The tax challenges of digitalization have been to the forefront of national and international discussions on public revenues in recent years. The digital transformation is seen as being an exacerbating factor in the erosion of tax bases and the shifting of profits to low tax jurisdictions, particularly by multinational companies, thus reducing tax revenues for governments. While there is a large literature examining the role of ICT and digitalization in raising economic growth, productivity and other macroeconomic variables, the relationship between digitalization and tax revenues has been relatively understudied – despite being one of key drivers of what could be most significant change to international tax rules in a century. This study utilizes panel data covering OECD countries during the period from 1995 to 2018, and examines the effect of the rise of digitalization on tax revenues employing both static and dynamic panel data analysis techniques. The findings indicate that digitalization may have a negative impact on a country’s ability to generate higher tax returns.

**JEL Codes:** H20, H25, L81, L86

**Key words:** Digitalization, taxation, revenues, OECD countries

**Introduction**

The tax challenges of digitalization have been the focus of much research by academics and policymakers at both national and international levels in recent years (OECD, 2017). This has been particularly true since the Global Financial Crisis of 2007/08, when the public finances of many countries were strained in the face of rising debt and substantial deficits. Many governments came under intense pressure from voters facing years of austerity and restrictive fiscal policy, i.e., rising taxes and falling government spending; leading many to become disillusioned with globalization and to protest at what they perceived to be “unfair” taxation (this pressure also intensified over the decade from 2008-2018 as a result of reports based on numerous financial scandals including the leaking of documents concerning tax evasion and corruption such as the so-called Swiss leaks, LuxLeaks and Panama Papers scandals). Thus, the issue of the erosion of national tax bases and the shifting of profit from high-tax to low-tax jurisdictions has been high on the policy agenda for some time. While digital firms are not exclusively responsible for base erosion and profit shifting (BEPS), it is argued that the process of digitalization exacerbates these issues (OECD, 2014, p. 13), reducing the base available for national governments on which to levy taxes.

Digitalization has significantly and irrevocably changed economies across the globe over the last three decades in particular. The process of digitalization, the challenges and, to a much lesser extent, the opportunities it represents to economies have been hotly debated. The diffusion of the Internet, and information communication technologies (ICT) more generally, have been well documented in the literature. However, it has also long been argued that digitalization has a negative impact on the tax raising capabilities of national
governments dealing with a new, digital world “without borders”. One early
warning on the negative impact of Internet-based activities with regard to tax
revenues came from TANZI (1996). Tanzi identified various technological
developments – namely aspects of digitalization such as e-commerce,
electronic money and cross-border transactions - as being a form of “fiscal
termite” which would ultimately erode and undermine the foundations of
national tax systems and likely lead to a discernible fall in the ratio of tax
revenue to GDP in many OECD countries (2000, p. 15). However, the question
must be asked: Is there a “Tanzi paradox” similar to the famous Solow paradox
- can the transformative process of digitalization be seen everywhere, except in
the revenue statistics?

However, despite the recent focus on the tax challenges of digitalization by
policymakers and in academia in recent years, digitalization has been little
studied in the literature as a determinant of taxation with a lack of solid, data-
based evidence for the flaws which have been asserted to exist in the current
international tax system (OLBERT/SPENGEL, 2019).

This paper investigates the relationship between digitalization and tax
revenues in a selection of OECD countries as a contribution towards filling this
gap. As a group of developed and advanced economies, the OECD has
consistently been to the forefront of attempting to find a consensus-based,
multilateral solution to the issues raised by BEPS and the tax challenges of
digitalization since being tasked with this role by major global economies.
Representing some of the most advanced (in broader terms) and most
digitalized economies globally, the OECD is natural starting point to
examining this issue – with 8 of the top 10 countries for e-commerce sales
globally being OECD members (UNCTAD, 2019) and Internet intensity
reaching saturation levels in many countries.

Understanding the role of digitalization in terms of tax revenues is a
crucial issue to consider as the OECD attempts to reach a solution in late 2020
as intended. The importance of digitalization during the coronavirus crisis ion
2020 (with millions of people worldwide working remotely, or engaged in e-
learning and other online solutions) will again bring the challenges it presents
to governments to the fore as states seek to recover from the deficits and rising
national debt incurred during that crisis.

Using panel data over the period from 1995-2017, including a novel proxy
for digitalization, the impact of advancing digitalization over time is examined
in order to test Tanzi’s “fiscal termite hypothesis” on the basis of the available
macroeconomic data on tax revenue.

**Digitalization**

While an in-depth discussion of digitalization¹ is beyond the scope of the
present paper, it is worth making some observations on the dynamics of the

¹Note, that while some researchers have identified different phases of the transformative
process (e.g., VERHOEF ET AL., 2019), for the purposes of the present paper, it is assumed
that digitalization has been a continuous, singular process.
process (for a broader discussion on digitalization see, e.g., CORROCHER/
ORDANINI, 2002). The OECD describes the digital economy as the result of
“a transformative process brought about by information and communication
technology (ICT)” (2013a, p. 11). Many forms of ICT have become general
purpose technologies impacting and reshaping both economies and societies
(OECD, 2013b). This process is also known as digitalization.

From the early 1990s, the phenomenon and its effect on the economy have
been described in various ways. The emergence of the so-called Network
Internet Era from the mid-1980s to early 1990s (ELLIOT/KRAMER, 2008),
led to the development of new business models and a growing importance of a
particular class of assets, namely intangible assets. These new business models
and the shift from tangible to intangible assets became the basis for a new
“Digital Economy” (TAPSCOTT, 1996) or “Internet Economy” (WISEMAN,
2000). As Internet intensity rose from the mid-1990s (see the following figure),
traditional firms increasingly moved from a ‘bricks and mortar’ to a ‘clicks and
mortar’ business strategy, combining traditional stores and outlets with an
online presence, and many new firms (based entirely online) emerged (e.g.,
Amazon (founded 1994), Yahoo and eBay (founded 1995), Google (founded
1998)). Fast-paced technological progress and falling real prices of ICT
(WELFENS/PERRET, 2014) allowed ICTs to become ubiquitous within a very
short period of time. The figure below shows how average Internet use grew in
OECD countries particularly from 1994 on - displaying a familiar S-shaped
curve for the diffusion of innovations (ROGERS, 2003). It is estimated that
global e-commerce sales reached over $29 trillion in 2017 with 1.3 billion
people engaging in e-commerce transactions, with growth in cross-border
transactions (particularly likely to create taxing issues) outpacing growth in e-
commerce over all in recent years – cross-border shoppers represented 15% of
global online shoppers in 2015, but 21% in 2017 (UNCTAD, 2019, see also
OECD, 2019c).

Digitalization is also a phenomenon which will continue to challenge
governments and tax authorities into the future. with the so-called Fourth
Industrial Revolution involving developments such as big data, artificial
intelligence, robotics, 3D printing and the Internet of Things likely to mean that
the challenges posed by digitalization to tax revenues shall continue if not
worsen over time.
From Figure 1, one can see that average Internet use in OECD countries was relatively stable in the early 1990s, before Internet usage rates rose steadily from circa 1996 until the late 2000s as saturation intensities began to be reached in some countries, e.g. 98% usage in 2017 in Iceland.

**The Tax Challenges of Digitalization**

Within a few years of significant growth in terms of Internet usage in the early to mid-1990s, the role of ICT and e-commerce in particular came on the national and international policy agenda, with the OECD’s 1998 Ottawa Ministerial Conference being the first international ministerial-level conference to deal with the issue of e-commerce (WYCKOFF/LOUX, 2019). However, in a survey of national responses to the challenge of taxing e-commerce in 2006, COCKFIELD (2006) shows that over the ten years from the mid-1990s to the mid-2000s, many countries had not enacted any significant legislation with regard to taxing the digitalizing economy. The result of this seeming inaction was that the digitalization of modern economies had “disturbed and outmanoeuvred taxes” (CORKERY ET AL. 2015).

The effect of this lack of action – possibly due to a quasi “infant industry” motivation - that the productivity gains associated with digitalization did not result in increased tax revenues, particularly for larger countries which have been “sorely tested” by the process (COLLIN/COLIN, 2013, p. 5). The tax challenges of digitalization are primarily related to corporate tax revenues and sales/value-added taxes on cross-border consumption with digital firms having the ability to take advantage of differentials in tax rates. Aspects of the new digitalized economies, which pose significant threats to the tax base and
revenue collection of countries, include, but are not limited to (OECD, 2015, 2018, 2019b; SAND-ZANTMAN, 2018; KÖTHENBÜRGER, 2020):

- The mobility of firms, users and the intangible assets that are crucial for digital businesses – and the geographic diffusion of value chains;
- The use of data and intangible assets – including the cross-border flows of data used;
- Network effects and increasing returns to scale;
- Multi-sided business models/platforms;
- Cross-border e-commerce and VAT issues.

In the aftermath of the Global Financial Crisis and with the onset of the sovereign debt crisis in certain countries in Europe, the issue of fair taxation of multinationals began to come to the fore, with a new impetus being provided by the leaders of the G20 at the Los Cabos Summit, in Mexico, in 2012 and of the G8 at Lough Erne in 2013 as they stressed the need for governments to act in order to prevent base erosion and profit shifting (G20, 2012; G8, 2013) and from the OECD itself which had proposed work on the area of BEPS to the G20 prior to the Los Cabos summit. At the same time, expert working groups were commissioned to examine the issue of taxation and the digital economy at an international level (EUROPEAN COMMISSION, 2014; ITU, 2015).

Having received the political backing and financial support to proceed with an examination of issues surrounding BEPS, the OECD published an Action Plan, which detailed 15 areas which required particular attention, in 2013 (OECD, 2013a). The first of these areas, i.e. the OECD’s Action Plan 1, tackling the tax challenges of the digital economy (OECD, 2014; 2015). With no consensus solution being found by the OECD in 2015, individual states took it upon themselves to proceed on a unilateral basis and enact various taxes and tax-related measures in order to try to generate additional tax revenue from digital firms. These measures generally take the form of turnover taxes, withholding taxes, alternative thresholds for the purposes of a permanent establishment (and thus a taxable presence) and specific measures targeting multinational firms, with measures being announced or enacted in, amongst others, the United Kingdom, France, Italy, Spain, Hungary, Turkey and Israel (for discussion of selected unilateral measures see UN, 2017; HADZHIEVA, 2019; AGYROPOLOU, 2019) as well as proposals for a Digital Services Tax at an EU level from the European Commission (EUROPEAN COMMISSION, 2017, 2018). Having received a new mandate, work continues at OECD level to develop an international solution to the tax challenges of digitalization (OECD 2018, 2019a).

However, while many seem to accept that digitalization self-evidently poses a challenge to the tax generating capabilities of national governments, there are also analyses that question the notion that digitalization and digital firms pose a particular and pressing challenge in terms of tax (LEE-MAKIYAMA/ VERSCHELDE, 2016; SCHOEN, 2018). Digitalization could also have a positive effect on tax revenues through direct and indirect channels. On the one hand, digitalization improves the performance of tax authorities through better
software, online tax return filing, and better record keeping etc. improving both compliance on the part of taxpayers and more efficient tax collection (IMF, 2018). Digitalization can also be seen as a crucial driver of innovation and growth (OLBERT/SPENGEI, 2017). This role can indirectly improve revenue-raising capabilities of government. Digitalization is associated with economic growth, productivity, inward foreign direct investment, and international trade as will be explored in the subsequent literature review.

In support of its own move towards an EU tax on digital services, the European Commission has argued that international digital firms faced an average effective corporate tax rate in the EU28 of just 9.5%, compared to the 23.3% effective corporate tax rate faced by “traditional” international firms (EUROPEAN COMMISSION, 2017). These figures have been called into question by, amongst others, BAUER (2018), who notes that the figures used by the Commission do not even appear in the sources cited by the Commission in support of their claim and it is unclear how the Commission arrived at their suggested respective corporate tax rates. BAUER (2019) and LEE-MAKIYAMA/VERSHELDE (2016) have argued that real-world data shows that digital firms indeed face effective corporate tax rates similar to more traditional, less digital firms (e.g., automobile manufacturers) – see Table 5 in appendix showing broadly similar tax burdens. On the other hand, studies of the tax planning of some firms reveal findings which seem difficult to reconcile with claims that digital firms face as more traditional firms, for example the case of Apple, with effective tax rates of key Apple subsidiaries of less than a tenth of one percent (TING/GRAY, 2019). However, one way to perhaps reconcile the two is to consider where and when taxes are paid.

**Figure 2.** Average Tax Revenues OECD Countries as Percentage of GDP, 1990-2018

![Average Tax Revenues OECD Countries as Percentage of GDP](source)

Source: Own representation based on data available from the OECD
A brief look at average OECD tax revenues over the time period from the beginnings of the process of digitalization in 1990 to 2018, shows no prima facie evidence of tax revenues being undermined by fiscal termites, rather average tax revenues as a percentage of GDP in the OECD have risen by circa two percentage points over the same time period (with two noticeable periods of decline, namely the aftermath of the “dot-com” bubble and September 11th attacks in 2000/01, and the Global Financial Crisis from 2007/08).

Thus, the following questions can be asked: Does digitalization really undermine tax revenues? What role does digitalization as a determinant of tax revenues in some of the most digitalized economies? The rest of the paper is structured as follows: Section 2 presents an overview of the literature on the determinants of tax revenue from a macroeconomic perspective. Section 3 presents the data and methodology used in the present analysis. Section 4 the empirical models used in the analysis. Section 5 presents the results of the empirical analysis and discussion. Section 6 concludes with a view of the policy options and ideas for future research.

Literature Review

The body of literature examining the determinants of tax revenues is broad. Many contributions have sought to examine the principal determinants of tax revenue and certain key determinants shall be presented here as some of these determining factors will be included in the subsequent empirical analysis.

ELTONY (2002), looking at panel data covering a selection of 16 Arab countries, finds inter alia that the level of economic development is a strong determinant of tax revenue mobilization. GUPTA (2007) using panel data to examine over 100 developing countries over a period of 25 years has provided further supportive evidence for earlier findings that economic development in terms of GDP per capita is a strong determinant of tax revenue, as is trade openness. Furthermore, the sectoral composition of economies is related to tax revenue generation – in particular, the share of agriculture is negatively related to tax revenue. STOTSKY/WOLDEMARIAM (1997), who use panel data covering over 40 sub-Saharan African countries during the period from 1990-1995, show that the share of agriculture in GDP is significantly negatively related to tax share as are import and export shares (i.e. openness). KARAGÖZ (2013) – looking at Turkey - finds that the share of industry is positively related to tax revenues. Other contributions to the literature consider the level of public debt (TEERA/HUDSON, 2004) and socio-economic and institutional factors such as the level of political rights, civil liberties (BIRD ET AL., 2008) and education (PIANCASTELLI, 2001). More recently, ANGELES-CASTRO/RAMIREZ-CAMARILLO (2014) providing further support for the findings of the previous researchers using a panel dataset covering OECD countries during the period from 2001 to 2011.

Many studies have also examined the macroeconomic effects of digitalization – usually employing a proxy indicator such as Internet usage.
intensity. Productivity gains related to Internet usage and diffusion have been identified in macroeconomic data (OLINER/SICHEL, 2000; JORGENSON, 2001; COLLECHIA/SCHREYER, 2002). At the same time, the Internet has been found to have a significant and positive impact on economic growth (NOH/YOO, 2008; SALAHUDDIN/ALAM, 2016). Other contributions have considered the impact of the Internet on international trade (XING, 2018; MEIJERS, 2014; VEMURI/SIDDIQI, 2009; BAUNSGAARD/KEEN, 2010), foreign direct investment inflows (CHOI, 2003) and inflation (YI/CHOI, 2005; CSONTO/HUANG/TOVAR, 2019 - who use the same data on IPv4 and IPv6 address allocations as the present study to construct a digitalization index in order to examine the impact of digitalization on inflation). Looking at ICT and income inequality, RICHMOND/TRIPLETT (2018) examine panel data covering 109 countries over the period 2001-2014 and find that the impact of ICT on income inequality varies by type of the type of ICT considered, whereby increases in fixed broadband subscriptions are associated on average with increases in income inequality, while increases in mobile phone subscriptions are associated on average with decreases in income inequality, with the former effect larger than the latter. JAUMOTTE ET AL. (2008) also find that income inequality in many countries has increased due to the biased nature of digitalization which raises the relative demand for, and thus wage premium of, skilled workers who possess the human capital required to fully exploit the benefits of these technological developments (on inequality issues, see also ALLEN, 2017).

Combining these two strands of the literature on the determinants of tax revenue and digitalization using macroeconomic data is a newly emerging field for research. Those studies which have looked at this issue have considered large samples of developed and developing countries, the highly digitalized with the less digitalized (where the marginal effects of increasing digitalizing on e.g. growth and tax revenues may be larger) and high tax countries with countries with lower overall tax burdens. KOYUNCU/YILMAZ/ÜNVER (2016) explore the impact of ICT penetration on tax revenues. Looking at 157 countries and four indicators of ICT penetration, the authors find that ICT penetration does increase tax revenue across countries during the period 1990 to 2013. GNANGNON/BRUN (2018) consider their work to be the first study to investigate the linkage between a variable that they calculate as representing each country’s “Internet gap” (i.e. the ratio of a country’s internet usage intensity to the world average internet usage intensity) and public revenue mobilization in a sample of 164 countries for the period from 1995 to 2013. Their analysis suggests that by reducing the Internet gap, countries can raise

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2 Some contributions have used microeconomic data to study the relationship between ICTs and tax revenues. Looking at the online purchase decisions of 25,000 US consumers, GOOLSBEE (1998) could show that consumers living in high sales tax jurisdictions were significantly more likely to buy items online, suggesting that early Internet adopters were already motivated to avoid sales tax thus reducing the tax base and, ultimately, tax revenues. BRUCE/FOX (2000) also find that ecommerce was reducing the sales tax base in the US, estimating over $10 billion in tax revenue losses in 2003. Many studies have shown similar results in relation to sales and value-added taxes.
their public revenues with low-income countries standing to benefit the most. Meanwhile GNANGNON/BRUN (2019) analyze the impact of the Internet on resource versus non-resource revenue for 99 countries over the period 1995-2015, finding that a higher Internet usage intensity has a negative effect on resource revenue and a positive effect on non-resource revenue (with the impact of the Internet being higher for less developed countries). The OECD, as a more homogenous group in terms of economic development, digitalization and the tax burden, while also being to the fore in examining the issue of the tax challenges of digitalization, is an interesting sub-group for the subsequent analysis.

Data and Methodology

The impact of digitalization on tax revenues is examined using a model where the explanatory variables are standard in the existing literature on the determinants of tax revenue with the exception of the variable of interest – a singular measure of digitalization. In the literature, a number of variables have been found to be significant determinants of public revenues as discussed in the literature review, namely the level of economic development, sectoral composition, international openness, as well as socio-economic factors including life expectancy, health, education and political and civil rights of residents.

Measuring Digitalization

Trying to measure digitalization has proved a difficult task. While many individual indicators exist, it is rarely possible to get a complete picture without combining several indicators. Many attempts have been made, primarily by international organizations, to measure digitalization to allow cross-country comparison. First published in 1997, a pioneering attempt was made by the International Data Corporation and its Information Society Index covering 53 countries. Since then, a number of broadly similar indices have been published by the World Economic Forum (Networked Readiness Index from 2002, Knowledge Economy Index from 2005), the International Telecommunications Union (ICT Development Index from 2002, Digital Access Index from 2003, Digital Opportunity Index (now known as the ICT Development Index) and the ICT Opportunity Index from 2005), the United Nations (Technology Achievement Index from 2001, E-Government Development Index from 2002, ICT Diffusion Index from 2006) and the EU (Digital Economy and Society Index from 2014) with a variety of countries, indicators and sub-indicators and time periods covered (for more, see KONONOVA (2015)).

Meanwhile, CORROCHER/ORDANINI (2002) created a synthetic index and used their index to determine a “digital divide” by means of the standard deviation of each country’s result from the mean More recently, some
researchers have compiled digitalization indices for their own research. KATZ/KOUTROUMPIS/CALLORDA (2014) construct an index comprised of six components (affordability, infrastructure reliability, network access, capacity, usage and human capital) and 24 sub-indicators. CAMARA/TUESTA (2017) have created the DiGiX, a digitization index, with six principle dimensions (infrastructure, households’ adoption, enterprises’ adoption, costs, regulation and contents) and 21 sub-indicators, for 100 countries in 2016 with a ranking for that year based on data for 2015.

The varying nature of individual indices from year to year (where new indicators have been added, other indicators dropped etc. – consider the rise of mobile internet and the role of apps in recent years which are not reflected in earlier years), or the relatively small number of sample years available means that such synthetic indices are not conducive to be used for an analysis over a longer time period.

This paper adapts the proxy used in CSONTO/HUANG/TOVAR (2019) – i.e., the number of internet protocol (IP) addresses allocated per country as a measure of digitalization. An IP address is a numerical label or identification key which is assigned to every device connected to a computer network communicating using internet protocol – i.e. every device connected to the internet including desktop computers, laptops, tablets, smartphones and networked devices such as printers, scanners etc.

With the exponential growth of Internet usage and the progress of digitalization, the number of devices connected to the Internet and thus the demand for the number of IP addresses has also grown exponentially. In use since the 1980s, IPv4 allows for $2^{32}$ IP addresses. Meanwhile, with a view to the growing demand, IPv6 was introduced in 2012 as a parallel network and allows for $2^{128}$ IP addresses, thus ensuring a supply of addresses to meet growing demand, as internet diffusion continues and the Internet of Things continues to see more and more devices connected to the internet, from household appliances to cars. Since its introduction, the allocation of IPv6 addresses had also grown dramatically (see Figure 3; a table with all OECD countries ranked according to their IP address allocations for 2018 can be found in the Appendix, Table 4) with IP addresses being allocated by the Regional Internet Registry to service providers or private or public entities. Following the introduction of iOS and Android operations systems in 2007 and 2008, respectively, the rapid diffusion of smartphones globally over the following years can be seen in the striking growth in IP address allocations (on smartphone diffusion see CHO (2015) and GÜNDÜC (2019)).
Thus, the IP address allocation data allows for a good proxy of digitalization with advantages over other common proxies. Internet intensity/usage (e.g. percentage of the population) does not capture the true diffusion of digital technologies. A single person reporting having used the Internet could have access to the Internet at work, but not at home (or vice versa). The person could have a single desktop computer, which is a different circumstance from an individual with multiple connected devices (i.e. highly digitized) each with a separate IP address. The same goes for the sheer number of connected devices in smart homes etc. Using IP data also avoids the problem of the addition or dropping of indicators with the emergence of new technologies or devices, i.e. a modern smartphone in 2017 is allocated an IP address in the same way as a desktop personal computer in 1995. However, there are also some caveats: Firstly, the allocation of IP addresses does not perfectly reflect actual usage. Secondly, in some circumstances a single IP address may, by way of a network address translator, be shared by a number of separate devices. Thirdly, where no allocation has been recorded, it does not definitively mean that no connected devices are being used in a particular jurisdiction. However, these caveats are not of sufficient concern to invalidate the usage of the data as a proxy (as also argued in CSONTO/HUANG/TOVAR, 2019).

Data on IPv4 and IPv6 allocations is provided by the Asia-Pacific Network Information Centre (APNIC) which has data for almost 200 countries and territories with data on IPv4 from 1990 and on IPv6 from 2009 – data is available on a monthly basis. While CSONTO/HUANG/TOVAR (2019) use
high frequency data (monthly) to construct an index of digitalization based on
growth rates per country, for the purposes of the present study, we use annual
data (i.e. the number of IP addresses as of 1 January (or closest available date)
each year\(^3\) as the macroeconomic data is frequently only available on an annual
basis.

**Data**

The dataset used in the present study is a panel of 36 members of OECD
members covering the period from 1995 to 2018\(^4\). An overview of the variables
is provided in the subsequent table (a brief description of each variable and its
source is available in the appendix – Table 3).

**Table 1. Descriptive Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaxRev</td>
<td>860</td>
<td>33.318</td>
<td>7.508</td>
<td>9.912</td>
<td>48.917</td>
</tr>
<tr>
<td>LnGDPPc</td>
<td>862</td>
<td>10.269</td>
<td>.676</td>
<td>8.545</td>
<td>11.615</td>
</tr>
<tr>
<td>TradeGDP</td>
<td>862</td>
<td>90.293</td>
<td>53.311</td>
<td>16.679</td>
<td>408.362</td>
</tr>
<tr>
<td>AgriGDP</td>
<td>847</td>
<td>2.749</td>
<td>2.058</td>
<td>.214</td>
<td>16.855</td>
</tr>
<tr>
<td>IndustGDP</td>
<td>847</td>
<td>25.633</td>
<td>5.338</td>
<td>10.517</td>
<td>41.107</td>
</tr>
<tr>
<td>GovtDebtGDP</td>
<td>839</td>
<td>57.668</td>
<td>38.632</td>
<td>3.664</td>
<td>237.115</td>
</tr>
<tr>
<td>UrbanPop</td>
<td>862</td>
<td>75.939</td>
<td>11.18</td>
<td>50.622</td>
<td>98.001</td>
</tr>
<tr>
<td>Unemployment</td>
<td>862</td>
<td>7.805</td>
<td>4.142</td>
<td>1.805</td>
<td>27.466</td>
</tr>
<tr>
<td>inFDIGFCF</td>
<td>855</td>
<td>.22</td>
<td>.444</td>
<td>-1.647</td>
<td>4.313</td>
</tr>
<tr>
<td>Inflation</td>
<td>862</td>
<td>3.707</td>
<td>7.741</td>
<td>-4.478</td>
<td>89.113</td>
</tr>
<tr>
<td>PolRights</td>
<td>862</td>
<td>1.194</td>
<td>.581</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>CivLib</td>
<td>862</td>
<td>1.447</td>
<td>.769</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>BankingCrisis</td>
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<td>.122</td>
<td>.327</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SovCrisis</td>
<td>862</td>
<td>.013</td>
<td>.112</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>POPgrowth</td>
<td>826</td>
<td>.552</td>
<td>.781</td>
<td>-2.233</td>
<td>2.963</td>
</tr>
<tr>
<td>Digital</td>
<td>858</td>
<td>3.295</td>
<td>5.574</td>
<td>0</td>
<td>50.145</td>
</tr>
</tbody>
</table>

Source: Own representation

The dataset is comprised of economic, institutional, specialization and
social determinants of tax revenue, most of which are commonly used in the

\(^3\)Unfortunately, there are some gaps in the data from APNIC, in particular missing data related
to the United States and Canada for whom no data on the allocation of IPv4 is available from
the period from September 2007 to July 2009. Thus, there is no observation for IPv4 and thus
of the variable Digitalization (which includes IPv4 data) for either of those countries for 2008
or 2009.

\(^4\)After initial reviews of the data, two observations were dropped from the analysis. Firstly, the
data for Iceland for the year 2016. Due to an exceptional item of tax revenue – “stability
contributions” - related to banks and credit institutions which amounted to over 17% of 2015
GDP - resulting in a tax revenue to GDP rate of over 50% in 2016, compared to 35% in 2015,
and 37% in 2017 (for more, see BALDURSSON/PORTES/THORLAKSSON, 2017). Also
dropped was one observation for Luxembourg which preliminary tests showed high residuals
and leverage making it an outlier in the data.
literature. In addition, our variable of interest is added, as are dummy variables
to represent banking crises and sovereign debt crises.

$\ln GDP_{pc}$ is the natural log of GDP per capita (in 2010 international
dollars) as a measure of the economic development of an economy. In the
literature on the determinants of tax, this variable is expected to have a positive
sign, as economies grow they tend to become more formalized and thus easier
to tax, rising GDP per capita also reflects an advantageous stage of the
economic cycle which should, amongst others, generate more profits and
income and thus higher taxes (CLAUSING, 2007). However, many of the
contributions who make this finding are considering developing countries. In
already developed economies such as the OECD, where tax revenues as a share
of income are already relatively high, and in crisis years in which governments
follow expansive fiscal policy to support economic growth and reduce the tax
burden the variable could also have a negative sign (see, e.g., ARNOLD ET

$TradeGDP$ is the sum of imports and exports of both goods and services as
a percentage of GDP. This variable serves as a proxy of the openness of an
economy and is expected to have an ambiguous effect on tax revenues. On the
one hand, higher levels of trade are a sign of openness and competitiveness
which should reflect a formal economy and a good opportunity to generate
higher tax revenues (for example, directly via tariffs, and indirectly via overall
economic growth). On the other hand, the sample of countries in the present
study are characterized by high levels of openness, integration and low barriers
to trade which should mean that, particularly the direct channel, should not
result in significantly higher tax revenues.

$AgriGDP$ is the share of agriculture, forestry and fishing value-added as a
percentage of GDP. The share of agriculture in value-added is expected to be
negatively related to tax revenues based on the literature, as the sector is
difficult to tax - with a high share of self-employed individuals and small and
medium enterprises and shadow economy effects.

$Industry$ is the share of industry value-added as a percentage of GDP. This
is expected to have a positive effect as it reflects a more formal, advanced
sector of the economy which is easier to tax and which creates a larger tax base
(ELTONY, 2002).

$GovtDebtGDP$ is General Government Gross Debt as a percentage of
GDP. On one hand, government debt could have a positive effect on tax
revenue, as government seeks to increase tax revenues in order to service the
costs of servicing increasing debt. On the other hand, government debt could
also be used to finance public spending, and governments may wish to borrow
to fund spending in a favorable interest rate environment rather than raise taxes
in a period of expansive fiscal policy.

$Urban Pop$ considers the percentage of the overall population living in
urban settings. This is expected to have a positive effect on tax revenue. Firstly,
a higher percentage of the population living in urban areas indicates a higher
level of industry, a larger service sector and a lower share of agriculture.
Secondly, a higher share of urban-dwellers reduces the costs for tax authorities to enforce tax compliance.

*Inward FDI/GFCF* relates to inward foreign direct investment (FDI) relative to gross fixed capital formation (GFCF). This variable could have a negative effect on tax revenues as higher inward GDI could reflect government approach of using tax policy and other fiscal incentives in order to attract FDI from investors abroad (CASSOU, 1997). On the other hand, higher levels of inward FDI could also be a sign of an economy which is competitive on global markets and of the confidence of investors in the stability, including the fiscal sustainability, of a country (GUGLER/BRUNNER, 2007).

*Inflation* can reduce tax revenues in real terms due to the time lag between the tax debt being incurred and the government actually collecting revenues — a phenomenon known as the Olivera-Tanzi effect (e.g., TANZI, 1977).

*Political Rights* and *Civil Liberties* are expected to be positively related to tax revenues. In democratic states with high levels of civil liberty, taxpayers may be more likely to willingly cooperate with state authorities to contribute to public coffers and have a lower incentive to seek to avoid or evade taxes (ALM/TORGLER, 2006). Strong state protection of individual rights also extends to property rights etc. which are conducive to functioning markets. In this instance a positive relationship will be indicated by a negative sign of the correlation as lower marks for political rights and civil liberties indicate a better performance in those areas.

*Population Growth* is used here as a proxy variable for social development and is expected to be positively related to tax revenues. Many factors contribute to a growing population including low levels of infant mortality, higher life expectancy, a (relatively) stable birth rate and immigration. The above factors reflect an economy with a functioning and adequate social security system, health care system and a high standard of living, while a growing economy may attract inward migration.

*Banking Crisis* and *Sovereign Debt Crisis* are dummy variables which take the value of 1 for the years a particular country was experience either a banking crisis (e.g. for many of the OECD countries this covers the Global Financial Crisis of 2007/8 – 2012), or a sovereign debt crisis. As can be seen in Figure 2, average tax revenues in the OECD fell by almost 1.5% from 2007 (33.6%) to 2009 (32.3%) before recovering from 2010 on. Therefore, the affect of these two dummy variables is ex ante ambiguous. Some countries responded to the crises by implementing austerity measures and raising taxes in order the stabilize public finances particularly in relation to rising interest rates and debt levels (BOZIO ET AL. 2015) whereas banking crises are also associated with a decline in tax revenues (ROGOFF/REINHART, 2008). To construct the dummy variables, information on the years individual countries experienced a crisis was taken from the data on systemic crises from LAEVEN/VALENCIA (2018) and the Systemic Banking Crises Database II of LAEVEN/VALENCIA (2020).

*Digitalization* is our primary variable of interest and as discussed previously is a measure of the number of IP addresses (IPv4 and IPv6)
allocated per capita. On the one hand, digitalization should have a positive affect on tax revenue via the direct and indirect channels. On the other hand, a highly digitalized economy could see a negative relationship, as digitalization exacerbates the problems of tax base erosion and profit shifting. A correlation matrix for all variables is included in the appendix (Table 6).

**Empirical Model**

The empirical model estimated is based on the literature, theoretical considerations and the hypothesis that digitalization is a relevant determinant of tax revenues. Thus, panel data analysis is deemed to be the most appropriate approach.

**Static Analysis**

The following regression is estimated (with subscripts \( i \) and \( t \) representing each country and time period, respectively):

\[
\text{TaxRev}_{it} = \beta_0 + \beta_1 (\ln \text{GDP}_{pcit}) + \beta_2 (\text{AgriGDP}_{it}) + \beta_3 (\text{TradeGDP}_{it}) + \beta_4 (\text{IndustGDP}_{it}) + \beta_5 (\text{GovtDebtGDP}_{it}) + \beta_6 (\text{UrbanPop}_{it}) + \beta_7 (\text{Unemployment}_{it}) + \beta_8 (\text{inFDIGFCF}_{it}) + \beta_9 (\text{Inflation}_{it}) + \beta_{10} (\text{POPgrowth}_{it}) + \beta_{11} (\text{PolRights}_{it}) + \beta_{12} (\text{CivLib}_{it}) + \beta_{13} (\text{BankingCrisis}_{it}) + \beta_{14} (\text{SovCrisis}_{it}) + \beta_{15} (\text{Digital}_{it}) + \eta_i + \delta_t + \nu_{it}
\]

where \( \eta_i \) are time invariant unobservable country-specific effects, \( \delta_t \) are time effects and \( \nu_{it} \) the error term.

**Methodology**

To determine the model specification, we begin with the standard pooled ordinary-least-squares method (POLS), followed by a fixed effects (FE) method – using diagnostic tests, it is determined that the fixed effects model is preferable to the POLS and a random effects (RE) model using the standard F-test and Hausman test (HAUSMAN, 1978) test. Following further diagnostic tests, it was determined that time-fixed effects should be included in the model and that there is a presence of heteroscedasticity (modified Wald statistic), cross-sectional/temporal dependence (using Pesaran’s test for cross-sectional independence (PESARAN, 2004)) and serial correlation in the error term (Wooldridge test for autocorrelation). Therefore, we estimate the Pooled OLS and FE model with DRISCOLL/KRAAY (1998) standard errors which account for and correct standard errors given these characteristics.
Dynamic Analysis

Extending the static analysis to a dynamic panel data analysis by including a lagged dependent variable on the right hand side is important for two reasons:

Firstly, the inclusion of a lagged dependent variable in the model is required in order to examine the relationship between previous values of tax revenue as a percentage of GDP on current year values. In the literature, it has been found that prior tax revenues are a determinant of current revenues. Second, it is needed to test the possibility that an omitted lagged dependent variable is causing model misspecification and giving rise to autocorrelation. Thus, an extended General Method of Moments estimator is applied as proposed by BLUNDELL/BOND (1998) which uses lagged differences of $Y_{it}$ as instruments for equations in both levels and first differences, i.e., the system GMM estimation (or sys-GMM). To allow this dynamic panel data analysis, it was required to take a sub-sample, which was done on the basis of time. For this purpose, the sys-GMM was applied to the data for the years 2007 to 2018, the period in which the average allocation of IP addresses per capita, our variable of interest which acts as a proxy of digitalization, increased substantially across the OECD (see Figure 3). Reducing the time period analyzed is also necessary to avoid instrument proliferation and to ensure that the short N, long T requirement is met. The sys-GMM estimator is based on the assumption that disturbances are not serially correlated, as otherwise the estimator would be inconsistent. Thus, tests of autocorrelation up to order 2 in the first-differenced residuals are required. The test of serial correlation in the first-differenced residuals are consistent with the maintained assumption of no serial correlation. The AR(2) test fails to reject the null hypothesis that the first-differenced residual error term is not second-order serially correlated, while the AR(1) test rejects the null (at 5 per cent level of significance). The results of the sys-GMM dynamic panel data are presented in Table 3.

Empirical Results

Two estimation methods are employed: pooled OLS and fixed effects (FE) in a static analysis. Both specifications include year dummies; standard errors are robust to arbitrary heteroscedasticity and serial correlation. The results of the chosen estimators (Pooled OLS with Driscoll-Kraay Standard Errors (model 1) and Fixed Effects with Driscoll-Kraay standard errors (DKSE) (model 2) presented in Table 2.
### Table 2. Results of the Static Model

<table>
<thead>
<tr>
<th></th>
<th>(1) Pooled OLS DKSE</th>
<th>(2) Fixed Effects DKSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnGDPpc</td>
<td>7.422***</td>
<td>-5.525***</td>
</tr>
<tr>
<td></td>
<td>(.389)</td>
<td>(.941)</td>
</tr>
<tr>
<td>TradeGDP</td>
<td>.01**</td>
<td>-.001</td>
</tr>
<tr>
<td></td>
<td>(.004)</td>
<td>(.005)</td>
</tr>
<tr>
<td>AgriGDP</td>
<td>-.232***</td>
<td>-.08*</td>
</tr>
<tr>
<td></td>
<td>(.065)</td>
<td>(.042)</td>
</tr>
<tr>
<td>IndustGDP</td>
<td>-0.011***</td>
<td>.032***</td>
</tr>
<tr>
<td></td>
<td>(.004)</td>
<td>(.003)</td>
</tr>
<tr>
<td>GovtDebtGDP</td>
<td>0</td>
<td>.081***</td>
</tr>
<tr>
<td></td>
<td>(.02)</td>
<td>(.028)</td>
</tr>
<tr>
<td>UrbanPop</td>
<td>.286**</td>
<td>-1.34***</td>
</tr>
<tr>
<td></td>
<td>(.122)</td>
<td>(.029)</td>
</tr>
<tr>
<td>lnFDIGFCF</td>
<td>-.831</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>(1.007)</td>
<td>(.148)</td>
</tr>
<tr>
<td>Inflation</td>
<td>.312***</td>
<td>-.015</td>
</tr>
<tr>
<td></td>
<td>(.053)</td>
<td>(.019)</td>
</tr>
<tr>
<td>PolRights</td>
<td>-3.273***</td>
<td>-.047</td>
</tr>
<tr>
<td></td>
<td>(.577)</td>
<td>(.306)</td>
</tr>
<tr>
<td>CivLib</td>
<td>-.022</td>
<td>-.052</td>
</tr>
<tr>
<td></td>
<td>(.519)</td>
<td>(.158)</td>
</tr>
<tr>
<td>POPgrowth</td>
<td>-3.07***</td>
<td>.563**</td>
</tr>
<tr>
<td></td>
<td>(.398)</td>
<td>(.248)</td>
</tr>
<tr>
<td>BankingCrisis</td>
<td>-1.705**</td>
<td>-.452**</td>
</tr>
<tr>
<td></td>
<td>(.63)</td>
<td>(.162)</td>
</tr>
<tr>
<td>SovCrisis</td>
<td>1.17</td>
<td>1.91***</td>
</tr>
<tr>
<td></td>
<td>(.917)</td>
<td>(.447)</td>
</tr>
<tr>
<td>Digital</td>
<td>-.218***</td>
<td>-.074***</td>
</tr>
<tr>
<td></td>
<td>(.047)</td>
<td>(.011)</td>
</tr>
<tr>
<td>Cons</td>
<td>0</td>
<td>89.524***</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(11.581)</td>
</tr>
<tr>
<td>Observations</td>
<td>787</td>
<td>787</td>
</tr>
<tr>
<td>(Within) R squared</td>
<td>.4864</td>
<td>.3475</td>
</tr>
<tr>
<td>Year Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses  
*** p < .01, ** p < .05, * p < .1

#### Figure 4. Sys-GMM Dynamic Panel Data Analysis 2007-2018

<table>
<thead>
<tr>
<th>TaxRev</th>
<th>Sys-GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaxRev_{1,t}</td>
<td>1.169***</td>
</tr>
<tr>
<td></td>
<td>(0.124)</td>
</tr>
<tr>
<td>LnGDPpc</td>
<td>-2.484*</td>
</tr>
<tr>
<td></td>
<td>(1.321)</td>
</tr>
<tr>
<td>TradeGDP</td>
<td>-.003</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
</tbody>
</table>
Results

In terms of the static analysis which examined the determinants of tax revenues for a sample of 36 OECD countries over the period from 1995 to 2018, the results are broadly in line with expectations. The coefficient for GDP per capita is negative and significant at the 1 per cent level. The share of value added contributed by agriculture is also negative and significant at the 1 per cent level, as is the unemployment level. The coefficients of the share of the urban population, the sovereign debt crisis and the level of government debt to GDP all have a positive sign and are all significant at the 1 per cent level, with population growth positive at the 5 per cent level. Meanwhile, the existence of
a banking crisis is negatively related to tax revenues at the 5 per cent level. The
variable of interest, digitalization, is negative and significant at the 1 per cent level.

Based on the dynamic analysis of the subsample of 2007 – 2018, most
variables maintain the sign of their coefficient but lose significance. It can be
noted that the lagged dependent variable is positive and significant at the 1 per cent level, showing prior year values of the overall tax burden are good
determinants of current year values as expected according to the literature. For
the subsample, the variable of interest, digitalization, is now positively related
to tax revenues but only at the 10 per cent level. Thus, the findings for
digitalization must be interpreted with caution.

One question that must be raised concerns the argument that macroeconomic
data such as Gross Domestic Product, and by extension tax revenues as a
percentage of GDP, are increasingly being misstated (WELFENS/PERRRET, 2014;
AHMAD/RIBARSKY/REINSDORF, 2017; MOULTON, 2018; ITKONEN, 2019). Even a minor restatement of GDP upwards to reflect the realities of the
modern digitalized economy, could see tax revenues plateauing or even falling
when expressed as a percentage of GDP. This would facilitate using
macroeconomic data to analyze the true effects of digitalization on tax revenues. It
may be hard for policymakers to maintain broad support for new digital taxes
when tax revenues are already seen to be stable or rising, particularly when digital
firms with market power can pass the burden of new taxes ostensibly required
to secure the tax pass completely on to users. If digitalization does pose a threat
to tax bases, government must ensure the best possible data is available to
show this.

Conclusions

The findings of the present study indicate that a country with high GDP
per capita, a low share of inward FDI in relation to gross fixed capital
formation, a sizeable industrial sector versus the agricultural sector, an urban
and growing population and the protection of civil liberties and democratic
institutions is more likely to be in a position to generate high tax revenues.
Meanwhile, high levels of unemployment and the existence of a banking crisis
may have a negative effect on tax revenue generation.

While digitalization and its impact on tax revenues have been to the
forefront of national and international discussions on public revenues in recent
years, previous studies on large samples of developed and developing countries
have found that ICT is positively related to tax revenues – providing evidence
against Tanzi’s fiscal termite warnings and the focus placed on digitalization
and tax by policymakers, nationally, at EU level and at the OECD. The
intersection of digitalization and tax revenues is likely to gain attention for
policymakers worldwide as the global economy emerges from the coronavirus
disease.
By placing a specific focus on OECD countries and examining macroeconomic determinants of tax revenues, the present study finds that digitalization may indeed have a negative impact on developed and highly digital countries’ tax revenues, possibly supporting the position of national governments in seeking to find a new multilateral solution to the tax challenges of digitalization. However, results should be interpreted with caution. Future research is required to provide more insights into the dynamics of digitalization and tax revenues, including in relation to an accurate recording of Gross Domestic Product.

Acknowledgments

I am grateful to Geoff Huston, Chief Scientist at APNIC for providing data on IP allocations. My thanks for helpful comments and suggestions are also due to Paul Welfens, Kaan Celebi, and colleagues at the EIIW/University of Wuppertal, and for feedback received when the paper was presented at the 15th Annual International Symposium on Economic Theory, Policy & Application, 29-30 June & 1-2 July 2020, Athens, Greece. Any errors are my own.

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## Appendix

### Table 3. Definition and source of variable used in the analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>TaxRev&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Tax revenue as a percentage of Gross Domestic Product (GDP)</td>
<td>OECD</td>
</tr>
<tr>
<td>lnGDPpc&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Log of GDP per capita of country &lt;i&gt;i&lt;/i&gt; in year &lt;i&gt;t&lt;/i&gt; in 2010 International Dollars</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>TradeGDP&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Sum of exports and imports of goods and services as % of GDP</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>AgriGDP&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Agriculture, forestry and fishing value-added as a % of GDP</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>IndustGDP&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Industry (including construction) value-added as a percentage of GDP</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>GovtDebtGDP&lt;sub&gt;it&lt;/sub&gt;</td>
<td>General government gross debt as % GDP</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>UrbanPop&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Urban population as % of total population</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>InFDIGFCF</td>
<td>Inward FDI as a % of Gross Fixed Capital Formation</td>
<td>Own calculation using data from World Bank / World Development Indicators</td>
</tr>
<tr>
<td>Unemployment&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Unemployment, total (as % of total labor force)</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>Inflation&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Annual consumer price inflation in percent</td>
<td>World Bank / World Development Indicators</td>
</tr>
<tr>
<td>PolRights&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Political rights</td>
<td>Freedom House (2020)</td>
</tr>
<tr>
<td>CivLib&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Civil liberties</td>
<td>Freedom House (2020)</td>
</tr>
<tr>
<td>POPgrowth</td>
<td>Growth rate of the total population in percent</td>
<td>Own calculation using data from World Bank / World Development Indicators</td>
</tr>
<tr>
<td>Banking Crisis</td>
<td>Dummy variable on annual basis if respective country experienced a banking crisis. Crises over 5 years are truncated at 5</td>
<td>Laeven and Valencia (2018, 2020)</td>
</tr>
<tr>
<td>SovCrisis</td>
<td>Dummy variable which takes the value of 1 in years when a country is experiencing a sovereign debt crisis. Crises over 5 years are truncated at 5</td>
<td>Laeven and Valencia (2018, 2020)</td>
</tr>
<tr>
<td>Digital</td>
<td>Digital penetration/intensity – allocation of IP addresses per capita</td>
<td>Own calculation based on data provided by APNIC</td>
</tr>
</tbody>
</table>

Source: Own representation
1. **Table 4. IP Allocations Per Capita 2018**

<table>
<thead>
<tr>
<th>Country</th>
<th>IP Allocations Per Capita 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>50.1452426</td>
</tr>
<tr>
<td>Sweden</td>
<td>41.3802219</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>34.0464056</td>
</tr>
<tr>
<td>Netherlands</td>
<td>26.314549</td>
</tr>
<tr>
<td>Australia</td>
<td>25.4440285</td>
</tr>
<tr>
<td>Norway</td>
<td>24.9034517</td>
</tr>
<tr>
<td>Switzerland</td>
<td>21.3199972</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>19.6373991</td>
</tr>
<tr>
<td>Germany</td>
<td>15.3133055</td>
</tr>
<tr>
<td>Denmark</td>
<td>14.7342418</td>
</tr>
<tr>
<td>Estonia</td>
<td>14.1491191</td>
</tr>
<tr>
<td>United States</td>
<td>13.8604189</td>
</tr>
<tr>
<td>France</td>
<td>13.1182164</td>
</tr>
<tr>
<td>Finland</td>
<td>12.5364134</td>
</tr>
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<td>Ireland</td>
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<td>Czechia</td>
<td>11.3123851</td>
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<td>Austria</td>
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<td>Slovenia</td>
<td>10.3860394</td>
</tr>
<tr>
<td>Italy</td>
<td>9.17202016</td>
</tr>
<tr>
<td>Korea</td>
<td>8.8472736</td>
</tr>
<tr>
<td>Belgium</td>
<td>8.78872828</td>
</tr>
<tr>
<td>Poland</td>
<td>7.75557301</td>
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<td>Latvia</td>
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<td>Japan</td>
<td>6.63836143</td>
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<td>Spain</td>
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<td>Slovakia</td>
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</tr>
<tr>
<td>New Zealand</td>
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<tr>
<td>Israel</td>
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<tr>
<td>Canada</td>
<td>3.10869289</td>
</tr>
<tr>
<td>Hungary</td>
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<td>Portugal</td>
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</tr>
<tr>
<td>Greece</td>
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</tr>
<tr>
<td>Turkey</td>
<td>1.4729257</td>
</tr>
<tr>
<td>Chile</td>
<td>1.07825706</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.4276671</td>
</tr>
</tbody>
</table>

Source: Own representation and calculations based on APNIC data
Table 5. Average 5-year Effective Tax Rates of Selected European Multinational Companies, 2009-2013

<table>
<thead>
<tr>
<th>Company</th>
<th>Average 5-year Effective Tax Rate (ETR) 2009-2013 in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrefour</td>
<td>55.41</td>
</tr>
<tr>
<td>Facebook</td>
<td>53.92</td>
</tr>
<tr>
<td>Royal Dutch Shell</td>
<td>44.60</td>
</tr>
<tr>
<td>Amazon</td>
<td>37.39</td>
</tr>
<tr>
<td>Allianz</td>
<td>30.08</td>
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Source: Own representation based on LEE-MAKIYAMA/VERSCHELDE (2016), Fig. 4.4, p. 61
### Table 6. Correlation Matrix

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Source: Own calculations