The relationship between tax payments and MNE's patenting activities and implications for real economic activity: Evidence from the Netherlands

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Abstract

We analyze the role of innovation in explaining tax payments using panel data analyzing patent active firms located in the Netherlands for the period 2000-2010. We estimate a model that looks at either the number of patent counts or the number of patent citations on tax payments. The results suggest that the coefficients on both the number of patent applications and patent citations enter the model negatively. Our model also suggests that the number of patent applications or citations per R&D euro invested is also negative. After some sensitivity checks, we find that these results are not affected when we consider sample selection and dynamics. In addition, our results reveal that the negative tax effect from patenting is merely driven by Dutch firms while foreign MNEs firms with higher investments in R&D pay lower taxes. As it is clear from these first results, this may reflect a limitation in the extent that firms in the Netherlands separate income from real innovative activity. To put some more emphasis on thus suggestive result, we also investigate to what extent innovating firms are actually embedded in real economic activities. We explore the role of both the Dutch patent box regime and the R&D tax credit that is put in place. Using a labor productivity analysis, weighted by employment, for the period 2011-2015, we find that these measures appear to have a productivity augmenting impact. Overall, our results suggest that the reallocation of income from innovation capital, which to a certain extent can be driven by beneficial tax schemes, does not seem to be interfere with real economic activities.

1 Introduction

It is well known that in a globalized economy, intellectual property (IP), such as patents, trademarks and copyrights, is a key driver of international competitive success. Many governments worldwide have indeed put innovation as a stimulus to growth at the forefront of their industrial policy agenda providing fiscal incentives, such as R&D tax credits and patent boxes, to firms investing in R&D.

A sizable literature on the effectiveness of innovation-related tax incentives exists. However, the use of such tax incentives raises the concern of policy makers about yet another tax device that can be employed by firms for tax structuring purposes in the sense that IP-related profits of multinational enterprises (MNEs) can be segregated from ordinary profits across borders. These concerns have been a driver of discussions in the context of the OECD Base Erosion and Profit Shifting (BEPS) and of the EU Code of conduct on business taxation with the aim to align taxation with substantial "research" activity. Because of the opportunity of tax structuring, one should be cautious when interpreting the evidence of the effectiveness of innovation-related tax incentives in view of the possibility that they may be driven by a shift in innovation efforts from one country to the other rather than an increase in net investment in innovation.

The focus of our paper is to empirically investigate the relationship between tax payments and MNEs innovation activities. In particular, we are interested to find out to what extent innovative MNEs pay lower taxes and whether they take advantage of tax credits in their real economic activity. The key methodological challenge in this relationship is to separate the tax structuring motive from the technological motive which concerns real economic activity rather than fiscal activity. To investigate the existence of a direct channel between innovation efforts and tax payment, we employ different measures of R&D efforts. We consider firm-level patenting activity (patent count applications and patent forward citations), R&D expenditures (investments and labor input) as well as R&D-related tax reductions, taking also into account other determinants of firm-level taxation. A major advantage of using patent applications is that the time of filing or applying for a patent coincides very closely with the time that innovative activities take place within a firm (Nagaoka et al., 2010).

Our empirical results show that both the quality and the quantity of firm-level patenting activities lead to lower tax payments. Indeed, this may be an indication that MNEs shift their

IP and R&D related assets, usually at relatively low costs, to countries with a beneficial innovation tax regime. This finding is in line with (the small body of) existence evidence. However, several factors may weaken the relationship between tax payments and innovation efforts. For instance, MNEs usually arrange protection of intellectual property rights in all countries in which they are active. In addition, tax schemes not specifically targeting R&D and innovation may also affect the decision to locate activities in a certain country. Therefore, we also investigate to what extent R&D investments per employee induces lower tax payments putting the hypothesis of real economic activities to the test. Our evidence confirms the existence of a positive relationship between R&D success (measured by R&D investments per employee and the number of patents/ citations per R&D euro) and reduced tax payments. This indicates that the Dutch tax regime provides a stimulus to a conducive environment for innovation.

In the next part of the paper, we zoom in on a specific tax measure to stimulate innovation, which is the innovation box, and study whether firms that take advantage of the innovation box regime also increase their real economic activities. The benefits of the innovation box regime are tied to a minimum requirement of R&D personnel that are subject to pay taxes in the Netherlands. Consistent with the literature, we hypothesize that the employment-weighted labor productivity of firms that utilize the innovation box and R&D related tax credits is higher than the productivity of firms that are not engaged in any of these tax policies. Using a decomposition analysis, we find evidence supporting our hypothesis: firms utilizing the innovation box regime have a higher labor productivity than firms that do not. Furthermore, we find that while the productivity premiums varies across industries, it does not vary systematically between the services sector and manufacturing.

The paper's focus on the Netherlands provides an interesting case because the Netherlands has put several tax instruments in place to lower taxes on R&D and IP-related innovation activities. Under the so called Dutch innovation box (originally introduced as patent box), income derived from innovations is subject to lower effective tax rates. This benefit can also be utilized by foreign companies with operations in the Netherlands as well as by Dutch firms with income derived from various types of intangible assets abroad. This accentuates the globalization issue as well as the key concern that a particular tax scheme must be tied to real economic activity.

Our data consist of a panel of patenting firms. The firms in our sample are enterprise groups (the highest national aggregate of the firm) located in the Netherlands, but not necessarily the ultimate parent firm since foreign control is possible (and controlled for in the analyses) The statistical unit "enterprise" is essential in the construction of dataset concerning patent data, because firms may register patents (and R&D) under different firm names. Generally speaking, the ownership of a patent applies at the level of the enterprise and it is practically impossible to link ownership to affiliate or plant level.

We consider two datasets. First, when looking at the relationship between innovation activities and tax payments using regression analysis, we consider a panel covering the period 2000-2010. We work with data including financial information, R&D expenditures, patent application counts, forward citations of these counts, and the utilization of the innovation box regime. A second dataset covers the period 2011-2015 which matches population data on the innovation box and the R&D tax credit regime, which enables us to verify to what extent R&D-related tax deductions are related to productivity and hence real economic activity.

The remainder of the paper is organized as follows. Section 2 presents a review of literature dealing with the relationship between innovation, tax payment and real economic activity. Section 3 outlines our hypotheses. Section 4 describes the data. Section 5 presents the empirical model. In Section 6 we present the estimation results of the model. Section 7 looks at real economic implications. Finally, Section 8 concludes.

2 Background and related literature

A compelling body of empirical literature shows that MNEs tend to shift income across borders (see Hines (1997), Gresik (2001) and Desai and Dharmapala (2009), among others, for an overview of the literature). The consensus is that MNEs face a significantly lower tax burden compared to domestic firms which do not have access to international tax strategies. For instance, Egger et al. (2010) estimate that foreign ownership reduces the tax burden by about 56 percent. MNEs can shift income across borders in two ways. First, they can locate the economic activities that generate income in the most beneficial location. For instance, an MNE can choose to locate its R&D center in a country that provides the most stimulating environment or the most R&D friendly tax regime. This offers firms the opportunity to minimize tax payments on the income generated from these activities. The OECD (2008) estimated the impact of tax rate differences on location choice. The results indicate that a reduction of the effective tax rate of 25 to 30 percent in one country leads to an investment increase of 30 percent in that specific country. Second, firms can also strategically price intra-firm transactions of goods and services (transfer pricing) to minimize the total tax burden by directing profit margins to the most tax-optimal location.[1]

In order to minimize tax payments, MNEs need to decide strategically where to locate tangible investments, human capital and IP investments. De Simone et al. (2016), using IRS-data on cross borders intra-firm transactions of US firms, show that the likelihood of US MNEs shifting income out of the country is positively related to subsidiaries in tax havens, high-tech operations, income tax incentives, R&D investment and foreign profitability, and negatively related to foreign sales, gross profits, and capital expenditures.[2] Grubert (2003) estimate that about 50 percent of US MNE's shifting of income to low tax countries can be accounted for by income from intangibles linked to R&D and IP activities. Intangible assets create opportunities for income shifting because it is less costly for intangible assets intensive firms to relocate their assets in comparison to capital-intensive firms (De Simone et al., 2016). One of the attractive features of IP is that ownership can be separated from the innovative activity, implying that firms can strategically claim ownership in favorable locations in term of taxation. This leads to a business model in which firms shift income by locating their patent activities in a country with a favorable tax rate and selling the right to use the patent (licensing) to affiliates in high tax countries.

2.1. Innovation Box Regimes

Intellectual property is considered to be an important determinant of firm growth (Hall and Sena, 2016). Therefore, many governments provide incentives to attract and retain MNEs by, for instance, providing tax credits on R&D or IP. Over the last decade, the introduction of the so called patent boxes refers to the introduction of reduced tax rates on revenues derived from IP and patent royalties. At the country-level, these patent boxes are very heterogeneous

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[1] Note that intra-firm transactions are required to be settled against market prices according to the Dutch corporate tax law.

[2] De Simone et al. (2016) use several proxies for intangible intensity. These include R&D, advertising (AD), "intangible assets" from the balance sheet, and selling, general & administrative costs (SG&S). AD expenses is a proxy to capture the investments such as self-created IP and brand value that are not capitalized; SG&A is a proxy for intangible assets so to capture investments related to administrative support, such as legal costs associated with patent and trade mark expenses.

in their design. For instance, in the Netherlands, the patent box applies to intangible assets that are self-developed and also covers intangible assets resulting from the efforts of R&D-labor. Alternatively, under the Belgian patent box regime, the patent must have been developed by the firm in an R&D center that qualifies as a branch of activity.[3]

A relevant strand of literature focuses on the way innovation is affected after an innovation box is implemented using patent data. For instance, Karkinsky and Riedel (2012), using data for European MNEs during the period 1995-2003, find a negative relationship between the difference in the relevant corporate tax rate imposed on an affiliate and other firms in the multinational enterprise group and the number of patent applications filed by the MNE affiliate. In particular, the authors find that a one percentage point increase in the corporate tax rate reduces patent applications filed in that location by around 3.5 percent. Alstadsaeter et al. (2015) employ a rich firm-level dataset concerning the top 2,000 corporate R&D investors worldwide covering the period 2000-2011. The authors show that offering a patent box regime is positively and significantly associated with attracting patents. Interestingly, a similar conclusion can be drawn for high quality patents which the authors consider as proxy for innovation with high earning potential. Related studies investigating to what extent innovation box regimes affect the location of firms' IP assets (Ernst and Spengel, 2011; Bradley et al., 2015; Gao et al., 2016; Hassbring and Edwall, 2013 and Koethenbuerger et al., 2016) come to similar conclusions.[4]

2.2. Implications for the real economy

The empirical evidence discussed so far does suggest that, generally speaking, tax rate reductions have strong effects on attracting patents. However, firms' patenting strategies may be heterogeneous when linked to the geographical dimension. Patent applications are not only affected by corporate tax rates in the host country, but also factors such as market size, competition intensity, the quality of the regulatory system, protection of IP rights as well as firm internal characteristics (quality of R&D personnel). For example, in an online survey

[3] Patent Box regimes were initially designed as an incentive to boost European R&D activity. Currently, there are seventeen countries in the world that have adopted innovation box regimes. Patent boxes have larger scopes than just patents and may additionally include trademarks, model designs, copyrights, domain names, trade secrets. (see Alstadsaeter et al., 2015)

[4] The empirical set up so to analyze how tax deductions may impact patent activities are different in some of these papers.

asking reasons why firms' remain in the Netherlands, den Hertog et al. (2015) report the following location determinants in order of importance: availability of qualified personnel, geographic location, personal preference, availability of knowledge centers, R&D know-how and policy related innovation incentives.

For several reasons, the link between location, tax payments and the innovation remains an empirical question. First, as pointed out by Chen et al. (2016), firms generally file for patent protection in all countries in which they are operatively active. Therefore, the association between IP related tax reductions and income shifting in a particular jurisdiction is unclear ex ante. Second, there is the threat of a crowding out effect. For instance, Evers et al. (2014) note, in the context of patent box regimes, that firms may already take advantage of alternative tax incentives available to them, watering down the importance of patent box related tax advantages. In addition, firms may relocate their IP income related activities but not their real economic activities. Third, the effective tax payments resulting from the patent box are also influenced by the design of the tax facility. In some countries, like the Netherlands, tax deductions are on the basis of net incomes after R&D cost deductions, to ensure that at least some real activity is associated with the patent box tax credit. In addition, the so called nexus approach, recently introduced by the OECD and the G20, is also a tax policy design aimed at ensuring that firms establish a clear link between real costs and benefits before taking advantage of relief tax facility. Consequently, the difference in effective tax payments between patenting firms that do not qualify for this type of tax policy and non-patenting firms may disappear.

A primary reason firms invest in, for instance R&D, is to increase their ability to innovate, which in turn provides opportunities for differentiation, organizational renewal, growth, and profitability. Indeed, one of the primary intents of introducing lower tax rates tied up to IP profits is also to encourage domestic innovation, which in return may lead to IP-related spillovers that are beneficial to growth, and hence the real economy.[5] In some countries,

[5] For instance, to ensure such aims is the discussion in the context of the OECD Base Erosion and Profit Shifting (BEPS) and at the EU Code of conduct on business taxation with the aim to align taxation with substantial "research" activity. This in turn enforces high-tax countries' policy to restrict the outflow of patents and other intangible assets from the host county to low-tax economies. Policy measures to circumvent such practices are for instance, tightened CFC legislation which makes foreign income taxable at the parent location. Another instrument is introduced in Germany in 2008 which allowed German tax authorities to tax a fraction of the future

including the Netherlands since 2008, the patent box regime modified its scope and also covers provisions specifying the link with the underlying research activity so to also include small and medium sized firms in the eligibility process.[6]

There is some interesting empirical evidence on the economic effects of R&D related tax credits. For example, Alstadsaeter et al. (2015) look at cross country mobility of inventors. They investigate whether patent applications lead to an increase in the number of inventors located in the country of patent registration and whether this occurs at the expense of the number of inventors located at the parent company.[7] The results show that locational shift of patents due to the existence of patent box regimes does not induce a corresponding shift in the base of inventors. Chen et al. (2016), using data of US and EU multinationals' subsidiaries from 2006 to 2014, find evidence that the introduction of innovation box regimes is associated with labor increases but do not result in significant increases in fixed asset investments. Using US located firm-level data for the period 1987-2010, Gao et al. (2016) regress multiple measures of firm-level tax payments on the number of patents as well as variables intended to capture patent counts and R&D success measured by patent application and citation counts per R&D dollar, with the premise that R&D investments lead to higher productivity of the innovation process.[8] They find robust evidence that patenting activities are strongly related to lower levels of taxation and this relationship is more pronounced for innovative firms located in states that have R&D tax credits. However, R&D success is not related to lower levels of taxation. Hence, these results suggest that firms are not inclined to allocate part of their income savings in higher R&D investments. Koethenbuerger et al. (2016), using data of European subsidiaries for the period 2007-2013, find that firms directly or indirectly owning patents (within the enterprise group) before patent box regimes were introduced, report on average 2.5 to 3.9 percent higher pre-tax profits compared to firms not owning patents. However, if the patent box regime only applies to newly created patents requiring a certain

income generated from patents and other (intangible) assets developed in Germany even after the relocation to a foreign income.

[6] See Evers et al. (2014) for a detailed overview on Innovation Boxes in an international perspective. In the Appendix we provide a short discussion on the Patent Box initiatives in the Netherlands.

[7] CEC (2014) points out that for EPO patent applications, the country of the inventor is not a reliable source as applications are not legally required to inform the EPO about the addresses of the inventors.

[8] R&D investments are usually regarded as the input side of innovation generating output innovation under form of patents, new products and/or processes, and hence, is therefore an important control (see Vancauteren et al., 2017).

amount of R&D activity, the difference in profits between the two groups disappears. The results indicate that nexus approach seems to be an effective instrument to prevent profit shifting and to encourage real R&D activity.

3 Hypotheses

Empirically, the focus of the paper is to investigate the relationship between various measures of taxation and MNE's innovation activities. The central premise of this paper is that innovating firms pay less taxes. Amongst other countries, the Netherlands has implemented the innovation box regime, which, by design, creates a tax-wise favorable environment regarding income generated from intangible activities (patents, R&D). We use historical data on patents as well as R&D efforts, and financial performance measures as extra controls to isolate the impact of innovation efforts on tax payments. Taking heterogeneity in patent citations into account enables us to separate the quantity and the quality component of patenting. A simple unweighted yearly sum of a firm's total patent counts is indicative of its volume; however, using information on the forward citations of these patents, we are capturing the quality effect of these patents. Higher patent quality implies a higher value of the innovation. Important determinants of patent quality are firm efficiency (Nagaoka et al., 2010), the willingness to take risks and accept uncertainty (Harhoff et al., 1999) and the investment in seeking network technological externalities (Capaldo and Petruzzelli, 2011).

In order to separate purely tax motivated patenting activities from patenting activity derived from real economic activity stemming from local R&D efforts, we also investigate the role of R&D investments. A primary reason for firms to engage in R&D is to increase their ability to innovate, which in turns provides opportunities for productivity growth. However, R&D investments are risky since firms must incur (considerable) costs in the present period with uncertain gains in the future (Roberts and Vuong, 2013).[9] These anticipated gains and the necessity to invest in R&D in order to spur firm growth are more likely to be realized if they are evaluated over a longer time period. This indicates that R&D activities may be perceived as a way to achieve long-term goals, suggesting that not only patent quality but also R&D investments are an important driver of firm growth. Specifically, if the Dutch taxation climate is actually conducive to the knowledge economy as a driver of economic growth in the sense

[9] The paper of de Haan and Haynes (2018) discusses dynamic R&D externalities and how this impacts national accounting measurement.

that it stimulates firms to invest in R&D locally, we should not find a significant difference between R&D efforts (input) and innovative output (i.e. patents) in the relationship with taxation.

These considerations can be operationalized into the following first set of hypotheses:

H1: The number of patents filed by MNEs is positively associated with lower tax payments.

H2a: Innovation success (quality) measured by the number of forward citations is positively associated with lower tax payments.

H2b: Innovation success measured by the number of patents or the number of forward citations per unit R&D investment is positively associated with lower tax payments.

The proposed analysis should yield an empirical answer to the question how tax credits relate to innovation among patenting firms. By incorporating R&D investments, we also put (to some degree) the hypothesis of real economic effects to the test. Further, if firms locate their innovation activities (both R&D and patenting activities) in a particular country merely to take advantage of tax benefits, this would have real economic implications. We dig into this issue by investigating to what extent innovation translates into higher productivity in terms of a more efficient allocation of resources, even though empirical evidence shows that taxation simultaneously provokes misallocation of resources.[10] To sort this out we use standard (productivity) approach, weighted by employment, to discern productivity differentials across sectors between firms that utilize these tax policies and firms that do not. In line with hypothesis 1 and 2, the third hypothesis states:

H3: the employment-weighted (labor) productivity of firms utilizing innovation related tax credits is higher than the employment-weighted productivity of firms that are not engaged in this type of tax scheme.

4 Data

We compile a panel dataset derived from various data sources for our analyses. First, we employ a dataset that consists of an unbalanced panel of over 2700 firms situated in the

[10] Pioneered in Restuccia and Rogerson (2008), the literature has looked at factors in explaining misallocation. These include amongst others labor and capital tax exemptions, but also institutional differences as well as input and output market imperfections.

Netherlands, representing the population of firms that has applied for at least one patent during the years 2000-2010. Unfortunately, more recent data was not available in time. The level of analysis is the enterprise group (the highest national aggregate of the firm) located in the Netherlands. We match the patent data to financial information using the General Business Register (GBR, the backbone of the firm-level statistics process in the Netherlands) in order to be able to connect tax payments and patent related activities. Second, we utilize a dataset consisting of an unbalanced panel of 343,025 enterprise groups which we match with the firm-level population data on the utilization of two tax instruments aiming at the stimulation of innovation: the innovation box and the WBSO covering the period 2011-2015. WBSO is a Dutch acronym for Promotion of Research and Development Act.[11] Earlier data of the innovation box and the WBSO is not available.

4.1. Patents and firm-level data

To collect information about the firms that applied for at least one patent, we used the database of the total population of filed patents in Europe (of the European Patent Office, EPO). The patent data gives us information about the application number, the patent owner (name of the firm), patent title, name of the inventor, year of publication and location. Since firms may register patents under different firm names, we retrieve information regarding the firms' complete ownership structure to match the names of patents with the direct ownership of the enterprise group of all their subsidiaries, holding units and their shareholders. This yields a dataset with patents matched to enterprise groups from the GBR.[12]

We also include information about forward citations. A forward citation means that a patent is cited by a later patent, which captures the relationship between a patent and subsequent technological developments that build upon it. The number of forward citations of a firm's patents is informative about the intrinsic quality of patents (Harhoff et al., 1999). We consider two measures of forward citation. First, we calculate the number of forward patent citations by later patents, issued by all patent granting authorities available in PATSTAT (European

[11] In Dutch: Wet Bevordering Speur- & Ontwikkelingswerk

[12] We refer to Vancauteren et al. (2017) for a more detailed description of the data. The paper applies a firm-level analysis using EPO patents for the period 2000-2006. For the purpose of this paper, we extended the database to the most recent year 2010 that can be retrieved from the PATSTAT database within Statistics Netherlands.

Patent Office (EPO), US Patent and Trademark Office (USPTO), Japanese Patent Office (JPO)), of all EPO patent applications (counts) for each sample firm.

The second measure concerns so-called patent families. A patent family refers to the set of patent applications across countries that protect the same technological invention, being defined as exactly the same priority or combination of priorities. For this reason, family patent data prevent double counting. The purpose of using family patent data as an indicator of patent value is to characterize to extent to which firms are involved with the internationalization of technology, and firms that seek international patent protection do so for the most valuable patents (Martinez, 2011). We use the so called DOCDB families, which include EPO expert control and consider the number of forward citations by later patents that belong to the same patent family. The forward citation data is restricted to all patents granted up to the year 2010 with forward citations until autumn 2016.[13]

We match consolidated financial information and foreign ownership information of MNEs located in the Netherlands to our matched patent dataset. These data cover the years 2000-2010 to arrive at a sample of 14,981 firm-year observations of 2,704 firms. These firms are in turn matched to a subsample of firms reporting R&D activities. We extract R&D data from the Community Innovation Surveys (CIS waves) and R&D surveys that are collected by Statistics Netherlands. We retain 4,166 firm-year observations distributed over 1,192 firms.

Summary statistics of our key variables (transformed to fit our analysis) are shown in Table A1. The statistics are based on the sample of firms concerning the period 2000-2010. The unweighted average firm in our sample applies for approximately 1.6 patent counts a year with an average number of forward citations of 1.4 resp. 1.9 for our two measures and spends on average 4.9 thousands of euros of R&D per employee. The average annual tax payment as a percentage of pre-tax financial income is equal to 24.1, which is very close to the Dutch corporate tax rate of 25 percent. We also note that the distribution of the patent variables is quite skewed, while the other variables are generally more evenly spread. The correlation matrix of the variables is presented in Table B2.

4.2. WBSO tax credit and innovation box

[13] See Martinez (2011) for a recent overview on the various definitions that are applied using the PATSTAT patent citation database.

Firms have to supply information on the number of hours of labor invested in R&D and the associated wage costs on an annual basis to be eligible for the WBSO. The WBSO only considers a credit for real R&D activities; R&D management is not taken into consideration. The match between the WBSO data (registered on the Chamber of Commerce number of the firm) with the GBR is set at the consolidated enterprise level. The WBSO data are available for the period 2011-2015.

The innovation box data are registered at the level of tax units, which are the legal entities used by the Dutch tax authority. These tax units can be matched to the enterprise groups of the GBR. It is important to note that the innovation box concerns profits that are derived not only from patents but also from intangible assets in general. Under certain circumstances, the patent is the intangible asset itself or de patent constitutes some part of the intangible asset. The innovation box data are available for the period 2011-2015. The data include information on the profits derived from the intangible assets, given they exceed a threshold value, and costs that are associated with it.[14]

5 Empirical Implementation

The following subsections present our stepwise empirical estimation strategy. First, we examine the impact of patenting activities on tax payments. This analysis is based on our panel dataset covering the period 2000-2010 which enables us to investigate if tax payments are correlated with patenting activities and patent quality. Our data also allows us investigate to what extent the introduction of the innovation box has accentuated this relationship for 2010, the initial period for which we have innovation box data.

5.1. Innovation and tax payments

We start by estimating the following equation to examine the effects of innovation activity (patenting) on tax payments:

[14] To get an idea of the internal consistency of the data concerning R&D, the innovation box and other dimensions of innovation, we refer to a recent study conducted by Statistics Netherlands that integrated the various data sources available on this topic (CBS, 2017b). Table B3 gives an overview of the number of firms that applied for the innovation box and that have applied for a WBSO tax credit during the period 2011-2015. The table indicates that there is complementarity between R&D input and innovation output: out of the 5,343 innovation box users, 3,312 firms have also applied for the WBSO. Notice that there is also still a significant number of firms that is granted a WBSO tax credit but that does not apply for the innovation box. Or in other terms, a considerable number of firms reports R&D input, but no innovation output.

$$TAX\_PAY_{it} = \beta_0 + \beta_1 PAT_{it-k} + \beta_2 \boldsymbol{X_{it}} + Year \,\&\, Industry\ Effects + \varepsilon_{it} \qquad (1)$$

where we let a firm be indicated by the subindex *i* and time be the subindex *t* and TAX_PAY_{it} is the firm's effective tax rate. TAX_PAY_{it} equals the ratio of taxes paid divided by financial income (i.e. profit before taxes). Based on empirical models used in the corporate tax payment literature (Dryeng et al., 2008, 2010; Mills et al., 2013; Gao et al., 2016) a firm's effective tax payment, TAX_PAY_{it} , is a widely used measure not only for evaluating a firm's ability to minimize income tax but also for evaluating a firm's strategy to defer tax payments to later periods (Erickson et al., 2004).

The variable of interest is PAT_{it-k} which expresses the various measures that capture a firm's patenting activities[15] (#patents, #direct/family controlled patent citations, #direct/family controlled patent citations per unit R&D), we allow for several k time lags as patenting activities and tax payments may not coincide contemporaneously. The vector of independent variables $\boldsymbol{X_{it}}$ represents firm's characteristics, and ε_{it} is a random error. We also include year and industry effects to capture unobserved heterogeneity.

We include the following independent variables in the vector $\boldsymbol{X_{it}}$ to explain the firm's effective tax rate: total assets ("Assets") measured in logs, the return on assets ("ROA"), the ratio of long-term debt to assets ("Leverage"), the ratio of tangible capital to total assets ("Tangible"), the ratio of intangible income to total assets ("Intangible"), the ratio of inventory to total assets ("Inventory"), the ratio of foreign income to total income ("Foreign"), R&D investment per employee[16] measured in logs, and a dummy ("Ownership") that takes the value 1 if the firm is the firm is foreign owned. The choice of these variables is based on previous studies with respect to explaining firm-level tax payments (see e.g., Gao et al., 2016, and Dryeng et al., 2008, for a recent review).

The variable "Assets", a proxy for the size of a firm, is expected to be negatively correlated with tax payments because it is argued that larger firms are able to work the tax system better than do smaller firms (Mills et al., 1998; Dryeng et al., 2008) and have greater resources to

[15] We refer to the data section for further details on these measures. Table B1 in the appendix lists all the variables and its definitions that are considered for this paper.
[16] 1+R&D per employee

engage in tax planning to reap the benefits from tax shelters (Gao et al., 2016). We also include firms' profits, "ROA", and hypothesize that profits and tax payments are positively correlated (Gupta and Newberry, 1997; Mills et al., 2013). On the other hand, more profitable firms have a larger incentive to engage in tax structuring due to their greater potential of cost savings (Manzon and Plesko, 2002; McGuire et al., 2012). The variables a firm's leverage, its fixed tangible and non-tangible capital capture firm characteristics that may also affect a firm's income tax liability. Firms with a higher leverage ("Leverage") have been found to pay lower taxes (Desai and Dharmapala, 2009) and, regarding MNEs, have a greater incentive to locate their leverage in high tax jurisdictions (Newberry, 1997). Generally, these studies posit a negative relationship between leverage and tax payments. We also control for the ratio of tangible capital to total assets ("Tangible") and non-tangible capital to total assets ("Intangible") which is expected to be negatively related to tax payments. This is because capital intensive firms have lower tax burdens as a result of legislated tax shields (Gupta and Newberry, 1997). In addition, countries often offer tax policies aimed at the promotion of investments, which provides tax planning opportunities (Mills et al., 2012). According to Evers et al. (2012) firms with a greater inventory intensity ("Inventory") are restricted in their tax planning activities. Accordingly, we expect a positive relationship between inventory and tax payments. As a final control, we also take into account the income of foreign affiliates scaled by total income, "Foreign", to proxy for income shifting opportunities of MNEs (Mills et al., 2012).

6 Results

In this section we present our estimation results for the first part of our analysis, presenting the various specifications and robustness checks .

6.1. Innovation and tax payments

We first focus on the regression results explaining tax payments, see Table A2. The model is estimated using OLS and results reported use robust standard errors clustered at the firm level. Four variants have been estimated. In the first column (I), we present the results without sector and year dummy effects, using patent counts. The remaining columns (II-IV) show the results with sector and year dummy effects, using patent counts and two measures of patent citations as proxies for patent quality. First, we notice that the coefficients of the patent count variables are negative and significant ranging between -0.012 (p-value 0.03) and -0.014 (p-value 0.004), after controlling for additional firm characteristics. These results indicate that the more patents a firm produces, the lower its effective tax rate, a result that validates hypothesis H1. Second, a robust finding from our regression is that a firm's engagement in R&D activities consistently and significantly negatively affects its effective tax rate. This suggests that firms pay lower taxes as they increase their R&D expenditures per employee. Indeed, this result can be partially explained by R&D tax incentives that are available to firms, as far as these concern benefits in terms of profit tax. An important result is that the effect of both patenting (innovation output) and R&D activities (innovation input) enter the relationship with tax payments significantly.

In column III and column IV, we employ patent citations as our dependent variable of interest in order to test hypothesis H2: "citations1", the number of direct forward citations by all other patents; and "citation2", measured by the number of forward citations by later patents that belong to the same patent family. The variable "citations1" is not significant. However, we find that the more accurate patent quality measure, the number of forward citations by later patents that belong to the same patent family ("citation2"), is significantly negatively related to lower tax payments..

The additional control variables show that tax payments are positively related to the size of the firm (measured by its total assets), its profit, (measured by the return on assets) and its tangible and intangible asset ratio's. The leverage of the firm is negatively associated with tax payments. These results partially align with earlier findings as discussed in section 5.1.

Some robustness checks At this stage, we conducted some robustness checks to investigate the sensitivity of our results to various data issues, see Table A3. As a first robust check, we tackle the issue of selectivity in R&D expenditures and account for the fact that firms with missing R&D expenditures may be engaged in patenting activities. To get an idea on the importance of 'missing' R&D, Koh and Reeb (2015) show that firms not reporting R&D have patents that are on average 27 percent more influential than R&D reporting firms. We run the regression for all firms, that is, R&D reporting and non-R&D reporting firms. From the panel B column of Table A3, we can infer that our result in terms of the negative effect of patent counts on tax payments becomes even stronger (patent coefficient is -0.025, p-value is 0.002). In column panel C, we set the R&D expenditures of firms with missing values to zero. The results are only slightly affected. This implies that the importance of R&D expenditures as an extra control variable does not seem to affect the negative relationship between patent activities and tax payments. A second robustness check involves adding a control group of non-patenting firms in our sample to the regressions. We match a control group of non-patenting firms with a firm size (in terms of sales revenue) closest to the patenting firm within the same industry (by two digit SIC classification). We then add an additional dummy variable for non-patenting 'counterfactual' firms. If the coefficient estimate of the dummy variable has the expected sign and significance, we can conclude that patenting activities do indeed have an effect in terms of tax payments (Gao et al., 2016). The coefficient on patent counts is -0.021 (p-value 0.003) and, in line with expectations, the coefficient of the "Zero Patent" dummy variable is positive and significant (coefficient is 0.012, p-value 0.003). These results thus confirm that patenting firms face a lower effective tax rate relative to non-patenting firms.

Patents and R&D success Table A3, Panels E-F, present the results regarding hypothesis H3 regarding alternative measures of the quality of innovations by looking at patent counts and the patent citations per unit R&D investment. Because it may take several years to reap the benefits of R&D projects, we try using both patent counts and patent citations with a three year lag. The results show that the coefficients of each of these measures is significant and returns the expected sign.[17]

Our results confirm hypotheses 1, 2A and 2B confirming to a certain extent that the Dutch taxation regime provide a stimulus to the innovation-based economy. Indeed, on the one hand, patent-active firms are less tax liable, which can be indicative for a favorite tax regime. On the other hand, we also find that the R&D investments, measured by the number of patents or citations per R&D euro invested, is also associated with less tax payments.

Innovation Box To measure the effect of the innovation box on the stimulation of innovation, we consider the interaction between the Dutch innovation box and both R&D and patenting activities. We use the Dutch innovation box for the year 2010. This tax device allows firms to enjoy a tax credit of 5 percentage on profits derived from intangible assets (not only patents) that have resulted from local R&D investments (i.e. R&D personnel) by the firm. As of 2010,

[17] We also tested the relationship between current year R&D, and tax payments. This did not yield any significant results.

firms need to provide proof that the qualified intangible assets derive from the deployment of the firm's own R&D staff. We define the innovation box (IB) as a dummy variable with value 1 if the firm has successfully applied for the IB.

The results, based on the specification of the models reported in Table A2, are presented in Table A4, columns Panels H-I. Fitting the model with data for 2010, we fail to find a significant relationship between patenting and tax payments. Both the coefficients on the interaction terms with patent counts are not significant in addition to the coefficients on the lagged patent measures. Similar results are obtained when we use the aggregated patent counts of year t, t-1 and t-2 or the lagged aggregate (t-1, t-2 and t-3) as an additional robustness test instead, or alternatively, when we express patent counts in 4 or 5 year averages.[18]

The role of ownership Table A4, Panels J-K considers the role of multinational headquarters. We subgroup our sample where we define a subsample of firms with Dutch headquarters and a subsample of firms that have a foreign parent. We note that a majority of Dutch headquartered firms also fulfill the definition of MNE since they have also foreign subsidiaries. We find that the coefficient of patents is significant for the Dutch firms while the coefficient related to the patent activities of foreign firms is not significant. For R&D, it is the other way around: foreign firms that do more R&D enjoy higher tax benefits than do foreign firms with lower R&D, but while the sign of the R&D variable is negative in the Dutch panel, it is not significant. These results indicate heterogeneous behavior between foreign MNEs and firms located in the Netherlands, namely that for those firms who do shift some of their activities to the Netherlands there is no significant relationship between patenting and tax payments. For foreign firms, the result implies that the tax benefit has a positive effect on the real economy, as only actual R&D activities performed locally lower the tax burden.

7 Implications for local economy

As already highlighted in Section 6 of the paper, our empirical results show that both the quality and the quantity of firm-level innovation output is positively related to a lower effective tax rate. This may be an indication that there is no valid reason to justify concerns

[18] Dynamics are important as we work with patent applications. The European patent grant procedure takes about three to five years from the date your application is filed. It is made up of two main stages. The first comprises a formalities examination, the preparation of the search report and the preliminary opinion on whether the claimed invention and the application meet the requirements of the EPC. The second involves substantive examination.

related to cross-border tax planning, since patenting firms reaping the benefits of their inventions in terms of lower tax payments also seem to major R&D players.

A natural question that remains regarding hypothesis H3 is to what extent innovating firms are actually embedded in real economic activity. We consider the measure of labor productivity to dig into this question.

In order to achieve this, we decompose productivity into the contribution of firms that receive tax credits from the innovation box and the WBSO-device and the contribution firms that did not. The analysis is conducted at the sector level for the years 2011-2015.

The productivity contribution of firm i belonging to category k in a sector j at period t is given by:

$$P_{jt}^{K_j} = \frac{1}{L_{jt}^{K_j}} \sum\nolimits_{i \in K_j} L_{ijt} P_{ijt}$$

where L_{ijt} is the employment of firm i in sector j at time t and P_{ijt} is its labor productivity, measured by value-added per employee, K_j designates the category type per sector j and $L_{jt}^{K_j}$ measures the total employment at firms in category K_j. We consider two categories. First, we compare a category of firms that utilized the innovation box regardless of whether or not they also received a WBSO tax credit. Second, we define a category of firms that both utilized the innovation box and received WBSO tax credit.

To understand how these firms differ by category from the rest of the sector we compute the the weighted average labor productivity in sector j:

$$\bar{P}_{jt} = \frac{1}{L_{jt}} \sum\nolimits_{i} L_{ijt} P_{ijt}$$

The ratio $P_{jt}^{K_j}/\bar{P}_{jt}$ captures the extent to which productivity in these categories differs.

The ratios expressed in 2 digit NACE averages are reported in Table A5 with standard deviations in parentheses. The first column reports the number of firms that utilized the innovation box, column 2 lists the labor productivity ratio of this subset of firms to that of the total number of firms in the sector, column 3 reports the number of firms that utilized both the innovation box and the WBSO, column 4 reports the ratio of this subset of firms vis-à-vis the total number of firms within the respective sector. We also report the average labor productivity as well as the average employment by sector. Looking at the differences between the two categories, we see that the majority of firms that utilized the innovation box also applied for a WBSO tax credit. For instance, in the IT and IT related service sector (62-63) we see, throughout the period 2011-2015, 898 firms that were granted an innovation box tax credit of which 611 firms also applied for the WBSO tax credit. This makes also sense because these tax instruments are complementary of nature, one focusing on innovation input, the other on innovation output. A labor productivity ratio larger than one indicates that firms that take advantage of the innovation box are more productive compared to the average weighted labor productivity within a particular sector. We see that for the majority of sectors, this is indeed the case. Sectors with relatively large labor productivity premiums include machinery and equipment (28) , textiles and clothing (13-15), furniture and n.e.c. (31-33). Sectors with a negative productivity premiums for firms engaging in R&D and innovation specific tax policies are transportation and storage (49-53) and distribution of natural resources (35-39). Furthermore, we find that these premiums vary by industry, but not systematically between services and manufacturing. In conclusion, the evidence supports the hypothesis that innovation tax credit policies are in general positively associated with higher levels of labor productivity.

8 Implications National Accounts

In July 2016 the Statistical Office of Ireland revised its GDP figure according to the accounting standard framework set by the ESA 2010. The revision implied that the Irish economy had grown by 26.3 per cent over 2015. The revision triggered a trail of comments from economist, statisticians, and the media, the bottom line of which was that growth figures of this order of magnitude were hard to take seriously. Paul Krugman referred to the issue as “Leprechaun economics”. Referring to James Joyce and Flann O’Brien, The Financial Times drew a comparison to the Irish merits regarding works of fiction (The Financial Times, July 12 2016).

For a large part, the growth of Irish GDP was the consequence of inversions related to firms moving assets, intellectual property or domicile. Being a small open economy, Ireland largely depends on foreign direct investment, and with an attractive corporate tax climate, the country proves to be attractive for big multinational companies.

In response to its publication, Eurostat responded that "[t]his revision can be seen as an effect of increasing globalization. It is primarily due to the relocation to Ireland of a limited number of big economic operators. Based on the preliminary information provided by the CSO, including data, the revision is plausible" (Eurostat, 2016). In addition, the pertinent communication warns that this could happen again, "if huge multinationals move their business around Europe or the globe."

It is important to reemphasize that the 2015 Irish growth figure was not the product of some evil statistician, but the result of applying internationally agreed accounting rules. However, clearly, this example shows the cautions one must be aware of when interpreting GDP figures, as the relation to real economy activity may be tenuous in cases where globalization issues play a big role. In general, the activities of multinational companies may raise concerns for the compilation of National Accounts (OECD, 2014). In particular, although there are other considerations to be taken into account, lower tax countries are evidently attractive for businesses to locate. This in itself is not directly a problem but, as recognized by for example by the OECD-led initiative against Base Erosion and Profit Shifting (BEPS), in practice the locus of production and the location where taxes are paid may get separated, undermining the fairness of tax systems, and indirectly affecting the quality of measuring national economies.

In addition, cross-border intra-firm flows are hard to measure, as a consequence of so-called transfer pricing: firms may strategically price their (intra-firm) exports so as to allocate profits to the location with the most attractive tax regime. Therefore it becomes harder to assess where the actual economic activity is taking place, which affect not only GDP but also the Balance of Payments. In this context, measurement of intellectual property and flows of R&D is particularly prone to such measurement problems, as market prices are absent and there is no physical flow of products. Because R&D and IP investment have to be capitalized under the SNA 2008 guidelines, this impacts directly upon GDP.The empirical results in this paper show that in general firms located in the Netherlands that innovate, benefit from a relatively lower tax burden. With respect to R&D, this means that the tax incentive seems to stimulate innovative efforts, creating employment for knowledge workers. For patenting activities, especially high quality patents seem to decrease the tax burden, so that it can be argued that the tax incentive stimulates high quality innovation.

Separating domestic and foreign owned firms, the patenting effect seems to concern mainly Dutch firms, while doing more R&D does not seem to be associated with a lower tax rate in this group. On the other hand, foreign MNEs with higher investment in R&D appear to have a higher tax benefit than foreign MNEs that do less R&D. In this sense, foreign firms can be thought to be stimulated to shift R&D to the Netherlands. As indicated in the previous section, this means that real economic activity is shifted to the Netherlands (R&D investment), adding to local and macro GDP. In itself, this does not pose any measurement problem for national statistics. However, the intra-firm knowledge flows following from such investments, which may be subject to strategic transfer pricing, are a challenge for National Accounts. For example, prices for the export of R&D products could be set at an artificially high level, effectively moving income from abroad to the Netherlands, so as to benefit from the lower effective tax rate provided by the innovation tax regime. In fact, such considerations could be part of what is driving this result.

On the other hand, our results suggest that the transfer of income generated by patents is not an issue, as patent activities are not associated with lower tax payments. In addition, the magnitude of the coefficients in our analysis do not suggest that reallocation of R&D is such a large scale phenomenon that National Accounts figures for the Netherlands are heavily affected by this. For the innovation box in particular, the 5% tax reduction does also not seem so generous to be causing major reallocations of innovation activities. Finally, our results indicate that foreign owned firms do not pay relatively less taxes (when controlling for innovative behavior, and financial variables). Nevertheless, this analysis does hint at what could be the mechanism behind the profit shifting, and measurement problems can be exacerbated in countries with more generous tax schemes and a greater dependence on FDI.

9 Conclusion

We analyze the role of innovation in explaining tax payments using panel data analyzing patent active firms located in the Netherlands for the period 2000-2010. We estimate a model that looks at either the number of patent counts or the number of patent citations on tax payments. The results suggest that the coefficients on both the number of patent applications and patent citations enter the model negatively. Our model also suggests that the number of patent applications or citations per R&D euro invested is also negative. After some sensitivity checks, we find that these results are not affected when we consider sample selection and dynamics. In addition, our results reveal differences between domestic and foreign firms. Our results reveal that the negative tax effect from patenting is merely driven by Dutch firms while foreign MNEs firms with higher investments in R&D pay lower taxes. As it is clear from these first results, this may reflect a limitation in the extent that firms in the Netherlands separate income from real innovative activity.

To put some more emphasis on thus suggestive result, we also investigate to what extent innovating firms are actually embedded in real economic activities. We explore the role of both the Dutch patent box regime and the R&D tax credit that is put in place. Using a labor productivity analysis, weighted by employment, for the period 2011-2015, we find that these measures appear to have a productivity augmenting impact.

Overall, our results provide some basis for the ongoing debate on real economic measurement in the context of globalization and has implications for National Accounting as well as policy. For example, we postulate that the reallocation of income from innovation capital, which to a certain extent can be driven by beneficial tax schemes, does not seem to be interfere with real economic activities. And, national account figures for the Netherlands will therefore not be hardly affected.

References

Alstadsaeter, A., S. Barrios, G. Nicodeme, A. Skonieczna, and A. Vezzani (2015), Patent boxes design, patents location, and location of R&D. Working paper.

Bradley, S., Dauchy E. and L. Robinson (2015), Cross-country evidence on the preliminary effects of patent box regimes on patent activity and ownership. Mimeo.

Capaldo, A. and M. Petruzzell (2011), In search of alliance-level relational capabilities. Balancing innovation value creation and appropriability in R&D alliances, Scandinavian Journal of Management, 27 (3): pp. 273-286.

Chen, S., De Simone, L., Hanlon, M., & Lester, R. (2016).*The Effect of Innovation Box Regimes on Income Shifting and Real Activity* (No. 3453).

CBS (2017b), Innovatie en Internationalisering: Inventarisatie van bronnen en populatieschets, Report.

Desai, M. and D. Dharmapala (2009), Corporate tax avoidance and firm value, Review of Economics and Statistics, 91: 537-546.

De Simone, L., L. F. Mills, and B. Stomberg (2016). Using IRS data to identify income shifting firms.

De Waegenaere, A., Sansing, R., and Wielhouwer, J. L. Financial accounting effects of tax aggressiveness: Contracting and measurement. Contemporary Accounting Research, 32(1):223–242, 2015

Dyreng SD, Hanlon M, Maydew EL (2008) Long-run corporate tax avoidance. Account Rev 83(1):61–82.

Egger, P., W. Eggert, and H. Winner (2010), Saving taxes through foreign plant ownership, Journal of International Economics, 81, 99-108.

Erickson, M., Halon, M. and Maydew, E. (2004). How much firms pay for earnings that do not exist? Evidence of taxes paid on allegedly fraudulent earnings. The Accounting Review, 29, (2), 387- 408

Ernst, C. and C. Spengel (2011), Taxation, R&D tax incentives and patent application in Europe, ZEW Discussion Papers 11-024.

Evers, L., Miller, H., & Spengel, C. (2014). Intellectual property box regimes: Effective tax rates and tax policy considerations. *International Tax and Public Finance*, *22*(3), 502–530.

Gao, L., Yang, L. and J. Zhang (2016), Corporate patents, R&D success, and tax avoidance, Review of Quantitative Finance, 47: 1063-1096.

Griffith, R., Miller, H. and M. O'Connell (2014), Ownership of intellectual property and corporate taxation, Journal of Public Economics 112: 12-23.

Grubert, H. (2003), Intangible Income, Intercompany Transactions, Income Shifting, and the Choice of Location, *National Tax Journal*, **56**:1, pp. 221-42

Gupta S, Newberry K (1997), Determinants of the variability in corporate effective tax rates: evidence from longitudinal data. J Account Public Policy 16(1):1–34

De Haan, M and J. Haynes (2018), R&D capitalisation: Where did we go wrong?, Paper prepared for the CRIW 2018, Washington DC.

Harhoff, D., Narin, F., Scherer, F. M. and K. Vopel (1999), Citation frequency and the value of patented inventions, *The Review of Economics and Statistics*, **81**, issue 3, pp. 511-515.

Hassbring, P. and E. Edwall (2013), The short-term effect of patent box regimes. Working paper.

Den Hertog, P., Vankan, A., Verspagen, B., Mohnen, P., Korlaar, L., Eren, B., Janssen M. and B. Minne (2015), Evaluatie innovatiebox 2010-2012, Report prepared for the Ministry of Finance.

Hall, B. and Sena, V. (2016), Appropriability mechanisms, innovation and productivity: Evidence from the UK, Paper prepared for the CDM conference, Paris, Oct. 8-9, 2014. NBER Working Paper No. 20514 and UNU-MERIT Working Paper No. 2014-059. *Economics of Innovation and New Technology*, 2016.

Hines, J.R. and E, Rice (1994), Fiscal paradise: Foreign tax havens and American business, The Quarter Journal of Economics 109, 149-182.

Karkinsky, T. and N. Riedel (2012), Corporate taxation and the choice of patent location within multinational firms, Journal of International Economics 88, 176-185.

Koethenbuerger, M., Liberini, F. and M. Stimmelmayr (2016). Is it luring innovations or just profits, Mimeo.

Koh, P.S. and D. Reeb (2015), Missing R&D, Journal of Accounting and Economics 60, 73-94

Manzon G, Plesko G (2002) The relation between financial and tax reporting measures of income. Tax Law Rev 55:175–214

Martinez, C. 2011. Patent families: When do different definitions really matter? Scientometrics 86: 39-63.

McGuire S, Omer T, Wang D (2012) Tax avoidance: does tax-specific industry expertise make a difference? Account Rev 87(3):975–1003

Mills L (1998) Book-tax differences and internal revenue service adjustments. J Account Res 36(2): 343–356.

Mills, L., Nutter, S. and C. Schwab (2013), The Effect of Political Sensitivity and Bargaining Power on Taxes: Evidence from Federal Contractors, The Accounting Review, 88, 3, 977-1005.

Nagaoka, S., Motohashi, K. and A. Goto (2010), Patent statistics as an innovation indicator, in B. Hall and N. Rosenberg (eds.): Handbook of the Economics of Innovation, Elsevier.

OECD (2008), Tax effects on foreign direct investment – Recent evidence and policy analysis, OECD Tax Policy Studies No. 17.

Restuccia, D. and R. Rogerson (2008), Policy distortions and aggregate productivity with heterogeneous establishments, Review of Economic Dynamics, Volume 11, Issue 4, pp. 707-720.

Roberts, M. and V. Van Anh (2013), Empirical modeling of R&D demand in a dynamic framework, *Applied Economic Perspectives and Policy*, Volume 35, Issue 2, Pages 185–205,

Stimmelmayr, M., Koethenbuerger, M. and F. Liberini (2016), Is it luring innovations or just profit? The case of European patent boxes, Annual Conference 2016 (Augsburg): Demographic Change.

Vancauteren, M., Melenberg, B., Plasmans, J. and R. Bongard (2017), Innovation and productivity of Dutch firms: A panel data analysis, Discussion paper, Statistics Netherlands, The Hague/ Heerlen, the Netherlands.

Appendix A: Results

Table A1: Sample Means and Standard Deviations, 2000-2010

Summary statistics of the overall sample consisting of 4166 panel firm-year observations. Number of firms is 1192.

Variable	Mean	Std. Dev.	Q1	Median	Q3
Log of patent counts	0.491	0.946	0	0	0.691
Log of citation1 counts	0.358	0.942	0	0	0
Log of citation2 counts	0.642	1.356	0	0	0.693
ETR	0.241	0.218	0.061	0.238	0.333
Assets	11.270	2.381	9.651	11.221	12.942
Leverage	0.201	0.224	0.001	0.140	0.316
ROA	0.091	0.116	0.018	0.066	0.120
Inventory	0.136	0.157	0.108	0.033	0.211
Tangibles	0.249	0.204	0.085	0.194	0.367
Intangibles	0.050	0.114	0	0.002	0.038
Foreign Income	0.049	0.115	0	0	0
Log R&D per employee	1.587	1.377	0.476	1.322	2.351
Origin (Foreign/Dutch, 1/0)	0.344	0.475	0	0	1

Table A2: Corporate tax payments and patents

Dependent variable is corporate tax payment. OLS with (robust) standard errors. Statistical significance is indicated by stars (*:10%, **:5%, ***:1% significance level). 4166 panel firm-year observations. Number of firms is 1192. All continuous control variables (except those in logs) are bounded between the 1st and the 99th percentile at each year.

Indep. Var-s **PANEL A**	**(I)**	**(II)**	**(III)**	**(IV)**	
Log Assets	0.009*** (0.002)	0.014*** (0.002)	0.012*** (0.002)	0.013*** (0.002)	
Leverage	-0.048** (0.019)	-0.034** (0.019)	-0.0360** (0.019)	-0.036** (0.017)	
ROA	0.251*** (0.040)	0.248*** (0.037)	0.248*** (0.037)	0.248*** (0.036)	
Inventory	0.068*** (0.019)	0.026 (0.020)	0.028 (0.020)	0.027 (0.020)	
Tangibles	0.112*** (0.020)	0.126*** (0.022)	0.131*** (0.022)	0.128*** (0.022)	
Intangibles	0.113*** (0.039)	0.113*** (0.036)	0.113*** (0.036)	0.114*** (0.038)	
Foreign	0.038*** (0.008)	0.036*** (0.009)	0.040*** (0.009)	0.038*** (0.009)	
Ownership	0.003 (0.008)	-0.008 (0.009)	-0.007 (0.008)	-0.008 (0.008)	
Lag log (1+R&D per employee)	-0.010*** (0.002)	-0.010*** (0.003)	-0.012*** (0.003)	-0.011*** (0.003)	
Lag log (1+patent applications)	-0.012*** (0.030)	-0.014*** (0.004)			
Lag log (1+forward citation1)			-0.005 (0.004)		
Lag log (1+forward citation2)				-0.008*** (0.003)	
Sector Effect	No	Yes	Yes	Yes	
Year dummies	No	Yes	Yes	Yes	
Intercept	0.095*** (0.020)	0.086** (0.044)	0.108** (0.044)	0.092** (0.044)	
R^2	0.071	0.142	0.140	0.142	

Table A3: Corporate tax payments and patents, alternative panels

Dependent variable is corporate tax payment. OLS with (robust) standard errors. Statistical significance is indicated by stars (*:10%, **:5%, ***:1% significance level)

	PANEL B R&D Missing	**PANEL C** R&D Missing =0	**PANEL D** Adding non-patenting firms	**PANEL E** Inno-vation quality	**PANEL F** Inno-vation quality	**PANEL G** Inno-vation quality
Lag log (1+patent applications)	-0.025*** (0.002)	-0.028*** (0.002)	-0.021*** (0.003)			
Zero Patent			0.012*** (0.003)			
Lag log (1+R&D per employee)		-0.021*** (0.001)				
Lag (patents/R&D 3YR				-2.669* (1.661)		
Lag (citations1/R&D3YR)					-1.512** (0.791)	
Lag(citations2/R&D3YR)						-0.442** (0.218)
Sector Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14847	14874	31736	1723	1723	1723
R^2	0.170	0.164	0.205	0.136	0.136	0.136

Table A4: Corporate tax payments and patents, Innovation Box regime

Dependent variable is corporate tax payment. OLS with (robust) standard errors. Statistical significance is indicated by stars (*:10%, **:5%, ***:1% significance level)

	PANEL H Innovation Box **(YR 2010)**	**PANEL I** Innovation Box **(YR 2010)**	**PANEL J** Dutch	**PANEL K** Foreign
Lag log (1+patent applications)	0.004 (0.014)	0.005 (0.010)	-0.016** (0.009)	0.002 (0.007)
Lag log (1+patent applications)*InnBox		-0.014 (0.028)		
InnBox	-0.019 (.026)	-0.082* (0.045)		
Lag log (1+R&D per employee)* InnBox		0.040** (0.021)		
Lag log (1+R&D per employee)	-0.022** (0.010)	-0.032** (0.013)	-0.006 (0.003)	-0.018*** (0.006)
Sector Effect	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	259	259	1861	1237
R^2	0.301	0.309	0.271	0.155

Table A5: Average relative labor productivity (LP), 2011-2015

Industry	#Firm Inn Box	LP ratio IB firms	#Firm_ Inn Box AND WBSO	LP ratio Inn Box& WBSO firms	LP (all firms)	Average Employ-ment (all firms)
Food (10-12)	569	1.032 (0.102)	506	1.033 (0.081)	156.123	28.163
Textiles, clothing (13-15)	36	1.291 (0.125)	32	1.258 (0.106)	65.930	19.446
Wood, paper, printing (16-18)	101	1.124 (0.172)	82	1.122 (0.171)	78.884	23.176
Chemicals, pharmaceuticals (19-21)	320	1.082 (0.115)	270	1.091 (0.122)	161.261	121.988
Plastics, non-metallic minerals (22-23)	286	1.066 (0.094)	254	1.061 (0.093)	80.860	34.120
Basic, fabricated metals (24-25)	507	1.211 (0.057)	438	1.227 (0.061)	78.965	27.859
Computers, electrical equipment (26-27)	391	1.150 (0.308)	363	1.184 (0.328)	130.631	43.584
Machinery, equipment n.e.c. (28)	782	1.302 (0.247)	663	1.334 (0.259)	109.533	40.797
Motor vehicles, other transp. (29-30)	172	1.162 (0.133)	152	0.869 (0.119)	88.971	54.145
Furniture, n.e.c. & recycling (31-33)	306	1.438 (0.144)	262	1.424 (0.187)	56.542	18.960
Distribution natural resources (35-39)	70	0.570 (1.4720	56	0.593 (1.464)	131.920	74.552
Construction (41-43)	263	1.059 (0.070)	240	1.064 (0.071)	66.364	17.914
Retail and wholesale (45-47)	1467	0.820 (0.163)	1229	0.820 (0.163)	53.580	22.834
Transportation and storage (49-53)	56	0.595 (0.083)	43	0.642 (0.122)	69.765	51.046
Publishing & audio (58-60)	45	1.388 (0.628)	26	0.966 (0.732)	74.718	17.911
Telecommunications (61)	62	1.085 (0.021)	24	1.070 (0.060)	218.916	93.406
IT & related services (62-63)	898	1.131 (0.084)	611	1.089 (0.139)	84.258	11.050
Financial institutions (64-66)	n.a.					
Consulting & architectural and engineering activities(69-71)	1155	1.116 (0.073)	901	1.189 (0.135)	83.669	5.314
R&D (72)	269	1.403 (0.169)	210	1.477 (0.151)	59.511	16.654
Advertising & other professional activities (73-75)	155	1.463 (0.426)	105	1.492 0.461)	58.906	8.051
OTHER Services, n.e.c. (77-82)	290	1.655 (0.761)	210	1.185 (0.850)	51.477	60.102

Appendix B: Additional tables

Table B1: List of Variables; Variable names in brackets refer to items compiled from the Statistics Netherlands financial database on Non-financial enterprises (NFO).

Variable	Definition
Basic Firm characteristics	
TAX_PAY	MNE's tax payments, defined as the ratio of taxes paid divided by pretax financial income (V14/V13). TAX_PAY values above one (below zero) are set to one (zero). (see also Mills et al., 2013)
Assets	Natural logarithm of assets (D80)
Leverage	Ratio of long-term debt to total assets (C50/D80)
ROA	The ratio of total profitability divided by total assets (V6+V7)/D80
Tangible	Ratio of tangible assets divided by total assets (D20/D80)
Intangible	Ratio of intangible assets divided by total assets (D10/D80)
Inventory	Ratio of inventory to total assets (D50/D80)
Foreign	Ratio of pretax foreign income to total income of subsidiaries (V71/V7)
Firm size	Natural logarithm of average number of employees in each firm of the year, collected in September of that year
Ownership	= 1 if firm is foreign owned; = 0 if firm is in the hands of a Dutch company
Firm innovative activities	
PATENT	The number of patent applications (counts) recorded by EPO for a firm during the application year, ,measured as log(0.1+PATENT) in regression analysis
CITATION1	The number of forward patent citations by later patents, issued from all patent granting authorities available in PATSTAT (EPO, USPTO, JPO, …), for all EPO patent applications (counts) for each sample firm. The analysis is restricted to all patents granted up to the year 2010 with forward citations until Autumn 2013.
CITATION2	The number of forward citations by later patents that belong to the same patent family which are considered as patents that protect the same technological invention, being defined as exactly the same priority or combination of priorities. We use the so called DOCDB families, which include EPO expert control. The analysis is restricted to all patents granted up to the year 2010 with forward citations until Autumn 2013.
R&D	R&D intensity, calculated as total R&D expenditures to total employment. R&D missing data were not imputed with 0.

Table B2: Correlation Matrix

Variables **2000-2010**	1	2	3	4	5	6	7	8	9	10	11	12	13
TAX_PAY 1	1.000												
Assets 2	0.052	1.000											
Leverage 3	-0.029	0.032	1.000										
ROA 4	0.123	-0.116	-0.100	1.000									
Inventory 5	0.043	-0.197	-0.051	-0.021	1.000								
Tangible 6	0.084	-0.057	0.164	-0.057	-0.071	1.000							
Intangible 7	0.051	0.162	0.223	-0.076	-0.123	-0.191	1.000						
Origin 8	0.007	0.475	-0.020	-0.075	-0.121	-0.219	0.142	1.000					
Foreign 9	0.080	0.177	-0.103	0.011	0.000	-0.141	0.072	0.007	1.000				
R&D 10	-0.093	-0.095	0.004	0.012	-0.036	-0.114	0.016	-0.003	0.051	1.000			
PAT 11	-0.075	0.392	0.045	-0.035	-0.099	-0.164	0.082	0.243	-0.026	0.276	1.000		
CIT1 12	-0.046	0.326	0.032	-0.019	-0.054	-0.112	0.044	0.217	-0.021	0.177	0.799	1.000	
CIT2 13	-0.067	0.360	0.033	-0.023	-0.089	-0.146	0.077	0.232	-0.003	0.269	0.916	0.844	1.000

Table B3: WBSO, Innovation Box, 2011-2014

	Innovation Box NO	**Innovatio n Box YES**	**Total**
R&D, WBSO NO	320678	2031	322709
R&D, WBSO YES	17004	3312	20316
Total	337682	5343	343025

Appendix C: Innovation tax incentives in the Netherlands

In the Netherlands, there are a number of tax schemes that aims to incentivize firms to innovate. From the perspective of the input side of the innovation process, the so called WBSO and RDA are tax credit schemes that enables firms to reduce R&D costs. At this stage of the innovation process, firms are rewarded for their innovation efforts regardless of its innovation success. So, at the output side of innovation, the introduction of the innovation box rather focusses on the outcome of R&D whereby profits as the results of successful patenting behavior receive a lower tax rate. In this sense, firms are stimulated to engage in R&D because not only innovation input but also the innovation output as a results of successful R&D merits are subject to lower tax rates.

R&D tax credits

Since 1994 the Dutch government introduced the WBSO which is an acronym for the Wage Tax and Social Insurance Act (in Dutch "Wet Bevordering Speur- en Ontwikkelingswerk", WBSO hereafter) to stimulate firms' R&D activities in the Netherlands. The WBSO is considered as an important driver of the ongoing Dutch innovation policy. Its aim is to stimulate R&D expenditures for firms located in the Netherlands. Additionally, there is an extra provision for small and medium sized firms as well as starting firms. The WBSO provides an R&D grant, primarily an R&D wage subsidy, that can be granted to any R&D performing firm located in the Netherlands regardless of size. The WBSO adds an additional funding under the so called RDA (in Dutch “R&D aftrek”) which allows firms to deduct an (annually set) fixed amount for R&D on their income tax payment. As of 2016, both the WBSO and the RDA are merged together under the WBSO scheme.

The range of R&D projects suitable for assistance include the development of new products, processes and IT software, technical and process oriented scientific research as well as innovation feasibility studies. Concerning the eligibility criteria, R&D development projects must include some degree of technical risks or uncertainties. The most important evaluation criteria that the WBSO considers is the embodied technological novelty in the R&D development project. The technological novelty itself must include a research component whereby technical obstacles as well as possible solutions are defined. R&D projects based on technical scientific research are categorized in domains such as, physics, chemistry, biotechnology, production technology and ICT. Concerning innovation feasibility analysis, the WBSO stipulates that the purpose of the R&D project is already structured and known. Economic and financial aspects surrounding the R&D project is less of an importance.

While there has been some changes in the provision of grants over time, the application procedures that makes projects eligible for assistance are as follows. The applicant (usually a firm) has to show that he or she is involved with the technical analysis as part of an ongoing R&D project that must take within the European Union. Additionally, the firm must pay corporate or income tax returns as well wage tax and national insurance contributions for those employees that are involved with R&D. The actual WBSO grant level is calculated on the basis of total R&D working hours multiplied by an average R&D hourly wage.

Innovation Box

A innovation box is fiscal instrument in the corporate tax regime that can be applied to all firms that have a corporate tax obligation in the Netherlands, that is, local and foreign owned firms. The point of departure for the application of an innovation box are intangible assets that cover primarily patents and associated patent rights, and to a lesser extent, designs and models, copyrights, and trade secrets.[19] The innovation box entails that the profits that are generated from the eligible intangible assets enjoy a tax deduction. Since 2010, the effective tariff on profits within the innovation box in the Netherlands, is 5%. Prior to 2010, the official rate amounts to 10%.

We note that Evers et al. (2014) provides a detailed overview across countries. In addition, the authors also calculate a so called ‘effective tax rate’ so that non-fiscal country-specificities are netted out. Focusing on the official tax rates, we may conclude that the Netherlands belongs to most favorite tax regime countries, along with Belgium, Luxembourg, Lichtenstein and Malta.

The effectiveness of an innovation box on tax revenues depend on some additional provisions. In the Netherlands, the innovation box applies to intangible assets that are considered as outcomes from R&D related activities. In that sense, especially, the focus is on technical

[19] We note that the scope of intangible assets to which an innovation box is applicable depends by country. We refer Alstadsaeter et al. (2015) for a cross country comparison.

innovation. Firms that are eligible for WBSO are also eligible for the innovation box; although, the related profits that are generated from the innovation must be at least for 30% be generated from patenting (RVO, 2014).

With the innovation box in place, pure fiscal motives may remain. The eligibility criteria makes it, especially, very attractive for firms that are able to be successful innovators both from the R&D input and the R&D outcome perspective, in terms of patenting. In addition, the so called 30% rule provides an extra stimulus for attracting highly skilled personnel from abroad. In combination with other fiscal incentives (e.g., negotiation with tax authorities are allowed) makes the Netherlands a fiscal attractive place, apart to the question whether these firms also significant role in the real economy. A recent online survey conducted by the Dutch Ministry of Economic affairs (RVO, 2014) concludes that firms do indicate that the favorite fiscal regime as the result of the innovation box does seem to be important.