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Effects of an unified system of Industrial Designs

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Abstract

While patent authorities the last decades have strived to harmonize IP legislation, little empirical evidence exists on the impacts of harmonization of IP law on innovation. This paper is first to put forward evidence from the harmonization of industrial designs (ID). From 1st of April 2003 it was possible for applicants that desired to apply for IDs to apply for all European countries in one application instead of national ID applications. Our findings evidence a sharp increase in number of IDs acquired after 2003 as firms apply for three times as many IDs after the harmonization. However, the findings also reveals that it was not, as expected, SMEs benefitting from the harmonization, but larger firms, firms with prior experience in applying for IP and firms with legal capabilities. We also present findings on the effect of the harmonization of the IP system on other economic outcomes than acquisition of IDs. We investigate whether we empirically can observe an impact from the unified IP system on firms' creative outcomes. We identify a weak effect four years after the harmonization, however, the change occurs for all firms not only the firms investing in the IDs. Why we cannot conclude that the harmonization had significant positive effects on creative outcome. These results highlight the complexity of harmonizing IP legislation and point to policy makers to be cautious.

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Abstract

While patent authorities the last decades have strived to harmonize IP legislation, little empirical evidence exists on the impacts of harmonization of IP law on innovation. This paper is first to put forward evidence from the harmonization of industrial designs (ID). From 1st of April 2003 it was possible for applicants that desired to apply for IDs to apply for all European countries in one application instead of national ID applications. Our findings evidence a sharp increase in number of IDs acquired after 2003 as firms apply for three times as many IDs after the harmonization. However, the findings also reveals that it was not, as expected, SMEs benefitting from the harmonization, but larger firms, firms with prior experience in applying for IP and firms with legal capabilities. We also present findings on the effect of the harmonization of the IP system on other economic outcomes than acquisition of IDs. We investigate whether we empirically can observe an impact from the unified IP system on firms' creative outcomes. We identify a weak effect four years after the harmonization, however, the change occurs for all firms not only the firms investing in the IDs. Why we cannot conclude that the harmonization had significant positive effects on creative outcome. These results highlight the complexity of harmonizing IP legislation and point to policy makers to be cautious.

1. Introduction

Do some firms benefit more than others from a unified IP system and how does a unified IP system influence longer-term creative outcomes? With the recent increase in policy efforts in harmonizing global IP systems (i.e. patent, trademark, industrial designs (ID) and copyrights legislation)[1] these questions are critical to policy makers. Creative outcome (related to trademarks, IDs and copyrights) and innovation (related to patents) is a core ingredient for economic growth, and policy makers are therefore eager to stimulate creative and innovative activities by changing the IP system. At the same time, research on firms' response to changes in IP systems have focused mainly on patents, and have shown that not all firms benefit equally when patent systems are altered. Research shows that the benefits local firms can derive from strengthening national patent law is dependent on the host country's economic strength; firms in the developing countries does not benefit from strengthening IP legislation whereas firms in the developed countries do (e.g. see Lerner 2002, Allred and Park 2007a). But the heterogeneity in response by firm characteristics within a country remains unexplored.

Given the trade-off we know on the determinants of innovation, such as firm size, scope etc., (See Ahuja, Lampert, and Tandon 2008 literature review on research on factors influencing innovation outcome) it is not likely that all firms, even originating from the same country, benefits equally from harmonization of IP laws. The question therefore arises - which firms benefits more when harmonizing IP legislation?

In addition, so far researchers have been focused at understanding IP changes and innovation by exclusively looking at patent data. However, recent survey data as well as global statistics on IP applications suggest that we should broaden our view to other formal IP mechanisms. Hall et. al. (2014) finds, using recent US data, that US firms rate alternative formal IP mechanisms related to creative outcomes (e.g. ID, copyrights and trademarks) as more important than patents[2]. Furthermore, register data on IP applications support the notion that alternative IP mechanisms to patents also are important, and worth studying to understand how firms capture value from innovation. There were almost twice as many trademarks applied for globally in 2013 than patents, and while patents and trademarks both have almost doubled in numbers over the last decade, number of IDs tripled (Alcácer, Beukel, and Cassiman 2017). Hence, understanding the heterogeneity in firm response to IP harmonization should go beyond national level statistics on

[1] E.g. TRIPS or more recently the Unified Patent court in Europe.

[2] All studies does not uniformly support this e.g. when looking at Belgium firms (in e.g. (Alcácer, Beukel, and Cassiman 2017)) or older surveys (e.g. (Cohen, Nelson, and Walsh 2000)).

patents, to enable a better understanding of the functioning of our IP system and its relation to innovation and creative outcomes.

Furthermore, despite the lack of evidence of strengthening IP system and inducing innovation, there has been a global trend towards harmonizing IP. So far, the link between IP and innovation is weak, and our current understanding provides a very complex picture in which the potential gains or losses from any IP change depend on the competitive structure of markets in which the IP is covering and a country's economic development. Implementing regulations to make IP systems more effective (e.g. harmonizing them) will therefore have potentially unknown effects on new businesses, SMEs and MNEs, inefficient industries, innovation, creative outcome and acquisitions, and might raise the costs of imitation and inevitably permit monopolistic behavior by IP owners hampering business creation and innovative and creative activities. Researchers have therefore reminded policy makers that because we lack clear knowledge on the topic it is impossible to predict the outcomes of any IP reform changes (Mazzoleni and Nelson 1998) – why policy makers are acting in blind. Empirical studies to supplement the already available work are therefore needed to get to a more thorough understanding of IP and innovation and creative outcomes.

In this study we focus on creative outcomes, we use the change in EU legislation in 2003 on IDs to build a natural experimental setting, to investigate three main issues, (1.) How did the IP harmonization influence the likelihood of acquiring IDs, (2.) What was the heterogeneity in firms' response to the harmonization of IP, and (3.) What about other economic outcomes than ID applications, how did the harmonization influence creative outcomes?

To conduct the study we construct a unique and detailed dataset linking IP activities (IDs, patents and trademarks), firm balance sheet data as well as data employee data for all firms in Denmark that are active IP registering during 2001 to 2009. The dataset enables a close examination of characteristics of the firms, for example what type of employees (measured by educational background) were employed in the firms that responded to the IP regulatory change.
We have four main sets of results, first, overall, there is a substantial increase in the application of IDs as a result of the harmonization. Firms applied for IDs three times as often after the harmonization than before. Second, we find that there is a heterogeneous response by firm characteristics in terms of application of IDs. Larger firms (measured by the total number of employees) are more likely to apply for IDs after 2003. Firms with greater number of prior IP

rights (trademark and patents) and firms with greater number of lawyers are more likely to apply for more design rights after 2003. Having lawyers employed in the firm shows to be a core human resource for firms in order to benefit from the harmonization. Third, we examine the impact on creative outcomes, here we find that, there is an increase in design-related employment from 2006, however, that this increase was across all firms and not only the firms investing in ID applications. These results suggest that the implementation of harmonization of IP legislations, even the IP legislation less complex than that of patents might not result in intended impact. Smaller firms were comparatively to larger firms left behind, and not having legal expertise beforehand also impeded the response to the new cheaper harmonized ID. Also, we can only weakly empirically showcase an impact on creative outcomes, questioning whether the harmonization had an effect on creative outcomes.

Below, we continue first by presenting a literature review, second we describe the details of the harmonization of IDs in Europe, third we present the method of the study. The fourth section presents the empirical results, and we finish the paper by a discussion and concluding remarks.

Literature review

A central question in the economics of innovation literature has centered on understanding how IP influence innovation. A substantial part of this literature has focused on questions concerning optimal patent strength, scope or length. However, despite the substantial interest in presenting the link between strengthening IP protection and inducing innovation, the empirical evidence is not convincing. One of the core reasons for this is the difficulty in empirically tackling what is cause and effect (as also already noted by Penrose in 1951 (Penrose 1951)). In addition, already 50 years ago, leading researchers (e.g. Arrow 1962, Nordhaus 1969) emphasized that the relationship between IP and innovation is not straight forward. In their early work they argue that there is both costs and benefits for innovation from patenting, namely a tradeoff between the inefficiencies IP impose by giving market power to a single innovator and the gains society and imitators get from innovations being diffused.

In literature, we have a number of empirical studies trying to tackle the question of linking IP and innovation using national- and firm-level research designs. Lerner (2002) studied patent regime changes over a 150 year period and found that in the 5 year period after a change in the IP system (e.g. strengthening of the regime) only foreign applicants benefit. Moser (2005) studied 15,000 innovations from 12 countries exhibited at two fairs in the mid and late 1800s and found that if

the innovations originated countries which did not have patent laws, the innovations were more likely to be in low-tech (and non-patentable) areas. In contrast, innovations originating countries that did have patent laws in place were more likely to belong to high-tech (and patentable) areas. More recent developments in this literature indicate that there is a threshold to whether a country will benefit from a stronger IP regime, the benefits or costs from IP regulatory change dependent on the stage of economic development of a country. For example, Allred and Park (2007b) studied 2,446 firms over a 35 year period, and found that the influence of strengthening the IP regime on innovation depends on the country's economic development. Domestic firms are penalized when strengthening the IP regime in developing countries and foreign firms benefit (measured by local patent filings decrease while foreign patent filings increase and foreign R&D increase). Whereas, it is the opposite in develop economies, here increase in patent strength positively influence domestic patent filings and R&D.

Research on the link between IP and innovation has highlighted a number of mechanisms that influence the relationship. For example, research shows that IP can be blocking and thereby deter innovation (Ziedonis 2004), that IP impose transaction costs in the market when transferring technologies, that licensing and cross-licensing negotiations are burdensome and resource demanding, that there is a reduced incentive to innovate because IP impose reduced rivalry in an industry (Horowitz and Lai 1996), and that IP delay competitors' investments in R&D, as the patent protected technology incentivize other firms to wait with investing in R&D in the area (Takalo and Kanniainen 2000). Teece (1986) argued that the degree to which firms protect innovation by IP (and other mechanisms) influence how well they profit from innovation, and subsequently that firms will be more likely to innovate, if they can benefit from its investments in R&D.

Research has also empirically investigated how firms assess the need and effectiveness of IP. In empirical studies using surveys firms' perception of the effectiveness of IP and other mechanisms for capturing value from IP has been examined. This literature has shown that firms does not view IP (e.g. patents, industrial designs, trademarks and copyrights) as the most effective means for capturing value from innovation, instead the alternative means, e.g. secrecy, complexity, and lead time are consequently, across industries (except Pharmaceuticals and Research Services) and countries, assessed as being more effective when firms are asked (e.g. Cohen, Nelson, and Walsh 2000, Levin et al. 1987, Alcácer, Beukel, and Cassiman 2017, Hall et al. 2014, Arundel 2001, Brouwer and Kleinknecht 1999, Blind et al. 2006). In addition, recent survey data shows that both

IDs, copyrights and trademarks are perceived as more effective for capturing value from innovation than that of patents if asking a random sample of firms (Hall et al. 2014). Whereby Hall et.al., (2014) states *"understanding why firms may prefer alternative methods to protect their IP is at the heart of understanding the functioning of the IP system."* (p. 379 in Hall et al. 2014).

2. Background

Different from a trademark that protects the name or a logo of a company or a product and a patent for technical inventions, an industrial design (ID) right protects the ornamental or aesthetic aspect of an object. An ID may consist of three dimensional features, such as the shape of an object, or two dimensional features, such as patterns, lines or color. IDs are applied to a wide range of products and industries, including furnishing and household goods, shoes and clothes, and industrial products such as parts of wind turbines (e.g. the spinner), cars, and pharmaceutical products (e.g. an insulin injection pen).[3]

In Europe, applicants may register IDs at patent and trademark offices (PTO). Information such as the shape of the design (pictures of the protected product from several angles), a short description, the owner of the design, and remaining length of protection is publically available.[4] The ID must fulfill two criteria: novelty and originality.[5] Different from the US system that examines the application before granting a design patent, IDs can be registered without examination in Europe.[6][7] Instead, third parties can file opposition applications to invalidate a registered ID if an earlier design has been disclosed or if the design resembles the overall

[3] To exemplify please see the following four examples: A design chair (# EM000751250-0001); walking shoes, such as registration # D092073-0004; Tesla's registration of a car front part in China (registration number CN201630002962.0); and insulin pen registration EM 001831975-0001.
[4] The designview database is the most wide ranging database for design rights, enabling users to search industrial designs applied in 35 countries (link: www.tmdn.org/tmdsview-web/welcome). European design are marked 'EM' in the database.
[5] Novelty, that the design should not have been disclosed before application. Originality, that an ID application should differ significantly from prior designs.
[6] A main argument for not examining IDs is that searching shapes and contours (instead of searching for words as when examining patents) is costly to systematize.
[7] Definition of ID is broader in Europe than in the US. "The appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or *materials of the product itself and/or its ornamentation".* (Article 3 in the Design Regulation, OHIM). *"*A design consists of the visual ornamental characteristics embodied in, or applied to, an article of manufacture.*"* (USPTO, Design patent application guide).

impression of the earlier design. To a great extent, this opposition procedure should prevent applications of designs that are not truly novel or original since, apart from initial registration costs, the losing party bears all the costs incurred in the opposition process.

ID rights are used for enforcement against product piracy, often at trade fairs, exhibitions, raids, and at custom. While patents are hard to comprehend without a deep technical understanding, product piracy can be relatively easily determined by local enforcement and arbitration officials by comparing whether the accused pirated product is identical to the displayed product in the ID registration. For example, the Global Association of the Exhibition Industry provide guidelines for how such activities should be conducted in trade fairs, and requirement for organizers to ensure that judges and arbitration are available during trade fairs.[8]

In Europe, before 2003, to obtain protection in a specific country, one needs to register the ID at the local PTO office. The registration fees differ by country, and one can bundle multiple unique IDs in a single application. For example, in Denmark, the registration fee is $180 for the initial ID and $110 for each additional ID included in the same application.[9] In Germany, the fees are $80 and $8 for the initial and subsequent IDs (up to 100 IDs in one application).[10] Despite the incentive to bundle registrations, as we show later, half of the applications include a single design. For those with multiple designs, the median number is 3. The lack of bundling is likely to be because delaying registration and, hence, the risk of losing protection for a certain period of time or completely due to competing designs, is sufficiently costly. The length of protection also varied by jurisdiction, ranging from 10 to 25 years.

On April 1st, 2003, the European Commission's Office of Harmonization for Internal Market (OHIM) initiated the Registered Community Design (RCD) – a new centralized European ID registration option. Instead of a single country, an RCD registration provides protection in all 27 European member countries. An RCD application can also include multiple designs, with the registration fee being $230 for the initial design, $125 per design for the second until the tenth

[8] http://www.ufi.org/wp-content/uploads/2016/01/ipr_recommendations.pdf See p.8 *"*Organizers (red. trade fair organizers) should be able to provide a neutral arbitration, arbitrator, or judge to help determine if there is a violation or to resolve IPR disputes during the trade fair, and should provide interpreters to facilitate communication in the case of disputes with foreign exhibitors. When appropriate and if possible, organizers should provide an on-site office, a special stand or a point of contact, to deal *with any IPR requests or complaints for the entire duration of the trade fair"* Accessed 29.5.2017.
[9] http://www.dkpto.dk/media/1045/prisliste-rettigheder.pdf Accessed 29.5.2017
[10] https://www.dpma.de/docs/service/formulare_eng/allgemein_eng/a9510_1.pdf Accessed 29.5.2017

designs, and $55 per design if the eleventh design forward. The RCDs lasts 25 years from the date of filing, with renewal fees every 5 years.

Even though national ID registrations are still available, RCD has been widely adopted since it essentially reduces the costs of registration for applicants seeking protection in multiple jurisdictions. After a decade or so, over three quarters of a million IDs has been applied for via the RCD system covering European countries (Filitz, Henkel, and Tether 2015). In 2015, RCD was the second most applied ID worldwide, only surpassed by China, however, exceeding other important IP jurisdictions such as South Korea, United States and Japan.

Data and empirical specifications

Sample

We chose to analyze Danish firms, Denmark is part of the European Union and therefore one of the countries embedded in the new unified RCD system. The Danish applicants account for 2% of the RCDs registered, which places Denmark as the number ten most active European country to apply for RCDs. But Denmark is second in terms of ID applications per capita. Importantly, in Denmark researchers can have access to detailed employee data on all firms through Statistics Denmark, and the movement of employees between firms on yearly basis. The employee data are crucial to understanding the heterogeneity in firms response to the harmonization as well as the influence of the harmonization on creative outcome, being the main reasons for choosing Denmark as empirical setting.

We collect the data of IDs applied by all Danish firms between 1995 and 2010 from three sources: (1) domestic applications from the Danish National Patent and Trademark Office (DKPTO); (2) applications in Germany from the Deutsches Patent- und Markenamt database; and (3) RCDs from the OHIM. Because a single application can contain multiple designs, we count the individual designs contained in an application as separate designs throughout the analysis. In total, we observe 19,120 individual designs, averaging 1,195 per year. Among them, 27 percent are domestic (Danish), 22 percent are obtained from Germany, and 51 percent are RCDs.

We link the ID data to firm characteristics using Statistics Denmark's matched employer-employee data. We can thus create firm characteristics including the total number of employees, number of employees by different educational backgrounds (e.g., designers, lawyers, and engineers), total revenues and revenues from export. Because we observe firm and employee data only in the period 2001-2009, we use this shorter sample period for empirical analysis using firm

characteristics. In total for the period of 2001-2009, 17,398 firms are sampled (having more than 2mio employees for which we observe educational background), these firms are the active IP registering firms in Denmark over the period (IP registering patents, trademarks and IDs). The full sample is used for robustness checks for all estimations, however, for the main models we use an xtpoisson estimation. Using the xtpossion means that we only observe the firms that has applied for at least one ID during the period 2001-2009, this is the case for 8% of the sampled IP active firms (n= 1,394 firms) (a majority of the firms are active in trademark registering). Due to missing observations in the firm and employee data for the 1,394 firms[11] we end with a panel dataset of 787 firms totaling 5,777 firm year observations (we conduct a number robustness checks relaxing the restrictions on the sample).

Finally, we also obtain data on other types of IP rights. We use international patent applications (PCT) from PATSTAT to measure the firms patenting activities, and we use national trademark registrations to measure firms' trademarks activities. We also collect the firms' international trademark activities (Community Trademark, CTM) from OHIM but due to a much lower mean for international trademarks than national trademarks (.70 vs .42) and not being able to control for double counting trademarks (they are not linked internationally in families) we use the national trademarks in the regressions.

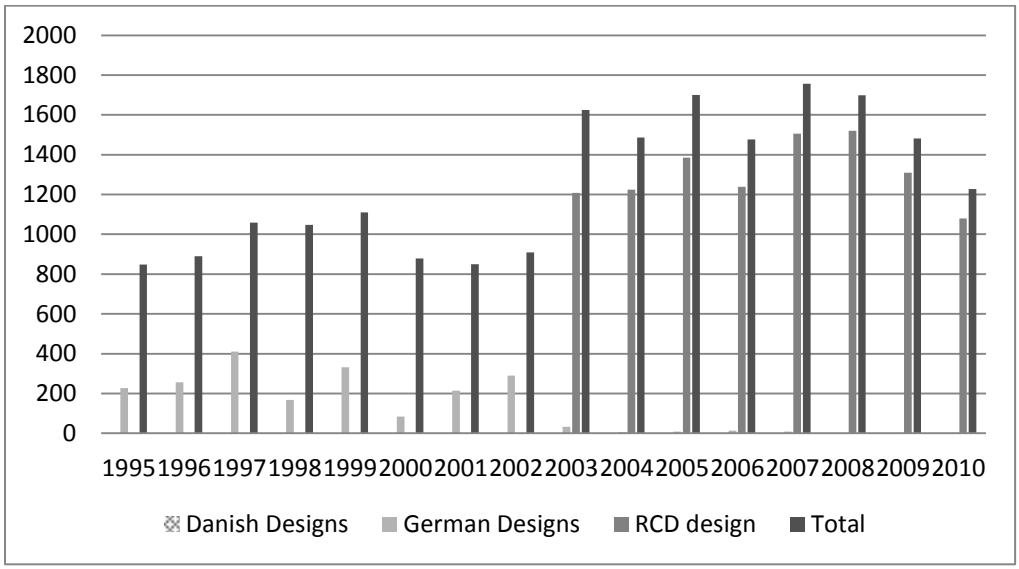
Variables and descriptive results

Figure 1 plots the number of IDs Danish firms applied in Denmark, Germany, RCD, and the total numbers combining the three jurisdictions between 1995 and 2010. Note that from the enforcement point of view, it is sufficient to compare the extent of protection within a single country and RCD. The figure shows that, the amount of designs under protection significantly increases after the implementation of a unified system (RCD), and the increase is immediate and substantial. For example, in Germany, immediately before the RCD regime is implemented (2001 and 2002), the number of designs by Danish firms that are under protection averages 147 per year. Immediately after the regime change (2004-2007), the total number of Danish designs under protection in Germany through the use of RCDs amounts to over 1,500 per year, which is more than ten times relative to before. Similarly, the amount of designs under protection domestically

[11] Because small firms do not have the same obligations to report to the tax-authorities (and, thereby, the statistic authorities) as larger firms, firms with missing balance-sheet information or employee data are likely to be smaller. In particular, the size of IP ownership, including the number of patents, designs and trademarks, is significantly smaller (at a 1% level) for the firms without firm and employee data than firms with firm and employee data.

in Denmark increases by over 70 percent after the regime change (about 1,600 per year after 2002 versus roughly 900 per year before).[12]

Figure 1: Number of industrial designs applied by Danish firms by office of application (1995-2010)



It is important to note that we can observe only the number of designs firms apply for protection, which is different from the genuine quantity of design innovations firms create that is both hard to observe and to quantify. For the rest of the analysis, we use the total number of designs combining the three jurisdictions as the outcome of interest. Because a firm can apply for protection in multiple countries for the same underlying design, this approach intends to get us closer to measuring the unique number of designs underlying these applications with important caveats. On the one hand, for the pre-period, adding applications in Germany to those in Denmark prevents missing designs that firms apply for protection only abroad. To confirm that we do not miss important design innovations by not including applications in other large countries in Europe such as France and the UK, we manually check the applications and their underlying designs for a small number of firms of different sizes. The data show that for almost all underlying design innovations for which these firms apply for protection foreign countries, the

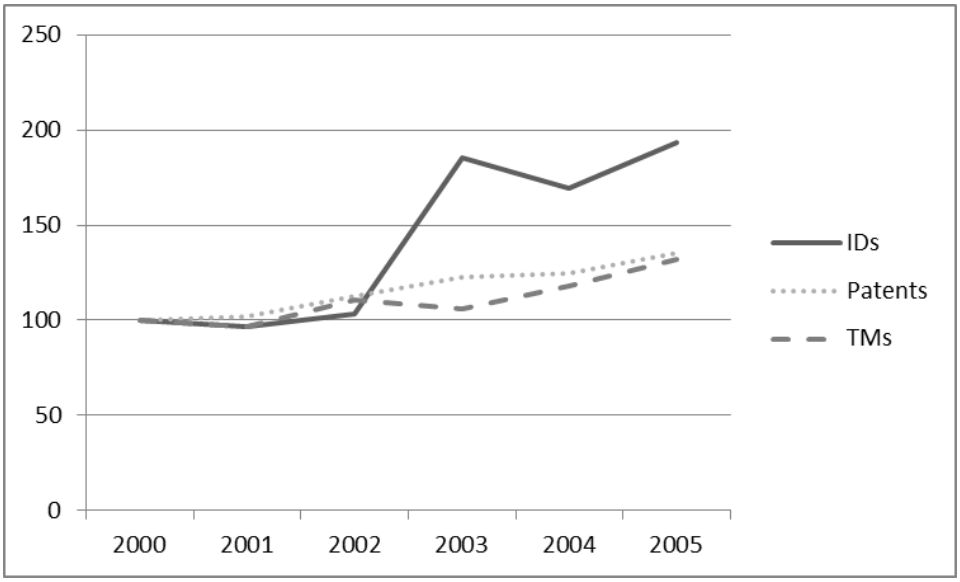
[12] Interviews with DKPTO representatives and firm representatives suggest that some firms may still apply for ID protection in Denmark (instead of using the RCD) because they possess limited awareness of the new harmonized RCD system or because these applicants prefers communicating with local Danish authorities instead of the central European office. Also, it is still marginally cheaper to apply for IDs only in Denmark than for RCD.

firms apply for protection in Germany (Appendix with detailed information available from authors). This is, in part, because Germany is the largest trading partner for Denmark, accounting for 24,6 percent of the total export from Denmark to the 27 RCD governed countries in 2011. On the other hand, using the sum for pre-period may over-count the number of unique design innovations if firms apply for protection for some of the designs in both countries. This possibility is likely to under-estimate the effect of the RCD system because it inflates the number of designs in the pre-period, and we are comfortable with reporting more conservative results.[13]

Figure 2 compares the increase in the number of designs relative to that of patents (PCT applications) and trademarks (national applications), within a relative short frame of time before and after the RCD implementation. During the same period, there are no significant changes in these two IP systems for European firms. Thus, to a great extent, changes in these two types of IP rights help control for the general time trend in firms' tendency to acquire IP rights. With the numbers normalized to 100 for year 2000, the figure shows that designs experience a similar time trend before the implementation of the RCD, but a sharp and substantially higher growth rate immediately afterwards. In contrast, the increases in patents and trademarks are smooth, consistent with a general increasing trend in IP acquisition without any discrete regime changes. This contrast further confirms the causal interpretation of the changes in IDs observed before and after the RCD implementation.

Figure 2 Increase in industrial designs relative to patents and trademarks

[13] For post-RCD periods, because there are almost no German applications, the data largely reflect the sum of Danish national applications and the RCDs. This sum is unlikely to double count the underlying designs because firms would not need to apply for Danish protection if they already registered at the RCD. It is possible that we miss designs for which the firm applies only in foreign countries not the RCD. Judging by the fact that German applications are almost zero after the RCD, the number of such applications is likely to be small.



Notes: The amounts of designs, patents and trademarks are all normalized to 100 in year 2000. The designs are the combined total of applications in Denmark, Germany and the RCDs. Patents are PCT applications and trademarks are Danish national applications.

Table 1 provides summary statistics of other variables that we use in the paper. Firm size can be measured by total number of employees and revenue. Because the two variables are highly correlated (the correlation between the total number of employees and firms' revenue is .7558) and that revenue is missing for more firms, we use the total number of employees as the measure of firm size. We also use the number of employees with different educational backgrounds as proxies for a firm's capability in a certain area, such as design, scientific (employees with a PhD), engineering and legal expertise. Finally, we also include the number of patents and trademarks in a firm, which reflect the firm's experience in obtaining and managing intellectual property. In Table 1 we present the descriptive data, and in Table 2 the pairwise correlations. As expected number of designers employed is the type of employee that is most highly correlated with applying for IDs. We also observe that having trademarks is highly correlated with IDs, this confirms prior descriptive studies, where ID and trademark has been shown to be correlated.

Table 1 Descriptive statistics (n=5,777)

Variable	Mean	Std. Dev.	Median	Min	Max
Total number of IDs	1.725	11.654	0	0	302
Number of designers	5.081	41.968	0	0	1062
Number of lawyers	.211	1.300	0	0	27
Number of engineers	1.907	11.877	0	0	266
Number of scientists	1.382	17.344	0	0	533

Export	29271.94	158812.3	849.159	0	4197508
Total Employees	156.3836	642.8302	19	1	11008
Trademarks	.7078068	4.216747	0	0	116
Patents	.7786048	5.397622	0	0	123

Table 2 Pairwise correlations (n=5,777)

		1	2	3	4	5	6	7	8	9
1	Total number of IDs	1								
2	POST	0.0439	1							
3	Log(Number of designers+1)	0.1333	-0.0068	1						
4	Log(Number of lawyers+1)	0.1191	0.0103	0.6068	1					
5	Log(Number of engineers+1)	0.1180	0.0136	0.7480	0.6491	1				
6	Log(Number of scientists+1)	0.0735	0.0087	0.6768	0.6965	0.7883	1			
7	Log(Export+1)	0.0991	-0.0132	0.5435	0.2615	0.4115	0.3057	1		
8	Log(Total Employees)	0.1184	-0.0494	0.7553	0.4209	0.5923	0.4367	0.7143	1	
9	Log (Trademarks)	0.2790	0.0091	0.4768	0.4717	0.4698	0.4474	0.2665	0.3896	1
10	Log(Patents)	0.2257	0.0156	0.5420	0.5797	0.6676	0.7114	0.2872	0.4045	0.5361

Empirical specifications

The raw data show that the total amount of IDs increased significantly and sharply after the RCD reform. The regression analysis examines the firm-level data. Due to the count nature of the dependent variables, our main analysis uses Poisson models with firm fixed effect. The use of firm fixed effects avoids confounding the change in the population of firms and the change in the tendency to acquire ID rights given the same firm. First, for the effect of a unified ID system on the acquisition of IDs, we use the following specification:

$$(1)\ \mathrm{ID}_{it} = \alpha \mathrm{Post}_t + X_{it}\beta + \mu_i + \epsilon_{it},$$

where the dependent variable, ID, is the number of design applications by firm i in year t, Post_t is a dummy that equals one for time periods including and after 2003, μ_i is firm fixed effect, and X_{it} are time-variant firm characteristics. For all regressions, we cluster the standard errors at the firm level. As discussed previously, the identification of the above effect relies on the assumption that, on average, firms' tendency to obtain ID rights does not change during the same sample period for reasons other than the RCD reform. We also replace Post_t with year dummies to investigate the immediate change in a firm before and after the reform.

Next, we investigate whether there exist heterogeneity in firms' response by including interaction terms between important firm characteristics and Post_t:

$$(2)\ \mathrm{ID}_{it} = \delta \mathrm{Post}_t \times \text{Pre-2003 Firm Char}_i + X_{it}\beta + \lambda_t + \mu_i + \epsilon_{it}.$$

We use firm characteristics before the policy change to avoid confounding any potential effect on these variables caused by the policy change. We are particularly interested in how the change in the acquisition of IP rights varies by firm size, firms prior IP registering (we look at IDs, patents and trademarks), design capability, engineering capability and legal expertise. Because pre-2003 firm characteristics stay constant, these variables themselves are dropped because of firm fixed effects. We control for time-varying firm characteristics and individual year dummies λ_t for the general time trend. We include the interaction between firm size and POST in all estimations, to ensure that the results are independent on the firm size.

Finally, we are interested in the long-run impacts on creativity beyond ID ownership, namely value creation. Because it is difficult to measure the actual amount of design innovations, we first focus on design-related employment of a firm to explore the impact on creative innovation. The following specifications examine whether there is an increase in design-related employment after the policy change (as relative to engineers); and whether changes in employment are proportional to changes in the number of IDs.

$$\text{(3) Design Employment/Engineer employment+1}_{it} = \alpha \text{Post}_t + X_{it}\beta + \mu_i + \epsilon_{it},$$

$$\text{(4) Design Employment/ Engineer employment+1}_{it} = \delta \text{Post}_t \times \text{Design Rights}_{it} + X_{it}\beta + \lambda_t + \mu_i + \epsilon_{it}.$$

As a complement to the quantitative approach outlined above, we also interviewed 5 IP managers from 5 different industries on the unified ID system.

Results

Average effect on the acquisition of IDs

Table 3 shows that the number of IDs applied after the implementation of RCD is significantly higher than before (the coefficients of Post in the first two columns are positive and significant). On average, firms apply for three times as many IDs after 2003 than before (estimated based on Column (1) and (2)). In Columns (3) and (4), the coefficients of year 2003 (immediately after the RCD reform) are substantially larger than that of year 2002, and the difference is statistically significant (p-value < 0.0000 in both estimations). Consistent with the overall pattern in the raw data, these results show that the change after the implementation of a unified IP system is large and immediate.

Our interviews also confirms the increased usages of ID, a firm representative explains the change in conditions for IDs in the following way:

> *"I simply cannot see any reasons for applying only a Danish design (national) after the 2003* implementation [RCD], for the same work and almost the same cost you get approx. 30 *countries instead of 1"* and later in the interview he continues *"The design IP right has with* the implementation of the RCD moved from being the step-daughter of the IP family to becoming a fully acknowledged member of the IP-*family"*, IP Manager, MNC (Valves & pumps).

To test the robustness of the results we run a number of different robustness checks. In the results presented Table 3 we use a xtpoisson regression with firm fixed effects, this influences sample size because observations are dropped if all outcomes are zero within a group (firm), meaning firms that do not at any time apply for IDs (in our estimation this is 8,748 firms accounting for 55,561 observations), and observations are also dropped if there only is one observation per group (in our sample this accounts for 1,232 firms equaling 1,232 obs). The sample size using an xtreg specification increases to 62,570 observations. Using this sample the results does not change. However, using this sample inquires us to be cautious in the interpretations as we are interpreting data with a substantial amount of zeros, which can influence results. We therefore also, as a robustness test, conduct the estimations with a dummy variable which takes one if the dependent variable equals zero and 0 if more than 0. This dummy is negative and significant in all models – also indicating the highly skewed towards zero dependent variable being used. The results in these estimations are qualitatively the same as in our main models.

As robustness test, we also do an estimation using negative binomial regression model, we test the models replacing the dependent variables with log(ID+1) and use OLS regressions, and we use all years from 1995-2010 (without including the time varying controls which we only have for the limited time period of 2001-2009), and all results confirm that there was a significant higher amount of IDs applied after the implementation of RCD.

The coefficients of the control variables in Table 3 are also consistent with the raw-data correlations. The number of design applications are higher for larger firms, for firms that employ more designers and for firms with a greater amount of trademarks and patents.

Table 3 Poisson regression, Dependent variable is Total number of IDs, firm fixed effects.

	(1)	(2)	(3)	(4)
POST	1.109***	1.093***		
	[0.037]	[0.038]		
year2002			0.506***	0.505***
			[0.075]	[0.075]
year2003			1.401***	1.429***
			[0.066]	[0.067]
year2004			1.216***	1.223***
			[0.068]	[0.068]
year2005			1.475***	1.485***
			[0.066]	[0.067]
year2006			1.252***	1.221***
			[0.067]	[0.069]
year2007			1.625***	1.509***
			[0.065]	[0.066]
year2008			1.611***	1.546***
			[0.066]	[0.067]
year2009			1.187***	1.243***
			[0.068]	[0.070]
Log(Number of designers)		0.252***		0.256***
		[0.041]		[0.041]
Log(Number of scientists)		-0.074		-0.093*
		[0.052]		[0.053]
Log(Number of engineers)		0.061		0.029
		[0.051]		[0.051]
Log(Number of lawyers)		0.140*		0.149**
		[0.072]		[0.073]
Log(Export)		-0.019**		-0.011
		[0.009]		[0.009]
Log(Total employees)		0.442***		0.407***
		[0.038]		[0.039]
Log (Trademarks)		0.307***		0.269***
		[0.023]		[0.023]
Log(Patents)		0.135***		0.166***
		[0.036]		[0.037]
Pseudo LL	-8.042.331	-7.757.603	-7.887.600	-7.656.521
No of Obs	5777	5777	5777	5777
Wald-Chi2	878.0467***	1348.493***	1159.004***	1522.439***

* p<0.1, ** p<0.05, *** p<0.001

Heterogeneous response by firm characteristics

In Table 4 we present the results on the heterogeneous response by firm characteristics.

Column (1) in Table 4 shows that, after the implementation of RCD, the rate of increase in the acquisition of IDs is significantly greater for larger firms. Specifically, for firms that are one percent larger, the rate of increase is about 10 percent faster. Recall that larger firms tend to have more IDs before the reform[14] this result suggests that a unified IP system might have resulted in an even more unequal allocation of IDs between larger and smaller firms.

First, we set out to test whether the firms that applied for IDs before the harmonization also were the ones benefitting from the harmonization. We do this in column (2) in Table 4, and it shows that, given firms of the same size, the rate of increase in ID is less for those that had registered IDs prior the legislative change. This indicates that the population of firms that prior the harmonization were using IDs as protective measure, are different from the firms that are engaged in ID applications after 2003. To deepen our understanding of the effect of the regulation on different type of firms, we divide firms into four categories based on median firmsize (high/low) and the median of prior IDs (high/low), resulting in four categories of firms: 1) firms with high firm size and high number of IDs pre 2003 (HIGHSIZEHIGHID), 2) firms with high firm size and low number of IDs pre 2003 (HIGHSIZELOWID), 3) firms with low firm size and high number of IDs pre 2003 (LOWSIZEHIGHID), and 4) firms with low firm size and low number of IDs pre 2003 (LOWSIZELOWID)[15]. We estimate how they differ (using the latter category as benchmark and testing for significance in between the different categories), and find the following ranking of firm type: HIGHSIZELOWID >[16] LOWSIZELOWID > HIGHSIZEHIGHID > LOWSIZEHIGHID. Regression results are also presented see Table 5 Model 1. The results thereby show that it is the smaller firms that were ID active prior 2003 that benefits the least from the harmonization, whereas larger firms that did not use ID prior 2003, after 2003 where more likely to apply for IDs. We can therefore expect that it is very different firms that applied for ID after the harmonization than before, to further investigate the characteristics of the firms that benefitted more from the harmonization we take a deeper look at

[14] The correlation between log(Total employees) and Design rights is (0.1184) in Table 2 which includes all years, if for the years 2001 and 2002 it is 0.0549.

[15] We use the median to split the variables, the number of observations in the four categories are 1)1242, 2) 1678, 3) 599 and 4) 2368

[16] The sign ">" means tested significantly more than at a 10% level.

the human resources of firms and prior IP activities in other domains than ID, namely patents and trademarks.

We start out by assessing the drivers of this unequal increase by distinguishing employees based on their educational backgrounds. Column (3) in Table 4 shows that, given firms of the same size, the rate of increase in IDs is greater for those with more employees with an educational background in design. These results are intuitive, as the number of designers is a good proxy for the underlying design capabilities. We would therefore think that firms with a greater number of designers have more design innovations that are worthwhile applying for protection since the cost of application has dropped after the regime change, that they prior the unified system had designs that they did not protect. Another, assumption would be that firms with designers employed are able to create more designs in response to the change in incentives brought by the unified system. In the table we also see that in column (3) the firm size variable interaction becomes insignificant and negative, indicating that the effect of having designers prior the regulation is confounded on firm size. We therefore investigate the results using a number of other estimations.

First, design educations can include technical (related to engineering parts, such as technical designer) as well as less technical educations (fashion designer, graphics, ceramics etc.) in total we have 36 educations that are related to becoming a designer in the educational codes. It is based on these 36 educations that we estimate our main models, however, as a robustness we narrow the definition of designers and exclude designers with a technical oriented design background. Using this narrow definition of designers the interaction between log number of designers (narrow) and POST becomes significant and positive, and in line with our main results (0.939***), however, again we see that the interaction between pre firm size and post becomes negative and significant (-0.235***). Repeating a suggestive confounded relationship between designers and firm size. Therefore, to examine the relation between number of designers employed (design capabilities) and firm size, we generate four variables (using the median value as split), 1) firms with high firm size and high design capabilities (HIGHFIRMSIZE_HIGHDESIGNCAP), 2) firms with high firm size and low design capabilities (HIGHFIRMSIZE_LOWDESIGNCAP), 3) firms with low firm size and high design capabilities (LOWFIRMSIZE_HIGHDESIGNCAP), and 4) firms with low firm size and low design capabilities (LOWFIRMSIZE_LOWDESIGNCAP) and estimate how they differ (we use the latter category as benchmark)[17]. We try with both our measures of

[17] The distribution of firm year observations is the following in the four categories, when broad and narrow definition is used: 1)1,752 / 994, 2) 1,168/1,926, 3) 130/94, 4) 2,837/ 2,873

designers (the broad and narrow definitions) and consistently we find that it is the firms with both high firm size and high design capabilities that benefits from the regulatory change. We test the difference between the three other groups and find no significant difference in between them (See Table 5, column (2)[18]). Given these results we do find that design capabilities does have an effect, as would seem most likely, however, that firms needed to have certain size when the regulatory change was implemented to benefit more from having designers employed.

Column (4) in Table 4 shows that, given firms of the same size, the rate of increase in IDs is greater for those with more lawyers (lawyers are identified by education). Lawyers are not an inherent part of the creative process, but often partaking in acquiring IP and in charge of enforcing IDs in the case of infringement. Firms with more legal resources are more responsive to the regime change, this may be because they are more informed about the legal system, or because obtaining IDs is more valuable for firms that are more capable of enforcing it (i.e., the enforcement abilities are complementary to the ownership of IP). The coefficient for lawyers is the highest of the firm characteristics studied, and it indicates that for a one percentage increase in having lawyer employed, the rate of increase in ID is 99% higher. We also observe that the interaction effect between pre firm size and post becomes insignificant. To study effect of legal capabilities in different sizes of firms, below or higher than median of firms size and legal capabilities (pre regulation), resulting in four categories: 1) firms with high firm size and high legal capabilities (HIGHFIRMSIZE_HIGHLEGALCAP), 2) firms with high firm size and low legal capabilities (HIGHFIRMSIZE_LOWLEGALCAP), 3) firms with low firm size and high legal capabilities (LOWFIRMSIZE_HIGHLEGALCAP), and 4) firms with low firm size and low legal capabilities and estimate how they differ (LOWFIRMSIZE_LOWLEGALCAP). We use the latter category as benchmark[19]. The results shows, presented in column (3) Table 5, that it is large sized firms with high legal capabilities that benefit the most from the implementation of the regulation.

In the final two columns we investigate the relationship between having prior IP experience and firms response to the harmonization of ID. In column (5) we show the results for pre regulation patenting activities and column (6) pre regulation trademark activities.

[18] Estimation with the narrow definition of designers is due to space limitations not displayed (but available from authors).
[19] The number of observations is the following in the four categories: 1) 337, 2) 2,583 3) 17, 4) 2,950. Notice that the category of low firm size and high legal capabilities only consists of 17 firm year observations, why we need to be cautious when concluding based on this variable.

Columns (5) and (6) Table 4 show that, firms with prior experience in patenting and in trademark registering prior 2003, did apply for more IDs after 2003[20]. These results reflect that firms which already prior the implementation of the unified ID system had been IP active were informed about the legislative change, put attention towards assessing the change, and were capable of directing resources towards obtaining IDs. The results could also be present due to the existence of a synergy between ID and other IP rights, rendering the value of obtaining ID is greater for firms already with IP protection.

[20] We run the same analysis dividing firms by median by firm size and patents/trademarks (but not presented here), and find that HIGHSIZEHIGHPATENT > HIGHSIZELOWPATENT > both LOWSIZE. For trademarks the results are HIGHSIZE (both low and high TM) and LOWSIZELOWTM are significantly more than LOWSIZEHIGHTM.

Table 4 Poisson regression, Dependent variable is Total number of IDs, firm fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Pre Log(Total employees)*POST	0.080***	0.171***	-0.166***	-0.013	0.035	-0.020
	[0.022]	[0.023]	[0.041]	[0.027]	[0.024]	[0.027]
Pre Log(Number of IDs)*POST		-0.099***				
		[0.008]				
Pre Log(Number of designers)*POST			0.422***			
			[0.059]			
Pre Log(Number of lawyers)*POST				0.641***		
				[0.111]		
Pre Log(Patents)*POST					0.016***	
					[0.004]	
Pre Log(Trademarks)*POST						0.062***
						[0.010]
Log(Number of designers)	0.251***	0.280***	0.302***	0.261***	0.271***	0.271***
	[0.041]	[0.042]	[0.042]	[0.041]	[0.042]	[0.041]
Log(Number of scientists)	-0.105**	-0.120**	-0.143**	-0.128**	-0.160**	-0.158**
	[0.053]	[0.054]	[0.054]	[0.053]	[0.054]	[0.054]
Log(Number of engineers)	0.021	0.051	0.004	0.053	-0.017	0.008
	[0.052]	[0.052]	[0.051]	[0.052]	[0.052]	[0.051]
Log(Number of lawyers)	0.127*	0.214**	0.153**	0.120	0.140*	0.093
	[0.073]	[0.073]	[0.073]	[0.075]	[0.074]	[0.074]
Log(Export)	-0.015*	-0.034***	-0.018**	-0.017*	-0.017*	-0.015*
	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]	[0.009]
Log(Total employees)	0.428***	0.432***	0.412***	0.428***	0.414***	0.415***
	[0.039]	[0.040]	[0.040]	[0.039]	[0.039]	[0.039]
Log (Trademarks)	0.264***	0.261***	0.271***	0.257***	0.267***	0.275***
	[0.024]	[0.023]	[0.023]	[0.024]	[0.023]	[0.024]

Log(Patents)	0.155***	0.107**	0.152***	0.143***	0.176***	0.177***
	[0.037]	[0.037]	[0.037]	[0.037]	[0.037]	[0.037]
year2002	0.513***	0.530***	0.512***	0.528***	0.516***	0.512***
	[0.075]	[0.075]	[0.075]	[0.075]	[0.075]	[0.075]
year2003	1.074***	1.164***	1.629***	1.330***	1.173***	1.254***
	[0.115]	[0.117]	[0.146]	[0.126]	[0.118]	[0.120]
year2004	0.866***	0.957***	1.423***	1.124***	0.962***	1.045***
	[0.116]	[0.119]	[0.147]	[0.127]	[0.119]	[0.121]
year2005	1.126***	1.206***	1.687***	1.385***	1.229***	1.313***
	[0.116]	[0.118]	[0.147]	[0.127]	[0.119]	[0.121]
year2006	0.863***	0.945***	1.425***	1.119***	0.969***	1.050***
	[0.117]	[0.119]	[0.148]	[0.128]	[0.120]	[0.122]
year2007	1.152***	1.241***	1.712***	1.409***	1.255***	1.333***
	[0.115]	[0.118]	[0.146]	[0.126]	[0.118]	[0.121]
year2008	1.190***	1.277***	1.749***	1.447***	1.295***	1.372***
	[0.115]	[0.118]	[0.146]	[0.126]	[0.118]	[0.121]
year2009	0.890***	0.976***	1.447***	1.148***	0.989***	1.071***
	[0.117]	[0.119]	[0.147]	[0.127]	[0.119]	[0.122]
Pseudo LL	-7.649.687	-7.569.576	-7.623.749	-7.631.691	-7.639.945	-7.631.773
No of Obs	5777	5777	5777	5777	5777	5777
Wald-Chi2	1521.48***	1583.654***	1539.64***	1511.414***	1520.362***	1523.561***

* p<0.1, ** p<0.05, *** p<0.001

Table 5: Poisson regression, Dependent variable is Total number of IDs, firm fixed effects.

	Model 1	Model 2	Model 3
HIGHFIRMSIZE_HIGHIDs	-1.097***		
	[0.179]		
HIGHFIRMSIZE_LOWIDs	0.940***		
	[0.275]		
LOWFIRMSIZE_HIGHIDs	-2.658***		
	[0.193]		
HIGHFIRMSIZE_HIGHDESIGNCAP		0.666***	
		[0.102]	
HIGHFIRMSIZE_LOWDESIGNCAP		0.282**	
		[0.127]	
LOWFIRMSIZE_HIGHDESIGNCAP		-0.086	
		[0.371]	
HIGHFIRMSIZE_HIGHLEGALCAP			1.229***
			[0.126]
HIGHFIRMSIZE_LOWLEGALCAP			0.299**
			[0.101]
LOWFIRMSIZE_HIGHLEGALCAP			-0.869
			[0.593]
Log(Number of designers)	0.238***	0.266***	0.267***
	[0.042]	[0.042]	[0.041]
Log(Number of scientists)	-0.110**	-0.108**	-0.179***
	[0.053]	[0.053]	[0.054]
Log(Number of engineers)	0.034	0.020	0.030
	[0.052]	[0.052]	[0.052]
Log(Number of lawyers)	0.134*	0.132*	0.102
	[0.073]	[0.072]	[0.075]
Log(Export)	-0.018**	-0.009	-0.021**
	[0.009]	[0.009]	[0.009]
Log(Total employees)	0.424***	0.427***	0.443***
	[0.040]	[0.039]	[0.039]
Log (Trademarks)	0.250***	0.276***	0.259***
	[0.023]	[0.024]	[0.024]
Log(Patents)	0.176***	0.151***	0.145***
	[0.037]	[0.037]	[0.037]
year2002	0.525***	0.502***	0.535***
	[0.076]	[0.075]	[0.075]
year2003	2.436***	0.937***	0.967***
	[0.185]	[0.105]	[0.104]
year2004	2.222***	0.730***	0.759***
	[0.185]	[0.106]	[0.105]
year2005	2.480***	0.993***	1.023***
	[0.185]	[0.105]	[0.104]
year2006	2.217***	0.728***	0.759***
	[0.185]	[0.106]	[0.105]
year2007	2.511***	1.015***	1.047***
	[0.184]	[0.105]	[0.104]
year2008	2.547***	1.053***	1.086***
	[0.185]	[0.105]	[0.104]

year2009	2.242***	0.756***	0.788***
	[0.185]	[0.107]	[0.106]
Pseudo LL	-7.440.527	-7.632.772	-7.592.675
No of Obs	5777	5777	5777
Wald-Chi2	1524.383***	1545.023***	1514.419***

* p<0.1, ** p<0.05, *** p<0.001

To test the robustness of the results presented in Table 4 and Table 5 we run a number of different robustness checks. In the presented Table 4 we use a xtpoisson regression with firm fixed effects why the sample is restricted to firms applying for more than one ID over the 9 years, we estimate the same sample using xtreg instead of xtpoisson. We also try the estimations using log(ID)+1 as dependent variable. Using the xtreg enables us to increase sample size to including firms that are not ID active over the 10 years and firms that only occur once in the dataset (n=62,570). In these estimations we include a dummy for when dependent variable is zero or not as there is an excess number of observations being zero, and it also shows that the dummy becomes negative and significant (p>0.0001) in all models. Only one result in our robustness checks stands out as qualitatively different than in the main estimations; we find that having prior ID turns positive and significant, however, the benchmark in this sample, is the excess number of firms that did not apply for IDs at any time during the period. We therefore take these results with great caution. All other results remain qualitatively the same as in our main estimations, and legal employment still shows the highest coefficients, indicating that lawyers were very important in order for firms to respond to the harmonization.

Effects on creative outcome: design-related employment

Our results show that after the RCD reform, firms are significantly more likely to apply for protection of design innovations. The extra IDs, however, might cover innovations that would have been created without the more extensive IP protection, or there might be new design innovations that result from the regime change. The former channel is more plausible given our interviews with practitioners, the sharp and immediate response pattern, and the disproportionately greater rate of increase for firms with greater legal expertise. It is much harder to make any definitive conclusion about the creative outcome because it is almost impossible to accurately measure innovation beyond IP ownership. Because it is hard to observe the creative aspects of a firm's products, to get us closer to the answer, we examine whether we see an increase in design-related employment after the regime change.

Column (1) to (4) in Table 6 we use the relative number of designers divided by the number of engineers+1 as dependent variables and the relative number of designers divided by the total number of employees+1 as dependent variables, we use both the broad and narrow definition of designers. Across all estimations (1) to (4) we find consistent results across the different specifications, the results show that there was no disproportionate increase in hiring of designers for the firms that applied for more IDs following the harmonization of IDs, the yearly interactions between log (Number of IDs) and year are all insignificant. However, we do see that there was an increase in hiring of designers after 2006 (in the year estimates), this means that not only the firms that applied for more IDs had an increase in number of designers employed, but all firms. It is therefore based on these results difficult to confirm an effect on creative outcomes.

To test the robustness of these results we run a number of different estimations. First, we change the dependent variable to a count of the number of designers employed, interestingly, we see in a few of the estimations that there is an increase in design-related employment immediately after 2002, and the difference in the coefficients between 2002 and 2003 is statistically significant, and we observe that the increase becomes greater over time. The coefficient of the interaction term between Post and log(number of IDs) is negative and insignificant in the estimations. This result is consistent for both the broad and narrow definition of designers. So these estimations confirm that the rate of increase of designers is not greater for firms that apply for a greater number IDs.

Table 6, Xtreg, dependent variables is design related employment, firm fixed effects.

	(1) designers (broad) / total number of employees+1	(2) designers (broad) / total number of engineers+1	(3) designers (narrow) / total number of employees+1	(4) designers (narrow) / total number of engineers+1
Log (Number of IDs)	0.000	0.011	0.000	0.013
	[0.001]	[0.013]	[0.000]	[0.009]
year2002	0.002	0.014	0.001	0.015
	[0.002]	[0.043]	[0.002]	[0.029]
year2003	0.001	0.008	0.000	0.005
	[0.002]	[0.042]	[0.002]	[0.029]
year2004	0.000	-0.002	-0.001	0.006
	[0.002]	[0.042]	[0.002]	[0.029]
year2005	0.001	0.058	-0.000	0.044
	[0.002]	[0.042]	[0.002]	[0.028]
year2006	0.005**	0.109**	0.002	0.061**
	[0.002]	[0.042]	[0.002]	[0.029]
year2007	0.004**	0.151***	0.003*	0.109***
	[0.002]	[0.042]	[0.002]	[0.029]
year2008	0.005**	0.172***	0.002	0.121***
	[0.002]	[0.043]	[0.002]	[0.029]
year2009	0.007***	0.123**	0.004**	0.122***
	[0.002]	[0.043]	[0.002]	[0.030]
Log (Number of IDs)*2002	-0.000	-0.008	-0.000	-0.013
	[0.001]	[0.015]	[0.001]	[0.010]
Log (Number of IDs)*2003	-0.000	-0.011	-0.000	-0.013
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2004	-0.000	-0.005	-0.000	-0.008
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2005	-0.000	-0.009	-0.000	-0.009
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2006	-0.000	-0.005	-0.000	-0.002
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2007	-0.000	-0.006	-0.000	-0.005
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2008	-0.000	-0.009	-0.000	-0.009
	[0.001]	[0.013]	[0.000]	[0.009]
Log (Number of IDs)*2009	-0.000	-0.002	-0.000	-0.002
	[0.001]	[0.014]	[0.000]	[0.009]
Log(Number of scientists)	-0.001	0.354***	-0.002	0.079
	[0.003]	[0.074]	[0.003]	[0.051]

Log(Number of lawyers)	0.001	0.061	0.000	-0.129**
	[0.003]	[0.082]	[0.003]	[0.056]
Log(Export)	0.001**	0.026***	0.000*	0.009*
	[0.000]	[0.007]	[0.000]	[0.005]
Log(Total employees)	0.003**	0.396***	0.002**	0.176***
	[0.001]	[0.023]	[0.001]	[0.016]
Log(Number of engineers)	0.001	-1.523***	0.001	-0.574***
	[0.002]	[0.054]	[0.002]	[0.037]
Log (Trademarks)	-0.000	0.021	0.000	0.038*
	[0.001]	[0.029]	[0.001]	[0.020]
Log(Patents)	-0.000	-0.019	0.000	0.001
	[0.002]	[0.044]	[0.002]	[0.030]
Constant	0.001	-0.223**	0.000	-0.117**
	[0.003]	[0.076]	[0.003]	[0.052]
R-squared	0.013	0.181	0.007	0.088
Adj.R-squared	-.1476456	.0479587	-.1547742	-.0605896
No of Obs	5777	5777	5777	5777
F test	2.788024***	45.87348***	1.493483***	20.00115***

* p<0.1, ** p<0.05, *** p<0.001

Discussion and conclusion

There are three main contributions of this paper, all empirical. First is an empirical test of whether the harmonization IDs in 2003 resulted in a substantial increase in the application of IDs. Second contribution is an empirical test of the heterogeneous response by firm characteristics in terms of application of IDs when the IP system is harmonized and a substantial costs reduction is implemented. Third is an empirical test of the influence of IP harmonization of IDs on creative outcomes.

First we evidence that the unified ID system did have a significant effect on the increase in ID applications. The empirical estimations suggest a 190% increase in ID applications after the harmonization. These results support the findings of Alcacer, et.al. (2017) that show that the number of ID applications globally has increased sharply from 2003 to 2013. The increased put forward in this paper, might very well be due to the harmonization of the European ID legislation.

Second, we show that the increase was driven by firms with different characteristics than expected. While one of the main arguments for implementing the unified ID system was a desire from policy makers to ease the access to IDs for SMEs, the empirical results shows a different picture. It is the larger firms, firms with human capital in law that benefitted, and it was also to a greater extent firms that were already active IP recipients that benefitted from the harmonization. This suggests that to incentivize SMEs to apply for more IP is not only a matter of reducing costs of IP. Instead, we observe that it is the large firms that have the needed experience in IP and human capital of law, that can respond and capture the benefits from a unified ID system. In fact the results on firm size suggest that an even a greater gab between MNCs and SMEs in utilizing IDs exists post harmonization than prior.

These finding are valuable to take into consideration for a number of new IP legislative initiatives currently in development. Most importantly, one of the main arguments in building the new unified patent court in Europe is to reduce costs of litigation to ensure that also SMEs can litigate their IP. Our results, despite it being on harmonization of ID applications and therefore not directly applicable raises a concern that the effect of implementing the Unified Patent Court, might not be beneficial for SMEs. It might be that SMEs will not be able to respond to the "improved system", patents are more complex than the IDs studied in this paper, why we might even experience and even larger tradeoff, putting SMEs behind MNCs in benefitting from the harmonization of IP. Policy makers should therefore, to ensure the intended effect for SMEs in the upcoming unified patent court, consider instruments to support SMEs. Our results suggests that the larger the size of the firm, the better equipped they are in adapting and thereby benefitting from harmonization of the legal IP system. Instruments to support SMEs could therefore be related to accessibility of certain knowledge domains and awareness of the change. Our estimations shows that human capital in law is central, as it is a significant driver in absorbing and responding to harmonization.

A third set of results is the empirical investigation of firms investing in creative outcomes, as a result of the harmonization of the ID application system. In a number of estimations, we identify a weak effect 4 years after the harmonization, however, the change occurs for all firms not only the firms investing in the IDs. Therefore, we find no support on firms applying for more IDs after 2003 to increase their knowledge pool in terms of designers and investing in creative outcomes. As such, we find no clear evidence that the unified ID system did have an effect on firms' creative innovation activities.

In conclusion, harmonization of IP legislation has been at the top of the policy agenda for decades. However, our level of knowledge on the implications of IP harmonization is very limited. The results presented in this paper, are first to study the effects at firm level, empirically giving us an understanding of how different firms, given their characteristics (size and type of employees and prior experience) adapts to harmonization of IP. The results highlights that harmonization of IP is by no means trivial, but instead complex, and might have unwanted effects on the competitive positioning between SMEs and larger firms. It should therefore be an imperative for policy makers currently working for harmonization of IP to investigate further the instruments and initiatives needed in order to achieve the desired adaptation to the harmonization of the IP legislation.

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