothesis, different studies employing his indicator reveal a higher regulatory formal independence when the level of political uncertainty increases (Gilardi, 2005a; Hanretty and Koop, 2012) (and, moreover, a higher basic inclination of governments to install autonomous authorities at all (Gilardi, 2005b)). These results together with the similarities between Gilardi's (2005a) and our uncertainty measure should hence allow us to assume a correlation to exist also between *uncert* and the statutory independence of regulatory agencies; the first condition for valid instruments would then be fulfilled by our uncertainty proxy.

Based on the following reasoning, we furthermore expect our uncertainty measure to meet also the second requirement for valid instruments. The liberalization of energy markets has been characterized by a growing complexity of regulatory challenges: to solve arising issues, a profound technical and scientific knowledge has become increasingly essential (Thatcher, 2002b). As a consequence, (ignorant) political decision makers responsible for the legal implementation of intended steps of reform have drawn extensively on the regulators' expertise (Moe, 1989; Majone, 1999; Maggetti, 2009). The authorities' specific capabilities to level information asymmetries

⁸Drawing on a calculation method originally introduced by Franzese (2002, ch. 3.2.8), Gilardi (2005a) constructs his indicator as follows: a government's hazard of losing office is captured by the reciprocal of the number of years that passed between the respective cabinet's inauguration and the date it was voted out of office again. The changes in the ruling parties' political orientation are operationalized by the standard deviation of yearly values rating the overall ideology of both government and parliament. The annual values are scores assigned to each party represented in these two political institutions according to their political orientation (ranging from 1 for right-wingers to 5 for left-wingers) weighted by their share of total seats; the period to which the standard deviation relates ranges from five years before the year of observation to one year after. In the end, both values are multiplied (Gilardi, 2005a, 2005b; see Gilardi (2008, ch. 8) for further details).

Two major differences exist between Gilardi's (2005a) measure and the uncertainty proxy we construct for this paper: first, we refrain from including future years, since we query that governments really have perfect foresight; twelve month before voting, election results are often entirely ambiguous. Second, we use a rather lengthy observation period of 25 years. This is mainly due to our simpler measure of a government's replacement risk that requires a longer time span to reveal variations.

between legislator and industry and to employ the internal specialist knowledge to ensure the provision of an efficient regulation (Thatcher and Stone Sweet, 2002) have thus turned regulators into central actors in the regulatory environment (Maggetti, 2009).

This gain in importance has become increasingly apparent also in the political process: certainly favored by the additional powers assigned to regulators in the last few years (Thatcher and Stone Sweet, 2002), independent authorities have developed own targets and liberalization concepts increasingly affecting regulatory policies and reforms (Thatcher, 2002b). Thatcher and Stone Sweet (2002) even argue that European autonomous agencies have taken over the function of rule-making in the domain they regulate, declaring them to be a potential "fourth branch of government" (Thatcher and Stone Sweet, 2002: 16).

Consequently, we expect the degree of liberalization in electricity and gas markets to be determined by the regulators responsible for monitoring both these sectors. A facet of the polity like a government's risk of losing office to a successor adhering to a different ideology, on the contrary, should not have an effect on the intensity of reforms, which is why we conjecture our uncertainty proxy to fulfill also the second condition for valid instruments.

Our assumption is substantiated by Maggetti's (2009) empirical results on the influence of regulators during the legislative procedure of regulatory laws (briefly labeled as "centrality"), albeit his sample does not include any energy agencies: on the one hand, his results suggest that five out of six surveyed financial market and general competition authorities are either the only or one out of two central actor(s) during political decision-making; in particular, they are found to be important not just in the enforcement, surveillance and penalization phases (as inherent in their monitoring task), but also in the early stages of legislation, where they can be key players during agenda-setting, preparatory inquiries and even draft formulation. On the other hand, his survey reveals that a regulator's "centrality" increases with a lower level of "professionalization", specifying a legislator's proficiency and means to develop an expedient regulation; the high expertise vital to regulate the energy sector should then, as conjectured, result in an exceptional role of the responsible independent agencies in the liberalization process of electricity and gas markets.

4.2.2 Economic Flows from and to Foreign Countries

The second instrument we apply is a measure that captures the intensity of economic flows from and to foreign countries, *econflows*. It is a sub-index forming part of the 2012 version of the KOF (*Konjunkturforschungsstelle*) index of globalization (Konjunkturforschungsstelle, 2012a), which, in turn, is an update of the globalization proxy originally introduced in Dreher (2006) and further developed and discussed in Dreher et al. (2008). The *econflows* sub-indicator takes account of four main items that affect the level of a country's economic interdependencies with foreign states: the trade (i.e., exports and imports) of goods and services; the scope of

inward and outward foreign direct investment (FDI) stocks; the amount of portfolio investment asset and liabilities stocks; and the income payments to foreign nationals, i.e., the remuneration of both workers and investors residing abroad. The sub-index can take values between 1 and 100, with increasing values indicating higher levels of economic globalization (see Konjunkturforschungsstelle (2012b, 2012c) for further details on both the data and the calculation method).

One can draw on the credibility hypothesis to substantiate this choice: Majone (1997a) argues that political credibility is of particular significance in open economies, since with many of the market-dominating actors being located outside the power holders' sphere of influence, it is impossible for them to reach objectives by simply using their authority; Gilardi (2002), trying to operationalize the hypothesis, refers to this reasoning and tests a measure quite similar to our instrument. Since empirical findings in general support the credibility hypothesis (Gilardi 2002, 2005a; Hanretty and Koop, 2012)⁹, expecting that economic flows have an effect on regulatory formal independence seems reasonable; in this case, also *econflows* would meet the first requirement for valid instruments.

The reasoning for why we conjecture cross-border economic flows to fulfill also the second condition for valid instruments is basically the same as in the case of political uncertainty: we expect the regulator to decide on the degree of liberalization fully autonomously and without being affected by outside influences - as, in this instance, a country's level of globalization - at all.

However, albeit this would imply that a state's economic relations with foreign countries do not have an effect on reform efforts, it does not mean that *econflows* and *lib* are uncorrelated, as empirical surveys indicate: a case study on the effects of the UK electricity market reform on foreign investment (Energy Information Administration, 1997) reveals that within the course

⁹The regressions substantiating the credibility hypothesis, though, do *not* operationalize it with a proxy that captures the scope of a country's economic relations with foreign economies. Spiller (1993) argues that employing independent regulators to signal a government's commitment credibly is especially important in industries where large investments in sector-specific assets and thus considerable sunk costs are indispensable for business activities. Consequently, dummy variables dividing the sample authorities into groups of economic and social (Gilardi, 2002) and of utility, competition/financial and social regulators (Gilardi, 2005a; Hanretty and Koop, 2012), respectively, are used to test the validity of the hypothesis in these estimations.

However, a major issue that would arise if we adopted this approach for our analysis make us draw on cross-border economic flows as an instrument, instead: the pooling criteria applied by Gilardi (2002, 2005a) and Hanretty and Koop (2012) would imply the authority monitoring the electricity sector and that regulating the gas market to be aggregated in the same category. But modifying the original, rather rough classification and using the gas market dummy as an instrument instead of as a covariate would neglect the conjectured lower liberalization pace in this industry (suggested by the OLS results in Section 3); the requirement for an instrument to have no direct effect on the second-stage dependent variable would thus probably be violated, resulting in the gas sector dummy to be invalid.

of liberalization both the takeovers of British electricity firms by external investors and the cross-border acquisitions by UK companies have increased considerably; reform measures are hence suggested to raise the number of takeovers by and of foreign firms in the power industry, which would affect the indicator of economic flows. Such transactions might furthermore go along with the secondment of, e.g., management personnel into the acquired firms, raising the value of the proxy's payment component when the executives from abroad are remunerated by the new affiliation.

Electricity market reforms that induce (more) acquisitions of power companies by firms from abroad will probably increase cross-border remunerations also for another reason: Alesina et al. (2005) find investments to be higher in more liberalized industries; returns from investments undertaken by companies with foreign owners would accordingly accrue to investors from abroad.

Finally, liberalization might affect the globalization proxy regardless of whether takeovers by and of foreign firms take place: the European Commission has identified insufficiently unbundled national incumbents to defer the construction of cross-border transmission infrastructure in their efforts to foreclose rival power and gas suppliers from abroad from domestic energy markets (European Commission, 2007a). As the reform process includes the implementation of (often increasingly stricter) rules on vertical separation (OECD, 2001; OECD/IEA, 2005; Newbery, 2009), liberalization alleviates or even entirely solves this issue; cross-border flows of electricity and gas should hence increase. This would, in turn, positively affect the transnational trade of goods and services.

The different economic flows included in the index might hence be affected by a country's degree of liberalization in various ways; a correlation between our proxy for governmental credibility and reform efforts implying *econflows* to be an invalid instrument thus cannot be ruled out. For this reason, we lag our instrument by one year: regulatory provisions adopted at some day in the future most probably do not affect today's foreign trade and investment and payments to external production factors. Rather, it is reasonable to expect a delayed effect, as the results of Alesina et al. (2005) suggest: regarding investments, they find that adjustments are primarily caused by regulations implemented two years earlier. Employing *lag econflows* in the IV regression should accordingly avoid potential correlation issues induced by an effect of liberalization measures on cross-border economic flows; since the regulator's decision-making power probably eliminates, as outlined, any reverse influences, we expect the lagged index to meet also the second requirement for valid instruments.

We finally want to supplement our considerations on the lacking correlation between our instruments and the degree of energy market liberalization by reporting the result of Hansen's (1982) J statistic chi-squared test. In case of an overidentified model (i.e., when the number of instrumental variables exceeds the number of endogenous regressors, as in our estimation), this tests allows to assess whether the second validity requirement is met by the instruments

employed: its null hypothesis claims that all instrumental variables are uncorrelated with the residual (Cameron and Trivedi, 2005, ch. 8.4.4). Yielding a p-value of 0.1978, the test does not reject the null and suggests that neither political uncertainty nor a government's need to credibly commit affects reform efforts through channels other than its effect on regulatory formal independence.

4.3 Potential First-Stage Effects of Covariates

Before we describe the IV estimation results, we briefly want to discuss the covariates that might affect a regulator's statutory autonomy besides the features of a country's political process and its economy, respectively, we employ as instruments.

First, the literature on agency independence suggests the authority's age to have an influence on its autonomy: Bernstein's (1955) theory on the *life cycle of regulatory commissions* divides the regulator's duration in four phases (gestation, youth, maturity and old age) and describes the agency's decline from a publicly desired, ambitious institution to a useless, self-perpetuating social burden just aiming at defending its status quo. The growing failure to fulfill its regulatory task associated with this development is assumed to entail an incremental evaporation of the political succor initially existing and, consequently, an increasing lack of both content-related leadership and financial support; interests and resources of the industry are expected to gradually fill the emerging gaps, instead. Martimort's (1999) theoretical analysis of the *life cycle* approach substantiates the unfavorable picture drawn of long-established regulatory agencies: he shows that a government's sole possibility to prevent collusion between the authority and a regulatee is the curtailment of the rents this malfeasance produces; an interventionist solution the regulator's principal is forced to adopt that implies the realization of suboptimal production levels. Furthermore, Maggetti's (2007) empirical results are at least partly in line with the theory (but are, in contrast to the analysis at hand, related to an agency's *de facto* independence): for his sample of banking, competition and telecommunications authorities, he finds a regulator's age to reduce political interferences in its day-to-day operations; other than predicted by the *life cycle* approach, however, his results also suggest that if the authority's duration of existence has an effect on the relation with regulatees at all, it leads to less industrial influence. This deviation from the original considerations notwithstanding, theory and empiricism coincide with respect to the regulator's increasing alienation from politics over time; it would therefore be reasonable to expect also the formal independence from politicians to be higher when agencies are long-established, implying a positive IRA age coefficient in our first stage estimation.

Second, also the ruling party's ideology might influence the energy authorities' statutory autonomy: expecting that compared to left-wing governments right-wing cabinets are more strongly inclined to install IRAs in the course of liberalization due to the close proximity between the conservatives' market orientation and the agencies' conventional mission, Gilardi (2005b)

TABLE 2: 2SLS, FIRST-STAGE ESTIMATES OF THE DEGREE OF FORMAL INDEPENDENCE

dependent variable: formind		
	coef.	std.err.
uncert	.0142***	.0024
lag econflows	-.0304***	.0069
gas dum	.0148***	.0054
IRA age	-.0228***	.0053
lag GDPcap crisis dum	.1261***	.0382
lag ensupGDPunit	.0058***	.0020
ideopotr	-.0059	.0137
corruption	-.0183	.0570
constant	2.5300***	.7380
country dummies	yes	yes
N		72
R^2		.8705

Note: Table 2 shows first-stage estimation results from a 2SLS IV regression. Dependent variable is the autonomy level of electricity and gas regulators, respectively, as measured on the basis of Gilardi's (2002) formal independence index. Robust standard errors are clustered at the country level. *** denotes statistical significance at the 1% level.

finds the exact opposite. The explanation for this surprising result draws on Laver and Shepsle (1990) and Shepsle (1991) who argue that a party professing to aim at a situation conflicting with its political preferences lacks credibility: since a left-wing government's will to liberalize might be challenged, it more urgently needs to establish an autonomous institution promoting reforms to signal serious intentions than a right-wing counterpart (Gilardi, 2008, ch. 6). Adapted to *existing* authorities, in turn, this would imply that left-wing cabinets have to provide regulators with a higher level of formal independence to credibly commit; we therefore expect a positive sign on the ideology index coefficient in the first stage.

4.4 Estimation Results

4.4.1 First-Stage Results

Table 2 shows the first-stage results with robust standard errors being clustered at the country level. As most of the significant coefficients call for further discussion (in part because they suggest that the respective regressor affects formal independence opposite to what was expected), we will proceed as follows: first, we will briefly report the regression results. Afterwards, we will elaborate on our findings and provide possible explanations for the effects the first stage estimates suggest; the remarks on the impact of economic flows on regulatory autonomy are

rather comprehensive and are therefore placed in a separate section.

As expected, estimation results hint at a greater formal regulatory independence from politics when the office holders' risk of being voted out of government is high. The size of this effect, though, seems rather minor: if we assume elections to take place every four years (i.e., six polls are included in the measure, neglecting years immediately after votings in the following) as well as governments to change from left-wing to right-wing dominated cabinets and back after every second election, the independence value just increases by slightly more than 0.04. Contrary to the expectations, regression results furthermore reveal a negative relationship between the previous year's economic flows from and to foreign countries and a regulator's formal autonomy: the corresponding coefficient suggests a 0.3-unit decrease in the independence index in case of a ten-unit increase of our globalization proxy. Both estimates are statistically highly significant, suggesting that our instrumental variables meet the validity requirement of a high correlation with the endogenous regressor. The first stage F-value of the excluded instruments is equal to 35.26, likewise indicating that we do not have a weak instrument problem¹⁰.

In addition, also some covariates reach statistical significance. The gas dummy is significant at the 1% level, but hints at an only small independence gap between electricity and gas regulators: according to the coefficient, the statutory autonomy of gas market authorities exceeds that of their electricity counterparts by less than 0.015 units of Gilardi's (2002) index. At variance with our considerations, the highly significant estimate on the regulator's age furthermore suggests an agency's independence to decrease throughout its life cycle; it indicates that a fully independent regulatory authority has forfeited all of its autonomy after not quite 44 years. The crisis dummy coefficient, also significant at the 1% level, suggests a regulator's independence to increase by slightly more than 0.1 index units after a year of negative GDP per capita growth. And finally, the estimate on our energy efficiency proxy hints at a considerable effect of energy-intensive production processes on an authority's statutory autonomy: it indicates that a regulator's independence value on Gilardi's (2002) scale rises by nearly 0.6 units if the total primary energy supply needed to generate 1000 US\$ of GDP grows by 0.1 tonnes of oil equivalent. The controls on government ideology and corruption do not reach statistical significance.

The first-stage results are robust to the use of the lagged corruption index (see Table 7 in the Appendix for detailed regression outcomes): the coefficients on our uncertainty proxy and the lagged globalization measure continue to be statistically highly significant and take values

¹⁰Staiger and Stock's (1997) rule of thumb demands an F-value of at least 10. Furthermore, for regressions with one endogenous regressor and two instrumental variables, Stock and Yogo (2005) report the critical value to be 19.93 when strong instruments are defined in a way that the size distortion of a nominal 5% Wald test of the hypothesis that the estimated and the actual coefficient of the endogenous regressor are identical is limited to 5 percentage points. However, since this threshold is calculated under the assumption of homoskedastic errors, a comparison with our F-value can only serve as an informal test.

of 0.0154 and -0.0360, respectively, indicating effect sizes very similar to those suggested by the estimates in Table 2; the high significance of both estimates together with a first stage F-value of the excluded instruments equal to 25.78 furthermore again suggests that no weak instruments are applied. Except for the gas dummy that reaches only the 5% significance level when the corruption proxy is lagged, also all significant control variables from Table 2 remain significant at the 1% level. Moreover, the change in their size is rather negligible: while the estimate on the lagged crisis dummy is reduced by slightly more than 0.02 units compared to its counterpart reported in Table 2, the coefficients on the gas dummy, the agency's age and the energy efficiency indicator are altered by only 0.002 units or less. The estimates on ideology and (lagged) corruption do not reach statistical significance again.

Our findings might be explained as follows: the increase in regulatory formal independence suggested as a consequence of a higher threat of being replaced in government by warring parties reflects the essence of the uncertainty hypothesis; with this threat to be growing, ruling politicians are willing to grant more and more autonomy to the regulatory authority. The notion that independent regulators serve as bulwarks against policy turnarounds induced by opponent successors expressed in the hypothesis is thus further substantiated by our results (albeit the size of the effect seems, as discussed, rather small).

To provide a possible explanation for the difference in the statutory autonomy of electricity and gas market authorities, one might argue on the basis of Spiller's (1993) interpretation of the credibility hypothesis that postulates the existence of more independent regulators in industries that employ large amounts of sector-specific assets (see also footnote 9): compared to electricity investments, various gas infrastructure projects are considerably larger because of the huge distances between production and consumption sites; a particularly high demand for a secure rate of return and investment protection should hence prevail in this industry. This, in turn, could be met by the establishment of a more independent regulator. However, given the negligible size of the gas dummy estimate, the divergence between the credibility requirements prevailing for investments in the electricity and in the gas market should not be expected to be overly high.

The surprisingly negative relationship between an agency's age and its formal independence suggested by the first stage outcome might result from the exceptional role the energy sector plays in industrialized countries: providing all production processes with electricity and gas, it is seen as a crucial factor for a nation's economic development (Schneider and Jäger, 2003; Domanico, 2007; Karan and Kazdağlı, 2011). Since the economic situation, in turn, considerably affects a ruling party's reelection chances, one might expect a government to try to counteract the alienation between regulator and politics as well as the associated growing neglect of the assigned tasks by the authority described in the *life cycle* approach: by gradually broadening the cabinet's influence on the regulator again, ruling politicians should be better able to make

also a long-established agency properly fulfill its mission, thus ensuring a continuous effective monitoring of electricity and gas markets; the resulting protection of competition in the energy sector then does not only benefit the economy, but indirectly also the government aiming for votes.

Our finding that formal independence is increased in the wake of an economic downturn is in line with the credibility hypothesis and Pitlik's (2008) (as well as Drazen and Easterly's (2001) and Pitlik's (2007) statistically significant) results substantiating it: granting a higher autonomy to the authority responsible for market supervision separates decisions on the implementation of a non-discriminatory and hence competition-enhancing regulation from the struggles in the political arena; steps of reform accelerating the liberalization process are therefore facilitated.

The positive relationship between energy intensity and statutory autonomy finally suggested by the estimation results is consistent with our expectation that a high energy use during production is associated with an interest in cheap electricity and gas supplies: highly independent regulators deemed to foster competition (and thus to reduce prices) are primarily established in economies that provide energy-intensive goods.

4.4.2 The Negative Effect of Cross-Border Economic Flows on Formal Independence

This section now completes the discussion of our first stage results by providing a possible explanation for the negative relationship between the scope of economic flows from and to foreign countries and the level of statutory autonomy that is, contrary to our expectations, suggested by the regression outcome.

The above-mentioned relevance of the energy sector for a country's economic development serves as a starting point for our considerations: due to its importance, politicians try to keep the sector under national control to the greatest possible extent (Domanico, 2007; Belkin, 2008); some EU member states' recent efforts to save domestic energy companies from foreign takeovers are significant examples for this eagerness to protect national interests (Ahearn, 2006; Barysch et al., 2007). In France, the government initiated a merger between *Suez*, a domestic electricity, gas and water company, and *Gaz de France (GDF)*, a national gas and power utility (European Commission, 2006a), to prevent a takeover of *Suez* by *Enel*, an Italian electricity supplier (Domanico, 2007; Barysch et al., 2007).

In Spain, the government fought tooth and nail against the acquisition of the electricity and gas supplier *Endesa* by the German energy company *e.on* (European Commission, 2006b, 2006c, 2006d), ignoring an existing Commission approval for this transaction (2006e). To hamper *e.on*'s takeover attempt, an urgent law was passed that was deemed to be in violation of the EU Treaty principles of free movement of capital and freedom of establishment (European Commission, 2006b) and (presumably as intended by the Spanish legislator) expected to scare off investors

from other member states (European Commission, 2006f); the conditions imposed on *e.on* by the Spanish regulator on the basis of the law were furthermore judged as breaching EU merger regulation (European Commission, 2006c). Modified conditions stipulated by the competent Spanish minister in response to objections of the Commission were not only seen as obstacles to the free movement of capital and the freedom of establishment, but additionally as a violation of the principle of free movement of goods (European Commission, 2006d).

The interventions of both the French and the Spanish government triggered the suspicion that these nations place their own concerns over Community ends (Ahearn, 2006) and culminated in the accusation that they pursue an (informal) target deviating from those determined by the Union's energy policy¹¹: the creation and maintenance of national champions in the European energy market (Domanico, 2007). The detailed reasons advanced for the pursuit of this aim range from politicians favoring lobbying groups (Domanico, 2007) via concerns about foreign shareholders spying for their homecountries (The Economist, 2006a) (probably getting even more solid with the expected increase in the number of Russian and Chinese takeover attempts (The Economist, 2006b)) to less awkward ones like the fear of layoffs (Ahearn, 2006) and assumed advantages in securing a country's energy supply (Barysch et al., 2007).

The Commission's reactions to the governments' interferences in the energy market, however, did not fail to appear: In the French case, it rated the merger as a severe obstacle to competition in the Belgian gas and electricity market as well as in the French gas and district heating market (European Commission, 2006a, 2006h, 2006i), making comprehensive remedies a condition for approval under merger regulation (European Commission, 2006h): the most important requirements were the divestiture of the French district heating operator, of the holdings in the Belgian gas incumbent and in the second biggest Belgian electricity and gas supplier as well as the ceding of control over the Belgian gas infrastructure operator and the obligation to invest in the gas infrastructure of Belgium and France (European Commission, 2006i, 2006j).

In the Spanish case, the Commission launched infringement proceedings over both the additional authorities the regulator was vested with during the attempt to prevent the takeover (European Commission, 2006b, 2006f) and over the original as well as the modified conditions imposed on *e.on* (European Commission, 2006c, 2006d, 2006k, 2007b, 2007c) due to the provisions' violation of the above-mentioned EU Treaty principles. In consequence of the nonabrogation of the unlawful conditions, Spain was even taken to the European Court of Justice (European Commission, 2007d) which found in favor of the Commission (European Commission, 2008).

The Commission's rigorous course of action (backed, when necessary, by the Court of Justice) in both cases underlines its unbending will to eliminate any anticompetitive behavior jeopardizing the functioning of the European energy market. With this steeliness, the Commission also deprives European politicians of the possibility to support the achievement of their national

¹¹These objectives are sustainability, competitiveness and security of supply (European Commission, 2006g).

TABLE 3: 2SLS, SECOND-STAGE ESTIMATES OF THE DEGREE OF LIBERALIZATION

dependent variable: lib		
	coef.	std.err.
formind	-2.4901***	.9545
gas dum	2.2150***	.2754
IRA age	-.3030***	.0485
lag GDPcap crisis dum	.9411***	.3131
lag ensupGDPunit	-.0020	.0142
ideopotr	.1159	.1234
corruption	-.3421	.4864
constant	5.4667	4.5747
country dummies	yes	yes
N		72
R^2		.7959

Note: Table 3 shows second-stage estimation results from a 2SLS IV regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. *** denotes statistical significance at the 1% level.

aims by shielding domestic energy companies from foreign influences. Assuming that governments were principally aware of the uncompromising attitude already in the early 2000s prior to the outlined events (and thus in the period of time covered by our sample), one might explain the lower level of regulatory autonomy in more globalized countries as follows: expecting considerable foreign investments wresting domestic energy companies from national control, ruling parties might have tried to retain a certain degree of influence on these firms by limiting the authority's independence from politicians, keeping up the possibility to interfere at least in parts with regulation.

4.4.3 Second-Stage Results

Second-stage results are reported in Table 3; standard errors are again robust and clustered at the country level. The coefficient of the instrumented formal independence of energy regulators is negative and statistically highly significant, suggesting a strong effect of a higher statutory autonomy from politicians on the degree of liberalization: the establishment of a fully autonomous authority reduces the liberalization measure by about 2.5, i.e. by approximately 40 percent of its maximum value¹². For existing regulators this means that if the aspects covered

¹²As an additional test for the strength of the instrumental variables employed in an overidentified regression, Angrist and Pischke (2009, ch. 4.6.4) advise to compare the second-stage 2SLS estimates with their LIML counterparts: large deviations hint at the presence of weak instruments. The LIML coefficient of the instrumented

by one of the five independence dimensions (see Section 2.1) are still under complete control of the government, the ruling parties can initiate steps of reform efforts corresponding to half an index unit by granting total autonomy to the authority in this domain.

All three highly significant covariates show the expected sign: the gas dummy coefficient is positive and of about the same size as in the OLS regression; the reform gap in gas markets approximates two units of the liberalization measure. Moreover, the positive relationship between experienced regulators and the degree of competition suggested by the regression results in Table 1 persists. However, different from its OLS counterpart, the second-stage estimate adumbrates that only about three years and four months periods of regulatory monitoring are necessary to lower the liberalization index by one unit. The coefficient of the lagged crisis dummy finally suggests a limitation of reform efforts to be induced by negative GDP per capita growth rates in the previous year; compared to periods with a positive economic development, every year of downturn prevents the OECD index to be reduced by nearly one unit. The estimates on the lagged energy intensity proxy, the government's ideology and the corruption measure do not reach statistical significance.

Lagging the corruption measure has hardly any influence on the results (Table 9 in the Appendix provides detailed regressions outcomes): the second-stage estimate on formal independence takes a value of -2.4940 and is hence almost identical to its counterpart in Table 3, even though its statistical significance reaches only the 5% level¹³. The coefficients on the gas dummy, the agency's age and the crisis dummy remain statistically highly significant and hint at effect sizes basically equal to those indicated by the estimates obtained with a non-lagged corruption proxy (changes amount to marginally more than 0.005 units at the maximum). The energy efficiency of production processes in the previous year, the ruling parties' political orientation and the previous year's perceived corruption are again suggested not to affect an authority's statutory independence.

5 Conclusion

Contradicting the first impression created by the scatterplots and OLS regressions neglecting the reverse causality problem, the IV estimation corroborates the conventional wisdom on formal independence is statistically highly significant and takes a value of -2.6066, revealing only a minor difference from the 2SLS estimate; considering our instruments to be strong is thus further substantiated. Second-stage LIML results are reported in detail in Table 8 in the Appendix.

¹³As in the original regression with the corruption index not being lagged, second-stage 2SLS and LIML coefficients on the instrumented formal independence do not differ much when the corruption measure is included with a lag of one period: the LIML coefficient takes a value of -2.5833 and is statistically significant at the 5% level, again suggesting our instruments not to be weak. Detailed second-stage LIML results for this estimation are reported in Table 10 in the Appendix.

the effect of regulatory independence: for our sample of EU energy regulators, a higher statutory autonomy from politics entails a higher liberalization level of electricity and gas markets. The European legislator's demand for an enhanced protection of regulatory authorities from government interferences is thus both justified and reasonable.

However, although our study can be seen as a helpful contribution to the understanding of long-term effects of independent regulatory authorities on energy market liberalization, it is obviously just a first step: in particular, a more comprehensive data set comprising information on the agencies' formal autonomy in additional years would be desirable. Likewise, panel data on the authorities' level of *de facto* independence from both politicians and regulatees would be useful; only the inclusion of these two dimensions of autonomy would allow for a complete and profound analysis of the impact of IRAs on the intensity of reform.

6 Appendix

TABLE 4: CONTROL VARIABLE DESCRIPTION

Variable	Description	Source
gas sector dum	Indicator variable, takes a value of 1 if the regulatory authority monitors the national gas market.	International Energy Regulation Network (2012)
IRA age	Number of years past since the national energy regulator has been introduced. Own calculations based on data on legal establishment dates.	International Energy Regulation Network (2012) (Establishment dates*.)
lag GDPcap crisis dum	Indicator variable, takes a value of 1 if the GDP per capita growth rate in the previous year was negative. Growth rates are calculated on the basis of GDP per capita values (constant 2000 US\$).	World Bank (2011) (GDP per capita data.)
lag ensupGDPunit	Total primary energy supply (measured in tonnes of oil equivalent) per million US\$ of GDP (constant 2000 PPP US\$), included with a lag of one year. Original ratios (total primary energy supply per thousand US\$ of GDP) were rescaled by multiplying by 1000.	OECD (2010)
ideopotr	Ideology index capturing the political orientation of governments in office. It takes integral values between 1 and 5 and is reduced with the share of cabinet and parliament seats right-wing parties hold: a value of 1 is assigned if more than 2/3 of all positions are staffed by right-wing partisans, a value of 2 if this share lies between 1/3 and 2/3. The measure takes a value of 3 when centre party members fill half of the positions or a balanced coalition of right- and left-wing parties governs. Values of 4 and 5 correspond to the situations described for 2 and 1 with left-wing parties holding the respective shares.	Potrafke (2009)
corruption	Perceived susceptibility to bribery of a country's public sector as measured by Transparency International's Corruption Perception Index (CPI). The indicator is based on answers to polls conducted by various proficient institutions and captures opinions about bribes, irregularities in public procurement, misappropriation of public funds as well as anti-corruption measures. The questions relate to public officials, civil servants and politicians. CPI values range from 0 (highly corrupt) to 10 (very clean).	Transparency International (2012)

**For Sweden the IERN homepage quotes the year of establishment of the Energy Market Inspectorate (EI), 2008, which is later than the execution of all three surveys analyzing the regulator's formal independence. We thus deviate from the source in this case and use the year in which the Swedish Energy Agency (STEM) was founded, 1998. The latter is stated in Gilardi (2002) and the CEER (2005) as being the regulator under assessment.*

TABLE 5: SUMMARY STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
<i>Main Variables</i>					
lib	72	1.797	1.426	0	5.333
formind	72	.6210	.1154	.4400	.8600
<i>Instruments</i>					
lag econflows	72	77.45	14.04	52.47	99.44
uncert	72	11.28	12.26	1.333	47.67
<i>Controls</i>					
gas sector dum	72	.3889	.4909	0	1
IRA age	72	4.889	2.614	1	14
lag GDPcap crisis dum	72	.0556	.2307	0	1
lag ensupGDPunit	72	153.5	35.55	110	250
ideopotr	72	2.792	.9132	2	4
corruption	72	7.707	1.563	4.200	9.767
lag corruption	72	7.672	1.609	4.200	9.867

TABLE 6: FIXED-EFFECTS OLS

dependent variable: lib		
	coef.	std.err.
formind	.2848	.7602
gas dum	2.1667***	.2924
IRA age	-.2415***	.0600
lag GDPcap crisis dum	.4798*	.2648
lag ensupGDPunit	-.0145	.0120
ideopotr	.1604	.1812
lag corruption	-.2628	.2161
constant	5.7290	1.8442
<i>N</i>		72
<i>R</i> ² <i>within</i>		.7335

Note: Table 6 shows estimation results of a fixed-effects OLS regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. ***/* denotes statistical significance at the 1%/10% level.

TABLE 7: 2SLS, FIRST-STAGE ESTIMATES OF THE DEGREE OF FORMAL INDEPENDENCE

dependent variable: formind		
	coef.	std.err.
uncert	.0154***	.0027
lag econflows	-.0360***	.0075
gas dum	.0133**	.0053
IRA age	-.0248***	.0057
lag GDPcap crisis dum	.1046***	.0316
lag ensupGDPunit	.0062***	.0019
ideopotr	-.0078	.0142
lag corruption	.0490	.0409
constant	2.3998***	.7306
country dummies	yes	yes
N		72
R^2		.8769

Note: Table 7 shows first-stage estimation results from a 2SLS IV regression. Dependent variable is the autonomy level of electricity and gas regulators, respectively, as measured on the basis of Gilardi's (2002) formal independence index. Robust standard errors are clustered at the country level. ***/** denotes statistical significance at the 1%/5% level.

TABLE 8: LIML, SECOND-STAGE ESTIMATES OF THE DEGREE OF LIBERALIZATION

dependent variable: lib		
	coef.	std.err.
formind	-2.6066***	.9539
gas dum	2.2172***	.2758
IRA age	-.3053***	.0483
lag GDPcap crisis dum	.9617***	.3139
lag ensupGDPunit	-.0015	.0144
ideopotr	.1146	.1230
corruption	-.3525	.4893
constant	5.5618	4.6138
country dummies	yes	yes
N		72
R^2		.7949

Note: Table 8 shows second-stage estimation results from a LIML IV regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. *** denotes statistical significance at the 1% level.

TABLE 9: 2SLS, SECOND-STAGE ESTIMATES OF THE DEGREE OF LIBERALIZATION

dependent variable: lib		
	coef.	std.err.
formind	-2.4940**	.9968
gas dum	2.2201***	.2756
IRA age	-.3066***	.0484
lag GDPcap crisis dum	.9406***	.2854
lag ensupGDPunit	-.0005	.0150
ideopotr	.1416	.1342
lag corruption	-.3318	.3405
constant	5.0936*	2.9067
country dummies	yes	yes
N		72
R^2		.7964

Note: Table 9 shows second-stage estimation results from a 2SLS IV regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. ***/**/* denotes statistical significance at the 1%/5%/10% level.

TABLE 10: LIML, SECOND-STAGE ESTIMATES OF THE DEGREE OF LIBERALIZATION

dependent variable: lib		
	coef.	std.err.
formind	-2.5833**	1.0013
gas dum	2.2219***	.2760
IRA age	-.3087***	.0481
lag GDPcap crisis dum	.9555***	.2865
lag ensupGDPunit	-.0001	.0152
ideopotr	.1410	.1337
lag corruption	-.3340	.3456
constant	5.1122*	2.9625
country dummies	yes	yes
N		72
R^2		.7956

Note: Table 10 shows second-stage estimation results from a LIML IV regression. Dependent variable is the mean of the electricity and gas sector sub-indicators, respectively, apart from public ownership, as described in Conway and Nicoletti (2006). Robust standard errors are clustered at the country level. ***/**/* denotes statistical significance at the 1%/5%/10% level.

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