

# Interest Groups, Partisan Politics, and the Development of Renewable Energy in the OECD Countries

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**Abstract:** This paper focuses on interest groups and partisan politics to study renewable energy development. Because renewable energy is still uncompetitive compared to fossil fuels, we assume that a country's renewable energy production is a positive function of the size of its state support. We focus on two determinants for the size of such state support: the weight that a government places on subsidizing industries (both green and brown) and the relative strength of the green sector. We posit that right parties are associated with higher level of state support to industries and when a government distributes state aid, the stronger sector is more likely to capture a larger share. Therefore, left-right partisanship of the government and relative strength of the green sector affect renewable energy production in an interactive way. We model renewable electricity generation for the OECD countries and find empirical support for our theory.<sup>1</sup>

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INTRODUCTION

The world is facing major environmental problems. One of the most urgent and pressing problems is global warming caused by the emission of greenhouse gases — mainly carbon dioxide. Many believe that one promising way to restrict global warming is the diffusion of emission-free energy technologies, in particular various types of new renewable energies. For instance, wind and solar powers are seen as promising ways to meet major shares of the world's energy demand in the future. Today, in countries such as Denmark, Portugal, and Spain, non-hydro renewable electricity accounts for more than 15% of total national electricity generation.<sup>2</sup> However, even for countries with the most affordable renewable energy technologies, many sources of new renewable energy are economically not competitive with fossil fuels.<sup>3</sup> Government support, via various forms of renewable energy policies, is vital to the survival and further development of renewable sectors. The development of renewable energies is not possible without the involvement of politics.

In this paper, building on recent research (Lipp 2007, Szarka 2010, Laird & Stefes 2009, Aklin & Urpelainen Forthcoming, Cheon & Urpelainen Forthcoming), we present a model based on interest group and partisan politics to explain the size of renewable energy sector in the OECD countries. The intuition of the model is similar to models on interest group politics and trade policy (Grossman & Helpman 1994), and more recently on environmental policies as well as energy policies and intensities (Aidt 1998, Damania 2001, Fredriksson, Vollebergh & Dijkgraaf 2004). A country's renewable energy production, given it is not as competitive as conventional fossil fuels,<sup>4</sup> is assumed to be a positive function of the size of the state support that it receives. Two factors are important for the size of the state support to renewable energy production: first, the weight that a government places on subsidizing industries (both the green and the brown types) against other objectives such as maximizing aggregate social welfare; second, the strength of the green sector (relative to the brown sector).

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<sup>2</sup>Author's own calculation. Data are from U.S. Energy Information Administration (EIA).

<sup>3</sup>Renewable energy is on average more expensive than fossil fuels. However, there are exceptions. For instance, a recent study shows that in Australia, electricity supplied from a new wind farm, even without a carbon price, is 14% cheaper than new coal and 18% cheaper than new gas.

<sup>4</sup>Environmental externalities are not included in the price though.

We argue that the left-right dimension of government partisanship matters for the weight that a government places on industry-support, with right parties associated with higher level of state support to industries in general. Moreover, when dividing the total state industry support between the green and brown sectors, the relative strength of two sectors matters. While caring about general social welfare, governments “trade” state industry aid for financial and other support from interest groups, with the stronger sector — one that is able to offer more contributions — more likely to reap a larger share of the state aid. Therefore, government partisanship and relative strength of the green sector affect renewable energy production in an interactive way: a right-party government with a strong green (weak brown) sector is the best scenario for the development of renewable energies, because the former is often associated with higher levels of total state support to industries and the latter with a larger share captured by the green sector. A less right-leaning government is associated with lower level of state-industry support; a weaker green sector (stronger brown sector) implies a smaller share of the total state-industry support for renewable sectors. In other words, a left-ward shift in government partisanship and/or a weakening of the green sector results in lower state support to the green sector and therefore decreased renewable energy production.

We model non-hydro renewable electricity generation using panel data on the OECD member states from 1980 to 2004. The empirical findings support the theoretical expectation. The rest of the paper is organized as follows: the next section discusses the theoretical model of the paper. The following sections present data and empirical findings. We conclude and discuss issues related to future research at the end.

#### AN INTEREST GROUPS AND PARTISAN POLITICS MODEL FOR RENEWABLE ENERGY

For simplicity, we focus on the two sectors in the economy that compete for energy-related state support: one green sector and one brown sector.<sup>5</sup> The green sector might include firms that invest in green technologies and produce renewable energy. They benefit from and therefore prefer government support for green technologies and various types of renewable energy. The brown sector might include those directly involved in the production and distribution of

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<sup>5</sup>The green and brown sectors each opposes state-aid going to the other sector not only because it directly reduces their own subsidies, but also because in the mid- to long-term, it will strengthen the industries that they are competing against for electricity market share.

conventional energies (for example, oil and natural gas and utility companies) and industries that are energy-intensive (for example, basic metals and paper and paper products). Companies producing and distributing conventional fossil fuel energy often compete directly with renewable energy for market shares and state support. For energy-intensive sectors, given the fact that renewable energy is on average more expensive than fossil fuels despite years of technological innovations, the preference is similar to those energy companies. They prefer the government not to subsidize the green sector, partly because more renewable energy as input of production often imply higher production costs. They prefer government subsidies going to their own sector and/or to fossil fuels (which reduces conventional energy prices therefore their production costs).

We focus on the OECD countries. Therefore, it is safe to assume democratic politics in which political parties trade policies for support from key interest groups. We use a very simple model setup where there are only two key interest groups (green vs. brown) that compete for government support. Voters (or consumers) are also important in democratic politics. However, we think it is reasonable to only focus on the green and brown sectors, at least as a first step to link interest groups and partisan politics to renewable energy production. Research on interest group politics points out how organization and action are often far more influential than public opinion in democratic politics. We suspect this asymmetry in influence between organized interest groups and the public is even more salient for the case of renewable energy given the complex nature of energy policies and politics.

Similar to previous research in international trade and environmental and energy policies (Grossman & Helpman 1994, Aidt 1998, Damania 2001, Fredriksson, Vollebergh & Dijkgraaf 2004), we assume government cares about aggregate social welfare and “bribes” taken from interest groups as means to survive in office: winning the next election in a democratic context. The “bribes” that a government takes from interest groups could include direct financial contributions, information, expertise, votes, and organization infrastructures to mobilize general voters. In return, government distribute rents to interest groups in accordance to the amount of their contributions. In the context of energy production, such rents might include different types of energy-related state support, for instance, subsidies and tax exemptions for energy production and consumption. The nature of government matters because different

governments put different weights on taking bribes from and therefore being subject to the influence of organized interest groups. The higher the weight associated with interest group contributions, the more bribes taken by the government, the higher the level of rents distributed by the government. In an extreme scenario, a government might put zero weight on interest group contributions and completely focuses on maximizing aggregate social welfare. But we think this is unlikely in real world politics.

Organized interest groups in our model are the green and brown sectors. We see them as industrial interest groups. We posit that a government's tendency to taking bribes from industrial interest groups is a function of its partisanship, more specifically the left-right dimension of partisanship of the government. We argue theoretically that right-leaning governments put higher weights on taking contributions from industrial interest groups. We also demonstrate empirically (in an online appendix) that right-leaning governments are associated with higher levels of state support given to industries.

There are other relevant dimensions that characterize the partisan nature of a government. For instance, a government's environmental emphasis might appear to be more important for environmental and energy policies.<sup>6</sup> But recent research suggests that the left-right dimension still is the "super-dimension" for partisan politics, even though its overall salience has been in decline in some Western democracies.<sup>7</sup> On the theoretical ground, the left-right dimension matters because it affects the tendency for the government to provide "aid" to domestic industries, for both the green and brown sectors, in exchange for electoral support. State aid to the industries often takes various forms of industrial subsidies. Recent research on state aid and subsidies, often based on the OECD countries, has discovered that right government is associated with higher level of subsidies. For instance, using European data from the 1980s, Neven (1994) finds that governments dominated by right-wing parties are

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<sup>6</sup>In the empirical section, we control for the environmental emphasis of the government and find that it does not affect renewable electricity production in the OECD context.

<sup>7</sup>For instance, Hellwig (2008) shows that for many voters, the left and right dimension remains an important means for comprehending many issues encountered during a campaign. However, his research also emphasizes that both deindustrialization and globalization reduce the salience of the left-right dimension of political contestation. Also note that other important dimensions have been proposed, for example, the post-materialist-materialist (Inglehart 1995), the libertarian-authoritarian (Flanagan & Lee 2003), and those associated with green, alternative, and libertarian-traditional values (Hooghe, Marks & Wilson 2002).

more likely to subsidize industry than left-wing governments. Clark (2003) concludes that when trade exposure is low and capital mobility high or when both are set at low levels, left-labor power has a negative effect on subsidies. Most recently, findings from Zahariadis (2010) reinforce right parties' association with more state support to industries. Zahariadis (2010) also provides theoretical explanations on right parties' preferences towards subsidizing industries: first, industrial subsidies involve more political payoffs to right-wing parties, because subsidies are direct and visible help to their core business owner and shareholder constituents; conversely, the left may find that social welfare measures are preferable instruments under the same conditions because workers, as core supporters of the left, prefer direct unemployment benefits.<sup>8</sup> Second, parties of the right engage in vote buying and subsidies with fewer adverse consequences, largely because they enjoy the image of fiscal responsibility while left-parties need to make real efforts to cut state support in order to appeal to the general voters that they are serious about fiscal discipline.

In sum, we posit that left-right partisanship of the government affects the total level of subsidies with right-party government associated with higher level of state support to industries. However, we want to emphasize that it is not because of certain traditions and ideologies that right parties are more responsive to industrial pressures. They are so because it generates the highest benefits by pleasing their key constituencies and it incurs the lowest costs thanks to their traditional image of fiscal responsibility. Therefore, assuming a re-election seeking government, it is logical for right-leaning governments to put more weight on subsidizing industrial organized interests in exchange for their electoral support. We are aware of the fact that there are many who argue for the opposite relationship between a government's left-right partisanship and its tendency to offer state support. Indeed, there is a tradition in the partisan politics literature to associate left-leaning parties with more government intervention in the economy, though often in the form of various types of social welfare provisions and trade protectionism (Hibbs 1977, Milner & Judkins 2004). State support to industries, even though much less studied, is often argued to be no exception to this traditional partisan politics argument (Blais 1986, McGillivray 2004). In this paper, in addition to previous theoretical discussion and cited supporting empirical findings from recent research (Neven 1994, Clark

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<sup>8</sup>For instance, industrial subsidies benefit firms, but they do not necessarily eliminate the possibility of layoffs.

2003, Zahariadis 2010), we conduct a brief data analysis using the most updated data on state aid. We find that in 18 EU countries, from 1992 to 2004, right-party governments are associated with more sectoral state aid, that is, the type of rents given to specific sectors and firms.<sup>9</sup>

In our model, a government's weight on taking contributions from industrial organized interests varies by the left-right dimension of partisanship. However, the government itself has no preference (e.g., as a function of ideology) toward either the green or brown sector. The government simply maximizes the chances of re-election by distributing state aid/subsidies to interest groups that can provide the most electoral support. In other words, the government weighs the political support that it can receive when it decides how much subsidies to give to each sector. In this simple two-sector setup, government trades state subsidies for electoral support such as votes that each sector can contribute in future elections, direct financial contribution, and organizational apparatus to mobilize general voters. We assume that electoral support is a function of the political strength of an interest group.

Studies of government-interest groups interactions abound in political science. Students of American politics have studied the ways by which interest groups and lobbyists influence public policies (Lowery & Brasher 2004). The exchange theory of lobbying assumes that interest group agents and legislators engage in mutually beneficial trade, typically campaign contributions for votes (Austen-Smith 1996). Lobbying is also conceptualized as a mechanism of persuasion in which lobbyists provides valuable and yet costly information in exchange for support for their favorite policies.<sup>10</sup> In West European context, interest groups, labor unions in particular, have also been studied for a long time (Korpi 1989). An interest group's ability to mobilize (for instance, measured by union density and level of coordination in the case of labor unions) has been shown to greatly affect the chances of swaying public policies in its favor (Castles 1978), even in the context of developing countries (Rudra 2002). In sum, the government (or individual legislators in the American context) seeks re-election by distributing state support to interest groups; those groups that are able to lend more support

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<sup>9</sup>See Appendix A for more details.

<sup>10</sup>Wright (1996). More recently, interest groups have been found to affect public policies by "subsidizing" their similar-minded legislators with information, intelligence, and legislative labor; see Hall and Deardorff (2006).

— for instance, by providing more direct monetary contribution, information, expertise, votes, or organization capacity to mobilize general voters — are likely to receive more state aid in return.

Therefore, in the simple “green vs. brown” two-sector setup, the final amount of state support that each sector can receive is likely to be a function an interactive effect of the left-right partisanship of the government (which affects a government’s weight towards subsidizing industrial sectors against other objectives such as maximizing aggregate social welfare) and the amount of electoral support one sector can offer to the incumbent (relative the other sector). We assume that a sector’s electoral support is positive function of its political strength. The best scenario for the green sector, therefore, is a situation in which there is a right party government and the brown sector is minuscule and politically weak. (Note that this is very unlikely in the real world because for most countries, the green sector is smaller and more likely to be politically less influential than the brown sector.) Having a right government means a higher weight for the government to offer state aid in exchange for electoral support from industrial organized interests, that is, a higher level of total potential state support to both sectors. With a weak brown sector, a larger proportion of the state aid is going to be given to the green sector. However, as the brown sector gets stronger, the government channels the money away from the green sector which results in lower state support for the green sector, and consequently a lower level of renewable energy production. Table 1 summarizes the theoretical expectations regarding the interactive effect of government partisanship and the relative strength between the green and brown sectors.

Insert Table 1 about here.

Before stepping into next section’s empirical analysis, we want to reiterate some of the assumptions that we made in the previous discussion. First, we assume that the size of the renewable sector is a function of the *absolute* amount of support it receives from the government, not the ratio between a government’s green and brown support to industries. This makes intuitive sense because the green sector, often a new entrant of the market and in need of more state support because of its price disadvantage, is often the one that requires more state aid per unit of production. For example, from the perspective of the green sector, given 50-50 split of the state aid between the green and the brown sectors, 10 billion dollars

of total aid (5 billion for the green and 5 billion for the brown) is a better situation than if the total aid is only 10 millions dollars (5 million for the green and 5 million for the brown).

Moreover, we argue that the tendency of a government to exchange rents with electoral support with industrial organized interests (both the green and sector in our model) is a function of left-right partisanship of the government. We implicitly assumes that this tendency or weight associated with taking bribes from industrial organized interests (against maximizing aggregate social welfare) is not a function of the total political influence of industrial organized interests, that is, the sum of the green's and the brown's political strengths, against a third, non-industrial interest group. We have simply argued that consumers and general voters are too disorganized to act as an interest group.<sup>11</sup> Moreover, empirically, this is a reasonable assumption if the total political influence of industrial organized interests is at a similar level across countries and over time. We study the OECD countries from 1980-2008. Assuming an industry's GDP contribution is a reasonable proxy for its political strength,<sup>12</sup> most of these countries' industrial production value added as a percentage of GDP is indeed around 30% through the whole period.<sup>13</sup>

## DATA

**Renewable Electricity.** For the dependent variable, we use the share of non-hydro renewable electricity in total electricity generation for the OECD countries, 1980 to 2004.<sup>14</sup> Data are from the U.S. Energy Information Administration (EIA).<sup>15</sup> There are two clarifications that need to be highlighted: first, we exclude hydroelectricity following previous research (Lipp 2007, Aklin & Urpelainen Forthcoming), because hydroelectricity is a mature technology that does not require the same level of state support as in geothermal, solar, wind, and

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<sup>11</sup>However, this does not mean that all governments would completely ignore the interest of consumers. For example, Rogowski and Kayser (2002) have shown that majoritarian systems are less likely to respond to organized interests and more responsive to consumers thanks to a large seat-vote disproportionality. We control for such effects in the empirical analysis.

<sup>12</sup>We will discuss why this might not be a good proxy in the empirical section.

<sup>13</sup>Based on own calculation. Data from World Development Indicators.

<sup>14</sup>Most model specifications cover 27 countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. Non-hydroelectric renewables include geothermal, wind, solar, tide, biomass and waste.

<sup>15</sup>See [www.eia.gov](http://www.eia.gov), data last extracted on October 10, 2011.

tide and wave. Moreover, hydroelectricity is not always considered green given its potential negative ecological impacts.

Insert Figure 1 about here.

Second, we only look at renewable electricity data rather than all types of renewable energy because of higher quality of the electricity data. Data on total renewable energy exist. For example, the OECD carries data on the contribution of renewables to total primary energy supply in the OECD countries.<sup>16</sup> But the total renewable contribution data cover a much briefer time period (1971, 1990, and 1999-2010).<sup>17</sup> More importantly, the data do not distinguish different components of renewables.<sup>18</sup> Hydro-electricity accounts for a disproportionately large shares of renewables for quite a few countries. Using the total renewable energy from the OECD as the dependent variable is almost equivalent to modeling hydro-electricity for many countries. Figure 1 shows the share of non-hydro renewable electricity in total electricity generation for the OECD countries. Enough cross-country and temporal variation is displayed. Renewable electricity, for most of the OECD countries, only accounted for a small share of total electricity (smaller than 2-3%) until quite recently (early and mid 1990s). European countries on average have larger share of renewable electricity generation: in countries such as Denmark (DEN), Iceland (ICE), and Finland (FIN), the renewable share became more than 10% after 2000. We log the dependent variable in our regression analyses to approximate a normal distribution.

**Left-Right Dimension of the Government.** There are different measures of government partisanship. Simple measures include the comparative institution data by Beck et al. (2007), which provide a three-category measure, left(3)-center(2)-right(1), of the executive party. Its advantage is the data coverage as it also includes developing countries. Its disadvantage is its lack of precision when estimating how left/right the party is. For the key variable, left right

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<sup>16</sup>OECD (2012): <http://dx.doi.org/10.1787/888932504937>, accessed July, 2012.

<sup>17</sup>The correlation between our dependent variable and the contribution of renewables to total primary energy supply is about 0.3 for overlapping countries and years.

<sup>18</sup>Renewables include the primary energy equivalent of hydro, geothermal, solar, wind, tide and wave as well as energy derived from solid biofuels, biogasoline, biodiesels, other liquid biofuels, biogases, and the renewable fraction of municipal waste.

dimension of the executive party, the categorization of left, center, right party is based on reading the name of the parties or the handbooks associated with the party.<sup>19</sup>

We choose to use a more detailed measure on the left-right party ideological positions. It is based on data from the Comparative Manifestoes Project (CMP) (Volkens, Laceywell, Lehmann, Regel, Schultze & Werner 2012). The Manifestos Research Group has carefully coded the content of party election manifestos, using a large number of substantive categories. The CMP content analyses quasi sentences. Left right scores are based on the percentage of sentences that are held to reflect themes of the ideological right *minus* the percentage held to reflect themes of the ideological left. They have then used these data to estimate the party left-right positions for most parties and elections in a large number of democracies. These data are very attractive for us, not only because they currently provide the only comparable means of estimating party left-right positions over a long time period in a large number of countries (Gabel & Huber 2000), but also because they include data up to recent elections. Gabel and Huber, in their analysis of the manifesto data, suggest that the data can be fruitfully employed to estimate party positions.<sup>20</sup>

We calculate the left-right partisan variable as follows. For the period up to the last national election before the year 2000, we used Cusack and Fuchs data set (Cusack & Fuchs n.d.), tying the CMP data to data on governing coalitions. For the remaining years up to 2004 when the Cusack and Fuchs data set ceases to be available, we extracted information about which coalitions formed from the Inter-Parliamentary Union's Parline database.<sup>21</sup> If no party or coalition held an overall majority, we operationalize the Left-right partisan variable as the average of all parties' positions, weighting by number of seats. If there was a single-party majority government, we use that party's position. If there is a majority coalition, we use the weighted average by seat shares in the coalition of members of the coalition,

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<sup>19</sup>The variable name is "EXECRLC". In case of lack of information from party names and handbooks, the coders consult the web-site [www.agora.stm.it/elections/parties.htm](http://www.agora.stm.it/elections/parties.htm). Armingeon et al. (2011) also provide a variable measuring the cabinet proportion of the left-leaning party member: here, partisanship (weighted by cabinet posts) is still a binary measure which is based on Schmidt (1996).

<sup>20</sup>See Gabel and Huber (2000). They also encourage future research on improving how political scientists use manifestos data to estimate party positions.

<sup>21</sup>We assume parties' left-right scores do not change between elections. In election years or years when there was a breakdown of the coalition, we weight scores proportionally to the number of months before the election/coalition shift.

which is consistent with the evidence that this is the most important determinant of coalition policy (Warwick 2001). The distribution of the Left-right variable is almost normal with a mean of 1.52 and a standard deviation of 16.40. Higher values represent a more right-leaning government. Australia from 1998 to 2000 and the United States in 2004 have the most right-leaning governments with the Left-right variable scoring more than 40. On the other hand, Norway in 1980 and 1991-1993 as well as Finland in 1988-1990 have the most left-leaning governments with left-right values lower than  $-30$ .<sup>22</sup>

**Political Strength of the Brown Sector.** We measure the political strength of an interest group based on the potential resources that it can mobilize. We assume this is a positive function of the size of the sector. Large groups, despite a more challenging free-riding problem, also have broader political base of support (Schonhardt-Bailey 1991). They also have more (electoral) resources such as direct monetary contribution, information, expertise, votes, and organization capacity to mobilize general voters. In principle, the relative size of the sector can be measured as its contribution to the total GDP of the economy.<sup>23</sup>

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<sup>22</sup>Another common source for detailed measures on the left-right party ideological positions is based on expert surveys (Castles & Mair 1984, Huber & Inglehart 1995). These surveys are widely used. However, they have been administered infrequently and only cover the period up to the mid 1990s and for about 20 OECD countries. Note that the development of renewable electricity production is a recent phenomenon even for many of the OECD countries (Figure 1). Using variable based on expert surveys will exclude years after 1996 and countries such as New Zealand, Poland, Czech Republic, and Luxembourg. Nevertheless, to check the validity of our measure based on the CMP data, we take the correlation between the Left-right partisan variable based on manifesto data and the expert-survey based “cabinet center of political gravity” variable from Cusack (1997). The correlation is about 0.6.

<sup>23</sup>The actual lobby effort of an interest group can be considered a function of not only the potential resources it can mobilize, but its ability to coordinate. The empirical tests of Grossman-Helpman or other menu auction models emphasize the importance of these factors (e.g., Gawande and Bandyopadhyay (2000) and Fredriksson et al. (2004)). The theoretical argument behind the second factor (i.e., free-riding effects) follows theory of collective action: it is often easier to solve the collective action problem if production is controlled by a small number of firms and/or the industry is geographically concentrated (Olson 1965). Four-firm concentration ratio and difference between population and industry production patterns across the 50 states are often used to test the concentration argument in US context (Trefler 1993). However, the empirical findings on the free-riding effect is mixed. Potters and Sloof (1996) find that there is relatively little empirical support for Olson’s argument. For our analysis, concentration measures are often only available for a small number countries, usually the US. The only research outside the American context is Ferreira and Facchini (2005) which test industrial concentration and trade liberalization in Brazil.

In theoretical section of the paper, we use general terms “green vs. brown sector”. In order to measure their sizes, we need to be more specific about what these sectors are. On the one hand, we can narrowly define the green sector as renewable energy sector and the brown sector as its rival fossil fuel energy sector. On the other hand, broader definitions might also apply in which the green sector include those that might benefit from more renewable energy production, for example, firms that engage in renewable-related R&Ds and provide goods and services in energy efficiency and pollution reduction.<sup>24</sup> A broader definition of the brown sector might include the energy intensive industries as well: these industries benefit from cheaper, fossil fuel energies and might share common interest with the fossil fuel energy sector.<sup>25</sup> In this paper, we choose to use the narrow definitions: given the diversity within each sector implied by broader definitions (for example, the brown sector would include industries as diverse as paper and paper products, non-metallic industry, basic metal industry, and transport), it is difficult to assume *ex ante* that they can act as a single interest group.

As far as we know, systematic data on renewable energy sector’s GDP contribution are not available. But the relative strength of the green sector (vs. the brown sector) is a negative function of the brown sector’s GDP contribution. Available breakdowns of GDP are not fine enough to measure fossil fuel energy sector’s GDP contribution for a large enough number of countries.<sup>26</sup> Things are more straightforward on the production side. We therefore use the World Development Indicators (WDI) data on national energy production in oil equivalent and divided by real GDP. This gives energy production per unit of real gross domestic product

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<sup>24</sup>The US Bureau of Labor Statistics, for example, considers green goods and services as those that fall into the following five categories: 1) production of energy from renewable sources; 2) energy efficiency; 3) pollution reduction and removal, greenhouse gas reduction, recycling and reuse; 4) natural resource conservation; and 5) environmental compliance, education and training, and public awareness.

<sup>25</sup>Energy intensive sectors can be identified, for instance by reference to those included in the EU’s CO2 emissions trading scheme such as electricity generation, cement production, and glass making; or by looking at sector level energy intensity, such as paper and paper products, non-metallic industry, basic metal industry, and transport, as in Fredriksson et al. (2004).

<sup>26</sup>OECD Structural Analysis Statistics (STAN) have GDP data for different industries at the 2-digits ISIC (rev 3.1) level. Data for total mining and quarrying of energy producing minerals are available, which is the closest proxy for the size of fossil fuel energy sector. But this variable also includes the GDP contribution from mining of uranium and thorium ores. Moreover, many activities related to fossil fuel energy sector are not included, for example, refining of petroleum products, test drilling and boring, geophysical surveying and mapping, and oil and gas well exploration.

(Energy Production per GDP), which we use as a proxy for the relative political strength of the brown sector.<sup>27</sup> The unit of this variable is in kilograms of oil equivalent per dollar of GDP: the mean in our sample is 0.17 with a standard deviation of 0.22. Denmark in 1980-81, Luxembourg in 1980-2005, Portugal in 1980-1992 and 2002-2005, and Ireland and Italy both in 2000-2005 have the lowest per GDP energy production, below 0.2 kilos per dollar. On the other hand, Norway tops the list with per GDP energy production over 0.65 kilos through the whole period; its per GDP energy production have been increasing over the years and reached 1.4 kilos in mid 1990s. Norway is followed by Canada and Australia though their levels of per GDP energy production are much lower, around 0.4 kilos.

**Control Variables.** In addition to the left-right partisan nature of the government, we also consider how “green” the government is. A government with more environmental emphasis is more likely to encourage renewable energies. We create a government environmental emphasis variable following the same strategy used to create the left-right government partisanship variable, only replacing the parties’ left-right position scores with their environmental scores that are also from the Party Manifesto Projects (Volkens et al. 2012). Environmental scores are based on percentage of sentences mentioning the environment. Moreover, to control for the effects of popular demand on environmental protection and sustainable energy, we control for the number of green NGOs per million pollution.<sup>28</sup>

We control the potential effects of political regime types and electoral rules. Our model is ultimately about interest groups competing for rents doled out by the government and we assume that left-right partisanship affects the extent to which the incumbent government is responsive to industrial interest group pressures. Other political variables might also affect the propensity of government to supply state aid to industries. The difference between presidential and parliamentary systems has been argued to affect the ways that governments tax and spend (Dewan & Shepsle 2008): compared to presidential systems, parliamentary systems are

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<sup>27</sup>We take the correlation between the variable Energy Production per GDP (based on the WDI data) and total mining and quarrying of energy producing minerals per GDP (based on the STAN data). The correlation is very high (0.90). However, the variable from STAN has many more missing values. Indeed replacing the Energy Production per GDP variable with the STAN variable would result in a loss of more than 200 observations. This is another reason why we choose to use the more straightforward Energy Production per GDP variable.

<sup>28</sup>Data on green NGOs are from International Union for Conservation of Nature (IUCN).

associated with larger public sectors (more taxation), more rents enjoyed by politicians and more spending on both the public good and redistribution (Persson, Roland & Tabellini 2000). Moreover, differences in electoral rules have also been shown to affect interest group politics (Lizzeri & Persico 2001). For instance, Rogowski and Kayser (2002) argue that majoritarian systems are less likely to respond to organized interests because they are more responsive to consumers thanks to a large seat-vote disproportionality.<sup>29</sup> Compared with the winning-take-all electoral systems, majoritarian systems are therefore likely to be associated with lower levels of rents for interest groups.<sup>30</sup>

We also control for the effects of international oil price. Other things equal the higher the price of fossil fuels, it is often argued, the higher the incentives to search for alternative energy sources. It is hard to get consistent time series data on coal and natural gas prices, but changes in these often correlate with changes in oil prices because they are partial substitutes. The longest consistent time series data on oil prices is an index of the 2010 dollar price of Illinois crude oil at the production pump. We call this variable Real oil price.<sup>31</sup>

We include both GDP per capita (in purchasing power parity) to capture the relationship between wealth and renewable energy. We also control for GDP growth rate. While higher growth rates often require more intensive use of resources and lead to higher levels of energy consumption, they may also encourage technological advancements including those related to renewable energies. Our model includes the share of industrial production in GDP because the industrial production is often associated with higher levels of energy use, therefore a stronger demand for the less expensive, fossil fuel based energy. We include a demographic variable, urban population (as a share of total population), as urban population is likely to be associated with environmental activism and green demand. We also control for the potential effect of globalization by including the trade openness variable (sum of imports and exports as a percentage of GDP).<sup>32</sup>

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<sup>29</sup>For more recent research on electoral rules, see Park and Jensen (2007) and Lipsky (2011).

<sup>30</sup>Data on political regime types and electoral rules are both from Golder (2005).

<sup>31</sup>See [www.ioga.com/Special/crudeoil\\_Hist.htm](http://www.ioga.com/Special/crudeoil_Hist.htm), downloaded December 2010.

<sup>32</sup>Data on GDP per capita, GDP growth rate, industrial production, urban population, and trade openness are from the World Development Indicators.

## EMPIRICAL FINDINGS

We model the share of non-hydro renewable electricity in total electricity generation as a function of left-right government partisanship, the strength of brown sector, their interaction effect, and a battery of control variables, using a simple OLS regression with lagged dependent variable as well as year and region fixed effects. Year fixed effects are important because it is of great importance that common external shocks (e.g., oil crisis) are controlled. We did not use country fixed effects because of the time-invariant/slowing-moving nature of the political regime type and electoral rules variables. Moreover, models with both fixed effects and a lagged dependent variable might be problematic because the lagged dependent variable is correlated with the error term by its correlation with the time-invariant component of the error term. When country fixed effects are included, “Nickell bias” results because the lagged dependent variable is still correlated with the error term.<sup>33</sup>

The empirical results are presented in Table 4. The first model specification does not include the interaction term between the Left-right government partisanship and the energy production per GDP variables. Here, in terms of short-term effects, that is, the direct interpretation of the coefficients associated with the independent variables in the regression analysis, only a few statistically significant relationships stand out. First, even without the interaction term, both the left-right government partisanship and energy production per GDP variables are associated with renewable energy production (at  $p < 0.1$  level): right-leaning governments

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<sup>33</sup>However, Adolph, Butler, and Wilson (2005) show that Nickell bias is often negligible and suggest that all remedies (e.g., Anderson-Hsiao or Arellano-bond) are worse than the original problem. As the number of years gets larger, this bias becomes less of a problem (Wilson & Butler 2007). Another concern for the empirical analysis is the presence of unit roots (or non-stationarity): quite a few countries in Figure 1 greatly increased the level of renewable production in recent years. Estimating a model with a lagged dependent variable in the presence of a unit root can lead to dramatically misleading results. We log our dependent variable; but time series after log transformation might still suffer from non-stationarity. Beck (2006) argues that while the exact test statistic for determining non-stationarity is controversial, after estimating a dynamic model, one can see if the residuals appear stationary (that is, whether an auto-regression of the residuals on their lags shows a coefficient on the lagged residual term near one) as well as examine whether the coefficients on any lagged dependent variables are near one. We followed the suggestion and conducted auto-regressions of the residuals on their lags and found that coefficients on the lagged residual terms are nowhere close to one, indicating the lack of non-stationarity.

are associated with higher level of renewable electricity and per GDP energy production, as a proxy for the political strength of the brown sector, reduces renewable energy production.

Insert Table 4 about here.

The second model specification includes the interactive effect and the third model specification further includes region dummy variables. In both cases, the interaction term itself is actually not statistically significant. However, there are still reasons to include the interactive effect. The most important justification is that a model with an interaction term yields coefficients that provide a more detailed description of the relationship between a dependent variable and a set of independent variables than a model without an interaction term (Friedrich 1982). Rather than assuming that the relationship between variables are the same everywhere, an interactive model assesses the possibility that relationships between variables change with changes in other variables. Moreover, in models with interaction terms, it is well known that not only the marginal effect but also the associated standard errors vary with the value of the other lower-order variable (Friedrich 1982, Braumoeller 2004). In other words, it is hard to get a sense of the conditional effects by looking at coefficients and standard errors in the table only. In Figure 2, we show the marginal effects of the left-right government partisanship and energy production per GDP variables with their 95% confidence intervals. In both figures, the long-dashed lines are the upper and lower bounds of the 95% confidence intervals of the estimated effect; the dark line in between the dashed lines represents the mean coefficient estimated.

Figure 2(a) shows the effects of Left-right partisanship on renewable energy, conditional on different levels of per GDP energy production which we use as a proxy for the strength of the brown sector. The conditional effect of brown sector strength revealed by the figure supports our theory. When the brown sector's strength is low, Left-right partisanship is positively associated with renewable energy production; increasing brown sector strength (energy production per GDP) reduces this positive effect and the statistically significant effect disappears when per GDP energy production reaches about 0.25 kilo per dollar of GDP. With a relatively weak brown sector, right-leaning government is good news for renewable energies: right government is more responsive to industrial pressures therefore is associated with a higher level of state support to industries in general; a weak brown sector means a relatively strong

green sector which might be able to capture a larger share of the state support compared with situations in which the brown sector is stronger. Indeed, the increasing strength of the brown sector drives state aid away from the green sector and the beneficial effect (regarding green sector) of a right-leaning government disappears eventually.

Insert Figure 2 about here.

Figure 2(b) shows the effects of per GDP energy production (proxy for brown sector strength) on renewable energy, conditional on different levels of left-right government partisanship. The mean estimated effects are always negative. Note the statistical significance, indicated by the 95% confidence intervals, is also a function of the number observations associated with different levels of the lower-order variable, left-right government partisanship in the case of Figure 2(b). The negative effects of brown sector strength are significant when the left-right government partisanship variable is about between  $-20$  and  $20$ : this is where most of the values of the left-right government partisanship are concentrated. Note the distributions of the the lower-order variables are displayed by their histograms, in gray color, for both Figure 2(a) and (b). More importantly for our theory, the negative effect associated with size of the brown sector gets stronger with the government becoming more right-leaning. This implies that compared with the case of a left-leaning government, one unit of increase in the size of the brown sector under a right government is associated with larger amount of decrease in renewable production. Right government is in general associated with more state support to industries; with the same level of increase in the political strength of the brown sector, a higher amount of resources are moved away from the green sector. In other words, a right-leaning government amplifies the negative effect of brown sector strength on renewable production. This is consistent with our assumption that the size of the renewable sector is a function of the *absolute* amount of support it receives from the government, not the ratio between green and brown support. This is a key assumption of the model without which, it won't make a difference whether we have a left or right government as long as the division of the rents is a function of the strength between two sectors. The finding as shown Figure 2(b) empirically supports this assumption.

The models estimated here include the lagged dependent variable, because we do not think that shocks to the political variables are likely to have their full impact in one year. If

changes in the nature of the political system are to have an effect, we would not expect this to occur within a single year; this requires that we look at least at the medium term. We know that in a model with a lagged dependent variable, for example,  $Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_0 X_t + \varepsilon_t$ , the mean long-term effects, also sometimes called long-run multiplier, for an independent variable is determined by  $\frac{\beta_0}{1-\alpha_1}$ . The less straightforward part is to estimate the standard errors for the long-run multiplier. But the long term effect is ultimately the ratio of two coefficients,  $a$  and  $b$  for instance; the approximation of the variance of a ratio of coefficients with known variances can be used (De Boef & Keele 2008):  $Var(\frac{a}{b}) = \frac{1}{b^2} Var(a) + \frac{a^2}{b^4} Var(b) - 2\frac{a}{b^3} Cov(a, b)$ .

It is difficult to calculate long-run multipliers for variables in interaction terms given that the marginal effects and the associated standard errors vary with the value of the other lower-order variable in the interaction term. But for model specification 1 in Table 4 in which no interaction term is included, we can follow the formula and calculate the “unconditional” long-term effects. For instance, the mean coefficient estimate for government partisanship is only 0.003; but this is short-term effect. The mean long-term effect, calculated by  $\frac{\beta_0}{1-\alpha_1}$ , is ten times larger — 0.033. To show the statistical distribution of the estimated long-term effects, we calculate the variance and the 95% confidence interval is  $\{-0.002, 0.068\}$ ; the 90% confidence interval is  $\{0.002, 0.064\}$ . Using the mean estimated long-term effect of 0.033, we can get a sense of how salient its the substantive effect is on renewable energy production: we hold every variable in the first model specification at its mean value, including the government partisanship variable, the predicted value of the dependent variable is 1.38 (non-hydro renewable as a percentage of total electricity generation); next, we keep all other variables at their mean levels, but increase the government partisanship variable by one standard deviation, that is, the government becomes more right-leaning, this increases the predicted value of the dependent variable to 1.47, which is about a 6% increase compared with the previous situation.<sup>34</sup>

**Why Oil Price Hurts?** Table 4 also suggests that few of the control variables affect renewable electricity production. Government environmental emphasis and Green NGOs per million population are positively associated with renewable electricity, but the these associations are

<sup>34</sup>We can also add one more standard deviation to the the government partisanship variable; this increases the predicted value to 1.55, which is about 12% increase compared with the first scenario in which the government partisanship variable is held at its mean level.

not statistically significant based on normal standards (e.g.,  $p < 0.05$  or  $p < 0.10$ ). Wealth seems to increase renewable electricity as indicated by the positive effect of GDP per capita; but this relationship disappears when region dummy variables are added (in Model 3).

One interesting and yet counterintuitive finding is the effect of real oil price: an increase in real oil price seems to drive down the level of non-hydro electricity production. This is just the opposite from our common sense that with increasing fossil fuel prices, people turn to alternative sources of energy. Searching “oil price and renewable energy” in popular press, most of what we find argues that increase in oil price is going to bring hope to renewable energy sectors. Few studies have looked at this relationship systematically. Modeling the change in renewable electricity in a non-dynamic model context, Aklin and Uperlanein (Forthcoming) find that oil price increases renewable energy, but only when what they call “positive reinforcement factor” (measured by renewable technology patents standardized by population size) is low, reason being that government worries about over-investment in renewable sectors in the future, therefore when the current renewable investment is already strong, the effect of oil price as exogenous shock would be limited. What we find in our empirical analysis, based on data covering a slightly different period of time (1980-2004 in this paper vs. 1990-2008 in Aklin and Uperlanein (Forthcoming)), seems to show a different story. Here, at least in terms of the short-term effect, higher oil prices reduce renewable energy production.<sup>35</sup>

However, this is less surprising if we look at the long-term trend of international oil price (solid line in Figure 4): since late 1970s and early 1980s, real oil price has been dropping until early 2000s; but the renewable electricity production, for many OECD countries, has started to take off way before that, some even in the late 1980s and early 1990s (Figure 1). This only explains why we might find a non-effect of oil price on renewable energy. What can further explains the negative effect might be an increased competition from the brown industries for government support with higher oil prices: assuming constant government budget for energy sectors, with oil price on the rise, often industries’ first response is to look for quick and cheap replacement, for instance, shale gas and oil sand. They are quick and relatively cheaper (at least compared to renewable energy) replacement for conventional oil and natural gas. If they compete also for government support, state subsidies available for renewable sectors would be

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<sup>35</sup>We have experimented with lagging the real oil price variable by 1, 2, 3, 4, and 5 years. The negative effect of real oil price on renewable electricity does not change.

reduced. Indeed, the huge run-up in oil prices over the last several years has given energy companies a big incentive to find new ways of harvesting unconventional oil, especially in North America. The US production of oil and natural gas has increased and much of the increased oil production has come from the exploitation of previously unreachable stores of shale oil in the Bakken formation underlying Montana and North Dakota.

We used the real oil price for the analysis given the fact that it is the real cost of energy that affect costs of living and production. However, one might also argue that the nominal oil price also affects policy outcomes because voters only see nominal price changes on a daily basis. We run the analysis replacing real oil price with nominal price. The result changes: nominal oil price increases renewable electricity and the positive effect is statistically significant.<sup>36</sup> Therefore, it seems that the effects of oil price are much more complex than we normally assume. Nominal prices' effect fits better with our intuition that high prices for fossil fuels offer more opportunities for alternative and more sustainable energies. The negative effect associated with real price changes might be explained by energy industry's search for alternative fossil fuels such as sand oil and shale gas that requires more state support. Whether this is the reason behind the negative relationship between real oil price and renewable electricity production is an open question for future research.

Insert Figure 4 about here.

**Is the US an Exception?** Some might argue that the theoretical story in this paper simply does not fit the American experience for a number of reasons. For instance, one key assumption of our model is that right party governments are in general associated with higher levels of industrial subsidies. In the US context, the common perception often is that the right (i.e., the Republicans) is fiscally conservative and does not want to throw government money at industries. In order to test this common perception, we conduct some very simple data analysis. In Figure 5, we plot two time series: the dashed line shows the level of left-right government partisanship of the US government from 1980 to 2004 based on the party manifesto data — the same variable we used in the regression analysis (in Table 4); the solid line shows

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<sup>36</sup>Dashed line in Figure 4 represents the nominal international oil price. Regression results using nominal oil price available upon request.

the level of US industrial subsidies as a percentage of GDP from 1980 to 2002.<sup>37</sup> Note the higher the value of the left-right government partisanship variable, the more right-leaning the government is. Here we see a clear pattern that indicates a strong positive correlation between right governments and industrial subsidies in the US context. We also take the correlation between the two variables and they are positively correlated at the level of 0.54. It seems that the US experience, at least from 1980 till early 2000s, is no exception to our assumption of right parties being associated with higher industrial subsidies.

Insert Figure 5 about here.

A second objection for applying our model in the US context also has to do with intuitions about American politics: in the US, the right-wing party (the Republicans) is generally opposed to supporting renewable energy technologies, while the left-wing (Democratic) party is known to be greener. The case of Solyndra — a solar panel company supported by the US president which then went bankrupt (for which many prominent Republicans criticized the president and his party) — is just one example of the left’s and the right’s positions on the issue of renewable energies and climate change in general. Renewable energy development in the US, in this case, reflects important ideologies of the Democrats and Republicans that are not be captured by the left-right government partisanship. Such ideologies, however, are captured by the environmental emphasis variable in our analysis.

Note the left right dimension captures the ideologies that are often associated with government intervention of economy and social equality.<sup>38</sup> It does not, however, considers the environmental values of the parties. Therefore, we have also included another variable in our analysis (though as a control variable), the environmental emphasis of the government. This variable is operationalized following the same strategy used to create the left-right government partisanship variable (Volkens et al. 2012). In this way, the particular party ideologies associated with environmental protection in the US context are controlled by the environmental

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<sup>37</sup>The data are from the OECD; subsidies are defined as “current unrequited payments that government units, including non-resident government units, make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods or services which they produce, sell or import” (OECD 2002).

<sup>38</sup>For instance, the Leftist categories used in the party manifesto data include regulation of capitalism, economic planning, protectionism, controlled economy, nationalization, decolonization, internationalism, democracy, social services expansion, education, and labor groups.

emphasis variable in the analysis. It is also interesting to note that right parties are in general associated with lower level of environmental emphasis in the sample of OECD countries included in our analysis: the left-right government partisanship variable and the environmental emphasis of the government variable is correlated at -0.30; for the US, the correlation is more negative at the level of -0.46.

## CONCLUSION AND DISCUSSION

In this paper, we present a model based on interest group and partisan politics to explain the size of renewable energy sector in the OECD countries. We start with the assumption that a country's renewable energy production, given its price disadvantage (compared with fossil fuels), depends on the size of the state support that it receives. State support here is conceptualized as rents doled out by governments in exchange for electoral supports from interest groups. We choose a simple two interest groups setup in the context of domestic energy production: a green sector competes with a brown sector for state industrial aid. The intuition of the model is similar to many menu-auction types of models of interest group politics (Grossman & Helpman 1994, Aidt 1998, Damania 2001, Fredriksson, Vollebergh & Dijkgraaf 2004). While maximizing supports from industrial interest groups in addition to aggregate social welfare, governments differ in the weights they place on taking "bribes" from industrial interest groups; this difference, we argue, is a function of the partisan nature of the government, with right-leaning governments being more responsive to lobby activities from industrial interest groups (both the green and brown sectors). Moreover, when dividing the total state industry support between the green and brown sectors, the relative strength of two sectors matters, with the stronger one (that is able to offer more contributions) more likely to reap a larger share. Therefore, government partisanship and relative strength of the green sector affect renewable energy production in an interactive way: a right-party government plus a strong green (weak brown) sector is the best scenario for the development of renewable energies — the former is often associated with higher levels of total state support to industries and the latter a larger share of the total state support for the green sector. A left-ward shift in government partisanship and/or a weakening of the green sector, on the other hand, results in lower state support to the green sector and therefore decreased renewable energy production.

We model non-hydro renewable electricity generation using panel data on the OECD member states from 1980 to 2004. We measure government partisanship on the left-right dimension and we use energy production per unit of GDP as a proxy for the relative strength of the brown sector. We find that when a country's per GDP energy production is low, right-leaning governments are associated with higher levels of renewable electricity generation; this positive association weakens and disappears with increasing strength of the brown sector (Figure 2(a)). We think that these empirical findings support the theory. However, there are issues that need to be further resolved in future research. First issue concerns the use of per GDP energy production as a proxy for the relative strength of the brown sector. As we have discussed in the empirical section, in an ideal situation, we should use the ratio of the political strength of the green sector to that of the brown sector. Political strength can be a positive function of the size of the sector, often measured by its GDP contribution to the economy. However, data on the size of the green sector are unavailable. We therefore can only use the brown sector side of the information: the larger the brown sector, all else equal, the lower the relative strength of the green sector. This is by no means a perfect way to operationalize the relative strength of an interest group; but it is what we can do given available data. We need to acknowledge the weakness of such a proxy and interpret our empirical findings with caution. Interestingly, if we assume that in many countries and at least in the initial stage of renewable energy development, the green sector, as a new entrant to the market, is politically weak, the variation in the strength of the brown sector would be the most relevant determinant for the share of the state aid going to the green sector. Here, we might have a reduced version of our theoretical model in which the relative strength of green sector is essentially a negative function of brown sector's political strength.

Moreover, the political strength of an interest group can be considered a function of not only the potential resources it can mobilize, but also its ability to coordinate (i.e., to solve collective action problem). Potential resources can be measured by the size of the interest group, for instance, its GDP contribution or its size of employment. The ability to coordinate is much trickier to measure. The theoretical argument behind it is straightforward and follows Olson's theory of collective action: it is often easier to solve the collective action problem if production is controlled by a small number of firms and/or the industry is geographically

concentrated (Olson 1965). For our analysis, concentration measures are often only available for a small number of countries, usually the US, at sub-national level. Again, in an ideal situation, we should operationalize the political strength of each sector as a product of their size (by its GDP or employment) and concentration.

Finally, our theoretical model is about interest groups and partisan politics and it posits that the strength of competing interest groups and the nature of government affect renewable energy production via state aid to the green sector. We want to emphasize that interest groups and partisan politics is only one of the many underlying causal mechanisms that account for renewable energy development across countries and over time. The existing literature has also revealed other important determinants of renewable production. For instance, Aklin and Urpelainen (Forthcoming) show how existing renewable technology capacities, in interaction with global oil prices, affect renewable electricity capacities in the OECD countries. Lipp (2007) and many other studies from the policy side of the literature pay more attention to factors such as the role of history, governments' choices of particular policies (e.g., feed-in-tariffs vs. renewable portfolio standards), and the consistency of government support schemes as well as private market actors' incentives to invest.<sup>39</sup> We hope this study can add to this emerging political economy literature on renewable energies and climate change and stimulate more research in the future.

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<sup>39</sup>Our key findings do not change after controlling for technology capacities (measured by patents) of the country and other variables such as unemployment rates.

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TABLE 1. Theoretical expectations of the levels of state support for the green sector.

	Strong Green	Strong Brown
Right Govt	high	medium
Left Govt	medium	low

TABLE 2. Summary Statistics Based on all Available Observations between 1981 and 2004.

Variable	N	Mean	SD	Min	Max
renewable electricity (% of total, logged)	686	-0.46	2.53	-6.91	4.50
GDP per capita (logged)	699	9.97	0.43	8.66	11.10
Industry (% GDP)	683	31.63	6.26	16.72	61.59
GDP growth	696	2.77	2.85	-14.57	11.68
Urban population (% of total)	720	72.43	11.62	43.30	97.18
Trade openness (logged)	690	4.14	0.53	2.77	5.67
Govt. environ. emphasis	611	4.73	3.30	0.00	16.26
Green NGOs	688	0.61	0.69	0.00	4.33
Real oil price	720	37.04	17.17	15.93	85.82
Regime types	696	1.30	0.73	0	3
Electoral rules	645	1.92	0.61	1	3
Energy production per GDP	699	0.17	0.23	0.00	1.53
Left-right govt. partisanship	611	1.63	16.39	-36.64	58.23

TABLE 3. Correlation statistics for independent variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1: GDP per capita (logged)	1.00	-0.24	0.05	0.46	0.22	0.26	0.38	-0.17	-0.20	0.24	0.00	-0.19	0.24	-0.06	-0.09
2: Industry (% GDP)	-0.24	1.00	0.08	-0.20	-0.12	0.00	-0.21	0.31	-0.09	-0.11	-0.04	0.01	0.30	0.00	-0.12
3: GDP growth	0.05	0.08	1.00	-0.06	0.14	-0.06	0.10	-0.15	0.02	-0.04	0.04	-0.10	0.03	-0.00	-0.01
4: Urban population (% of total)	0.46	-0.20	-0.06	1.00	0.17	0.10	0.44	-0.03	-0.23	0.02	-0.16	-0.14	0.18	0.14	0.13
5: Trade openness (logged)	0.22	-0.12	0.14	0.17	1.00	0.22	0.39	-0.03	-0.05	-0.30	0.52	-0.12	-0.05	-0.16	-0.14
6: Govt. environ. emphasis	0.26	0.00	-0.06	0.10	0.22	1.00	0.13	-0.12	-0.06	-0.03	0.19	0.02	0.15	-0.33	-0.28
7: Green NGOs	0.38	-0.21	0.10	0.44	0.39	0.13	1.00	0.07	-0.02	-0.04	0.17	-0.19	0.07	-0.05	0.00
8: Real oil price	-0.17	0.31	-0.15	-0.03	-0.03	-0.12	0.07	1.00	0.01	-0.04	0.04	-0.16	-0.04	-0.05	0.03
9: Regime: mixed democracy	-0.20	-0.09	0.02	-0.23	-0.05	-0.06	-0.02	0.01	1.00	-0.13	0.15	-0.16	-0.08	-0.05	0.03
10: Regime: presidential	0.24	-0.11	-0.04	0.02	-0.30	-0.03	-0.04	-0.04	-0.13	1.00	-0.15	-0.09	-0.01	0.22	0.15
11: Electoral: proportional	0.00	-0.04	0.04	-0.16	0.52	0.19	0.17	0.04	0.15	-0.15	1.00	-0.46	-0.05	-0.20	-0.23
12: Electoral: mixed	-0.19	0.01	-0.10	-0.14	-0.12	0.02	-0.19	-0.16	-0.16	-0.09	-0.46	1.00	-0.13	0.05	-0.00
13: Energy production per GDP	0.24	0.30	0.03	0.18	-0.05	0.15	0.07	-0.04	-0.08	-0.01	-0.05	-0.13	1.00	-0.04	-0.44
14: Left-right govt. partisanship	-0.06	0.00	-0.00	0.14	-0.16	-0.33	-0.05	-0.05	-0.05	0.22	-0.20	0.05	-0.04	1.00	0.62
15: Energy prod. $\times$ Left-right	-0.09	-0.12	-0.01	0.13	-0.14	-0.28	0.00	0.03	0.03	0.15	-0.23	-0.00	-0.44	0.62	1.00

TABLE 4. Modeling Renewable Electricity Share in the OECD countries, 1981-2004.

	Model 1		Model 2		Model 3	
	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )
Intercept	-1.034	1.209 (0.39)	-0.972	1.212 (0.42)	0.278	2.021 (0.89)
Lagged dependent variable	0.896	0.015 (0.00)	0.895	0.015 (0.00)	0.892	0.015 (0.00)
GDP per cap	0.185	0.109 (0.09)	0.181	0.109 (0.10)	0.058	0.194 (0.76)
Industry (% GDP)	-0.000	0.007 (0.99)	0.000	0.007 (0.96)	-0.001	0.008 (0.92)
GDP growth	-0.009	0.013 (0.47)	-0.009	0.013 (0.46)	-0.009	0.013 (0.49)
Urban population (% of total)	0.000	0.003 (0.87)	0.001	0.003 (0.81)	0.002	0.003 (0.58)
Trade openness	-0.039	0.073 (0.59)	-0.043	0.073 (0.56)	-0.006	0.090 (0.94)
Govt. environ. emphasis	0.010	0.010 (0.34)	0.010	0.010 (0.31)	0.012	0.010 (0.25)
Green NGOs	0.061	0.051 (0.23)	0.066	0.051 (0.20)	0.075	0.054 (0.16)
Real oil price	-0.010	0.005 (0.06)	-0.010	0.005 (0.05)	-0.012	0.006 (0.04)
<i>Regime, baseline: parliamentary</i>						
Mixed democracy	0.040	0.077 (0.60)	0.044	0.077 (0.57)	0.053	0.081 (0.51)
Presidential democracy	-0.118	0.129 (0.36)	-0.121	0.129 (0.35)	-0.113	0.159 (0.48)
<i>Electoral, baseline: majoritarian</i>						
Proportional	0.037	0.085 (0.67)	0.019	0.088 (0.82)	0.048	0.095 (0.61)
Mixed	0.002	0.121 (0.99)	-0.023	0.125 (0.86)	0.006	0.130 (0.96)
Energy production per GDP	-0.238	0.132 (0.07)	-0.311	0.161 (0.05)	-0.287	0.186 (0.12)
Left-right govt. partisanship	0.003	0.002 (0.08)	0.004	0.002 (0.06)	0.005	0.002 (0.05)
Energy prod. $\times$ Left-right			-0.006	0.008 (0.43)	-0.007	0.008 (0.39)
<i>Region, baseline: East Asia</i>						
Eastern Europe					-0.262	0.301 (0.39)
North Africa/Middle East					-0.293	0.339 (0.39)
North America					-0.053	0.234 (0.82)
Western Europe					-0.172	0.200 (0.39)
Adjusted $R^2$		0.92		0.92		0.92
N. of observations/Countries		575/27		575/27		575/27

Year fixed effects are estimated but not reported because of space limit.

TABLE 5. Modeling Renewable Electricity Share in the OECD countries, 1981-2004: more model specifications.

	Model 4: no dynamic		Model 5: no Norway		Model 6: random effects	
	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )	<i>Coef.</i>	$\hat{\sigma}$ ( $p> t $ )
Intercept	-0.990	9.934 (0.92)	1.147	2.175 (0.60)	-1.467	1.071 (0.171)
Lagged dependent variable			0.892	0.015 (0.00)	0.892	0.015 (0.000)
GDP per cap	2.205	0.894 (0.01)	-0.023	0.210 (0.91)	0.167	0.109 (0.125)
Industry (% GDP)	0.135	0.032 (0.00)	-0.000	0.009 (0.99)	-0.000	0.007 (0.981)
GDP growth	0.023	0.029 (0.43)	-0.009	0.013 (0.47)	-0.011	0.012 (0.355)
Urban population (% of total)	-0.212	0.042 (0.00)	0.003	0.004 (0.36)	0.001	0.003 (0.799)
Trade openness	-0.787	0.611 (0.20)	-0.027	0.091 (0.77)	-0.054	0.073 (0.458)
Govt. environ. emphasis	0.017	0.026 (0.51)	0.015	0.011 (0.17)	0.012	0.010 (0.211)
Green NGOs	0.296	0.131 (0.02)	0.104	0.057 (0.07)	0.072	0.051 (0.159)
Real oil price	-0.083	0.014 (0.00)	-0.012	0.006 (0.04)	-0.002	0.002 (0.299)
<i>Regime, baseline: parliamentary</i>						
Mixed democracy			0.057	0.081 (0.48)	0.045	0.077 (0.568)
Presidential democracy			-0.166	0.164 (0.31)	-0.130	0.130 (0.324)
<i>Electoral, baseline: majoritarian</i>						
Proportional			0.004	0.099 (0.97)	0.025	0.088 (0.779)
Mixed			-0.061	0.135 (0.65)	-0.024	0.124 (0.850)
Energy production per GDP	1.164	0.880 (0.19)	-0.736	0.437 (0.09)	-0.318	0.161 (0.049)
Left-right govt. partisanship	0.013	0.006 (0.02)	0.006	0.003 (0.04)	0.005	0.002 (0.044)
Energy prod. $\times$ Left-right	-0.060	0.020 (0.00)	-0.014	0.016 (0.38)	-0.007	0.008 (0.376)
<i>Region, baseline: East Asia</i>						
Eastern Europe		-0.229	0.304	0.45	-0.262	0.301 (0.39)
North Africa/Middle East		-0.315	0.341	0.36	-0.293	0.339 (0.39)
North America		0.092	0.263	0.73	-0.053	0.234 (0.82)
Western Europe		-0.143	0.202	0.48	-0.172	0.200 (0.39)
Fixed Country Effects:	✓					
Random Country Effects:					✓	
Fixed Year Effects:	✓		✓			
Time Trend:						✓
Adjusted $R^2$	0.67		0.92			
logLik					-612.1021	
N. of observations/Countries	601/27		551/26		575/27	

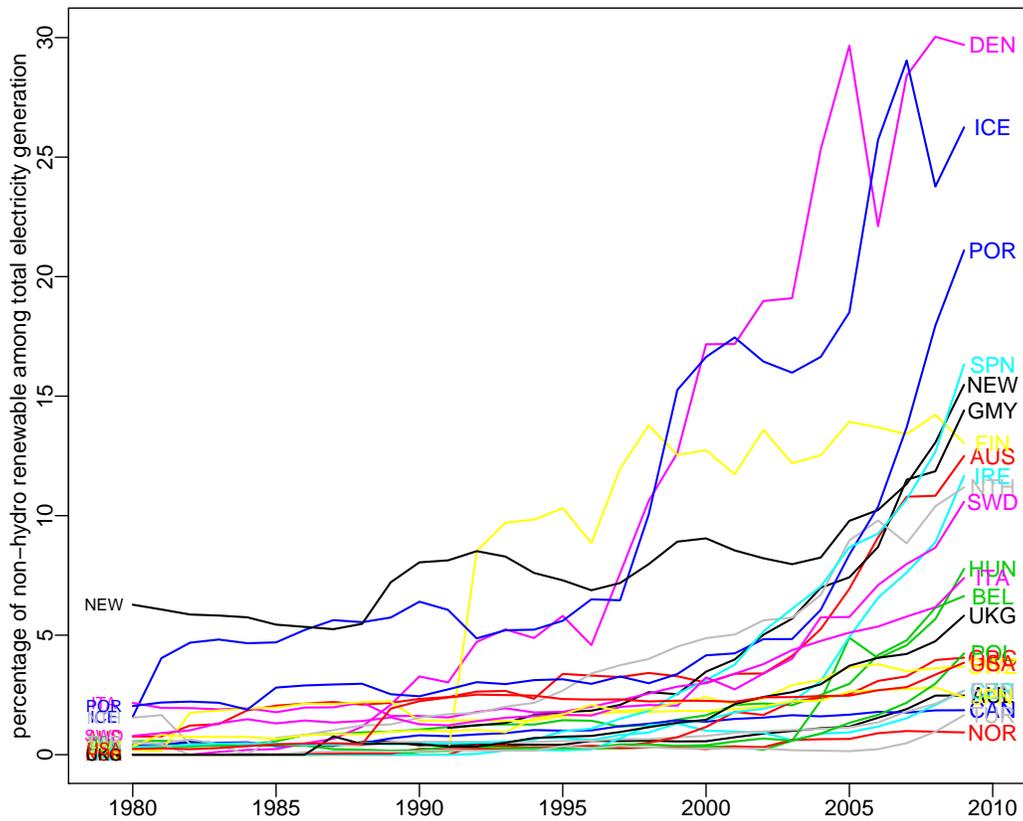
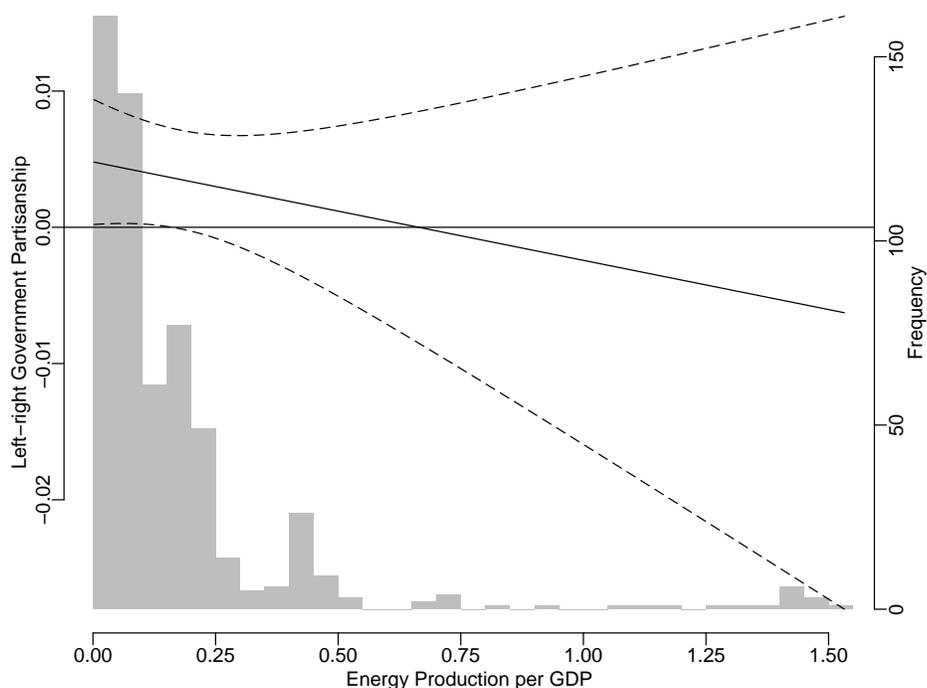
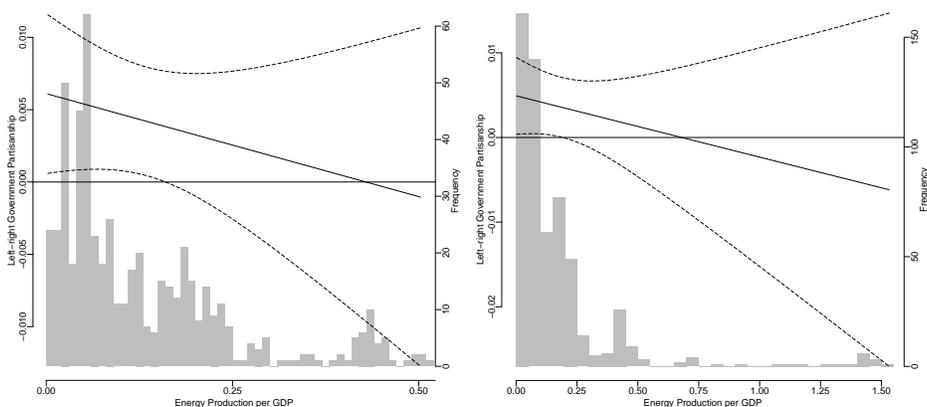


FIGURE 1. Non-Hydro Renewable Electricity, 1980-2009.



(a) Effects of partisanship conditional on the size of the brown sector.



(b) Effects of partisanship conditional on the size of the brown sector: after excluding extreme values in energy per GDP variable. (c) Effects of partisanship conditional on the size of the brown sector: adding country random effects.

FIGURE 2. Conditional Effects: left-right partisanship and per GDP energy production.

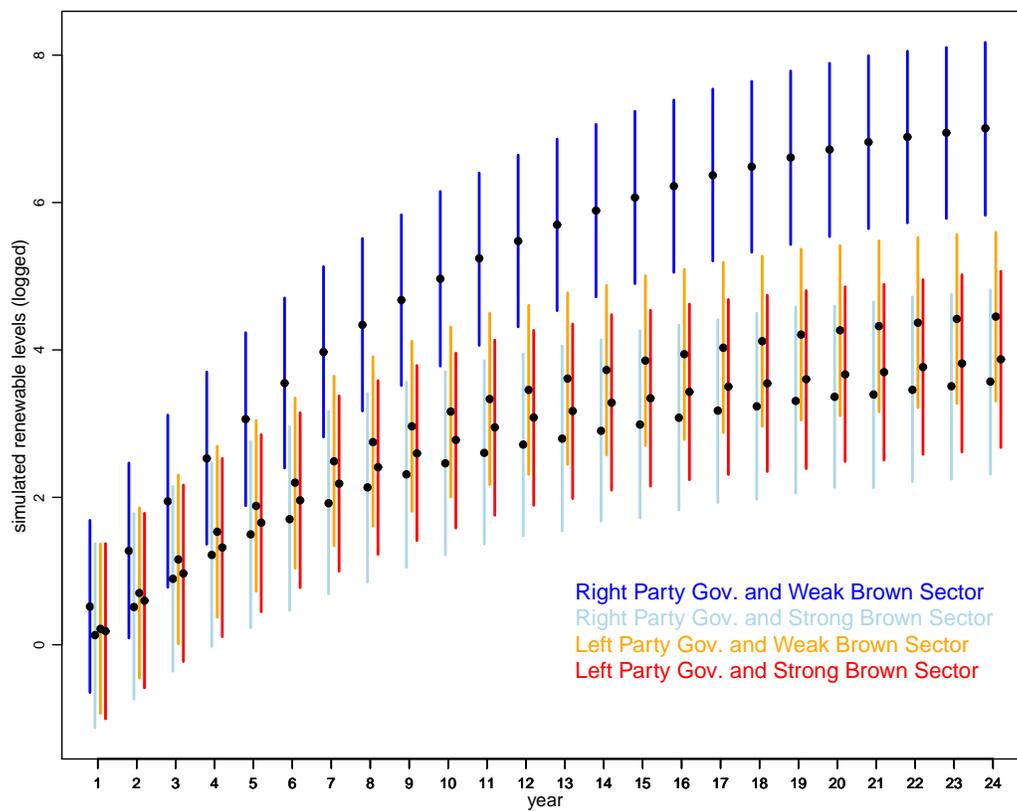


FIGURE 3. Simulated long-term effects for interactions between partisanship and brown sector size.

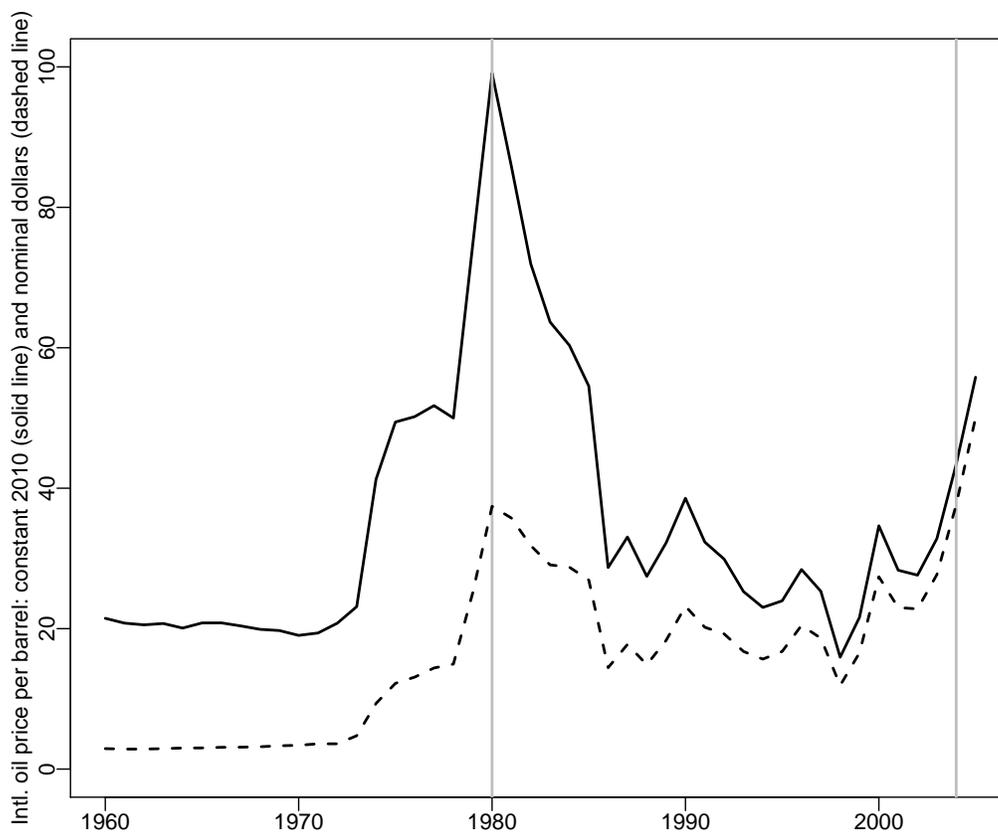


FIGURE 4. Real Oil Price, 1960-2005: constant 2010 in solid line and nominal dollars in dashed line; two gray vertical lines mark the period of time covered by this study.

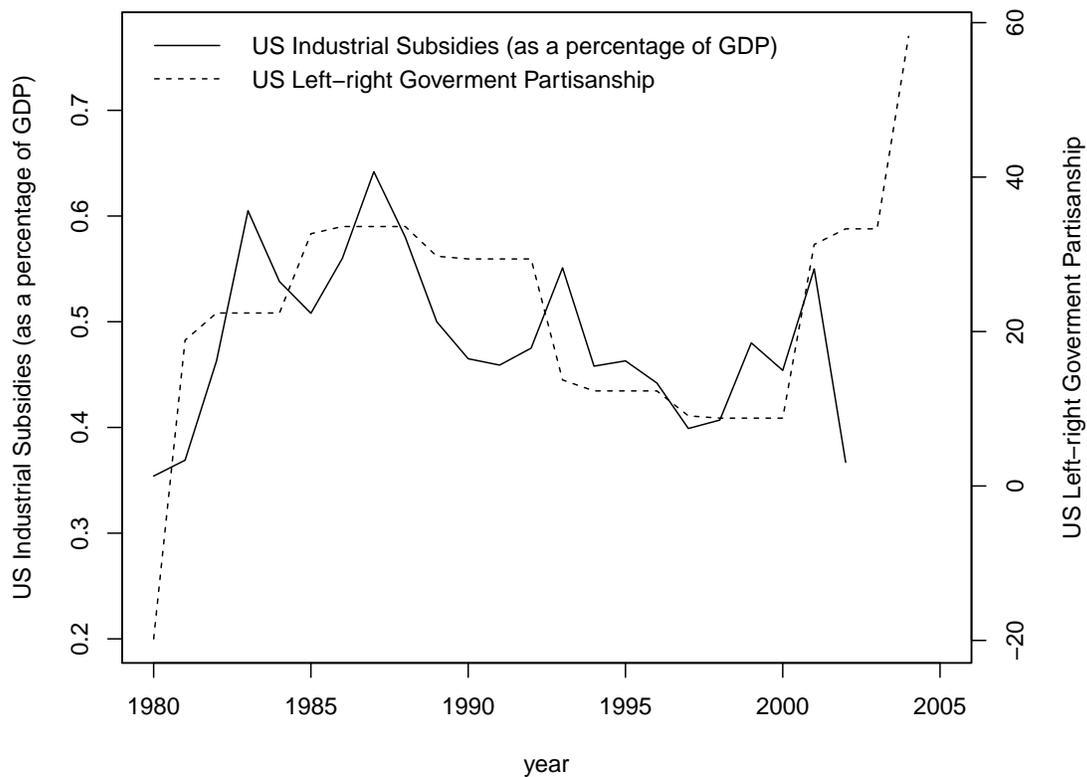


FIGURE 5. Left-right government partisanship and the level of industrial subsidies (as a percentage of GDP) in the US.