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Policy Spillovers: The Impact of Foreign Policy on Domestic Creation of Green Energy Innovation

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Policy Spillovers: The Impact of Foreign Policy on Domestic Creation of Green Energy Innovation

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Abstract: In this paper, we investigate, based on a representative sample of Swiss and German firms, the impact of foreign green energy related policies on domestic innovation activities. Under control of the respective domestic policy stringency, we find a significant positive effect of foreign regulations, foreign voluntary agreements, and foreign public subsidies. However, when we introduce foreign (policy induced) demand, the significant effects of the other foreign policies vanish. Hence, we see that foreign policy impacts domestic innovation primarily from the demand side. We further find that foreign subsidies negatively affect domestic innovation activities of foreign owned firms operating in domestic. Finally, we find that foreign policies dampen the effect of national policy initiatives. Our results therefore call for an international coordination of policy initiatives to increase the effectiveness of the respective national policies.

Zusammenfassung: In dieser Studie untersuchen wir, basierend auf einer repräsentativen Stichprobe bestehend aus Schweizer und Deutschen Firmen, den Einfluss von ausländischen Umweltpolitikmassnahmen auf die Innovationsaktivitäten von inländischen Firmen. Wir finden, unter Konstanthaltung der jeweiligen inländischen Politikmassnahmen, einen signifikant positiven Einfluss von ausländischer Regulierung, ausländischer Selbstverpflichtung und ausländischen Subventionen. Wenn wir jedoch ausländische Nachfrage als Kontrollvariable hinzufügen, verschwinden die signifikanten Effekte der ausländischen Politikmassnahmen fast vollständig. Wir schliessen daraus, dass ausländische Umweltpolitik die inländische Innovationsaktivität primär von der Nachfrageseite her stimuliert. Wir finden zudem, dass ausländische Subventionen die Innovationsaktivitäten von Firmen im Inland, die in ausländischem Besitz sind, negativ beeinflussen. Im Allgemeinen schwächen die ausländischen Politikmassnahmen den Effekt von inländischen Politikmassnahmen stark ab. Dieses Resultat hebt die Wichtigkeit von internationaler Koordination von Politikmassnahmen zur Steigerung derer Effektivität hervor.

Résumé: Nous étudions dans cet article, l'impact des politiques environnementales sur les activités des entreprises nationales en termes d'innovation. Cet article se base sur un échantillon représentatif d'entreprises suisses et allemandes. Si l’on prend comme constante les décisions politiques nationales respectives, nous trouvons un effet positif significatif des réglementations étrangères, des accords volontaires étrangers et des subventions publiques étrangères. Cependant, lorsque nous introduisons la demande étrangère comme variable de contrôle, les effets significatifs des autres politiques étrangères disparaissent presque entièrement. Nous en déduisons que les politiques environnementales étrangères stimulent tout d’abord les activités d’innovation intérieures par la demande. Nous constatons en outre que les subventions étrangères affectent de manière négative les activités d’entreprises exerçant sur un territoire national, mais étant entre des mains étrangères. Dans l’ensemble nous pouvons dire que les mesures politiques étrangères atténuent considérablement les effets des initiatives politiques nationales. Ce résultat témoigne donc de l’importance d’une coordination internationale des mesures politiques visant à accroître l’efficacité respective de ces mesures.

1 Introduction

The link between policy measures and green innovation has been investigated intensively (for a review of the literature see Ambec et al. 2011 or Popp et al. 2010). Most of these studies focus on the analysis of domestic policy effects, that is, they analyze how domestic policy impacts domestic innovation, omitting the possible influence of foreign policy activities. However, in today's globalized world, advanced economics are strongly interrelated. Export of goods and services as a share of GDP in the OECD was measured at 29% in 2014, and in open economies like Germany and Switzerland at 46% and 64%, respectively (OECD 2016). Hence, business activities in these countries heavily depend on developments abroad, and innovation activities are likely to be affected by foreign policy, too. For example, the introduction of a new regulation on the energy efficiency of new household products in the EU has to be considered by a Swiss producer of household products, otherwise he cannot export his products to the EU, irrespective of regulations in Switzerland. The analysis of such policy spillovers, that is, the effect of foreign policy on domestic green innovation, has largely been neglected so far. Accordingly, most existing studies are likely to underestimate the total effect of policies on green energy-related innovation.

The paper at hand sheds light on this question by investigating the impact of foreign supply-side policies and foreign demand on domestic green innovation in both Germany and in its smaller neighbor country Switzerland. With "supply-side" policies we identify the effects of foreign regulation, foreign public subsidies, and foreign voluntary agreements. Moreover, we can consider the stringency of foreign demand, which is a proxy for current or expected green exports; or to express it differently, it represents the firm's exposure to foreign green markets, which allows us to capture potential "demand-side" policy effects. Policies support the development of new green knowledge and technologies and cause positive spillovers for innovation activities in other countries (Stucki and Woerter 2016). However, policies may also help to better adapt green technologies to consumer demand and thus expand markets, triggering demand also for foreign

firms. The distinction of the two foreign policy effects, the supply-side and the demand-side, is new to the literature in the field.

Existing empirical evidence is based on patent data in single technologies; it primarily focuses on foreign demand effects measured by installed capacity and foreign technology push factors covered by R&D subsidies or public R&D expenditures; the unit of analysis is the country level. Peters et al. (2012) investigate the photovoltaic industry and find that foreign R&D subsidies, in contrast to domestic R&D subsidies, do not show a significant effect on domestic environmental patenting. Foreign demand, by contrast, is significantly positively related to domestic environmental innovation. Similarly, Dechezleprêtre and Glachant (2014) find in their study of the wind power industry that foreign wind power capacities significantly positively affect domestic environmental patenting. Popp (2006) investigates whether the adoption of stringent SO_2 and NO_X standards changes patenting activities in the respective countries. At this aggregate level, patenting activities primarily react to the adoption of standards in the home country and much less so to the adoption of standards in foreign countries.

Hence, the paper at hand will improve our understanding of the relationship between foreign policy and domestic green innovation activities in several aspects. First, we can identify and compare the relevance of different domestic and foreign political measures by using information of firms' assessments about their importance for their activities; we simultaneously test the effect of foreign subsidies, foreign voluntary agreements, and foreign regulations. Second, firm-level information on the stringency of foreign demand in addition to foreign policies, allows us to capture indirect effects of foreign policies operating via foreign demand, and thus to properly identify the direct (supply-side) effects of foreign policy measures.

Using a representative sample of firms for both the German and the Swiss economy, results show that all foreign policy variables are positively related to domestic green innovation; regulation, voluntary agreements, and public subsidies all show significantly positive coefficients. However, when foreign demand is introduced to the equation, the other foreign policy variables lose their significance, indicating that foreign demand is the driver behind any positive innovation

effect of foreign policy. Compared to domestic policies, we find that the effect of foreign demand is almost half as large as the one of domestic demand, indicating substantial demand spillovers over national borders. As a further possible link between domestic and foreign, we find that when a firm is foreign owned, foreign policies such as foreign R&D subsidies lower domestic innovation, as firms reallocate their innovation activities into their home countries.

The paper is organized as follows. Section 2 provides the conceptual background and motivates the hypotheses. Section 3 presents the data and section 4 describes the empirical framework. Section 5 presents the empirical results and Section 6 discusses the results and policy implications. Section 7 presents the conclusion.

2 Conceptual background and hypotheses

The effect of foreign policy on green product innovation

Mainstream economics sees regulation as detrimental to economic efficiency. Regulation constrains firms in their choices and forces suboptimal economic outcomes. In the presence of negative external effects, however, regulation may become necessary and a trade-off between the environment and economic efficiency arises. Porter and van der Linde (1995) contributed to this discussion by arguing that constraints imposed by new regulations can serve as a stimulus triggering action on behalf of firms, in the sense that firms innovate their way out of an initially adverse situation. Porter and van der Linde (1995) thus see the proper use of regulation as a tool to steer the otherwise unfocused direction of technical progress.

While Porter and van der Linde (1995) focus on regulation, their hypothesis can be extended to other policy types as well (see Lanoie et al. 2011). Industry-wide voluntary agreements about environmental standards, for instance, could be a more efficient tool to affect innovation activities, since the targeted firms dispose over superior information and generally know it best themselves how to solve a given environmental problem. Of course, this argument requires that firms are willing to set themselves standards that existing technologies do not already meet. In this paper, we will be able to compare voluntary agreements with governmental regulation, which will allow

us to assess which type of policy is more fruitful in inducing environmental innovation. To contrast these two policies with the most popular supply-side measure, we can use information on public R&D subsidies. R&D subsidies are expected to solve the issue of positive external effects that come along with new knowledge. In order to encourage further innovations, new knowledge in green technologies should be available to everyone. However, the more difficult it is for a firm to keep new knowledge secret (lack of adequate property rights protection) or to appropriate R&D results, the lower the incentives for firms to pursue such research. Hence, the government could directly support innovation activities of firms and push technological progress in environmental technologies from the supply-side.

The empirical literature on the effectiveness of policy instruments to foster green innovation is mostly concerned with the impact of domestic regulation (see Ambec et al. 2011 for a review of this literature) and other domestic policy types (e.g., Lanoie et al. 2011, Ley at al. 2016, Veugelers 2012). These empirical papers usually find the expected positive links, although the strength of the links vary greatly. We add to this literature an investigation including the effects of policies for the innovation activities of firms in other countries; or to formulate it differently, we identify the effects of foreign policies on domestic green innovation activities. In the following, we will present three channels that relate foreign policy to domestic green innovation, namely knowledge spillovers, expected innovation gaps, and international trade.

First, given that foreign policy is successful in inducing foreign green innovation, the latter is likely to entail knowledge spillovers that affect domestic green innovation activities, too. Popp (2006) presents two channels via which foreign knowledge can translate into domestic innovation activities. First, domestic firms can directly purchase foreign inventions upon which they can conduct their own research. Such “blueprints” can provide valuable inputs for the domestic innovation process. Second, the knowledge about a successful green innovation in one country can markedly influence the direction of R&D performed in another country. The knowledge that a solution to a problem exists is often sufficient to trigger extensive further research in this direction,

targeted at both, replicating the result and extending upon it. It is the knowledge that success is possible itself which motivates people to come up with their own ideas.

Second, creating an innovation hub in a renewable technology is likely to provide the respective country with a decisive first mover advantage, as also renewables are likely to incur increasing dynamic returns to innovation. If the technological distance between countries/firms gets too large, catching up will hardly be possible (see, e.g., Stucki and Woerter 2016). Hence, in anticipation of the emergence of such innovation hubs in a given country, firms in other countries may intensify their innovation activities as well.

Third, foreign policy will also affect domestic green innovation through international trade. In highly interrelated economies, foreign regulation imposes the same constraints on domestic firms as on foreign firms. When domestic firms strive for foreign market access, they have to play by the same rules as foreign firms. Consequently, foreign regulation will provide the same stimuli to the innovation activities of both foreign and domestic firms. Foreign subsidies, on the other hand, are usually granted to foreign firms only and therefore put domestic innovators at a disadvantage. Thus, if domestic firms do not want to lose their market shares (abroad or at home), they will have to intensify their innovation activities, too.

In sum, the presence of knowledge spillovers, expected innovation gaps, and international trade lead us to formulate the following hypothesis for green product innovation, that is, the creation of new products or services for end-user:

Hypothesis 1: Foreign voluntary agreements, foreign regulations and foreign subsidies positively affect a firm's domestic green product innovation activities.

The effect of foreign demand

The literature about the impact of environmental policies on green innovation usually emphasizes the supply-side, that is, it discusses the incentives of firms to innovate regarding the negative external effects of pollution and the positive external effects of knowledge creation (Jaffe et al.

2002). However, in a market economy, firms need prospects of making profits, otherwise they will not be willing to innovate in the first place. Schmookler (1966), for instance, prominently argued that in a market economy firms start to promptly bring forward inventions when only the consumer demand and thus future profits are large enough. Firms align their innovation activities with their expectations of what kind of products consumers will want in the years to come. Schmookler (1966) sees modern research laboratories as so powerful that they can essentially model anything out of the knowledge they possess. Hence, technological progress is largely guided by the expectations firms have about future consumer wants. While the importance of domestic demand for green innovation activities has been shown in Horbach (2008), the relevance of foreign demand is not a priori clear. As for domestic demand, however, we expect a positive link.

Hypothesis 2: Foreign demand positively affects a firm's domestic green product innovation activities.

Identifying the direct policy effect on green product innovation

In reality, firms often have large problems in correctly anticipating future consumer wants. Today's preferences for products cannot be taken as granted and are likely to change over time. Actually, firms perceive consumer demands as one of the most important barriers to the introduction of new products (Kemp et al. 1998). Producing products for which there is no clearly articulated demand, as it is always the case with newly introduced products, is difficult. Of course, consumers often react very positively to innovations, and some firms know exactly how to exploit this. However, for the majority of firms, stable future demand conditions is an absolute necessity for them to increase their innovation activities. Governments thus use policies in order to stabilize firms' demand conditions and create niche markets, steering technological progress into a certain direction. In this respect, many government policies do not only address the supply-side but explicitly take the demand-side into account (see Girod et al. 2016). For example, regulations do not only directly stimulate innovation, but also affect consumer demand, as consumers have to

introduce certain energy-efficient technologies. Thus, new legislation and standards, whether enforced or voluntary, can create demand and thus increase incentives for firms to bring forward green innovations (Jaffe and Palmer 1997). Similarly, a subsidy on behalf of the government can include a guaranteed price for a new technology and strengthen innovation from the demand-side. Consequently, foreign policy, besides a direct effect on green innovation, can also have an indirect effect via policy-induced demand (see Figure 1). Thus, the direct (supply-side) policy effects on green innovation should be lower. In contrast to the studies of Peters et al. (2012) and Dechezleprêtre and Glachant (2014), we can directly measure demand conditions and thus clearly separate (supply-side) policy from any demand effects and then compare their relative efficiency in strengthening green innovation.

Hypothesis 3: Controlling for policy-induced demand reduces the effect of foreign voluntary agreements, foreign regulations, and foreign subsidies on domestic green product innovation.

Differences between foreign-owned and domestically-owned firms

Besides the impact NO_X and SO_2 standards have on innovation activities in every country, Popp (2006) also analyzes whether the effects of these standards cross borders. In general, he finds that NO_X and SO_2 control patents in each country primarily respond to regulations in domestic, but much less so to foreign regulatory pressures. The transfer of inventions from foreign to domestic seems to be only indirect, in the sense that domestic firms use foreign inventions as building blocks in their own research. However, only a reinforcement of domestic regulation can substantially increase domestic innovation activities. A potential explanation for this result is given by Peters et al. (2012), who argue that the closer policy-makers are to inventors and consumers, both regionally and culturally, the more suitable information they have at their disposal. Thus, because policy-makers know better how to bring policies into line with local firms, foreign firms should be more responsive to foreign policy than domestic firms. Even more important, foreign subsidies and regulation target foreign firms directly, whereas domestic firms are targeted only indirectly via, as

outlined, knowledge spillovers, expected innovation gaps, or the degree of market access. Foreign policy should therefore have a much larger effect on innovation activities of firms located in foreign countries. At the firm level, we would therefore expect that the effect of foreign policy on innovation significantly differs between foreign-owned and domestically-owned firms. On average, foreign-owned firms are expected to react stronger to foreign policy than domestically-owned firms, as they are more strongly connected to foreign via their mother companies.

Hypothesis 4: Foreign policy shows larger effects on the green innovation activities of foreign-owned firms than domestically-owned firms.

3 Description of the data

The firm-level data used to answer the outlined hypotheses was collected in the course of a survey on the "creation and adoption of energy related technologies" carried out in 2015. In order to test the robustness of the findings across countries, the survey was simultaneously conducted in Germany and Switzerland. The survey covers the whole manufacturing sector (excluding the food industry, textile and clothing industry, printing, pharmaceuticals, and 'other manufacturing') and firms belonging to the two service industries 'information technology services' and 'technical services'.[1]

Our final estimation sample includes 1,837 observations. The sample is quite equally distributed between the two countries; 52% of the firms are German, 48% Swiss. On average, the firms in our sample have 272 employees (median: 40 employees), whereupon 88% are SMEs with less than 250 employees. 71% of the firms belong to the manufacturing sector, 21% to the service sector and only 8% to the construction sector.

[1] In order to reduce confusion, all other industries received only questions referring to the adoption of green technologies (i.e., process innovation), because they are very unlikely to have generated green energy technologies for end-users (i.e., product innovation).

Besides questions on some basic firm characteristics (sales, exports, employment, investment and employees' education), the survey included questions on energy related adoption and product innovation activities. Descriptive statistics for all model variables based on the estimation sample are presented in Table A.1 in the appendix; the correlation matrix is shown in Table A.2.

The information on green energy innovation activities is based on questions that directly ask about the creation of different green energy technologies for end-user comprising *energy-saving* technology applications in (1) production, (2) information and communication technologies, (3) transport, (4) building and heating, and green *energy-generating* technologies from renewable sources. 13% of the firms in our sample created green energy technologies for end-users, that is, they had green energy product innovation, and the green technologies add up to 11% of the green innovators' total sales, on average.

To compare the effect of different foreign policy types on firm level is hardly possible based on publicly available data. Such a comparison requires survey data for three reasons. First, the relevance of foreign policy is firm specific, as the relative importance of foreign markets differs among firms. Second, to get a complete picture, all relevant policies would need to be identified, which is hardly possible as they can be firm/sector- and technology- specific. Third, besides the identification of relevant policies, also the stringency of every policies, that is, how strong a firm is affected, has to be identified, which is a difficult task (Levinson 2008, Shadbegian and Wolverton 2010, Xing and Kolstad 2002). The difficulty arises from the fact that each policy typically covers different firms, exists at multiple levels (e.g., federal and local), and varies in monitoring and enforcement (Millimet and Roy 2015).

To overcome these problems, the survey included a specific set of questions that directly asked every firm on the relevance of different foreign and domestic policy types (for a related procedure for domestic policy only, see, e.g. Johnstone et al. 2012, Lanoie et al. 2011, Stucki and Woerter 2016, Veugelers 2012). The relevance of the different policy types has been assessed by the firms on a three-point Likert scale.

4 Empirical framework

Because a large number of firms did not have green product innovations, we focus in our baseline specification on the firms' green innovation propensity (other dependent variables are tested in the robustness section). To deal with the binary characteristics of this variable, we used a probit model.

A general concern in the empirical economic literature is endogeneity. Policies are usually designed by the respective governments and they are beyond the influence of a single company. Hence, they are exogenous. However, since our policy measures are based on self-assessments, the estimated policy effects may share systematic factors with the firms' green innovation activity (see Bertrand and Mullainathan 2001). We address this problem in three ways.

First, we significantly reduce this potential problem by including, next to the policy variables, a broad set of observables affecting the firms' innovation activities in our estimations. In doing this we are following the Schumpeterian tradition and include appropriability of research results, firm size, competition, demand, sector affiliation, and the technological potential (see Cohen 2010 for a review of the literature). Moreover, in order to identify the policy effects independent of firm characteristics that bias the assessment of policies, we have to control for the firms' green innovation affinity, too. One could for example argue that energy related policies primarily affect energy intensive firms, which in turn are often operating in industries that typically have few opportunities to create green products for end-user, themselves. To capture such indirect effects, we add specific controls for the firms' green process innovation activities, as well as a measure for whether the firms' products are suited for green product innovation or not (in addition, we also control in detail for the firms' industry affiliations).

Second, most existing studies using self-reported policy measures use policy information coming from questions that link the importance of different policies directly to their green innovation activities (e.g., studies based on Community Innovation Survey). However, such a direct link between the policy exposure and the firms' innovation behaviour may introduce a "common-response" bias. We overcome this problem, by asking the policy questions in a separate

section in the beginning of the survey with no link to the section referring to the firms' green energy innovation activities.

Third, we simultaneously control for the relevance of the different policy types at home and abroad. As all policy variables should be similarly affected by a potential assessment bias, the simultaneous inclusion of domestic and foreign policy measures captures a potential assessment bias of the policy variables making it unlikely that the effect of our foreign policy measures is correlated with unobservables.[2]

Given the mentioned reasons, we expect that the policy variables affect the firms' green product innovation directly and endogeneity is not a main concern.

5 Estimation results

In Table 2 we test the effect of every foreign policy instrument on the firms' domestic green innovation propensity. As predicted in Hypothesis 1, we find significant positive effects for all three foreign policy instruments; foreign regulations, voluntary agreements and public subsidies all show significant positive effects. Moreover, capturing the effect of the respective policy instruments at home does only marginally affect the magnitude of the coefficients (see columns 2, 4 and 6 of Table 2); only the magnitude of the effect of public subsidies decreases significantly after controlling for domestic policies, however, the effect is still statistically significant at the 15% test level.

To identify the relative importance of domestic and foreign policy, we apply Wald tests that compare the size of the different coefficients pair-wise. No significant differences can be identified for the effect of voluntary agreements (p-value for test on equality of coefficients: 0.476) and public subsidies (p-value: 0.368). The effect of foreign regulation, by contrast, is significantly

[2] Alternatively, we could have pursued an instrumental variable approach. Lacking valid instruments for all policy categories (9 variables) made such an approach not feasible. We would have needed at least 10 exogenous instruments in order to test endogeneity, which are simply not available. Hence, we are left with the applied approach as the best available choice.

larger than the effect of domestic regulations (p-value: 0.023), which hints at more stringent foreign regulations.

In Table 3, we introduce the foreign demand variable to the model. In line with hypothesis 2, the effect of foreign demand is significantly positive (see columns 1 and 2 of Table 3). Based on their capacity measure, Peters et al. (2012) find that foreign capacity shows a much larger marginal effect on domestic innovation than domestic capacity. Dechezleprêtre and Glachant (2014) present a related finding. However, they argue that this finding results from the fact that foreign capacity is much larger than domestic capacity. When focusing at sample means, they find that domestic capacity shows a larger effects than foreign capacity. We similarly find that the effect of domestic demand is larger than the effect of foreign demand; the differences, is, however, not statistically significant (p-value for test on equality of coefficients: 0.249).

In order to identify the direct (supply-side) effect of policy on green innovation, we add the variable foreign demand to every equation (see columns 3 to 5 of Table 3). When controlling for foreign demand, the effects of the three foreign policies vanish. Hence, in line with hypothesis 3, controlling for policy-induced demand reduces the effect of foreign voluntary agreements, foreign regulations, and foreign subsidies on domestic green product innovation. This result indicates that foreign policy affects domestic innovation primarily from the demand side. Consequently, the effectiveness of the three impact-channels of foreign policy presented in Section 2 seems to be rather moderate.[3]

We also run several robustness checks. In columns (6) and (7) of Table 3, we present regressions that simultaneously include all domestic and foreign policy variables. As before, we cannot observe a significant effect of any of the foreign policy types on domestic green innovation. Moreover, we find a significant difference between foreign and domestic policy for regulations

[3] The negative effect of domestic regulations and taxes on green product innovation is mainly driven by a reduction in financial resources that can be used for product innovation, in the case of regulations due to high compliance costs or in the case of taxes more indirectly via induced process innovation (see Stucki et al., 2016).

only (p-value for test on equality of coefficients: 0.087), but not for voluntary agreements (p-value: 0.423), public subsidies (p-value: 0.328), and demand (p-value: 0.374).

In Table A.3 in the appendix, we present estimation results for two alternative dependent variables. In column (1) the firms' share of green energy technologies in total sales is used as a measure for green production; in order to deal with the presence of many firms that did not have green product innovation at all–which results in a pile-up of zeros–we estimate a Tobit regression model (Wooldridge 2002). In column (2) we analyze the effect on green R&D propensity. Both models largely confirm our previous findings. While the explanatory power of these two models is somewhat smaller, we still observe only small direct (supply-side) effects of foreign policies, and the positive effect of foreign demand is confirmed. Compared with our main model, foreign regulations show a stronger effect in these regressions too. While the green innovation propensity does not measure the quality of innovations, the most innovative firms are expected to have the largest shares of green innovations and green R&D activities, respectively. Hence, the two measures reflect the firms' green innovation potential. The firms' innovation potential is of special relevance in order to adapt to new regulations. Regulations introduce high complexity into business operations with high compliance costs (Berry and Rondinelli 1998, Buysse and Verbeke 2003). A firm's green innovation potential is expected to facilitate the adaptation of products to new regulations or the detection of completely new innovation opportunities (see Stucki 2016). Hence, it is not surprising that foreign regulations show a larger effect on the firms' green innovation share and R&D propensity than green innovation propensity. The prediction that the firms' innovation potential moderates the effect of foreign regulations on domestic innovation is also confirmed in the regressions that split up green innovations by the degree of the firms' innovativeness (see columns 3 and 4 of Table A.3). While foreign regulations do not seem to affect innovations that are only new to the firm, a much larger effect is observed on innovations that are new to the market.

Finally, we test in Table A.4 whether the effect of foreign policies differs for the two countries included in our regressions. In columns (1) and (2) we present separate regressions for Swiss firms and German firms, respectively. In column (3) we directly test the significance of the

differences between the respective policy effects in two countries by the use of interaction terms. While Switzerland and Germany are both open economies, they are subject to many different characteristics. Switzerland has only about 8 million inhabitants, while Germany has about 82 million inhabitants. Moreover, Germany is part of the EU, Switzerland is not. Nevertheless, our previous findings for foreign policy seem to be rather robust. Again, no effect can be identified for the three foreign policy types. Moreover, the size of the foreign policy effects is not significantly different between the two countries. The only difference arises for foreign demand, which shows a significant effect on Swiss innovation activities only; however, the effect is not (statistically) significantly different from its effect in Germany. A possible explanation for this finding is that due to their smaller home market, Swiss firms are much more dependent on foreign markets.

Differences between foreign-owned and domestically-owned firms

In order to test hypothesis 4 that refers to differences in the effects of foreign policies between domestically-owned and foreign-owned firms, columns (1) and (2) of Table 4 presents separate estimates for the two types of firms. Due to the relatively low number of foreign-owned firms in our sample, the explanatory power of the model is relatively small. Nevertheless, the size of the effects indicates clear differences between the two categories of firms. As predicted in hypothesis 4, foreign regulations and foreign voluntary agreements show much larger effects on domestic innovation activities of foreign-owned firms than domestically-owned firms. However, we do not observe such a difference for foreign public subsidies. In line with our prediction that local policy primarily affects local firms, we find that the effect of foreign public subsidies on the green innovation activities of domestically-owned firms is smaller than the effect of domestic public subsidies. However, contrary to our expectations, the effect of foreign subsidies is significantly smaller (see column 3) for foreign-owned firms than for domestically-owned firms. Hence, public subsidies seem to affect the location of the innovation activities of multinational corporations, which is likely due to the fact that public subsides often cannot be transferred across countries (Dechezleprêtre and Glachant 2014). Because public subsidies primarily affect local innovation

activities, an increase in foreign subsidies negatively affects the attractiveness of domestic innovation activities, and may thus even decrease domestic innovation activities. Such a negative correlation is observed in our data, that is, we observe that an increase in the importance of foreign subsidies significantly decreases domestic innovation activities of foreign-owned firms.

6 Discussion and policy implications

Evidence-based policymaking is of utmost importance in usually emotional loaded policy discussions about climate change and policy effectiveness. Available studies have already provided important empirical facts about the relationship between foreign demand/policies and domestic innovation activities. Lanjouw and Mody (1996) found that environmental innovations in one country (e.g. Germany, Japan) respond to regulations in other countries (e.g. vehicle emission regulation in the USA). Popp (2006) provided empirical evidence that environmental innovators respond only to domestic pollution control policies. Peters et al. (2012), in contrast, found that domestic and continental capacities (proxy for demand) are positively related to domestic inventions in photovoltaic modules and similarly, Dechezleprêtre and Glachant (2014), demonstrated that wind technology inventions responded positively to both, domestic and foreign demand, whereas domestic demand is more effective. All available studies are based on patent data at the country level. Although the study at hand is based on firm-level survey data considering different types of policy measures and a broader spectrum of technologies, we can roughly confirm the results of the available studies; the stringency of foreign and domestic demand is positively related to domestic innovation activities in the field of green energy technologies.

Moreover, we see that foreign policies (foreign regulation, foreign voluntary agreements) effect domestic innovation activities only indirectly, via triggering foreign demand; the effects of single policy types vanish once we introduce the foreign demand effect. This implies–on the one hand–that international market frictions, like trade barriers (e.g. customs), might seriously dampen such effects (Dechezleprêtre and Glachant 2014); low trade barriers with environmentally friendly countries, in contrast, might promote domestic innovation activities. On the other hand, it indicates

that technological-push measures are more effective if policy makers' intent to give the domestic industry a head-start over international competitors, since it is difficult to respond to demand if it requires bridging a substantial technological gap (Stucki and Woerter 2016).

The results also reveal that foreign demand policies are not a potential substitute for domestic policies. Although foreign demand influences domestic innovation activities, the effect of domestic demand is significantly stronger. Hence, national policy makers cannot solely rely on international demand related policy measures to increase domestic innovation activities. Although coordination and alignment with trade policy is desirable, given the current framework conditions, one-sided measures are beneficial, too.[4]

The innovation activities of foreign-owned companies tend to be negatively influenced by foreign subsidies. This result suggests that subsidies for the development of energy-related technologies attract foreign R&D and can weaken the effect of national policy initiatives targeted to augment domestic green innovation activities.[5] Hence, countries might enter into a so-called "policy-race" to attract the most innovative firms, which is not beneficial, since it might trigger public subsidies without causing behavioral additionalities: a firm might have developed a technology in a country with lower subsidies, but moves its innovation activities to a country with greater subsidies to pursue the same R&D projects.

Overall, we see some first indications that foreign policies influence the effectiveness of domestic policy initiatives. This clearly calls for a greater international coordination, not only in terms of environmental goals but also in terms of policies to promote the development of new green technologies.

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[4] Such a policy regime must not be very costly for the national government. Demand related measures might also refer to information campaigns, labels, or educational activities, which improves the individual responsibility for the environment and might increase the willingness to pay for green innovations.

[5] There is a comprehensive literature on plant location decision and environmental regulation. Basically, it was found that environmental regulation has an significant influence of location shifts of plants in polluting industries (Millimet and Roy 2016, Brunnermeier and Levinson 2004). With the study at hand, we find some first indications that this might also be the case for the location decisions of green energy related innovation activities. However, further and more comprehensive empirical evidence is necessary to strengthen these results. For instance, Edler (2007), found that R&D location decisions are most often part of broader business strategy considerations that are affected by very general political framework conditions, FDI policies (trade, taxes, general subsidies) and international regulation (IPR, standards).

7 Conclusions

The effect of foreign policies on domestic innovation activities has hardly been investigated empirically, although many countries make considerable efforts to promote the development of green energy-related technologies; the effects of foreign policy activities are likely to have an impact on the effectiveness of these domestic policy initiatives. And, indeed, based on a representative sample of Swiss and German firms we find a significant positive effect for foreign regulations, foreign voluntary agreements, and foreign public subsidies controlling for the respective domestic policy stringency. However, when we consider the foreign demand the significant effects of other foreign policies vanish. Hence, foreign policy impacts domestic innovation primarily from the demand side.

These results have several policy-related implications. First, technology-push measures are likely to be more effective to increase the international technology competitiveness of domestic firms, since demand augmenting domestic policy measures significantly benefit foreign innovation activities; depending on market frictions (e.g. customs) other countries can “free-ride” on domestic measures. Second, the effect of domestic demand is significantly greater than the one of foreign demand. Hence, national measures to increase demand for green energy technologies are desirable. Third, foreign subsidies encourage firms to shift their innovation activities and attenuates the effectiveness of domestic policies. Especially the last point reveals some important policy implication. We see that domestic policy efforts might be weakened by foreign efforts. Hence, a greater international coordination of policy efforts–similar to emission goals–can augment policy efficiency, which is required to increase the incentives for successfully mastering the technological challenges on our way to a more sustainable economy.

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Figure 1: Impact of foreign demand

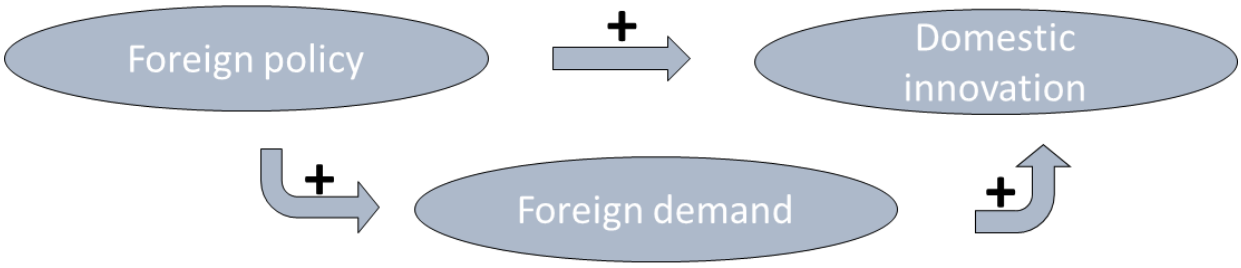

Table 1: Variable definition and measurement

Variable	Definition/measurement
Dependent variables	
Green innovation propensity	Firm developed new green energy products or services for end-users yes/no
Green innovation share	Share of new green energy products or services in total sales, ln
Green R&D propensity	Firm has domestic R&D activities in the field of green energy technologies yes/no
New to the firm propensity; New to the market propensity	Firm developed new green energy products or services that were new to the firm or market, respectively, yes/no (reference category: no green energy products were developed)
Independent variables	
Domestic regulations; Foreign regulations	Firm-specific relevance of energy related regulations and standards (three-level ordinary variable; level 1: 'not relevant'; level 3: 'high relevance')
Domestic voluntary agreements; Foreign voluntary agreements	Firm-specific relevance of industry-specific energy related voluntary agreements or standards (three-level ordinary variable; level 1: 'not relevant'; level 3: 'high relevance')
Domestic public subsidies; Foreign public subsidies	Firm-specific relevance of energy related public subsidies (three-level ordinary variable; level 1: 'not relevant'; level 3: 'high relevance')
Domestic demand; Foreign demand	Firm-specific relevance of demand for energy efficient products and services (three-level ordinary variable; level 1: 'not relevant'; level 3: 'high relevance')
Domestic taxes	Firm-specific relevance of energy related taxes (three-level ordinary variable; level 1: 'not relevant'; level 3: 'high relevance')
Export intensity	Share of exports in total sales, ln
Share of high qualified employees	Share of employees with a tertiary-level degree, ln
Foreign owned	Firm is owned by a foreign company yes/no
Firm age	Firm age in years, ln
Competition intensity	Firm has more than five competitors on their domestic and foreign prime market yes/no
R&D propensity	Firm has domestic R&D activities yes/no
Green process innovation intensity	Share of investments for green energy products or services (for the use within the firm) in total investments, ln
Products not suited	Green energy innovation is hampered by the fact that existing products/services are not well suited for this type of innovation (four-level ordinary variable; level 1: 'low relevance'; level 4: 'high relevance')
Number of employees	Number of employees measured in full-time equivalents; ln
Swiss firm	Country of the firm's origin (reference country: Germany)
Industry controls	Controls for industry affiliation on NACE two-digit codes

Table 2: Identification of foreign policy effects (Probit regressions)

	(1)	(2)	(3)	(4)	(5)	(6)
			Green innovation propensity			
Foreign regulations	0.217**	0.266***				
	(0.090)	(0.102)				
Domestic regulations		-0.072				
		(0.070)				
Foreign voluntary agreements			0.199**	0.164+		
			(0.095)	(0.110)		
Domestic voluntary agreements				0.049		
				(0.077)		
Foreign public subsidies					0.334***	0.147+
					(0.083)	(0.094)
Domestic public subsidies						0.270***
						(0.065)
Export intensity	-0.028	-0.029	-0.027	-0.026	-0.024	-0.018
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
Share of high qualified employees	0.087**	0.084**	0.089**	0.092**	0.087**	0.091**
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.043)
Foreign owned	-0.108	-0.109	-0.108	-0.108	-0.097	-0.063
	(0.133)	(0.133)	(0.133)	(0.133)	(0.134)	(0.135)
Firm age	0.004	0.001	0.001	0.002	0.006	0.020
	(0.054)	(0.054)	(0.054)	(0.054)	(0.055)	(0.056)
Competition intensity	0.210**	0.211**	0.212**	0.211**	0.205**	0.209**
	(0.097)	(0.097)	(0.097)	(0.097)	(0.097)	(0.098)
R&D propensity	0.479***	0.479***	0.485***	0.484***	0.474***	0.487***
	(0.101)	(0.101)	(0.101)	(0.101)	(0.101)	(0.102)
Green process innovation intensity	0.060***	0.062***	0.060***	0.059***	0.057***	0.048***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.014)
Products not suited	-0.097***	-0.097***	-0.097***	-0.098***	-0.088**	-0.090**
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Number of employees	0.118***	0.122***	0.117***	0.115***	0.119***	0.109***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Swiss firm	-0.117	-0.113	-0.104	-0.103	-0.117	-0.087
	(0.098)	(0.098)	(0.097)	(0.097)	(0.098)	(0.100)
Constant	-6.830***	-6.761***	-6.811***	-6.844***	-6.944***	-7.069***
	(0.288)	(0.288)	(0.289)	(0.289)	(0.283)	(0.293)
Industry controls	yes	yes	yes	yes	yes	yes
N	1837	1837	1837	1837	1837	1837
pseudo R2	0.15	0.15	0.14	0.14	0.15	0.16
Wald chi2	1936.34***	2297.64***	1815.38***	1698.48***	1994.04***	1210.71***
Log Likelihood	-619.99	-619.48	-620.75	-620.54	-615.23	-606.96

Notes: see Table 1 for the variable definitions; robust standard errors are in brackets under the coefficients; ***, **, *, + denote statistical significance at the 1%, 5%, 10% and 15% test level, respectively.

Table 3: Capturing potential foreign demand effects (Probit regressions)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Green innovation propensity				
Foreign regulations			-0.048			0.172	0.170
			(0.105)			(0.144)	(0.145)
Foreign voluntary agreements				-0.127		-0.148	-0.166
				(0.114)		(0.156)	(0.157)
Foreign public subsidies					-0.040	-0.027	-0.017
					(0.112)	(0.138)	(0.139)
Foreign demand	0.602***	0.253***	0.617***	0.642***	0.621***	0.254**	0.260**
	(0.073)	(0.095)	(0.081)	(0.082)	(0.092)	(0.114)	(0.114)
Domestic regulations						-0.221***	-0.168*
						(0.085)	(0.089)
Domestic voluntary agreements						-0.006	0.008
						(0.094)	(0.095)
Domestic public subsidies						0.148*	0.160**
						(0.077)	(0.077)
Domestic demand		0.430***				0.424***	0.416***
		(0.075)				(0.084)	(0.084)
Domestic taxes							-0.143**
							(0.070)
Export intensity	-0.027	-0.006	-0.026	-0.025	-0.027	-0.002	0.000
	(0.032)	(0.033)	(0.032)	(0.032)	(0.032)	(0.034)	(0.034)
Share of high qualified employees	0.095**	0.095**	0.095**	0.094**	0.095**	0.084**	0.075*
	(0.042)	(0.043)	(0.042)	(0.042)	(0.042)	(0.043)	(0.043)
Foreign owned	-0.124	-0.104	-0.124	-0.124	-0.126	-0.088	-0.083
	(0.137)	(0.138)	(0.137)	(0.137)	(0.137)	(0.139)	(0.140)
Firm age	-0.003	0.011	-0.004	-0.003	-0.004	0.010	0.015
	(0.055)	(0.056)	(0.055)	(0.055)	(0.055)	(0.057)	(0.057)
Competition intensity	0.152+	0.157+	0.151+	0.147+	0.151+	0.157+	0.164+
	(0.099)	(0.100)	(0.099)	(0.099)	(0.099)	(0.101)	(0.100)
R&D propensity	0.481***	0.500***	0.483***	0.482***	0.482***	0.511***	0.508***
	(0.104)	(0.105)	(0.104)	(0.104)	(0.104)	(0.106)	(0.106)
Green process innovation intensity	0.055***	0.048***	0.055***	0.056***	0.055***	0.048***	0.050***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Products not suited	-0.081**	-0.079**	-0.081**	-0.080**	-0.081**	-0.078**	-0.076**
	(0.037)	(0.039)	(0.037)	(0.037)	(0.037)	(0.039)	(0.039)
Number of employees	0.099***	0.085***	0.098***	0.098***	0.098***	0.094***	0.099***
	(0.032)	(0.033)	(0.032)	(0.032)	(0.032)	(0.033)	(0.033)
Swiss firm	-0.073	-0.068	-0.068	-0.067	-0.070	-0.041	-0.085
	(0.100)	(0.100)	(0.100)	(0.100)	(0.100)	(0.102)	(0.104)
Constant	-7.015***	-7.274***	-7.079***	-6.959***	-6.985***	-7.162***	-7.015***
	(0.272)	(0.284)	(0.289)	(0.284)	(0.281)	(0.304)	(0.312)
Industry controls	yes	yes	yes	yes	yes	yes	yes
N	1837	1837	1837	1837	1837	1837	1837
pseudo R2	0.19	0.21	0.19	0.19	0.19	0.21	0.22
Wald chi2	2285.28***	2373.61***	2207.93***	2215.39***	2261.36***	2440.26***	2634.78***
Log Likelihood	-590.75	-575.18	-590.63	-590.06	-590.68	-569.59	-567.54

Notes: see Table 1 for the variable definitions; robust standard errors are in brackets under the coefficients; ***, **, *, + denote statistical significance at the 1%, 5%, 10% and 15% test level, respectively.

Table 4: Test the moderating effect of foreign ownership (Probit regressions)

	(1)	(2)	(3)
	Green innovation propensity		
	Domestically-owned	Foreign-owned	All firms: interactions with foreign ownership dummy
Foreign regulations	0.159	0.727+	0.568
	(0.154)	(0.458)	(0.482)
Foreign voluntary agreements	-0.183	0.557	0.739
	(0.170)	(0.556)	(0.580)
Foreign public subsidies	0.088	-1.612**	-1.700***
	(0.143)	(0.642)	(0.656)
Foreign demand	0.249**	0.355	0.105
	(0.123)	(0.377)	(0.396)
Domestic taxes	-0.162**	-0.055	0.107
	(0.075)	(0.232)	(0.243)
Domestic regulations	-0.186*	-0.335	-0.148
	(0.098)	(0.298)	(0.313)
Domestic voluntary agreements	0.025	-0.570*	-0.595*
	(0.102)	(0.317)	(0.332)
Domestic public subsidies	0.136*	0.261	0.125
	(0.082)	(0.297)	(0.308)
Domestic demand	0.452***	0.590*	0.138
	(0.088)	(0.352)	(0.362)
Export intensity	-0.014	0.063	0.077
	(0.035)	(0.128)	(0.132)
Share of high qualified employees	0.102**	-0.223	-0.325*
	(0.042)	(0.174)	(0.179)
Firm age	0.017	-0.200	-0.217
	(0.062)	(0.191)	(0.201)
Competition intensity	0.095	0.968***	0.872***
	(0.104)	(0.309)	(0.325)
R&D propensity	0.537***	0.242	-0.295
	(0.113)	(0.342)	(0.359)
Green process innovation intensity	0.042***	0.101**	0.059
	(0.015)	(0.052)	(0.054)
Products not suited	-0.046	-0.433***	-0.387***
	(0.040)	(0.140)	(0.146)
Number of employees	0.115***	0.120	0.005
	(0.034)	(0.131)	(0.135)
Swiss firm	-0.093	-0.384	-0.291
	(0.109)	(0.366)	(0.381)
Constant	-2.983***	-5.944***	-2.983***
	(0.315)	(1.388)	(0.315)
Main effects			yes
Industry controls	yes	yes	yes
N	1632	205	1837
pseudo R2	0.21	0.42	0.24
Wald chi2	262.62***	652.86***	1030.50***
Log Likelihood	-506.18	-48.26	-554.44

Notes: see Table 1 for the variable definitions; robust standard errors are in brackets under the coefficients; ***, **, *, + denote statistical significance at the 1%, 5%, 10% and 15% test level, respectively.

Table A.1: Descriptive statistics; based on basic model (column (7) of Table 3; N=1837)

	Mean	Std. Dev.	Min	Max
Green innovation propensity	0,13	0,34	0	1
Domestic regulations	1,48	0,68	1	3
Foreign regulations	1,13	0,40	1	3
Domestic voluntary agreements	1,38	0,62	1	3
Foreign voluntary agreements	1,12	0,37	1	3
Domestic public subsidies	1,43	0,67	1	3
Foreign public subsidies	1,12	0,40	1	3
Domestic demand	1,35	0,62	1	3
Foreign demand	1,16	0,45	1	3
Domestic taxes	1,70	0,73	1	3
Export intensity	25,33	32,54	0	100
Share of high qualified employees	22,27	26,75	0	100
Foreign owned	0,11	0,31	0	1
Firm age	45,80	38,19	1	260
Competition intensity	0,70	0,46	0	1
R&D propensity	0,48	0,50	0	1
Green process innovation intensity	552,70	1905,85	0	41666,67
Products not suited	1,77	1,12	1	4
Number of employees	271,80	3191,41	1	112305
Swiss firm	0,48	0,50	0	1

Notes: see Table 1 for the variable definitions.

Table A.2: Correlation matrix; based on basic model (column (7) of Table 3; N=1837)

	Green innovation propensity	Domestic regulations	Foreign regulations	Domestic voluntary agreements	Foreign voluntary agreements	Domestic public subsidies
Domestic regulations	0,03					
Foreign regulations	0,08	0,43				
Domestic voluntary agreements	0,07	0,56	0,29			
Foreign voluntary agreements	0,08	0,29	0,63	0,48		
Domestic public subsidies	0,17	0,40	0,26	0,44	0,24	
Foreign public subsidies	0,15	0,27	0,56	0,27	0,56	0,46
Domestic demand	0,30	0,23	0,19	0,29	0,22	0,47
Foreign demand	0,30	0,19	0,37	0,22	0,39	0,34
Domestic taxes	0,00	0,50	0,21	0,37	0,17	0,30
Export intensity	0,09	0,10	0,13	0,08	0,14	0,02
Share of high qualified employees	0,10	-0,14	0,01	-0,11	-0,01	-0,04
Foreign owned	0,01	0,09	0,07	0,07	0,07	-0,02
Firm age	0,01	0,11	0,03	0,08	0,03	0,01
Competition intensity	0,00	0,05	0,00	0,02	-0,01	0,01
R&D propensity	0,19	0,05	0,09	0,06	0,08	0,05
Green process innovation intensity	0,16	0,22	0,11	0,24	0,12	0,25
Products not suited	-0,06	0,03	0,01	0,05	-0,01	-0,02
Number of employees	0,16	0,20	0,08	0,19	0,10	0,13
Swiss firm	-0,05	0,10	0,05	0,03	0,01	-0,06

	Foreign public subsidies	Domestic demand	Foreign demand	Domestic taxes	Export intensity	Share of high qualified employees
Domestic demand	0,31					
Foreign demand	0,54	0,62				
Domestic taxes	0,17	0,11	0,11			
Export intensity	0,06	-0,06	0,11	0,13		
Share of high qualified employees	0,04	0,03	0,05	-0,15	0,11	
Foreign owned	0,02	-0,01	0,05	0,04	0,28	0,03
Firm age	0,00	0,01	0,02	0,06	0,09	-0,25
Competition intensity	0,02	0,03	0,01	0,00	-0,22	-0,14
R&D propensity	0,08	0,02	0,11	0,03	0,41	0,28
Green process innovation intensity	0,11	0,14	0,12	0,23	0,18	-0,01
Products not suited	-0,06	-0,05	-0,07	0,02	0,04	-0,04
Number of employees	0,05	0,10	0,14	0,18	0,36	-0,05
Swiss firm	0,00	-0,02	-0,04	-0,10	0,01	-0,33

	Foreign owned	Firm age	Competition intensity	R&D propensity	Green process innovation intensity	Products not suited	Number of employees
Firm age	0,07						
Competition intensity	-0,14	0,06					
R&D propensity	0,10	-0,04	-0,20				
Green process innovation intensity	0,08	0,11	-0,04	0,19			
Products not suited	-0,01	0,00	0,01	0,06	0,01		
Number of employees	0,24	0,33	-0,07	0,25	0,28	0,01	
Swiss firm	0,15	0,43	0,13	-0,12	-0,05	0,06	0,18

Table A.3: Test alternative dependent variables and estimation procedures

	(1)	(2)	(3)	(4)
	Green innovation share	Green R&D propensity	New to the firm	New to the market
Procedure	Tobit	Probit	Multinomial logit	
Foreign regulations	0.606	0.263+	0.075	0.536+
	(0.465)	(0.175)	(0.356)	(0.338)
Foreign voluntary agreements	-0.240	-0.182	-0.321	-0.480
	(0.510)	(0.186)	(0.358)	(0.402)
Foreign public subsidies	-0.249	0.037	0.042	-0.147
	(0.464)	(0.155)	(0.298)	(0.334)
Foreign demand	0.617+	0.195+	0.406*	0.537**
	(0.379)	(0.129)	(0.247)	(0.273)
Domestic regulations	-0.473+	-0.150	-0.562***	0.057
	(0.319)	(0.120)	(0.208)	(0.246)
Domestic voluntary agreements	0.046	-0.056	0.261	-0.249
	(0.314)	(0.114)	(0.201)	(0.245)
Domestic public subsidies	0.655**	0.092	0.312*	0.172
	(0.281)	(0.098)	(0.173)	(0.208)
Domestic demand	1.415***	0.384***	0.618***	0.960***
	(0.290)	(0.108)	(0.179)	(0.224)
Domestic taxes	-0.753***	-0.170**	-0.286*	-0.305+
	(0.258)	(0.085)	(0.156)	(0.200)
Export intensity	0.124	0.012	-0.077	0.072
	(0.128)	(0.045)	(0.072)	(0.095)
Share of high qualified employees	0.388**	0.127**	0.157+	0.233+
	(0.161)	(0.060)	(0.100)	(0.143)
Foreign owned	-0.322	-0.253+	-0.184	-0.090
	(0.502)	(0.171)	(0.322)	(0.369)
Firm age	0.013	-0.029	0.029	-0.007
	(0.213)	(0.075)	(0.129)	(0.168)
Competition intensity	0.613*	0.071	0.226	0.221
	(0.369)	(0.123)	(0.218)	(0.267)
R&D propensity	1.735***	0.921***	0.641***	1.530***
	(0.403)	(0.155)	(0.232)	(0.341)
Green process innovation intensity	0.184***	0.055***	0.046+	0.132***
	(0.052)	(0.017)	(0.032)	(0.041)
Products not suited	-0.456***	-0.221***	-0.051	-0.312**
	(0.155)	(0.055)	(0.088)	(0.132)
Number of employees	0.096	0.114***	0.181**	0.162*
	(0.118)	(0.040)	(0.070)	(0.086)
Swiss firm	1.184***	-0.006	-0.242	0.023
	(0.372)	(0.127)	(0.235)	(0.303)
Constant	-25.561***	-7.195***	-19.827	-21.547
	(1.473)	(0.411)	(1355.114)	(1389.626)
Industry controls	yes	yes	yes	yes
N	1837	1769	1819	
pseudo R2		0.29	0.21	
Wald chi2	1019.09***	1748.19***	366.17***	
Log Likelihood	-768.74	-334.67	-703.05	
Violation of IIA assumption			No	

Notes: see Table 1 for the variable definitions; robust standard errors are in brackets under the coefficients; ***, **, *, + denote statistical significance at the 1%, 5%, 10% and 15% test level, respectively; In order to allow convergence, tests of independence of irrelevance alternatives (IIA) include sector controls only.

Table A.4: Identify country differences (Probit regressions)

	(1)	(2)	(3)
		Green innovation propensity	
	Swiss firms	German firms	All firms: interactions with Swiss firm dummy
Foreign regulations	0.089	0.290	-0.201
	(0.224)	(0.204)	(0.303)
Foreign voluntary agreements	-0.005	-0.278	0.272
	(0.240)	(0.222)	(0.327)
Foreign public subsidies	-0.235	0.101	-0.335
	(0.215)	(0.188)	(0.286)
Foreign demand	0.324*	0.171	0.153
	(0.177)	(0.162)	(0.240)
Domestic taxes	-0.038	-0.196**	0.158
	(0.122)	(0.088)	(0.151)
Domestic regulations	-0.128	-0.267**	0.138
	(0.131)	(0.131)	(0.185)
Domestic voluntary agreements	-0.100	0.098	-0.197
	(0.145)	(0.132)	(0.196)
Domestic public subsidies	0.226*	0.141	0.085
	(0.131)	(0.102)	(0.166)
Domestic demand	0.462***	0.434***	0.028
	(0.133)	(0.116)	(0.176)
Export intensity	-0.001	-0.007	0.005
	(0.056)	(0.045)	(0.072)
Share of high qualified employees	0.090	0.054	0.035
	(0.068)	(0.056)	(0.088)
Foreign owned	-0.140	-0.025	-0.116
	(0.190)	(0.234)	(0.301)
Firm age	-0.075	0.072	-0.146
	(0.096)	(0.071)	(0.119)
Competition intensity	0.244	0.141	0.103
	(0.179)	(0.124)	(0.218)
R&D propensity	0.686***	0.489***	0.197
	(0.177)	(0.135)	(0.222)
Green process innovation intensity	0.078***	0.033+	0.045+
	(0.021)	(0.020)	(0.030)
Products not suited	-0.159***	-0.018	-0.141*
	(0.060)	(0.051)	(0.078)
Number of employees	0.171***	0.092**	0.079
	(0.063)	(0.041)	(0.075)
Constant	-7.582***	-3.100***	-3.100***
	(0.620)	(0.423)	(0.423)
Main effects			yes
Industry controls	yes	yes	yes
N	873	964	1837
pseudo R2	0.29	0.21	0.25
Wald chi2	1432.71***	159.96***	1928.27***
Log Likelihood	-223.10	-324.07	-547.17

Notes: see Table 1 for the variable definitions; robust standard errors are in brackets under the coefficients; ***, **, *, + denote statistical significance at the 1%, 5%, 10% and 15% test level, respectively. In column 3 only the interaction terms of the variables with the Swiss firm dummy are presented, the respective main effects are captured but not presented.