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Innovations in digital government as business facilitators: implications for Portugal

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Innovations in digital government as business facilitators: implications for Portugal[1]

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Abstract

Administrative and regulatory burden reduction is considered nowadays a priority to improve governmental efficiency and economic competitiveness. Innovations in government through Information Communication Technology (ICT) are seen as key tools in designing policies to achieve those goals. Using a large panel dataset, covering 174 countries from 2004 to 2016, we investigate a possible contribution of innovations in digital governments to facilitate business, and extract implications for Portugal. Progress in digital government is proxied by the United Nations' e-gov index, while the business environment is proxied by the World Bank's Ease of Doing Business indicators. Empirical results suggest that progress in e-gov may contribute to the creation a more business-friendly environment in several areas, particularly at starting a business, dealing with construction permits, getting electricity, paying taxes, getting credit, trading across borders, and protecting minority investors.

Although Portugal has been evolving positively both in the Doing Business and e-gov rankings, it is still far from the top performers in several aspects, and gains could be obtained from improvements in digital government intended to facilitate business. Among the variables used in the construction of the Ease of Doing Business indicators, Portugal is always below the best performing countries in those that measure the number of procedures, time, costs and transparency. These are aspects where we can easily foresee a positive role of e-gov. Creating a favourable environment for business is particularly relevant for a country whose economy has been growing slowly over the last decades, has a GDP per capita that represents 80% of the EU average, and a public debt level of 130% of GDP. We believe that in a constantly evolving world, in which only the most innovative remain competitive, governments can play a strategic role as business facilitators.

JEL Classification: O3, D2, H5

Keywords: *Doing business, digital government, Portugal*

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1. Introduction

Administrative and regulatory burden reduction is nowadays seen as a priority to improve governmental efficiency and economic competitiveness. In a world increasingly based on the electronic exchange of information, information communication technologies (ICT) are considered key tools in designing policies to achieve those goals. ICT-based solutions may reduce time, search and coordination costs associated with traditional bureaucratic procedures, to citizens, firms, and the government (Malone *et al.*, 1987; Brynjolfsson e Hitt, 2004; Zuurmon e Robben, 2009). At the policy level, the European Commission has been encouraging Member States to adopt digital government[4] innovations (e.g. electronic ID, interoperability, e-certification, etc.) aiming at public administration modernization, the achievement of a digital internal market and the engagement of more citizens and businesses in order to improve the quality of the services. (EU, 2014; HGLAB, 2014; EU, 2016).

Since 2003, the Doing Business project, from the World Bank, has been publishing annual quantitative data on the main regulatory and administrative constraints affecting domestic small and medium- size enterprises throughout their life cycle. Significant efforts have also been made to measure progress in electronic government (e-gov). In this paper, we use the United Nations' E-Government Survey, which makes available a biannual evaluation of national online services, telecommunication infrastructure and human capital. However, the relationship between innovations in government, here proxied by e-gov, and the ease of doing business is a topic that has not yet been analysed quantitatively. This paper tries to fill this gap in the literature. Results show that e-gov developments can facilitate business in several areas.

Portugal has been evolving positively in the Doing Business ranking, and has been considered a top reformer in several reports (Capgemini, 2010). Among others, Martins *et al* (2010) and Sarmento and Reis (2011) analysed the ease of doing business in Portugal and formulated policy recommendations to improve the country's performance. Also at the e-gov level, important innovations have been adopted during the last years,[5] improving the Portuguese ranking in the e-gov indices. We improve on previous studies on the ease of doing business by expanding the period analysed (which is particularly important in a constantly changing environment in which only the most innovative countries remain competitive), and also by examining how innovations at the digital government level can facilitate the interaction between economic agents and the government, and create a more business-friendly environment.

The remainder of the paper is structured as follows. Section 2 presents the literature review. Section 3 describes the World Bank's Ease of Doing Business indicators, the UNDESA's E-Gov index, and the European Union's Digital Economy and Society Index. Section 4 elaborates on the Portuguese performance over time, and compares it with the European Union average. Section 5 describes the econometric methodology, while section 6 presents the empirical results. Finally, section 7 discusses the policy implications for Portugal of the empirical analysis implemented.

[4] See Janowski (2015) for a survey on the evolution of the digital government.
[5] Fernandes and Barbosa (2016) describe the e-gov programs implemented in Portugal, namely the openness of the first citizen shop in 1999 and the launch of the programmes Simplex and Simplex + in 2006, and 2016, respectively. The development of the digital government and the e-gov services available in Portugal are also analysed by Rodousakis and Santos (2008), and David and Abreu (2015).

2. Literature Review

The administrative and regulatory burdens' impact on economic outcomes has been a topic of research for several studies, over the last decades. In particular, since Djankov *et al* (2002) presented a new measurement methodology and data on the regulation burdens of start-up firms, finding that countries with heavier regulation had higher corruption and larger unofficial economies; and the subsequent beginning of the World Bank's Doing Business publications, several authors analysed the economic effects of regulatory burdens through the Doing Business indicators.[6] Their results show that the Doing Business indicators significantly influence economic aspects such as the registration and entry of new firms in the economy (Klapper and Love, 2011; Júlio *et al*, 2011; Braunerhjelm and Eklund, 2014), the attraction of foreign direct investment (Morris and Aziz, 2011; Jayasuriya, 2011; Corcoran and Gillanders, 2015), and economic growth, either measured by the annual growth of GDP per capita (Djankov *et al*, 2006) or by total factor productivity (Barseghyan, 2008).

Other authors have also researched the relationship between administrative and regulatory burdens and macroeconomic variables, without making use of data from the Doing Business reports. Fonseca *et al* (2001) built a theoretical model to study the relationship between start-up costs and entrepreneurship. Monteiro and Assunção (2012) analysed the impact of a program for bureaucratic simplification and tax reduction on formality among Brazilian microenterprises. The program reduced the tax burden and the red tape involved in tax payments, therefore contributing to bypass cumbersome procedures that increase the costs of being formal. Using data from a survey of micro and small firms, they conclude that the program increased by 13 percentage points formal licensing among retail firms created after the program, and therefore contributed for a significant reduction in the size of the shadow economy. They argue that the program did not affect the licensing of other eligible sectors, such as construction, transportation, manufacturing, and services, because firms in the first two sectors face other barriers to register, while there is uncertainty over eligibility in the other two sectors. Branstetter *et al* (2014) analysed the effects of an entry deregulation reform implemented in Portugal, in 2005, on firm and employment creation. The 'On the Spot Firm' programme (*Empresa na Hora*) substantially decreased administrative fees and simplified procedures, generating a positive impact on firm and job creation in Portugal. Regarding the shadow economy, Thieβen (2003) studied the impact of fiscal policy and deregulation on Ukraine's shadow economy. The paper concludes that direct tax burden, regulatory burden and complexity of the tax system are important causes of unofficial activity. In the case of Ukraine, regulatory burden is the prime moving force beyond the size of the shadow economy.

Analyses on large panels of countries also conclude that high levels of administrative and regulatory burdens have a negative impact on the economy. Friedman *et al*. (2000) conclude that entrepreneurs go underground not to avoid official taxes but to reduce the burden of bureaucracy and corruption. Working on a panel of 85 countries, Djankov et al. (2002) show that stricter entry regulation is associated with higher levels of corruption and the size of unofficial economy. Auriola and Warlters (2005), studying 64 countries, present evidence that higher fixed costs of entry into the formal economy increase the size of the shadow economy. Klapper *et al* (2006) measured the impact of costly regulations on new firm creation in Europe. Focusing on OECD countries, Alesina *et al* (2005) conclude that regulatory reform of product market is positive for investment and Bourlès *et al* (2013) found evidence that anticompetitive upstream regulations harmed productivity. Analysing a panel of 54 countries, Levie and Autio (2011) demonstrate that lighter burden regulation is associated with a higher rate of entrepreneurial entry. Using data from the World Bank Group Entrepreneurship Snapshots and from the World Bank's Doing Business project, Braunerhjelm and Eklund (2014) analysed 118 countries, over six years, and concluded that tax administrative burden has a negative effect on new firm formation.

[6] Despite the fact that the Doing Business indicators may suffer from inconsistency problems, as argued by Pinheiro-Alves

Administrative and regulatory simplification is part of the European agenda. Wegrich (2009) analysed several policies, and their diffusion mechanisms, targeted to reduce administrative burden in Europe, between 2003 and 2007. According to a survey conducted in 28 OECD countries that implemented programs to reduce regulatory costs, 26 countries reported that they had included ICT based solutions in their agenda (OECD, 2004). Additionally, recent reports, e.g. EU (2014) and HLGAB (2014), proposed measures, aiming its reduction that mostly rely on e-gov and ICT solutions, to be implemented between 2014 and 2018 at the national and European level. Recently, the European Commission (EU, 2016) launched the *EU eGovernment action plan 2016-2020*, aiming at public administration modernization, the achievement of a digital internal market and the engagement of more citizens and businesses in order to improve the quality of the services.

Both academic literature and policy guidelines by international organizations suggest that there is a great potential for innovations associated with e-government. However, the e-government concept is not consensual and has been evolving over time. Fang (2002: 1) defined e-government as "a way for governments to use the most innovative information and communication technologies, particularly web- based Internet applications, to provide citizens and businesses with more convenient access to government information and services, to improve the quality of the services and to provide greater opportunities to participate in democratic institutions and processes." According to Janowski (2015), the digital government concept is an evolution-like process, that evolved towards more complexity and greater contextualization. Four main stages are identified in the digital government evolution: digitization or technology in government, transformation or electronic government, engagement or electronic governance and contextualization or policy-driven electronic governance. According to Veiga *et al* (2016), the ICT for reduction of administrative and regulatory burdens goes until the fourth stage of the concept evolution and may contribute to the reduction of the informal economy, an increase in tax compliance and a reduction of corruption.

However, empirical studies focusing on the effects of e-gov innovations on businesses are rare. As far as we know, Arendsen *et al* (2014) is a notable exception by analysing the administrative infrastructure for business-to-government information transfer. Using a large-scale survey conducted amongst Dutch businesses using business-to-government systems, it concludes that firms' characteristics, such as size, attitude and ICT staff, are positively correlated with perceived burden reductions and implementation effectiveness. Therefore, organizational readiness is the most important factor for the adoption of governmental e-services. Despite the fact that, during the last decade and a half, several indices were constructed to measure e-gov development across countries, no study has yet empirically analysed the relationship between electronic government development and the ease of doing business. In this article, we try to fill this gap in the literature by studying the effects of e-government innovations and the Doing Business indicators. The analysis is performed on a large panel dataset, covering 174 of countries from 2004 to 2016. To measure e-gov we use the UNDESA's E-Gov index, which is considered the best among the available indices (Purian, 2014).

3. Description of the ease of doing business indicators and the e-gov indices

As explained in the previous section, we use the indicators of the World Bank's Doing Business report as a proxy for administrative and regulatory burdens. These indicators attempt to measure the main regulatory constraints affecting small and medium-size enterprises in a large panel of countries. The Doing Business reports have been published since 2003, and aggregate information from 11 areas of business regulation - starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, labour market regulation and resolving insolvency - to develop an overall ease of doing business ranking, and an overall distance-to-frontier (DTF) score.[7] The DTF score captures the gap between a country's performance and a measure of the best practice across the entire sample. This score is the ratio of the difference between the worst performance in the sample for a given indicator and the observed performance, and the difference between the worst performance and the best performance on the indicator across all economies since the third year in which the data for such indicator was collected. Both the best performance and the worst performance are established every five years.[8] In the DTF score, the scores obtained for individual indicators for each economy are aggregated through simple averaging into one DTF score, first for each topic and then across the 10 topics. All topics are equally weighted and, within each topic, it is given equal weight to each indicator. The data collection is made through the examination of laws and regulations, and interactions with local experts. In each business area, dimensions such as the number of procedures required, the time and monetary costs involved, as well as some more specific components of each area, are taken into account, as shown in Table 1.

Table 1 - Variables included in the Doing Business Indicators

Indicator	Variables
Starting a Business	Procedures (number)
	Time (days)
	Cost (% of income per capita)
	Paid-in min. capital (% of income per capita)
Dealing with Construction Permits	Procedures (number)
	Time (days)
	Cost (% of warehouse value)
	Building quality control index (0-15)
	Quality of building regulations index (0-2)
	Quality control before construction index (0-1)
	Quality control during construction index (0-3)
	Quality control after construction index (0-3)
	Liability and insurance regimes index (0-2)
	Professional certifications index (0-4)

[7] The first edition of the Ease of Doing Business covered 133 countries and five of the eleven mentioned areas. The analysis was progressively expanded, and the 2017 edition covers 190 countries and eleven areas. The labour market regulation area, although mentioned in the reports as one of the Doing Business topics, has not been analysed nor taken into account for the overall ranking and the distance-to-frontier calculation since 2011.

[8] For more detailed information see World Bank (2015).

Getting Electricity	Procedures (number)
	Time (days)
	Cost (% of income per capita)
	Reliability of supply and transparency of tariff index (0-8)
	Total duration and frequency of outages per customer a year (0-3)
	Mechanisms for monitoring outages (0-1)
	Mechanisms for restoring service (0-1)
	Regulatory monitoring (0-1)
	Financial deterrents aimed at limiting outages (0-1)
	Communication of tariffs and tariff changes (0-1)
	Price of electricity (US cents per kWh)
Registering Property	Procedures (number)
	Time (days)
	Cost (% of property value)
	Quality of the land administration index (0-30)
	Reliability of infrastructure index (0-8)
	Transparency of information index (0–6)
	Geographic coverage index (0–8)
	Land dispute resolution index (0–8)
Getting Credit	Strength of legal rights index (0-10) old methodology
	Depth of credit information index (0-6) old methodology
	Credit registry coverage (% of adults)
	Credit bureau coverage (% of adults)
Protecting Minority Investors	Strength of minority investor protection index (0-10)
	Strength of investor protection index (0-10) old methodology
	Extent of conflict of interest regulation index (0-10)
	Extent of disclosure index (0-10)
	Extent of director liability index (0-10)
	Ease of shareholder suits index (0-10) old methodology
	Extent of shareholder governance index (0-10)
	Extent of shareholder rights index (0-10)
	Extent of ownership and control index (0-10)
	Extent of corporate transparency index (0-10)
Paying Taxes	Payments (number per year)
	Time (hours per year)
	Total tax rate (% of profit)
	Profit tax (% of profit)
	Labor tax and contributions (% of profit)
	Other taxes (% of profit)
Trading Across Borders	Documents to export (number) old methodology
	Time to export (days) old methodology
	Cost to export (US$ per container) old methodology
	Cost to export (deflated US$ per container) old methodology
	Documents to import (number) old methodology
	Time to import (days) old methodology
	Cost to import (US$ per container) old methodology
	Cost to import (deflated US$ per container) old methodology
Enforcing Contracts	Time (days)
	Cost (% of claim)
	Procedures (number, old methodology)
	Quality of judicial processes index (0-18)

Resolving Insolvency	Recovery rate (cents on the dollar)
	Time (years)
	Cost (% of estate)
	Outcome (0 as piecemeal sale and 1 as going concern)
	Strength of insolvency framework index (0-16)
	Commencement of proceedings index (0-3)
	Management of debtor's assets index (0-6)
	Reorganization proceedings index (0-3)
	Creditor participation index (0-4)

Our empirical analysis intends to study the potential of electronic government to improve the Doing Business indicators. Therefore, the main explanatory variable is an e-gov index. Among the e-gov indices currently available, we chose to use the United Nations' E-Government Development index due to its reliability and large coverage, both in terms of years and countries (Purian, 2014). The e-gov index is based on the biannual E-Government surveys implemented by UNDESA. Currently, these surveys, make available a quantitative evaluation of national online services, telecommunication infrastructure and human capital in 193 countries. The E-Government Development index is a weighted average of three normalized indexes:[9] the Telecommunications Infrastructure Index (TII), based on data provided by the International Telecommunications Union; the Human Capital Index (HCI), based on data provided by UNESCO; and the Online Service Index (OSI), based on data collected from an independent survey questionnaire that evaluates the national online presence of the 193 United Nations Member States (UN, 2016). A weight of one third is given to each one of those three indexes.

The TII is an arithmetic average of five indicators:[10] the estimated number of internet users per 100 habitants, the number of main fixed telephone lines per 100 habitants, the number of mobile subscribers per 100 habitants, the number of wireless broadband subscriptions per 100 habitants, and the number of fixed broadband subscriptions per 100 habitants.[11] The HCI is a weighted average[12] of five standardized indicators: the adult literacy rate, the combined primary, secondary and tertiary gross enrolment ratio, the expected years of schooling and the average years of schooling.[13] Finally, the OSI is based on a survey questionnaire that assesses a number of features concerning online service delivery, whole of government approaches, open government data, multi-channel service delivery, e-participation mobile services, usage up-take, digital divide and innovative partnerships through the use of ICT. The data is collected through a primary research performed by a group of 111 researchers under the supervision of UNDESA. Each country's national website, including the national portal, e-services portal, e-participation portal and websites related with the ministries of education, labour, social services, health finance and environment are assessed in the native language and both the availability of the e-tools and the easiness of the interaction are taken into account.

[9] The normalization is performed through a z-score standardization where the mean and the standard deviation of the population are used.
[10] Each one of these indicators is also standardized using the z-score procedure.
[11] This index has mainly remained unchanged for the entire sample period. Some exceptions were the replacement of online population with fixed-broadband subscription and the removal of number of television sets in 2008, the replacement of personal computer users with fixed internet subscriptions in 2012 and the replacement of fixed internet subscriptions with wireless broadband subscriptions in 2014.
[12] A weight of 1/3 is given to the adult literacy and a weight of 2/9 to the other components.
[13] Until 2014, only the first two components were taken into account.

Table 2 presents the overall mean, and the mean by year, of the ease of doing business indicators, and the e-gov index. As can be seen from Table 2, *Resolving Insolvency* is, by far, the Doing Business indicator with the lowest average DTF, meaning that it is the indicator where the difference between the average country and the leading country is higher. On the opposite side, *Starting a Business* is the Doing Business component with the highest average DTF. Table 2 also reveals the existence of a positive trend in all Doing Business variables over time. Over time, the mean values of the e-gov index mostly improve but there are decreases in 2010 and 2014. These decreases probably are not due to an e-gov development backlash but rather to changes in the UN's e-gov surveys. Due to the inclusion of new variables in the composition of some Doing Business DTF's, we also observe a large change in their average score from 2014 to 2016.

Table 2 - Mean values and mean by year

Variable	Mean	Mean by year						
		04	05	08	10	12	14	16
Overall_DTF	60.4	-	-	-	58.8	60.5	61.9	61.0
StartingBusiness_DTF	72.4	61.4	63.1	68.4	73.8	76.4	78.5	82.1
DealConstructPermits_DTF	63.6	-	-	61.1	63.7	64.7	66.3	65.7
GettingElectricity_DTF	67.3	-	-	-	66.8	67.9	70.0	65.4
RegisterProperty_DTF	61.5	-	58.2	59.5	62.6	64.4	65.0	60.9
GettingCredit_DTF	48.6	-	41.8	45.6	50.1	53.6	58.1	47.4
PayingTaxes_DTF	65.4	-	-	61.8	64.6	66.8	68.6	69.9
ResolvingInsolvency_DTF	37.3	34.9	34.6	35.9	35.9	37.9	37.9	43.7
ProtectMinorInvestors_DTF	50.3	-	-	48.1	50.2	51.1	51.6	52.0
EnforcingContracts_DTF	56.3	57.3	56.8	56.4	56.4	56.2	56.3	56.0
TradeAcrossBorders_DTF	63.8	-	-	61.8	63.9	65.5	66.5	67.3
Egov_index[14]	43.1	38.5	40.0	42.8	42.0	48.8	47.1	49.2

Finally, Table 3 presents averages by regions. We used the World Bank region classification: NA stands for North America; ECA for Europe and Central Asia; EAP for East Asia and Pacific; MENA for Middle East and North Africa, SSA for Sub-Saharan Africa; SA for South Asia; LAC for Latin America and the Caribbean. Table 3 reveals regional differences in both e-gov and Doing Business indicators that, in most cases, are in line with the level of development of such regions: North America has the highest average score in all components and Europe and Central Asia tends to have the second highest score, while Sub- Saharan Africa and South Asia tend to have the poorest scores.

[14] Although in the UNDESA's reports this index assumes values between 0 and 1, we multiplied it by 100 in order to be in the same scale as the DTF's.

Table 3 - Mean values by region

Variable	Mean by region						
	NA	ECA	EAP	MENA	SSA	SA	LAC
Overall_DTF	82.5	69.6	65.1	59.1	48.9	54.4	60.0
StartingBusiness_DTF	94.1	83.7	75.3	70.0	58.1	76.3	72.7
DealConstructPermits_DTF	75.8	62.0	72.4	64.6	57.6	57.1	66.9
GettingElectricity_DTF	73.5	71.1	75.8	72.3	51.6	58.9	75.1
RegisterProperty_DTF	82.0	72.5	61.3	65.8	51.0	49.8	59.4
GettingCredit_DTF	87.9	62.1	53.3	32.6	34.8	44.0	52.5
PayingTaxes_DTF	83.2	69.9	73.5	75.9	55.0	64.1	59.2
ResolvingInsolvency_DTF	90.2	54.5	41.0	31.4	21.5	32.4	32.1
ProtectMinorInvestors_DTF	81.2	55.3	55.7	44.6	43.4	51.0	49.4
EnforcingContracts_DTF	70.5	67.4	58.8	53.0	48.5	41.1	53.5
TradeAcrossBorders_DTF	70.5	67.4	58.8	53.0	48.5	41.1	53.5
Egov_index	85.7	60.0	40.2	44.0	24.4	31.6	46.2

4. The Portuguese case

In this section, we describe Portugal's e-gov performance and business environment, over time and relative to the EU average. With this purpose, we analyse data from the United Nations' E-Government Development index, the European Union's Digital Economy and Society Index, and the World Bank's ease of doing business indicators. A brief description of electronic government developments in Portugal is also presented (highlighting the major reforms and initiatives that took place since the early 1990's), as well as some reforms that created a more business-friendly environment and relied on ICT solutions.

4.1. Electronic governance and the e-gov indices

In Portugal, one of the first initiatives to foster the introduction of ICT in public administration occurred in 1991, with the launching of INFOCID, which stands for Interdepartmental System for Citizen's Information.[15] INFOC is an integrated database to which citizens have access to updated information on rights and duties, administrative procedures and formalities, as well as their location and accessibility. Since 1995, INFOCID is available on the internet (www.infocid.pt). Another important step towards a more comprehensive E-gov program was taken in 1999, with the establishment of the first *Citizen Shops*, in Lisbon and Porto. Citizen Shops aim at easing the relationship of citizens and companies with public administration by combining in the same space several public and private entities. In the following decade, several landmark e-gov initiatives were adopted, such as the establishment of the *Agency for Administrative Modernization* (2007); the launch of the program *Simplex* (2006) and its version for the municipal level (2008); the expansion of the *Citizen Shop*'s network; the launch of the *Citizen Card* (2007), which combined identification, social security, the national health service, the taxpayer and the voter card; and the approval of a new public contracts code, that lead to the creation of a mandatory national e-procurement platform. The Simplex programme (or Administrative and Legislative Simplification Programme) was particularly important in the Portuguese e-gov strategy as it significantly improved public administration efficiency (EU,2014). The programme was a package of measures aimed at combating bureaucracy, modernizing public administration, and facilitating the interaction between citizens' and companies' with public administration.

[15] For an overview of E-GOV in Portugal see Fernandes and Barbosa (2016).

In the current decade, additional digital government initiatives were implemented such as the *Digital Mobile Key* (a mechanism for digital signatures authentication through mobile phones), the portal of integrated services *Entrepreneur's Desk*, the spread of the *Once Only* principle through different governmental agencies,[16] the *Interoperability Platform* and the launch of the programme *Simplex +* (the successor of the former *Simplex* programme). According to Fernandes and Barbosa (2016) three principles guided the Portuguese programme for administrative modernization: the proliferation of citizen-centric services, administrative simplification, and improvements in terms of public administration's interconnection. The *Citizen Card*, the *Business Online* platform, the e-declarations in the portal of the *Ministry of Finance* and the *Social Security Online* were considered the country's best practices in terms of e-gov (Capmengi, 2010), and the *Zero Licensing* initiative received the European Commission's Innovation Award.

Table 4 shows the Portuguese performance according to the UN's e-government development indicators. It contemplates the values for the e-gov ranking, and the e-gov index, as well as the three e-gov sub-indexes, for all the index's editions. Although informative, the values presented have to be analysed with caution, since they represent relative measures of the electronic government across countries. Therefore, a drop in the index value for a specific country means that the country's performance is further away from the best performing country, but it does not necessarily signal a worse performance in absolute terms. As can be seen from Table 4, except for 2003 (the year of the first edition of the index), Portugal has always been between the 30th and 39th country more developed in e-gov, according to UNDESA. Although the position in the ranking tended to decrease over time, the value of the index evolved positively. This means that although Portugal is nearing the best-performing country, other countries are progressing even faster. The largest drop (almost seven points) in the e-gov index occurred in 2010, and seems to results mainly from a substantial decrease in the OSI. Taking into account that the OSI is based on a survey that changed from time to time, it is likely that the drop resulted from a change in the set of questions used to compute the index. The values for the sub-indexes reveal that Portugal is closer to the top performer in the human capital dimension, and that it has become closer to the top performer both in terms of the online services and the telecommunication infrastructure, since 2010.

Table 4 - Portugal at the UNDESA's e-gov development indicators

Indicator	2003	2004	2005	2008	2010	2012	2014	2016
E-Gov Ranking	26	31	30	31	39	33	37	38
E-Gov Index	64.6	59.5	60.8	64.8	57.9	71.7	69.0	71.4
Online Service Index	50.7	39.4	42.7	59.9	38.7	65.3	63.8	74.6
Human Capital Index	94.0	97.0	97.0	92.5	93.6	89.3	82.3	81.3
Telecommunication Infrastructure Index	49.0	42.2	42.8	42.2	41.9	60.3	60.9	58.4

Table 5 presents the e-gov index, in all its editions, for all EU countries, and the EU-28 average. Denmark, Netherlands, Sweden and United Kingdom are consistently among the group of top performers in all the UN's e-gov ranking editions. With the exception of the first edition, Portugal always performed below the average for the EU-28. However, in the present decade it is closer to the EU-28 average than in the last decade. In the most recent edition, the Portuguese score is similar to that of Croatia, Poland and Romania.

[16] According to EU (2014), Portugal was one of the best EU countries in the implementation of the *Once Only* principle.

Table 5 - Portugal and the other EU countries at the UNDESA's e-gov index

Country	2003	2004	2005	2008	2010	2012	2014	2016
Austria	67.6	74.9	76.0	74.3	66.8	78.4	79.1	82.1
Belgium	67.0	75.2	73.8	67.8	72.2	77.2	75.6	78.7
Bulgaria	54.8	54.2	56.0	57.2	55.9	61.3	54.2	63.8
Croatia	53.1	52.3	54.8	56.5	58.6	73.3	62.8	71.6
Cyprus	47.4	51.9	58.7	60.2	57.1	65.1	59.6	60.2
Czech Republic	54.2	62.1	64.0	67.0	60.6	64.9	60.7	64.5
Denmark	82.0	90.5	90.6	91.3	78.7	88.9	81.6	85.1
Estonia	69.7	70.3	73.5	76.0	69.7	79.9	81.8	83.3
Finland	76.1	82.4	82.3	74.9	69.7	85.1	84.5	88.2
France	69.0	66.9	69.3	80.4	75.1	86.3	89.4	84.6
Germany	76.2	78.7	80.5	71.4	73.1	80.8	78.6	82.1
Greece	54.0	55.8	59.2	57.2	57.1	68.7	71.2	69.1
Hungary	51.6	58.6	65.4	64.9	63.1	72.0	66.4	67.5
Ireland	69.7	70.6	72.5	73.0	68.7	71.5	78.1	76.9
Italy	68.5	66.0	67.9	66.8	58.0	71.9	75.9	77.6
Latvia	50.6	54.9	60.5	59.4	58.3	66.0	71.8	68.1
Lithuania	55.7	53.7	57.9	66.2	63.0	73.3	72.7	77.5
Luxembourg	65.6	66.0	65.1	75.1	66.7	80.1	75.9	77.0
Malta	63.6	68.8	70.1	65.8	61.3	71.3	65.2	74.2
Netherlands	74.6	80.3	80.2	86.3	81.0	91.2	89.0	86.6
Poland	57.6	60.3	58.7	61.3	55.8	64.4	64.8	72.1
Portugal	**64.6**	**59.5**	**60.8**	**64.8**	**57.9**	**71.7**	**69.0**	**71.4**
Romania	48.3	55.0	57.0	53.8	54.8	60.6	56.3	72.1
Slovakia	52.8	55.6	58.9	58.9	56.4	62.9	61.5	59.2
Slovenia	63.1	65.1	67.6	66.8	62.4	74.9	65.1	77.7
Spain	60.2	58.4	58.5	72.3	75.2	77.7	84.1	81.4
Sweden	84.0	87.4	89.8	91.6	74.7	86.0	82.3	87.0
United Kingdom	81.4	88.5	87.8	78.7	81.5	89.6	86.9	91.9
EU 28 average	**63.7**	**66.6**	**68.5**	**69.3**	**65.5**	**74.8**	**73.0**	**76.1**

As can be seen from Table 6, Portugal is currently below the EU 28 average in all the three components of the UN's e-gov index. Although in the OSI Portugal is getting closer to the EU 28 average in the most recent years, the same does not happen in the HCI, where the gap has been increasing, or in the TII, where the gap fluctuated but remained considerably large. The HCI and the TII series also present some abrupt changes in their values (e.g.: OSI from 2012 to 2014; TII from 2010 to 2012) that are related with changes in the indicators used to calculate the index, as explained in the previous section.

Table 6 - Portugal and the EU 28 average in the UNDESA's e-gov sub-indexes

Sub-index		2003	2004	2005	2008	2010	2012	2014	2016
OSI	Portugal	50.7	39.4	42.7	60.0	38.7	65.4	63.8	74.6
	EU 28 average	50.0	59.0	63.8	61.8	49.0	68.6	64.0	76.0
HCI	Portugal	94.0	97.0	97.0	92.5	93.6	89.3	82.3	81.3
	EU 28 average	93.9	94.3	94.8	95.4	95.6	90.3	86.0	86.0
TII	Portugal	49.0	42.2	42.8	42.2	41.9	60.3	60.9	58.4
	EU 28 average	47.3	46.4	46.9	50.9	52.3	65.6	69.0	66.4

Although, as previously explained, we use the UN's e-gov index in the empirical work mainly due to its large coverage (both in terms of countries and years), it is also relevant to analyse the Portuguese e- gov performance using as reference the European Union's Digital Economy and Society Index (DESI). Note that only four editions of the index are available, starting in 2014. The DESI is a composite index that summarises European Union's countries digital performance based on five dimensions: *Connectivity*, *Human capital*, *Use of internet*, *Integration of digital technology* and *Digital public services*. *Connectivity* refers to the development and quality of the broadband infrastructure. *Human capital* has to do with the skills required to take benefits from the tools available on a digital society. *Use of internet* reports the diversity of tasks and activities that the citizens perform online. *Integration of digital technology* accesses the digitization of business and their use of the online sales channel. *Digital public services* has to do with the digitalization of public services and e-gov development.[17]14 By comparing the composition of the DESI and the E-gov development index, we concluded that there are both similarities and differences, suggesting that information regarding the Portuguese situation in both indexes can be complementary. In the following table, we present the scores for Portugal and the EU-28 average in the DESI and its five dimensions. In Table 8 we report the position of Portugal in the EU-28 ranking in the DESI and its dimensions.

Table 7 - Portugal and EU 28 average scores in the DESI and its dimensions

	Year	DESI	Connectivity	Human Capital	Use of internet	Integration digital technology	Digital Public Services
Portugal	2017	0.53	0.67	0.45	0.44	0.43	0.65
	2016	0.51	0.63	0.44	0.42	0.41	0.68
	2015	0.49	0.59	0.39	0.44	0.37	0.7
EU 28 average	2017	0.52	0.63	0.55	0.48	0.37	0.55
	2016	0.49	0.59	0.53	0.45	0.35	0.51
	2015	0.5	0.57	0.58	0.43	0.33	0.54

[17] The weights attributed to each dimension are as follows: 25% to the *Connectivity* and *Human capital* dimensions, 20% to the *Integration of digital technology* dimension, and 15% to the *Use of internet* and *Digital public services* dimensions. All indicators are normalized using the min-max method and within each dimension different weights are given to the several sub-dimensions. Within the *Connectivity* dimension, a weight of 33% is given to the sub-dimensions *Fixed broadband* and *Speed*, a weight of 22% is given to *Mobile broadband* and 11% to *Affordability*. In the *Human capital* dimension 50% weight is given to the *Basic skills and usage* and 50% to the *Advanced skills* and development sub- dimension. In the *Use of internet* dimension all the sub-dimensions, *Content*, *Communication* and *Transactions* are equally weighted. In the *Integration of digital technology* dimension, *Business digitization* has a weight of 60% and *eCommerce* a weight of 40%. Finally, the *Digital public services* has only one sub-dimension, *E-Government*, which contains the variables *eGovernment users*, *Pre-filled forms*, *Online service completion* and *Open data*. See European Commission (2017) for more details and the complete list of variables considered in each dimension.

While in the UN's index Portugal is below the EU average since 2004, in the DESI Portugal it is always close to the EU-28 average, being above it in 2016 and 2017. According to the DESI Portugal is behaving better than the EU average in terms of Connectivity (ranked 10th), Integration of Digital Technology (ranked 9th) and Digital Public Services (ranked 10th), and worse in the Human Capital (ranked 22nd) and Use of Internet (ranked 19th) dimensions.

Table 8 - Portugal's rankings in DESI and its dimensions

Year	DESI	Connectivity	Human Capital	Use of Internet	Digital Public Services
2017	15	10	22	19	10
2016	14	11	19	19	7
2015	16	14	23	13	5

Therefore, both the DESI and the UNDESA's index put Portugal below the EU average in terms of human capital. If we look at the variables included in each index computation, the combination of the *Connectivity* and *Use of internet* dimensions of the DESI can be compared to the TII in the UN's index. In any case, we should not look at the TII as an average of the *Connectivity* and *Use of Internet* dimensions, given that the variables that are used to calculate them are not exactly the same, neither is the weight that each index gives to each one of them. Portugal is above the EU average in terms of *Connectivity* and below the average in terms of *Use of internet*, while in the TII Portugal is below EU average. Finally, the *Digital Public Services* dimension of the DESI can be compared to the OSI. While in the first Portugal is above the EU average, in the second it is below. This different result for the two e-gov sub-indexes indicates that the OSI is giving more weight to e-gov dimension in which the Portuguese performance is worse than the EU average.

To finalize this subsection, we compare Portugal with the EU-28 average in the variables that form the *eGovernment* sub-dimension of the DESI. Since there is no raw data for the OSI of the UN's index, this comparison is particularly useful to know in more detail how Portugal is behaving in different components of the digital government. *eGovernment users* represents the percentage of internet users that have engaged with the public administration and exchanged filled forms online. *Pre-filled forms* is the variable that tries to capture the level of sophistication of the digital government, by measuring the extent to which data that is already known to the public administration is pre-filled in the forms presented to the users. *Online service completion* measures the extent to which the various steps in an interaction with the public administration are possible to perform totally online. *Open data* is an indicator of the government commitment to open data, which is related to the public availability of governmental data, documents and proceedings.

Table 9 - Portugal and EU 28 average scores on the variables of the e-Government sub-dimension

	Year	eGovernment Users	Pre-filled forms	Online service completion	Open Data
Portugal	2017	41%	74	96	41%
	2016	41%	81	98	260
EU 28 average	2017	34%	49	82	59%
	2016	32%	49	81	351
Portugal-rank	2017	9	4	4	25
	2016	9	4	3	25

The table shows that Portugal is above the EU-28 average in terms of *eGovernment users*, *Pre- filled forms* and *Online service completion* but below the average in the *Open Data* variable.[18] The situationis particularly good in terms of pre-filled forms and online service completion, but the percentage of e- government users (41%) is still relatively low (although above the EU-28 average). The Portuguese government's commitment to open data is clearly the main issue that needs improvement, given the poor score of the country, both in absolute (41%) and in relative (25th rank, 18 percentage points below the EU average) terms.

4.2. The ease of doing business

Shifting the focus to the ease of doing business indicators, we report in Table 10 the Portuguese scores in the ten business areas for all the Doing Business editions.[19] Also on this topic several measures were implemented, in the last decade, that improved the country's ease of doing business.[20] According to the World Bank Doing Business Group, several of these measures rely on innovations at the digital government level. In 2008, the implementation of an online incorporation system for use by lawyers made starting a business easier, and continued computerization of real estate registries in Lisbon reduced the time required to register property. In 2009, online applications for building permits were allowed. In 2010, computerization at the registry backed by an amendment to the registry code that made the use of notaries optional reduced the time required to register a property; additionally, the possibility of electronic filing for the initiation of a suit improved the *Enforcing Contracts* dimension. In 2011, a one-stop shop for property registration was implemented. In 2013, *Trading Across Borders* was facilitated by the introduction of an electronic single window for port procedures. More recently, paying taxes became easier and less costly by the use of a better accounting software, and the launching of an online filing system of taxes.

Martins *et al* (2010) in their survey of measures that reduced administrative and regulatory burdens in Portugal, between 2005 and 2010, also highlight some e-gov developments, namely: the *Firms' Portal*, an online portal that makes available relevant services and information to firms and entrepreneurs; the initiatives *Empresa na Hora* and *Marca na Hora*, which allow, respectively, for the creation of a company or a brand, in an online one-stop shop; the *Online Commercial Registration*, the *Electronic Customs Declaration*, the *Zero Licensing* initiative and the *Regime de Exercício da Actividade Industrial*, which simplified the process of industrial licensing through online filling, monitoring and information. According to the authors, by July 2009, the initiatives *Empresa na Hora*, *Marca na Hora* and *Online Commercial Registration* generated saving of approximately 54.6 million euros, and reduced by 36 minutes the average time necessary to create a new firm. Furthermore, 76271 firms were created and 600 brands acquired in one-stop shops.

As can be seen from Table 10, over time, Portugal considerably reduced the gap to the top performing country in the areas of *Starting a Business*, *Dealing with Construction Permits*, *Registering Property* and *Trading Across Borders*. In the most recent years, Portugal achieved very high scores in *Starting a Business* and *Trading Across Borders*, reaching 100 in the latter area. Scores above 80 points were also obtained in the items *Getting Electricity*, *Registering Property*, *Paying Taxes* and *Resolving Insolvency*. The lowest scores (45 and 56.7, respectively) were achieved in *Getting Credit* and *Protecting Minority Investors*.

[18] The way Open Data is measured changed from 2016 to 2017.
[19] In the tables we report the 2017 values for the ease of doing business indicators, but in the regressions only data until 2016 is used since the UN's e-gov index is only available until 2016.
[20] See the link http://www.doingbusiness.org/reforms/overview/economy/portugal for an overview of reforms on business regulation in Portugal, since 2008.

Table 10 - Portugal in the Ease of Doing Business indicators

Indicator	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Overall	68.7	62.9	65.8	68.0	68.9	68.5	71.5	74.8	76.2	76.0	76.2	77.4	77.6	77.4
Starting a Business	61.8	61.7	69.2	86.3	88.4	90.2	90.2	90.2	94.6	94.5	96.3	96.3	96.3	92.8
Dealing with Construction Permits	-	-	50.8	51	51.2	49.8	56.7	63.2	69	76.8	77.3	76.3	76.4	76.5
Getting Electricity	-	-	-	-	-	-	82	82	82	82	82	84.7	84.7	80.7
Registering Property	-	59.5	59.4	59.7	1	66	70.8	83.7	83.7	83.7	83.7	80.3	80.3	80.3
Getting Credit	-	50	50	50	50	50	50	50	50	50	50	45	45	45.0
Protecting Minority Investors	-	-	60	60	60	60	60	60	60	60	60	56.7	56.7	56.7
Paying Taxes	-	-	75	75	75.4	75.6	75.7	76.5	77.7	78	77.9	77.8	78.5	83.7
Trading Across Borders	-	-	82.6	84.4	84.6	84.3	84.7	84.7	84.8	86.6	85.1	100	100	100
Enforcing Contracts	65.6	64.5	64.5	64.5	64.5	65.6	70	70	70	70	70	73	73	73
Resolving Insolvency	78.8	78.8	80.4	80.7	79.6	74.8	74.8	78.2	76.4	80.3	77.1	84.2	84.8	85.2

To see where Portugal stands in the EU context, Table 11 contains the scores, in 2017, of all business areas DTF's for the EU-28 countries. In general, the Portuguese scores are in line with the EU-28 average in the areas with highest and lowest scores. *Trading Across Borders* and *Starting a Business*, which are the best performing areas for Portugal, are also areas in which the EU-28 average reaches the highest values. *Resolving Insolvency* is the area in which Portugal has the highest positive distance from the EU average, and *Getting Credit* the area in which the distance is more negative. Denmark is the country with more scores above 90 points, and *Trading Across Borders* is the business area where European Union countries perform best, with sixteen countries, including Portugal, obtaining a score of 100. *Getting Credit* and *Protecting Minority Investors* are the areas in which the European Union's countries performance is more far away from the frontier.

Finally, for a more exhaustive analysis of the Portuguese situation, Table A1 in appendix provides the Portuguese score for each of the Ease of Doing Business variables, as well as the sample average and the value for the top performer.

Table 11 - Portugal and the other EU countries in the Ease of Doing Business indicators (2017)

Country	Overall	Starting a Business	Dealing with Construction Permits	Getting Electricity	Registering Property	Getting Credit	Protecting Minority Investors	Paying Taxes	Trading Across Borders	Enforcing Contracts	Resolving Insolvency
Austria	78.9	83.7	75.0	87.7	80.0	60.0	65.03	83.4	100	75.5	78.9
Belgium	73.0	94.5	75.3	79.6	51.4	45.0	58.3	77.3	100	64.3	84.3
Bulgaria	73.5	86.8	75.1	65.0	70.2	70.0	73.3	72.8	97.4	65.1	59.4
Croatia	73.0	85.6	63.4	76.2	69.8	55.0	66.7	81.7	100	75.9	55.6
Cyprus	72.7	91.2	64.0	78.3	63.4	60.0	66.7	84.5	88.4	48.6	81.4
Czech Republic	76.7	86.9	62.8	90.3	79.7	70.0	60.0	80.7	100	60.4	76.4
Denmark	84.9	94.1	84.7	90.2	89.9	70.0	71.7	92.1	100	71.2	84.9
Estonia	81.0	95.1	82.6	83.2	91.0	70.0	60.0	88.0	99.9	75.2	65.5
Finland	80.8	93.1	75.5	89.0	82.9	65.0	56.7	90.2	92.4	69.4	93.9
France	76.3	93.3	79.2	85.8	61.1	50.0	65.0	78.7	100	73.0	76.6
Germany	79.9	83.4	81.4	98.8	65.7	70.0	60.0	82.1	90.8	73.2	92.3
Greece	68.7	90.7	73.6	80.6	49.7	50.0	63.3	78.2	93.7	50.2	56.7
Hungary	73.1	87.3	71.7	60.1	80.1	75.0	55.0	74.5	100	75.8	51.3
Ireland	79.5	95.9	76.0	84.2	76.3	70.0	73.3	94.4	87.2	57.9	80.0
Italy	72.3	89.4	69.4	80.7	81.7	45.0	63.3	61.6	100	54.8	76.6
Latvia	80.6	94.2	78.9	82.1	81.9	85.0	63.3	89.8	95.3	71.7	64.0
Lithuania	78.8	93.0	80.4	80.1	92.9	70.0	61.7	85.4	97.7	77.9	49.2
Luxembourg	68.8	88.7	83.7	84.3	63.8	15.0	45.0	89.9	100	73.3	45.4
Malta	65.0	80.2	70.0	73.0	48.8	30.0	65.0	84.6	91.0	62.2	45.3
Netherlands	76.4	94.1	69.3	81.6	80.0	50.0	56.7	88.1	100	59.9	84.0
Poland	77.8	84.2	75.2	81.3	76.5	75.0	63.3	82.7	100	63.4	76.4
Portugal	**77.4**	**92.8**	**76.5**	**80.7**	**80.3**	**45.0**	**56.7**	**83.7**	**100**	**73.0**	**85.2**
Romania	74.3	89.5	68.7	56.5	71.1	85.0	60.0	81.6	100	71.1	59.2
Slovakia	75.6	88.6	67.8	80.3	91.0	65.0	53.3	80.6	100	58.9	70.5
Slovenia	76.1	91.4	70.3	89.2	77.0	35.0	75.0	86.6	100	53.0	84.0
Spain	75.7	86.6	65.9	73.0	73.9	60.0	65.0	83.8	100	69.5	79.6
Sweden	82.1	94.6	78.8	96.2	90.1	55.0	71.7	85.3	98.0	72.0	79.4
United Kingdom	82.7	94.6	80.3	89.1	74.1	75.0	78.3	90.7	93.8	69.4	82.0
EU-28 average	**76.3**	**90.1**	**74.1**	**81.3**	**74.8**	**59.6**	**63.3**	**83.3**	**97.4**	**66.6**	**72.1**

5. Database and methodology

Besides the variables from the World Bank's Doing Business reports and the United Nations' E-Gov Surveys, that were explained in the previous section, the database that supports our analysis also includes data from the World Bank's Development Indicators, the World Bank's Governance Indicators, the Fraser Institute's indicators on the Economic Freedom of the World, and the International Country Risk Guide from the PRS group. The data used in the regressions contains a maximum of 174 observations per year covering the years of 2004, 2005, 2008, 2010, 2012, 2014 and 2016. In each regression, the number of observations varies according to the dependent variable that is being considered.

Controls for each country's economic situation were extracted from the World Bank's Development Indicators: the share of government expenditures on GDP, and the openness of the economy.[21] The perceived government effectiveness is used as a proxy for the institutional quality of the country and was obtained from the World Bank's Governance indicators. This variable captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Its values correspond to the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. Although more than one governance indicator from the World Bank's database could be used for the purpose of our analysis (namely the regulatory quality or the rule of law), these indicators are highly correlated. Variance inflated factors tests revealed that is not appropriate to include more than one of them in each regression. Therefore, we have selected government effectiveness because it is the most comprehensive indicator.

The analysis that we report in the next section is based on eleven different regression models, where the dependent variables are countries' overall DTF and the DTF for each of the ten regulatory areas analysed. Each model is estimated both by fixed effects and random effects, and the Hausman test is used to asses which method is more appropriate. As the fixed effects are capable of controlling for unobserved heterogeneity at the country level, while the random effects are not, the Hausman test is critical to evaluate the consistency of the random effects estimator, which, when consistent, is more efficient. Analytically these models can be represented as follows:

$$DTF_{i,t}=\beta_0+\beta_1 egov\_index_{i,t}+\lambda t+\theta(egov_{index\ i,t}*\lambda t)+\rho X'_{i,t}+\mu i+\varepsilon_{i,t} \quad (1)$$

$$DTF_{i,t}=\beta_0+\beta_1 egov\_index_{i,t}+\lambda t+\theta(egov_{index\ i,t}*\lambda t)+\rho X'_{i,t}+\mu i+\varepsilon_{i,t} \quad (2)$$

where equation (1) is the fixed effects model and equation (2) the random effects model. D , represents both the overall DTF and the DTF of each of the 10 indicators analysed for country *i* in year *t*. Among the explanatory variables, we highlight the $egov\_index\ i$, which is the E-Government Development Index of county *i* in year *t*. $X'_{i,t}$ is a set of control variables, and λt stands for time effects, which in this case are captured by year dummies. In order to control for differences in the impact of e-gov on DTF over time, we also included the interaction between the e-gov index and the year dummies. In equation (1), μi represents country fixed effects; and in equation (2) μi represents a random element, specific for country *i*. Finally, $\beta 0$ and $\beta 1$ are coefficients to be estimated, ρ and θ are vectors of coefficients to be estimated, and $\varepsilon\ i$,, is the error term.

Vector X includes the following economic and institutional variables:[22]

- $Gov\_C\ i,t$-1: the lagged value of the share of government consumption on GDP;
- $Openness i,t$-1: the lagged value of the openness of the economy, measured by the sum of the percentages of exports and imports on GDP;
- $Gov\_Effectiveness\ i,$-1: perceptions of government effectiveness.

[21] The GDP per capita was also initially considered, but was not included in the specifications due to high values in the variance inflated factors (VIF).

[22] Besides the GDP per capita, several other variables were also tested but not included, either because they created multicolinearity problems (high VIF values) or led to the loss of many observations without significantly improving the explanatory power of the regression. Perceived regulatory quality, perceived rule of law and perceived control of corruption fall in the first category; while the number of government crises, the weighted conflict index, the government fractionalization index, judicial independence, corruption index, perceived voice and accountability and democratic accountability fall in the second category. The Index of Economic Freedom, by the Heritage Foundation, was not used because it includes variables from the World Bank's Ease of Doing Business indicators in its calculation.

As previously mentioned, in all considered models, the e–gov index was interacted with the time dummies because its composition changed over time. While the compositional changes in the TII and the HCI are trackable and easily identifiable, changes in the OSI (which are more frequent) are not, because the raw data is not available. Therefore, it is not possible to compute an index based on indicators for which data is available for all years. To overcome this problem, the e-gov index is multiplied by the time dummies. This procedure allows for the estimated coefficient associated with the e-gov index variable to change over time. All regressions were estimated with robust standard-errors in order to avoid heteroskedasticity problems.

6. Empirical results

As described above, we started by estimating both fixed effects and random effects regressions for the overall Ease of Doing Business index, and its components, and by performing Hausman tests to determine which method was most appropriate. Tables 12 and 13 contain the estimation results for the eleven dependent variables. At the bottom of the tables we show the marginal effects of e-gov in each year.[23] The Hausman tests revealed that the Fixed Effects method is appropriated for models in columns 1, 2, 4, 5, 7 and 10, while the Random Effects is consistent for models in columns 3, 6, 8, 9 and 11. For most of the estimated models there are positive time effects on the distance-to-frontiers. The majority of the estimated coefficients associated with the time dummies are statistically significant, positively signed, and their magnitude increases over time, revealing a global approximation between the average country and the top performing country in each area of the Ease of Doing Business indicators.

The empirical results suggest that progress in electronic government can facilitate business, as suggested by the literature and policy guidelines. As can be seen from Table 12, the *E-Gov_index* is statistically significant when the dependent variable is the *Overall_DTF*, in the base year and in all years for which data is available.[24] The *E-gov_index* is positively signed and statistically significant in seven out of the ten doing business areas (Tables 12 and 13): Starting a Business (*Starting Business_DTF*), Dealing with Construction Permits (*Deal Construct Permits_DTF*), Getting Electricity (*Getting Electricity_ DTF*), Paying Taxes (*Paying Taxes_DTF*), Getting Credit (*Getting Credit_DTF*), Trading Across Borders (*Trade Across Borders_DTF*) and Protecting Minority Investors (*Protect Minor Investors_DTF*). In several of these cases, the coefficient associated with the *E-Gov_index* varies over time, and decays in 2012 and 2014.

[23] Empty cells in the time dummies and the interaction terms appear when the base year of the regression is not 2004. Some indicators only started being taken into account in the Doing Business reports in 2005 or later, and therefore, there is no data prior to these years

[24] As previously explained, the GDP per capita was not included in the specifications due to high values in the variance inflated factors (VIF). However, the inclusion of this variable does not substantial change the results for the E-gov_index coefficients, as can be seen from Table A2 in appendix. The table shows the fixed effects results for the Overall_DTF for regressions including, and excluding, GDP per capita.

Table 12 - Regression results (part I)

Variables	(1) Overall _DTF	(2) Starting Business _DTF	(3) Deal Construct Permits_ DTF	(4) Getting Electricity _DTF	(5) Register Property _DTF	(6) Paying Taxes _DTF
E-gov_index	0.134***	0.352***	0.131*	0.178***	0.0691	0.188**
	(3.428)	(4.086)	(1.865)	(2.952)	(1.198)	(2.390)
2005		2.941***				
		(2.961)				
2008		9.180***			4.603***	
		(3.798)			(3.355)	
2010		19.00***	4.020***		8.592***	1.787
		(6.184)	(2.620)		(4.348)	(1.497)
2012	2.883***	24.26***	6.158***	2.944**	10.60***	5.019***
	(6.389)	(8.036)	(2.961)	(2.567)	(5.414)	(2.894)
2014	6.432***	30.13***	9.726***	6.548***	13.78***	7.119***
	(9.575)	(9.759)	(3.975)	(4.158)	(6.068)	(4.297)
2016	4.921***	39.51***	5.843**	-6.669***	4.528	8.093***
	(4.782)	(10.13)	(2.065)	(-2.935)	(1.605)	(4.245)
E-gov_index .2005		-0.0257				
		(-1.426)				
E-gov_index .2008		-0.0309			-0.0411*	
		(-0.737)			(-1.872)	
E-gov_index .2010		-0.110**	-0.0181		-0.0477	0.0342
		(-1.987)	(-0.681)		(-1.415)	(1.485)
E-gov_index .2012	-0.0491***	-0.193***	-0.0619*	-0.0644***	-0.0688**	-0.0118
	(-4.662)	(-3.724)	(-1.706)	(-2.855)	(-2.039)	(-0.383)
E-gov_index .2014	-0.0802***	-0.261***	-0.0842**	-0.0850***	-0.105***	-0.00606
	(-5.863)	(-4.783)	(-1.962)	(-2.797)	(-2.666)	(-0.197)
E-gov_index .2016	-0.0557***	-0.379***	-0.00711	0.0962**	0.00300	0.00337
	(-3.047)	(-5.822)	(-0.145)	(2.344)	(0.0641)	(0.0968)
Gov_C	-0.196**	-0.192	-0.189	-0.127	-0.211	-0.276**
	(-2.144)	(-1.271)	(-1.115)	(-0.590)	(-1.439)	(-2.125)
Openness	0.0298**	-0.00187	0.0263	0.0194	0.0285	-0.00831
	(1.983)	(-0.0578)	(1.293)	(1.288)	(1.281)	(-0.380)
Gov_Effect	5.102***	1.743	5.847***	8.496***	4.340**	7.758***
	(4.264)	(0.692)	(3.963)	(6.369)	(1.989)	(2.935)
Constant	53.64***	47.68***	55.20***	58.52***	55.61***	57.15***
	(21.65)	(9.054)	(11.35)	(11.73)	(14.05)	(12.96)
# of countries	170	174	172	172	174	172
Observations	662	1,102	828	662	969	828
R-squared	0.336	0.581	0.207	0.412	0.248	0.297
Model	FE	FE	RE	RE	FE	FE
Marginal effects of e-gov						
2004		0.352***				
		(4.086)				
2005		0.326***			0.0691	
		(4.02)			(1.198)	
2008		0.321***	0.131*		0.028	0.188**
		(3.76)	(1.865)		(0.45)	(2.390)
2010	0.134***	0.242***	0.112	0.178***	0.021	0.222**
	(3.428)	(2.70)	(1.60)	(2.952)	(0.33)	(2.57)
2012	0.085**	0.159**	0.069	0.114**	0.000	0.176**
	(2.59)	(2.15)	(1.19)	(2.40)	(0.00)	(2.29)
2014	0.054*	0.091	0.046	0.093*	-0.035	0.182**
	(1.67)	(1.29)	(0.376)	(1.82)	(-0.64)	(2.40)
2016	0.078**	-0.027	0.123**	0.274***	0.072	0.192**
	(2.10)	(-0.33)	(0.031)	(5.74)	(1.21)	(2.46)

Notes: Robust t-statistics and z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 13 - Regression results (part II)

Variables	(7) Resolving Insolvency_DTF	(8) Getting Credit_DTF	(9) Trade Across Borders_DTF	(10) Enforcing Contracts_DTF	(11) Protect Minor Investors_DTF
E-gov_index	0.0415	0.422***	0.245***	0.0559	0.182***
	(0.554)	(6.733)	(2.677)	(1.493)	(2.996)
2005	0.670			0.262	
	(0.813)			(0.760)	
2008	5.040***	1.363		1.647	
	(3.165)	(0.844)		(1.636)	
2010	5.319***	6.895***	3.468***	1.913*	2.269**
	(3.525)	(2.695)	(2.906)	(1.699)	(2.048)
2012	5.175***	16.97***	6.112***	1.804	3.906***
	(3.022)	(7.042)	(3.986)	(1.535)	(2.746)
2014	5.134***	30.43***	8.987***	3.324**	4.387***
	(3.219)	(11.85)	(5.279)	(2.461)	(2.847)
2016	18.47***	15.94***	7.856	2.383	5.522***
	(6.171)	(4.305)	(1.596)	(1.343)	(2.842)
E-gov_index .2005	-0.000944			-0.00464	
	(-0.0467)			(-0.661)	
E-gov_index .2008	-0.0242	0.0901***		-0.0227	
	(-0.699)	(2.777)		(-1.343)	
E-gov_index .2010	-0.0331	0.0831*	-0.0209	-0.0223	-0.00532
	(-0.999)	(1.707)	(-0.923)	(-1.162)	(-0.299)
E-gov_index .2012	0.00268	-0.103**	-0.0809***	-0.0301	-0.0381*
	(0.0711)	(-2.575)	(-3.085)	(-1.528)	(-1.671)
E-gov_index .2014	0.0188	-0.262***	-0.110***	-0.0555**	-0.0270
	(0.501)	(-6.257)	(-3.683)	(-2.412)	(-1.078)
E-gov_index .2016	-0.108*	-0.202***	-0.0405	-0.0354	-0.0352
	(-1.726)	(-3.454)	(-0.513)	(-1.125)	(-0.898)
Gov_C	-0.0592	-0.299***	-0.0353	-0.0606	-0.0943
	(-0.512)	(-2.781)	(-0.202)	(-0.626)	(-0.991)
Openness	0.0125	-0.0366	0.0401**	0.00922	-0.00389
	(0.505)	(-1.479)	(2.268)	(0.642)	(-0.245)
Gov_Effect	6.002***	8.718***	11.94***	0.732	5.547***
	(3.587)	(5.804)	(5.863)	(0.593)	(4.456)
Constant	30.98***	29.42***	47.19***	53.92***	41.88***
	(8.402)	(7.557)	(8.798)	(20.74)	(11.81)
# of countries	174	174	172	174	172
Observations	1,102	969	828	1,102	828
R-squared	0.321	0.453	0.523	0.025	0.314
Model	FE	RE	RE	FE	RE

Marginal effects of e-gov

Year	Resolving Insolvency_DTF	Getting Credit _DTF	TradeAcross Borders_DTF	Enforcing Contracts_DTF	ProtectMinor Investors_DTF
2004	0.0415			0.0559	
	(0.554)			(1.493)	
2005	0.041	0.422***		0.049	
	(0.57)	(6.733)		(1.32)	
2008	0.017	0.512***	0.245***	0.030	0.182***
	(0.24)	(7.64)	(2.677)	(0.76)	(2.996)
2010	0.001	0.505***	0.224**	0.033	0.177***
	(0.11)	(6.72)	(2.24)	(0.81)	(2.77)
2012	0.044	0.318***	0.164*	0.025	0.144***
	(0.74)	(5.21)	(1.93)	(0.72)	(2.67)
2014	0.060	0.160**	0.135	0.000	0.155***
	(1.03)	(2.52)	(1.65)	(0.00)	(2.84)
2016	-0.067	0.220***	0.205**	0.020	0.147***
	(-0.90)	(2.93)	(2.19)	(0.47)	(2.72)

Notes: Robust t-statistics and z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Until 2012, the largest estimated coefficients for the *E-gov_index* were obtained for the *Starting a Business* and *Getting Credit* areas. According to the estimations, in the base years, a one point increase in the E-Gov_index (in a scale from 0 to 100) led to an increase of 0.35 and 0.42 points in each of these DTF's, respectively. In both cases the impact of e-gov seems to decrease over time. This result is particularly strong for the *Starting a Business* area, where the e-gov index stops being statistically significant after 2012. For the *Getting Electricity*, *Paying Taxes*, *Trading Across Borders* and *Protecting Minority Investors* areas the estimated marginal effect of e-gov index, in each year for which data is available, is always statically significant, and varies between 0.1 and 0.27. The most stable coefficients were obtained for the *Paying Taxes* and *Protecting Minority Investors* areas. For *Dealing with Construction Permits* there is only evidence of a positive effect of e-gov in 2016 and 2008, although in this last year only at the 10% significance level.

Although the raw data used in the indices construction is not available, we may infer that the variations in the estimated coefficients associated with *E-Gov_index* over time are due to methodological changes in the *E-Gov_index* construction. This variable's definition changes over time in order to accommodate the new trends in electronic government. According to UN (2016), the first two editions of the index focused on countries' readiness for e-gov but over time the focus moved to actual development, e-gov maturity and people-driven services. Additionally, "each edition of the Survey has been adjusted to reflect emerging trends in e-government strategies, evolving knowledge of best practices in e-government, changes in technology and other factors" (UN, 2016: 133). The data collection process has also been periodically redefined. It is possible that in the formula used to calculate the index more weight was given to very specific contents of the ICT based processes that may not be very relevant for the business and regulatory environment, particularly in 2012 and 2014. Additionally, the inclusion of new variables in some of the Ease of Doing Business areas, may also help justifying fluctuations in the estimated coefficients across the years.

Besides progress in electronic government, other factors seam to influence the doing business distance-to-frontiers, especially the institutional ones. The variable used to proxy the quality of institutions (*Gov_Effectiveness*) exhibited a positive and statistically significant coefficient in the *Overall_DTF* model, as well as in eight of the ten models for the distance-to-frontiers of the business areas included in the Doing Business database. The statistically significant coefficients are all between 5 and 12, indicating that an increase of one point in this variable is associated with an increase between 5 and 12 points in the DTF's, depending on the business area being considered. Only for *Starting a Business* and *Enforcing Contracts* did *Government Effectives* not turn out to be statistically significant. The estimated coefficient associated with the lagged value of government consumption over GDP (*Gov_C*) is always negative, although it is only statistically significant for the overall index, and the *Paying Taxes* and *Getting Credit* areas. The lagged value of the degree of openness of the economy (*Openess*) seems to be statistically significantly related to a higher score in the *Overal_DTF* and in the *Trading Across Borders* area.

In order to further investigate how electronic government developments facilitate business, and to build a more solid bridge to the theoretical literature, we estimated regressions for all the Doing Business raw indicators, using the same set of independent variables of the previous models and the same estimation techniques, except for the cases were only one year of data was available.[25]The results[26] corroborated our expectations that e-gov can help reducing the time, paper-handling, wait and coordination problems of the bureaucratic processes. Regarding the *Starting a Business* topic, the analysis shows that improvements in the *e-gov_index* are associated with decreases in the number of procedures and days required to start a business. In *Dealing with Construction Permits*, the index turned out to be significantly correlated with some of the indicators that were recently added in this area: building quality control, quality of building regulations, quality control during construction, quality control after construction and professional certification. In *Getting Electricity* some of the most recent indicators included in this area also turned out to be statistically significantly associated with the *e-gov_index*: reliability of supply and transparency of tariff, total duration and frequency of outages per costumer, mechanisms for monitoring outages, mechanisms for restoring service, regulatory monitoring and price. For *Registering Property* electronic government is associated with a decrease in the number of days and an improvement in the new variables that were considered in the most recent editions of the ease of doing business, such as quality of land administration, transparency of information, geographic coverage and land dispute resolution. In the *Getting Credit* area, e-gov seems to positively affects the depth of credit information and credit registry coverage. In the *Paying Taxes* area, higher values of the E-gov_index are associated with a decrease in the number of annual tax payments. In the *Trading across Borders* area, there is evidence that the number of documents required to export is smaller when e-gov is more developed, and that the time to export and the costs involved in both exports and imports are also lower. *Protecting Minority Investors* is an area where *the e-gov index* may influence the strength of investor protection, extent of disclosure, extent of director liability, ease of shareholder suits and extent of corporate transparency.

As explained in section 3, the E-Government Development index is a weighted average of three indexes: The Telecommunications Infrastructure Index (TII), the Human Capital Index (HCI), and the Online Service Index (OSI). The OSI is the index that is more directly related with the electronic government services provided in each country. Therefore, we also estimated the models using as the main independent variable the OSI instead of the full index. The results presented in Tables A3 and A4 of the appendix, corroborate the hypothesis that innovations in public online services facilitate business. The coefficient associated with the OSI turned out to be positive, and statistically significant, in seven regressions for the base year. Comparing to the regressions including the full index as explanatory variable, in the base year, the OSI index was not significant for the *Dealing with Construction Permits* and *Paying Taxes* areas but was marginally significant for the *Enforcing Contracts* area. As before, the coefficients varied over time and tended to decay after 2012. In most cases, the magnitude of the estimated coefficients that are statistically significant is smaller than in the regressions with the *E-gov_index*. This is not surprising, if we take into account that the two sub-indexes not included in the regressions (HCI and TII) capture dimensions that are also expected to facilitate business.

[25] This happened for the variables that were recently added to the ease of doing business. In these cases, we estimated either OLS or Tobit models, depending on the nature of the dependent variable.
[26] The results are not presented for parsimonious reasons, but they can be obtained from the authors upon request. Given the large quantity of variables that are being analysed using the same set of independent variables, it is likely that in some cases, relevant variables are missing. Moreover, for the variables for which only one year of data is available it is not possible to control for time and unobserved heterogeneity. Therefore, the results of these regressions should only be interpreted as indicave.

Finally, several robustness tests were implemented. As the methodology to compute the e-gov index changed over time, cross sectional regressions for each year in which data is available were estimated. The Tobit model was used in these estimations because the dependent variable is both left-censored and right-censored. Most of the estimated coefficients for the *E-Gov_index* variable had larger magnitude and were statistically significant in more doing business areas than when we used panel data.[27] For example, for 2016, the *E-Gov_index* was positive and statistically significant in ten of the eleven estimated models, whereas using panel data techniques and considering the interactions between this variable and the year dummies, the coefficient was only significant in six of the eleven models. Another robustness test was the inclusion of a time trend, instead of time dummies. This procedure lead to very similar results to those presented in Tables 12 and 13.

Since the variables used as dependent variable are indices, they are bounded between zero and one hundred, and fixed and random effects may not be the most appropriate estimation methods as the predicted values from the estimations cannot be guaranteed to lie within the unit interval. Therefore, a final robustness check consisted in the estimation of the regressions using the fractional probit (Papke and Wooldridge, 1996). In this model, the dependent variable has to be between zero and one, so we divided the DTF's by 100. In order for the e-gov_index to be in the same scale as the DTF, we put it back on its original scale. The estimated models included the same set of independent variables as those of Tables 12 and 13, and also control for country fixed effects. The results are presented in Tables 5A and 6A in appendix. For the base years, when using the fractional probit, we obtain eight statistically significant coefficients for the e-gov_index variable, the same number as when using fixed/random effects. The main differences are that with the fractional probit, the e-gov index turned out to be statistically significant for *Enforcing Contracts* and non-significant for the *Trading Across Borders* area. Although marginally significant, the coefficient of the e-gov variable in the *Enforcing Contracts* area is almost exactly equal to the one obtained by fixed effects for the base year, and decays over time. On the *Trading Across Borders* the difference can be explained by the use of random effects in the previous estimation, while in the fractional probit estimations fixed effects are used. If we compare one by one the results of Tables 12 and 13 to the results of Tables 5A and 6A, we can see that they are identical for the cases where the Hausman test led to the selection of the fixed effects model. In the cases for which the random effects estimations were more appropriate, the values of the estimated coefficients are not so similar with those of the factional probit, but the statistical significance of the coefficients associated with the e-gov is not very different (except for the *Trading Across Borders* area). Therefore, we believe that the results are robust to the use of different estimation techniques.

7. Discussion and implications for Portugal

Using a large panel dataset, covering 174 countries from 2004 to 2016, our empirical results confirm that innovations in public administration, based on electronic government, may be used to create a more supportive environment for business. This in turn will contribute to a more dynamic and competitive economy, as well as to the attraction of foreign investment and growth which are of great importance for Portugal.

[27] These results need be taken with caution since with cross-section data we cannot include controls for time and country level unobserved heterogeneity.

In this section, we present some policy implications, for the Portuguese case, of the empirical results previously discussed. We started by computing the difference between the value of the e-gov index for the EU-28 average (76.1) and the value for Portugal (71.4), in 2016. This value was then multiplied by the estimated coefficients associated with the e-gov index in each of the business areas where this variable turned out to be statistically significant, in 2016. The results obtained provide us an indication of the benefits for business that can be generated by improvements in e-gov. [28] The following table presents the estimated impacts. Trade across the border was not included in the table because Portugal already reached the maximum of 100 in this business area.

Table 14- Estimated impacts of Portuguese convergence to the EU 28 average in the e-gov index

Variable	Estimated coefficient for the e-gov index in 2016	Impact of convergence to the EU-28 average	Impact of convergence to the top performer (e-gov = 100)
Overall	0.078	0.367	2.231
Deal Construction Permits_ DTF	0.123	0.5781	3.518
Getting Electricity _DTF	0.274	1.2878	7.836
Paying Taxes _DTF	0.192	0.902	5.491
Getting Credit_ DTF	0.220	1.034	6.292
Protect Minor Investors	0.147	0.691	4.204

This simple exercise illustrates some potential benefits for business of policies relying on ICT based solutions which improve the e-gov index. Recalling Table 11 of section 4.2., we can see that, with the exception of the *Trading Across the Borders* area where Portugal already achieved 100, there is room for improvement in the other five areas in which the e-gov index turned out to be statistically significant. This is particularly true for the *Getting Credit*, *Protecting Minority Investors* and *Getting Electricity* areas, where Portugal is, respectively, 14.6, 6.6, and 0.6 points below the EU-28 average. Even in terms of *Dealing with Construction Permits* and *Paying Taxes* where Portugal is already above the EU-28 average, and in *Trading Across Borders* where Portugal is a top performer, innovations in electronic government are necessary if the country wants to remain among the best. Besides these six business areas, until 2012 the e-gov index was also statistically significant in the *Starting a Business* DTF, which is an area where several ICT solutions were launched in Portugal (as described in the previous section). Therefore, we also think that developing electronic government services can have a positive influence in this dimension of the ease of doing business. Portugal has a very high score in this area, but the same happens with most of the other EU countries, so improvements are necessary to keep competitiveness.

[28] Note that the Doing Business reports only focus on small and medium-sized enterprises (SME), ignoring large firms. Since, in general, SMEs have more trouble dealing with ICT based solutions than large firms (OECD, 2004), mainly due to a lack of skilled human resources, one would expect the estimated benefits of e-gov improvements to be higher if large enterprises were also taken into account.

To further explore the implications of the empirical results presented in section 6, we compared Portugal's score with that of the top performer in each of the Ease of Doing Business variables that are used to compute the DFT's (Table A1 in appendix), for each of the business areas where the e-gov index seems to matter the most. In most of the areas that take into account the number of procedures, time and costs, Portugal is below the top performance, which suggests that further reforms to simplify and expedite procedures would be beneficial. For example, in Portugal, taxes are paid, on average, 8 times per year, requiring 243 hours of tax payers time, while in the best performing country these numbers are much lower (3 and 49, respectively). These are aspects in which we think electronic governance may continue to give a significant contribution. To be more exhaustive, we identify other variables in which Portugal is below the top performer and in which e-gov may also be relevant. In *Dealing with Construction Permits* there's also margin for improvements in building quality control index. In *Getting Electricity*, besides the number of procedures, time and costs, Portugal may improve in the reliability of supply and transparency of tariff index. In *Registering Property*, Portugal may benefit from developing e-gov in terms of land administration, transparency of information, geographic coverage and land dispute resolution. The depth of credit information is a variable within the *Getting Credit* area where marginal benefits may result from electronic government innovations. Additionally, in the *Protecting Minority Investors* area, electronic government may help Portugal to improve in terms of investor protection, corporate transparency, extent of disclosure, extent of director liability and ease of shareholder suits.

The World Bank's Doing Business portal reports several examples of reforms implemented since 2008, that relied on ICT-based solutions and contributed to a more business-friendly environment. These reforms may give guidance for future initiatives to be implemented in Portugal. Examples are: improvement in the central collateral registry via online accessible databases; the creation and improvements of online platforms for public credit information and penalties for institutions that do not provide proper information to these platforms; innovations on online systems for banks to share credit information at the private credit bureau, collecting data on all loans from financial institutions and distributing historical credit information covering a longer period, and online system for data exchange between all banks and microfinance institutions and the central bank's credit registry; simplifications in the tax system and several taxes being paid jointly electronically; improvements in the online system for filing and paying VAT and social security contributions; creation of electronic application processes to submit and track applications to get electricity; introduction of an electronic capacity/availability connection map to determine new costumers for electricity connection points; improving the electronic verification of prebuilding certificates; improvements in the electronic processing of applications for building permits and allowance of construction companies to apply for safety certificates online and merging several requirements; improvements in the online one-stop shops; upgrades in the electronic data interchange system for customs operations; the creation of electronic single- window systems, which reduce the time for border compliance and documentary compliance for both exporting and importing; improvements in the geographic coverage of online registration; or several innovations on the online systems of firm's registry and licensing.

As the raw data of the Online Service Index is not available, one way to obtain a hint on which areas of electronic government should be developed in Portugal is by recalling the country's situation in each *eGovernment* indicator of the DESI (Table 9). Although Portugal is well ranked in terms of *Pre-filled forms* and *Online service completion*, improvements could be made in terms of *eGovernment* users and *Open Data*. The Portuguese situation is particularly bad in terms of commitment with open data, and innovations in this area should be a priority. Anyway, given that progress in ICT is fast, electronic government innovations are necessary in the other areas as well, to improve the country's situation in absolute terms and avoid a deterioration of Portugal's performance relative to other countries. Finally, taking into account the importance of the human capital and telecommunications infrastructures dimensions, and that Portugal is not a top performer in any of them, policies in these matters are also recommended.

A final note to stress that in order for reforms in digital governance to be successful in reducing burdensome regulation and creating a supportive environment for business, all stakeholders involved in the process should be consulted and actively involved. We do hope our analysis contributes to a more informed discussion of the topic and to stress the need to use ICT-solutions in public administration that improve governmental efficiency and economic competitiveness. Creating a favourable environment for business is particularly relevant for a country whose economy has been growing slowly over the last decades, has a GDP per capita that represents 80% of the EU average, and a public debt level of 130% of GDP. In a constantly evolving world, in which only the most innovative remain competitive, we believe that governments can play a strategic role as business facilitators.

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APPENDICES

Table A1 - Portugal in all Ease of Doing Business Variables (2017)

Area	Variables	Portugal	Sample Average	Top Performer
Starting a Business	Procedures (number)	5	7.2	1
	Time (days)	4.5	21.2	0.5
	Cost (% of income per capita)	2.1	24.4	0
	Minimun capital (% of income per capita)	0	12.2	0
Dealing with Construction Permits	Procedures (number)	14	14.7	5
	Time (days)	113	162.1	26
	Cost (% of warehouse value)	1.3	4.7	0.1
	Building quality control index (0-15)	11	9.5	15
Getting Electricity	Procedures (number)	7	5.2	3
	Time (days)	41	98.1	18
	Cost (% of income per capita)	37.3	1321.8	0
	Reliability of supply and transparency of tariff index (0-8)	7	3.9	8
Registering Property	Procedures (number)	1	6.0	1
	Time (days)	1	51.4	1
	Cost (% of property value)	7.3	5.6	0
	Quality of the land administration index (0-30)	21	14.2	29
Getting Credit	Strength of legal rights index (0-12)	2	5.3	12
	Depth of credit information index (0-8)	7	4.7	8
	Credit registry coverage (% of adults)	100		100
	Credit bureau coverage (% of adults)	7.8		100
Protecting Minority Investors	Extent of disclosure index (0-10)	6	5.7	10
	Extent of director liability index (0-10)	5	4.7	10
	Ease of shareholder suits index (0-10) old methodology	7	6.1	9
	Extent of shareholder rights index (0-10)	4	5.9	10
	Extent of ownership and control index (0-10)	6	4.5	9
	Extent of corporate transparency index (0-10)	6	4.9	9
Paying Taxes	Payments (number per year)	8	24.9	3
	Time (hours per year)	243	273.6	49
	Total tax rate (% of profit)	39.8	41.3	26.1
	Postfilling index (0-100)	92.71	59.6	99.1
Trading Across Borders	Time to export - Documentary compliance (hours)	1	56.4	1
	Time to export – Border compliance (hours)	0	59.4	1
	Cost to export - Documentary compliance (US$)	0	148.5	0
	Cost to export - Border compliance (US$)	0	411.8	0
	Time to import - Documentary compliance (hours)	1	70.8	1
	Time to import – Border compliance (hours)	0	83.2	1
	Cost to import - Documentary compliance (US$)	0	186.9	0
	Cost to import - Border compliance (US$)	0	500.8	0
Enforcing Contracts	Time (days)	547	543.3	120
	Cost (% of claim)	13.8	34.5	0.1
	Quality of judicial processes index (0-18)	12.5	8.3	15.5
Resolving Insolvency	Recovery rate (cents on the dollar)	74.2	37.1	92.9
	Time (years)	2		
	Cost (% of estate)	9		
	Strength of insolvency framework index (0-16)	14.5	8.0	15

Table A2 - Regression for the Overall_DTF with and without logGDP per capita

Variables	(1) With logGDP per capita	(2) Without logGDP per capita
E-gov-index	0.123***	0.134***
	(3.195)	(3.428)
2012	2.706***	2.883***
	(5.399)	(6.389)
2014	6.087***	6.432***
	(7.920)	(9.575)
2016	3.908***	4.921***
	(3.391)	(4.782)
E-gov-index.2012	-0.0473***	-0.0491***
	(-4.247)	(-4.662)
E-gov-index.2014	-0.0778***	-0.0802***
	(-5.569)	(-5.863)
E-gov-index.2016	-0.0455**	-0.0557***
	(-2.379)	(-3.047)
logGDP	4.865*	
	(1.667)	
Gov_C	-0.157*	-0.196**
	(-1.751)	(-2.144)
Openness	0.0278*	0.0298**
	(1.951)	(1.983)
GovEffectiv	4.037***	5.102***
	(3.716)	(4.264)
# of countries	170	170
Observations	662	662
R-squared	0.344	0.336
Selected Model	FE	FE

Notes: Robust t-statistics and z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A3 - Regressions with the OSI as independent variable (part I)

Variables	(1) Overall_ DTF	(2) Starting Business_ DTF	(3) Dealing Construct Permits_ DTF	(4) Getting Electricity_ DTF	(5) Registering Property_ DTF	(6) Paying Taxes_ DTF
OSI	0.0450***	0.193***	0.0378	0.0617**	0.0327	0.0418
	(2.683)	(4.363)	(0.911)	(1.998)	(0.957)	(1.230)
2005		2.375***				
		(2.650)				
2008		8.229***			4.116***	
		(4.297)			(3.759)	
2010		17.52***	3.680***		7.826***	2.083**
		(7.828)	(3.001)		(5.679)	(2.427)
2012	1.422***	19.99***	4.451***	1.203	9.495***	3.192**
	(3.461)	(8.338)	(2.989)	(1.608)	(6.148)	(2.156)
2014	4.778***	25.31***	8.144***	5.081***	12.74***	7.047***
	(9.636)	(10.77)	(4.301)	(4.850)	(7.183)	(4.953)
2016	3.115***	33.13***	3.513	-6.863***	4.294*	7.108***
	(3.398)	(10.50)	(1.540)	(-4.151)	(1.945)	(4.206)
OSI.2005		-0.0178				
		(-0.977)				
OSI.2008		-0.00718			-0.0382**	
		(-0.206)			(-2.031)	
OSI.2010		-0.0741*	-0.0120		-0.0410*	0.0365*
		(-1.730)	(-0.552)		(-1.664)	(1.724)
OSI.2012	-0.0178**	-0.116***	-0.0238	-0.0298**	-0.0503*	0.0335
	(-2.116)	(-2.732)	(-0.884)	(-2.011)	(-1.853)	(1.126)
OSI.2014	-0.0479***	-0.178***	-0.0515	-0.0580**	-0.0931***	0.00188
	(-4.665)	(-4.203)	(-1.545)	(-2.551)	(-2.957)	(0.0673)
OSI.2016	-0.0200	-0.265***	0.0430	0.101***	0.00600	0.0272
	(-1.255)	(-5.186)	(1.034)	(3.234)	(0.162)	(0.860)
Gov_C	-0.167*	-0.160*	-0.172	-0.0850	-0.201	-0.0218
	(-1.948)	(-1.678)	(-1.063)	(-0.439)	(-1.407)	(-0.231)
Openness	0.0227	0.00277	0.0260	0.0217	0.0288	0.0164
	(1.540)	(0.146)	(1.270)	(1.460)	(1.302)	(1.112)
GovEffectiv	5.029***	7.632***	6.447***	9.159***	4.152*	9.286***
	(4.564)	(5.768)	(5.337)	(8.137)	(1.883)	(5.653)
# of countries	170	174	172	170	174	172
Observations	662	1,102	828	662	969	828
R-squared	0.322	0.487	0.21	0.399	0.248	0.377
Model	FE	RE	RE	RE	FE	RE

Notes: Robust t-statistics and z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A4 - Regressions with the OSI as independent variable (part II)

Variables	(7) Resolving Insolvency_ DTF	(8) Getting Credit_ DTF	(9) Trade Across Borders_DTF	(10) Enforcing Contracts_DTF	(11) Protecting Minor Investors_DTF
OSI	-0.00803	0.121**	0.0948**	0.0295*	0.104***
	(-0.207)	(2.526)	(2.298)	(1.768)	(3.062)
2005	0.660			0.457	
	(1.348)			(1.364)	
2008	4.279***	4.191***		1.274*	
	(3.583)	(2.847)		(1.894)	
2010	4.406***	10.76***	3.794***	1.646**	2.871***
	(4.205)	(5.644)	(4.119)	(2.173)	(2.906)
2012	4.543***	16.24***	4.432***	1.054	3.144**
	(3.306)	(7.579)	(3.463)	(1.218)	(2.328)
2014	5.387***	26.80***	7.472***	2.373**	4.563***
	(4.507)	(12.39)	(5.557)	(2.355)	(3.180)
2016	16.03***	13.43***	8.410*	1.503	5.385***
	(6.394)	(4.459)	(1.927)	(0.995)	(3.113)
OSI.2005	0.00393			-0.0108	
	(0.322)			(-1.288)	
OSI.2008	-0.0109	0.0408		-0.0162	
	(-0.378)	(1.315)		(-1.445)	
OSI.2010	-0.0248	0.0170	-0.0281	-0.0175	-0.0100
	(-0.924)	(0.424)	(-1.453)	(-1.321)	(-0.526)
OSI.2012	0.0216	-0.0748**	-0.0439**	-0.0151	-0.0260
	(0.746)	(-2.073)	(-2.021)	(-1.016)	(-1.097)
OSI.2014	0.0208	-0.191***	-0.0775***	-0.0389**	-0.0311
	(0.738)	(-5.102)	(-3.151)	(-2.212)	(-1.185)
OSI.2016	-0.0569	-0.136***	-0.0485	-0.0189	-0.0391
	(-1.087)	(-2.748)	(-0.731)	(-0.724)	(-1.116)
Gov_C	-0.0431	-0.206	-0.0153	-0.0598	-0.0721
	(-0.385)	(-1.231)	(-0.0955)	(-0.621)	(-0.838)
Openness	0.0113	-0.00415	0.0426**	0.00805	-0.000787
	(0.456)	(-0.150)	(2.406)	(0.557)	(-0.0501)
GovEffectiv	6.008***	15.80***	13.86***	0.870	6.072***
	(3.745)	(6.180)	(10.05)	(0.785)	(6.100)
# of countries	174	174	172	174	172
Observations	1,102	969	828	1,102	828
R-squared	0.317	0.392	0.518	0.021	0.314
Model	FE	FE	RE	FE	RE

Notes: Robust t-statistics and z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A5 - Fractional Probit Regressions (part I)

Variables	(1) Overall_ DTF	(2) Starting Business_ DTF	(3) Dealing Constr Permits_ DTF	(4) Getting Electricity_ DTF	(5) Registering Property _DTF	(6) Paying Taxes_ DTF
E-Gov_index	0.353***	0.925***	0.701***	0.401*	0.212	0.564***
	(3.884)	(4.667)	(3.532)	(1.879)	(1.553)	(3.132)
2005		0.0692				
		(0.953)				
2008		0.203***			0.117**	
		(2.837)			(2.141)	
2010		0.453***	0.101**		0.219***	0.0412
		(6.130)	(2.003)		(4.462)	(0.980)
2012	0.0720***	0.604***	0.165***	0.0768**	0.274***	0.128***
	(5.081)	(8.691)	(3.288)	(2.131)	(5.880)	(3.207)
2014	0.160***	0.774***	0.268***	0.176***	0.364***	0.175***
	(10.17)	(10.89)	(5.045)	(4.503)	(7.585)	(4.624)
2016	0.123***	1.052***	0.149**	-0.180***	0.121**	0.189***
	(5.720)	(11.02)	(2.436)	(-3.601)	(2.082)	(4.404)
E-Gov_index.2005		-0.0338				
		(-0.245)				
E-Gov_index.2008		0.0872			-0.0900	
		(0.623)			(-0.900)	
E-Gov_index.2010		-0.0166	-0.00377		-0.0651	0.134
		(-0.115)	(-0.0402)		(-0.692)	(1.569)
E-Gov_index.2012	-0.123***	-0.247*	-0.181**	-0.194***	-0.130	0.0129
	(-3.860)	(-1.903)	(-1.994)	(-2.580)	(-1.562)	(0.167)
E-Gov_index.2014	-0.191***	-0.411***	-0.237**	-0.233***	-0.224**	0.0739
	(-5.545)	(-3.029)	(-2.457)	(-2.907)	(-2.545)	(0.963)
E-Gov_index.2016	-0.131***	-0.731***	-0.0159	0.266***	0.0363	0.135
	(-3.081)	(-4.336)	(-0.148)	(2.786)	(0.357)	(1.613)
Gov_C	-0.00542***	-0.00627**	-0.00914**	-0.0131***	-0.00858**	-0.00736*
	(-3.002)	(-1.982)	(-2.379)	(-3.205)	(-2.405)	(-1.815)
Openness	0.0877***	-0.0254	0.0544	0.148**	0.0946**	-0.00333
	(2.750)	(-0.331)	(0.748)	(2.255)	(2.224)	(-0.0737)
GovEffect	0.138***	0.0900*	0.191***	0.295***	0.136***	0.234***
	(5.734)	(1.715)	(3.717)	(5.350)	(2.888)	(4.426)
Observations	662	1,102	828	662	969	828

Marginal effects for the E-Gov_index

2004		0.265***				
		(4.676)				
2005		-0.00968			0.0716	
		(-0.245)			(1.553)	
2008		0.0249	0.239***		-0.0304	0.180***
		(0.623)	(3.529)		(-0.900)	(3.137)
2010	0.128***	-0.00474	-0.00128	0.127*	-0.0220	0.0427
	(3.885)	(-0.115)	(-0.0402)	(1.879)	(-0.692)	(1.569)
2012	-0.0445***	-0.0706*	-0.0619**	-0.0614***	-0.0441	0.00412
	(-3.863)	(-1.905)	(-1.994)	(-2.582)	(-1.563)	(0.167)
2014	-0.0693***	-0.117***	-0.0810**	-0.0737***	-0.0757**	0.0236
	(-5.549)	(-3.035)	(-2.457)	(-2.910)	(-2.546)	(0.963)
2016	-0.0474***	-0.209***	-0.00543	0.0842***	0.0123	0.0430
	(-3.080)	(-4.352)	(-0.148)	(2.789)	(0.357)	(1.613)

Notes: Robust z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A6 - Fractional Probit Regressions (part II)

Variables	(7) Resolving Insolvency_DTF	(8) Getting Credit_DTF	(9) Trading Across Borders_DTF	(10) Enforcing Contracts_DTF	(11) Protect.Minority Investors_DTF
E-Gov_index	0.121	1.036***	0.395	0.153*	0.396**
	(0.610)	(4.984)	(1.243)	(1.681)	(2.469)
2005	0.0145			0.00637	
	(0.204)			(0.243)	
2008	0.207***	0.0591		0.0420*	
	(3.249)	(0.821)		(1.752)	
2010	0.229***	0.230***	0.119**	0.0495**	0.0616*
	(3.615)	(3.294)	(2.343)	(2.027)	(1.859)
2012	0.226***	0.520***	0.182***	0.0481**	0.102***
	(3.474)	(8.033)	(3.541)	(1.999)	(3.172)
2014	0.207***	0.893***	0.252***	0.0898***	0.113***
	(3.358)	(14.09)	(4.661)	(3.394)	(3.393)
2016	0.770***	0.524***	0.189	0.0659*	0.156***
	(7.911)	(6.049)	(1.547)	(1.787)	(3.427)
E-Gov_index.2005	0.0107			-0.0113	
	(0.0699)			(-0.240)	
E-Gov_index.2008	-0.141	0.236*		-0.0579	
	(-1.041)	(1.868)		(-1.293)	
E-Gov_index.2010	-0.209	0.208	-0.0605	-0.0577	-0.0126
	(-1.552)	(1.569)	(-0.623)	(-1.306)	(-0.206)
E-Gov_index.2012	-0.0668	-0.331***	-0.180*	-0.0822*	-0.0867
	(-0.495)	(-3.019)	(-1.867)	(-1.851)	(-1.480)
E-Gov_index.2014	0.0158	-0.767***	-0.233**	-0.153***	-0.0535
	(0.118)	(-6.977)	(-2.231)	(-3.099)	(-0.894)
E-Gov_index.2016	-0.644***	-0.679***	0.111	-0.104	-0.0986
	(-3.315)	(-4.746)	(0.520)	(-1.481)	(-1.094)
Gov_C	-3.48e-05	-0.00831**	-0.0110*	-0.00186	-0.00404*
	(-0.00797)	(-2.148)	(-1.950)	(-0.947)	(-1.783)
Openness	0.0267	0.00453	0.126	0.0239	-0.00218
	(0.443)	(0.0672)	(1.303)	(0.777)	(-0.0581)
GovEffect	0.189***	0.356***	0.224**	0.0198	0.133***
	(4.066)	(6.082)	(2.132)	(0.715)	(3.286)
Observations	1,102	969	828	1,102	828
Marginal effects of the E-Gov_index					
2004	0.0344			0.0563*	
	(0.610)			(1.681)	
2005	0.00305	0.349***		-0.00414	
	(0.0699)	(4.990)		(-0.240)	
2008	-0.0401	0.0793*	0.122	-0.0213	0.147**
	(-1.042)	(1.867)	(1.243)	(-1.293)	(2.468)
2010	-0.0594	0.0699	-0.0187	-0.0212	-0.00469
	(-1.554)	(1.568)	(-0.623)	(-1.306)	(-0.206)
2012	-0.0190	-0.111***	-0.0557*	-0.0302*	-0.0322
	(-0.495)	(-3.024)	(-1.868)	(-1.851)	(-1.481)
2014	0.00450	-0.258***	-0.0721**	-0.0562***	-0.0199
	(0.118)	(-7.005)	(-2.232)	(-3.099)	(-0.894)
2016	-0.183***	-0.229***	0.0345	-0.0381	-0.0366
	(-3.306)	(-4.739)	(0.521)	(-1.480)	(-1.093)

Notes: Robust z-statistics in parentheses. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.