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Effects of taxation on software piracy across the European Union

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Abstract

This paper explores the relation between levels of taxation among different types of households in the European Union and the levels of software piracy from 1996 to 2010. It extends previous works introducing a large panel data set for the European Union and it´s different regions. We estimate our model using the fixed effect, comparing results from the Euro Area and the Countries that joined EU in 2004 and 2007. Results show that levels of taxation increase the levels of software piracy losses; moreover these results depend on marital status and number of children. The weight of taxation on GDP, namely the taxes on consumption, have a positive effect on piracy losses while the impact of inflation is negative and marginal. Additional to this we also found that the relative importance of these taxes in relation to total taxation can affect this phenomenon. An increase in the weight of capital taxation would decrease software piracy while this effect was opposite when considering the relative importance of consumption taxes.

Key words: Panel data, personal taxation, software piracy

JEL: C23, H20, O52

1. Introduction

European Union is characterized by a high level of taxation and at the same time, countries in the Euro Area face budgetary restrictions that prevent a lower taxation. Due to its importance, we will analyze the impact that personal income tax (PIT) has on software piracy. The personal income tax is very heterogeneous among countries; it is progressive and in some cases can exceed 50% of annual income.

The levels of income of the household can affect it´s purchase decisions; as his income increases it will seek non-essential goods such as video games. On the other side we have households with low income that cannot afford these types of goods. Being the personal income tax progressive, households with higher income will be more affected by taxes. With the disposable income that remains after taxes they will face the decision on what type of goods to purchase. It can happen that more taxes will shift the consumption from legal to illicit software.

Up to our knowledge the effects of taxation on software piracy was not studied on previous empirical research. This work attempts to see the relationship between the level of taxation of the worker and the level of software piracy in a country. Additionally, other taxes will be considered reflecting indirect taxation and social security contributions made by households. We will use Eurostat data which provides estimates from different levels of income that represent different types of households. With this division it's possible to measure thirteen households types that vary according to marital status and number of children's. Households represent potential buyers or pirates of software. Our sample is constituted by the European Union over the period of 1996 to 2010. Being able to disaggregate the different taxation levels among different incomes that represent households we try to answer the following questions:

i) Reducing taxation can prevent the software piracy phenomenon?

ii) If yes, how to implement this reduction on the different households that represent potential software buyers.

iii) Finally we will try to ask if this reduction must be differentiated based on the different EU regions that also represent different levels of development.

The level of personal income tax in a country is an aggregated variable, measuring only the overall tax rate, e.g. the rates applied. This variable is aggregated and to understand better the effects of taxation on households we introduced the effective levels of direct taxation on these households that include both the personal income tax and social security contributions. Another important variable introduced was the relative importance of these taxes on total taxation[1].

We found that the weight of taxation on an Economy GDP, namely the taxes on consumption increase piracy. The results suggest that there is room to increase the importance of corporate taxation while an increase on indirect taxation leads to more piracy.

Section two describes the structure of taxes in the European Union and briefly describes the personal income tax, value added tax and corporate income tax. Section three describes the variables used and presents some summary statistics. In section four we test for the presence of unit roots of the variables; we provide the econometric specification and present the effects of taxation on the different types of households. In addition to this we

[1] We also compared the different regions of the European Union, namely the New Countries and Countries outside the Euro Zone and the results were maintained and were significant.

also consider the relative importance of the three main taxes analyzed in section 2 as a share of total taxation. Finally, section five concludes.

2. The structure of taxes in the European Union

This section describes the general tax policy of the European Union focusing essentially on three taxes; value added tax (VAT), corporate income tax (CIT) and personal income tax (PIT). This tax policy derives from the treaty establishing the European Community, namely, the article 3, which eliminates between Member States "Customs duties (…) and of all other measures having equivalent effect", and of "ensuring that competition in the common market is not distorted"; article 93 which deals with indirect taxation; other taxes have their base legislation on articles 94, 96 and 97, which includes corporate income tax and personal income tax.

The Community pursues general objectives due to the creation of the single market and the monetary union. These are: (i) preventing huge differences in indirect taxation to prevent distorting competition within the single market; (ii) to fill the gaps in the legislation that sometimes permit tax evasion and to prevent or mitigate double taxation; (iii) to prevent the harmful effect of tax competition, namely the migration of both firms and persons to countries with lower taxation.

The final objective of this tax policy is to not distort competition among Member States and at the same time financial sustainability. The Maastricht treaty introduced some important aspects, such as the limitation of Government's ability to finance public expenditure by borrowing.

The Stability and Growth Pact imposes to the participating Member States of the European Union a budget deficit lower than 3% of GDP. During the process of integration towards the Euro, countries had to prevent movements above 2.25% relative to ECU[2] (European Currency Unit) which was a fictional currency composed by the currencies of the Member States. Later on, in 1993, the bandwidth increased to 15% as a result of the 1992 crisis of the European Monetary System. Another important rule is that the annual average inflation shall be no more than 1.5% higher than the three EU Member States with the lowest inflation rate. Public debt must be lower than 60% or has a declining pattern. The final criteria stated that the long-term interest rates shall be no more than 2.0% higher,

[2]Europa.eu/legislation_summaries/economic_and_monetary_affairs/introducing_euro_practical_aspects/I25007_pt.htm

than the average of the 3 EU Member States with the lowest ones. The next subsections describe these taxes in detail.

2.1. The Value Added Tax in the EU

In May 2001 the Commission published the "Tax policy in the European Union - Priorities for the years ahead". The main conclusion of the report is that a "high degree of harmonization is essential in the indirect tax field". The transitory system of VAT was "complicated susceptible to fraud and out of date".

The treaty establishing the European Community, art 93, provides the basis for the harmonization of indirect taxation (VAT). In 11 April of 1967 was published the first directive of VAT, which stated that all Member States must replace their general indirect taxation by a common system. The goal of this publication was of "de-taxing" of exports and "re-taxing" of imports.

More recently, in 2006 was published the VAT directive (see Council Directive (2006/112/EC)). This directive emended the sixth VAT directive of 1977 (see Sixth Council Directive (77/388/EEC)) of 17 May, combining in a single document all the relevant legislation that was previously scattered.

With respect to the rate of VAT, Member States have to apply rates within a predetermined band. The minimum standard rate is of 15% subject to review every two years. Member States have the option to set a minimum of one or two rates called "reduced rates", which must be over 5%; the goods in which this rate is applied are listed in Annex H of the amended sixth VAT directive.

Member States must abolish "luxury" or higher rates. Due to the fact that we are in a transitional system of VAT, there exist derogations for certain Member States; they can apply a "zero rate", a "super-reduced" rate or a "parking" rate. The maximum standard rate allowed is 25%, which is in vigor on Denmark and Sweden (see COM (331)). Table 1 presents the Standard VAT rate. Overall we have small variations on VAT being the minimum standard rate applied in Luxembourg. On average in the European Union, the average VAT rate is around 21%.

Table 1: Standard VAT rate applied in 2012

Country	VAT
Belgium	21
Bulgaria	20
Czech Republic	20
Denmark	25
Cyprus	17

Germany	19
Estonia	20
Ireland	23
Greece	23
Spain	18
France	21.2
Italy	21
Latvia	22
Lithuania	21
Luxembourg	15
Hungary	27
Malta	18
Netherlands	19
Austria	20
Poland	23
Portugal	23
Romania	24
Slovenia	20
Slovakia	20
Finland	23
Sweden	25
UK	17.5
EU Average	21,08

Notes: Standard tax rate is reported. Results are based on Taxation trends in European Union 2012 edition. EU Average is a simple mean of the European Union Countries.

2.2. Corporate Income Tax in the EU

Taxation of Companies is generally described in art. 94. The treaty doesn't impose rules directly. Instead, there are bilateral tax treaties involving both Member States and third countries that fill this gap in legislation. The main goal of this legislation is to prevent tax evasion and elimination of double taxation. In 1990 it was published the "Guidelines for company taxation" (SEC (90) 601, 1990) which focused on the mergers directive (see Council Directive (90/434/EEC)), the parent companies and subsidiaries directive (see Corrigendum to Council Directive (90/435/EEC)) and the arbitration procedure convention (90/436/EEC).

Over the years it was proposed that the rates were placed within a band. Initially in 1975 the Commission published a draft in which the rates were placed between 45% and 55%. In 1999 the "Report of the Committee of independent Experts on Company Taxation" recommended a harmonization of corporate taxation, being the rates between 30% and 40%.

Table 2 presents the corporate income tax (CIT) applied to firms' profits. The CIT correspond in many countries to one quarter of the taxable profit. We also have that on average 20% of profits are taxed.

Table 2: Corporate Income Tax rate applied in 2012

Country	CIT
Belgium	33.99
Bulgaria	10
Czech Republic	19
Denmark	25
Cyprus	10
Germany	15
Estonia	21
Ireland	12.5
Greece	20
Spain	20
France	33.33
Italy	27.5
Latvia	15
Lithuania	15
Luxembourg	28.8
Hungary	19
Malta	35
Netherlands	25
Austria	25
Poland	19
Portugal	25
Romania	16
Slovenia	20
Slovakia	19
Finland	24.5
Sweden	26.3
UK	24
EU Average	19,85

Notes: Nominal tax applied to CIT. Results are based on Taxation trends in European Union 2012 edition. EU Average is a simple mean of the European Union Countries.

2.3. The Personal Income Tax in the EU

Personal income tax was left to the Member States to legislate, even in the situation of full integration[3]. Nevertheless this tax policy established some actions, namely elimination of tax obstacles to cross-border activities; elimination or at least mitigation of double taxation. In the absence of harmonization, the European Court of Justice stated that it must respect the fundamental Treaty principles on the free movement of workers, services and capital and the freedom of establishment (Articles 39, 43, 49 and 56 of the EC Treaty). Discrimination on the basis of nationality is forbidden. The treaty also states that every citizen of the Union has the right to move and reside freely within the territory of the Member States (Article 18 of the Treaty). The personal income tax is legislated by each country central authority (Central Governments), and in some cases such as in Germany,

[3] See "Tax Policy in the European Union - Priorities for the years ahead" (COM, 2001 (260) 260) of 23 May 2001

the local authorities receive a large share of this tax (the federal government and Länder Government receives 45% each and municipalities receives 15% of total taxation). Due to the large heterogeneity of legislation and rates applied across the European Union, we will only discuss some important aspects of this tax.

We can classify the personal income tax on three groups[4] on the basis on the tax complexity. The first group of countries has a flat tax rate (Bulgaria, Czech Republic, Denmark, Estonia, Hungary, Latvia, Lithuania, Romania, Slovakia and Sweden). The second group of countries is where the top rate is 50% or more (Austria, Belgium, Denmark, Netherlands, Sweden and UK). Finally the third group of countries is characterized by a large number of brackets (Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, Malta, Poland, Portugal, Slovenia, Finland and Cyprus).

Another important characteristic of this tax is the amount of taxable income within each bracket. Sometimes the taxable income between the lowest tax rate and the highest tax bracket is high like, for instance in France. In Belgium this gap is low. Another feature of this tax is the taxable income within each bracket. To understand these characteristics we provide some examples for 2010.

France had 5 brackets; in the fourth, the applicable rate was 30% for an income that range from 26,420 to 70,829 euros; a total amount of 44,409 euros was taxed at this rate. Portugal had 8 brackets; the equivalent one was the fourth at 35,5% from an income ranging from 18,375 to 42,259 euros; a total of 23,884 euros was taxed at this rate. In Belgium, with 5 brackets, the equivalent one was the second at 30%; it ranged from 7,900 to 11,240 euros; only 3,340 euros were taxed at this rate. From these three examples it can be seen that taxes are heterogeneous. For Belgium a rate of 50% was applicable to income higher than 34330€. France had a tax of 41% applicable to income more than 70830€ and Portugal had a tax of 46,5% for income higher than 153300€.

2.3.1. The Effective taxation level on households

Although the taxes shown until now appear to be high, the final tax that households pay also includes the social security contribution. Higher levels of taxation can also mean higher social protection, so people are willing to accept such fact and obey social norms. To the personal income tax we must sum the contributions to social security that are mandatory; they can range from 10% in case of employees to more than 20% in the case of employers but also we must subtract deductions that the different tax legal systems allow.

[4] This classification was based on "Taxation trends in the European Union" 2011 edition

This will result in the effective taxation levels of households that will be used in the empirical analysis. Contributions to social security contributions vary greatly among countries. In some situations employees must pay more than 20% of social security contributions; Germany, Slovenia and Slovakia are some examples[5]. Rates paid by employers are even bigger accounting to more than 30% in Slovakia, Czech Republic and Estonia.

Deductions play an important role in order to mitigate the levels of taxation; they differ across countries. Some of these deductions include education and health care expenses, and they can represent a percentage spend within a certain limit or a value. Information on deductions are only available since 2000[6].

Table 3 shows the average wage in the European Union. It shows that having children's affect the level of taxes and social security contributions. These values are a simple mean of all countries; they hide huge differences among them. To show these differences table 4 presents the net earnings for each type of household and for each country in 2010.

Among the countries with the highest net earnings, for single parent with 100% of the average wage, are Denmark (31,043€), Luxembourg (35,738€), Finland (27,257€) and UK (30,565€). When Portugal and Slovenia are compared, differences on net earnings are small, for the case of single parent with 100% of average wage; in Portugal the net earning is (13,528€) and in Slovenia (11,078€). Differences in income from the newly entered countries are big when compared with the 15 European Countries.

Table 3: Average earnings on the EU in 2010

	children	Av. wage	Taxes	Social Security	Net Earn.
Single parent	0	50%	1071€	1475€	10024€
	0	67%	2019€	2113€	12612€
	0	80%	2862€	2502€	14721€
	0	100%	4253€	3064€	17787€
	0	125%	6320€	3704€	21347€
	0	167%	10256€	4577€	27002€
	2	67%	1111€	1988€	16027€
Couples	2	100%0%	2736€	3004€	21225€
	2	100%33%	3815€	3943€	27482€
	2	100%67%	5630€	5174€	32838€

[5] This information was based on the "Taxation Trends in The European Union, 2011 edition".
[6] Information was obtained from http://ec.europa.eu/taxation_customs/tedb/taxSearch.html

	2	100%100%	7927€	6128€	37957€
	0	100%33%	4391€	3968€	25195€
	0	100%100%	8460€	6149€	35733€

Notes: Source Eurostat. In column 1 of table 3 are the types of households, column 2 the number of children's and in column 3 the percentage of the average wage earned (for the case of couples the first percentage is referring to the head of the household and the second to the other household). For example a couple that earn 100%67% means that the head of the household earn 100% and the other earns 67% of the average wage. Table 3 shows the average value of taxes in column 4, social security contributions in column 5 and net earnings for the different types of households in column 6 for 2010. Unfortunately data was not available for Cyprus.

Net incomes in households in which both men and woman earn 100% of the average wage are higher in Luxembourg (80,719€), Ireland (65,500€), Denmark (65,392€) and UK (63,179€). Among the 15 European Countries, Portugal (28,023€), Greece (33,630€) and Spain (39,238€) have the lowest net earnings.

2.4. Brief Summary

In conclusion, although the EU Commission has provided tools for the harmonization of taxes, there still are huge discrepancies in their respective levels. It was covered only three taxes, but there are others equally important. There exists 27 Member States; from these, 17 are in the Euro Area. There are 27 different legislations. Commission has provided basic tools for harmonization, but seeing the current level of indirect taxes, personal and corporate income tax. "Richer" economies like Germany have a lower or equal level of taxation on personal income tax that some "poor" economies like Portugal.

Table 4: Net earnings in 2010

	Single Parent							Couple					
# Children's	None						Two	None		Two			
Average wage	50%	67%	80%	100%	125%	167%	67%	100%33%	100%100%	100%	100%33%	100%67%	100%100%
Belgium	15298€	17837€	20256€	23989€	28254€	35229€	23000€	36074€	48006€	32460€	40745€	46447€	52678€
Bulgaria	1536€	2058€	2458€	3072€	3840€	5130€	2488€	4086€	6144€	3502€	4515€	5560€	6574€
Czech Republic	4913€	6223€	7272€	8844€	10809€	14085€	8590€	12229€	17688€	12042€	14189€	16726€	19185€
Denmark	16282€	21237€	25201€	31043€	37323€	46533€	29856€	42369€	62085€	36673€	45676€	55587€	65392€
Germany	14533€	18315€	21227€	25381€	30614€	39119€	23349€	36631€	50762€	33564€	41351€	48636€	55697€
Estonia	3984€	5192€	6157€	7606€	9417€	12435€	6474€	10383€	15212€	8429€	11206€	13620€	16035€
Ireland	18559€	22383€	26075€	30950€	35795€	43871€	31981€	45820€	61900€	37942€	49420€	57596€	65500€
Greece	7360€	9813€	11776€	14231€	17104€	21715€	10795€	20823€	30852€	17085€	22973€	28861€	33630€
Spain	11102€	13460€	15778€	19154€	23270€	30003€	15062€	26777€	38307€	21000€	27242€	33544€	39238€
France	13818€	16739€	19823€	24449€	29524€	37668€	19294€	33479€	48899€	27930€	36986€	43995€	51705€
Italy	10968€	13816€	16092€	19527€	23388€	29321€	17842€	27643€	39054€	23068€	29807€	35496€	40905€
Latvia	2919€	3860€	4579€	5685€	7067€	9390€	4685€	7664€	11369€	6788€	8489€	10370€	12195€
Lithuania	2798€	3638€	4280€	5268€	6503€	8589€	5511€	7210€	10537€	5786€	7367€	9063€	10693€
Luxembourg	20581€	26188€	30276€	35738€	42173€	52879€	35971€	53426€	73197€	48078€	60948€	71404€	80719€
Hungary	3383€	4292€	5018€	6109€	7169€	8989€	5581€	8564€	12217€	7267€	9723€	11559€	13376€
Malta	8224€	10587€	12394€	14914€	17986€	22885€	12634€	20389€	29828€	16639€	20889€	26001€	30328€
Netherlands	17527€	21618€	24981€	30130€	36579€	45864€	28042€	42950€	60260€	34297€	45785€	54583€	63095€
Austria	15693€	19435€	22429€	26789€	31946€	41529€	25236€	38176€	53578€	32619€	43337€	51406€	58777€
Poland	3656€	4809€	5731€	7113€	8842€	11723€	5165€	9617€	14227€	7748€	10174€	12479€	14784€
Portugal	7556€	9729€	11249€	13528€	16377€	20351€	11358€	19458€	27056€	15882€	20528€	24224€	28023€
Romania	2068€	2719€	3209€	3972€	4918€	6527€	3264€	5246€	7945€	4451€	5576€	7008€	8229€
Slovenia	6395€	7884€	9161€	11078€	13431€	16886€	11296€	15375€	22155€	14911€	17889€	21216€	23986€
Slovakia	3973€	5042€	5898€	7182€	8786€	11483€	6051€	10243€	14364€	8930€	112501€	13233€	15372€
Finland	15701€	19949€	22895€	27257€	32354€	40767€	23593€	38463€	54514€	29783€	40989€	49732€	57040€
Sweden	15399€	19969€	23625€	28893€	33935€	41350€	22800€	39722€	57786€	31724€	42553€	51694€	60617€
UK	16404€	21124€	24901€	30565€	37629€	47720€	26797€	42248€	61130€	33252€	44935€	53738€	63179€

Notes: Cyprus was missing. Source Eurostat. Line 1 of table 3 shows the type of households, line 2 shows the number of children's and line 3 the average wage.

3. Data and description of the variables

Our dataset was constructed using the official publications provided by the *Business Software Alliance* and the Eurostat.

The dependent variable is the software piracy losses at current prices[7] from 1996 to 2010. Software piracy can be defined as the unauthorized use of software that is protected by nationals or international Intellectual Property Rights. Some of this use can be a result of lack of enforcement of these laws. The software piracy losses measures the commercial value of the software that is currently being used trough illicit means and is a result of extensive surveys done over the years by the Business Software Alliance (BSA) with the help of International Data Corporation (IDC) and IPSOS BSA (2012). A total of 33 observations were missing for Estonia, Latvia, Lithuania and Luxembourg. Png (2010) found that when surveys are not applied, the software piracy rates are based on national income, it also found that the yearly rate of decrease of the piracy rates before 2003 were 2.0 (p.p), while the period after 2003 this rate of decrease fell to 1.1 (p.p) for the non-survey countries. With this in mind we will introduce a variable that will reflect this change[8].

One of the independent variables will be the different tax rates applied to different types of households. Labor costs include several dimensions such as social security contributions and family allowances that are captured by this variable. We will consider several hypotheses that vary according to the marital status, the existence of children in the constitution of the household and the percentage of the average wage that is earned. Several alternative types of households will be analyzed as independent variables:

- Single person with no children and 50%, 67%, 80%, 100%, 125% and 167% of the average wage (AW) respectively;
- Single person with two children and 67% of the AW;
- Married couple with two children and the following levels of the AW: husband 100% / wife 0%, husband 100% / wife 33%, husband 100% / wife 67% and husband 100% / wife 100%;
- Married couple with no children and 100% of the AW for the husband and 33% for the wife and husband 100% / wife 100%;

[7] We will introduce a variable, the HICP that reflects the change in prices of products at current prices

[8] Piracy rates have a decreasing pattern while the piracy losses are increasing over the years. This dummy variable reflects the break in the series, as the Business Software alliance change its consultant and methodology in this period.

Hereafter we will use "*SP"* to denote single parent, "*C"* to denote couples; the number of children's will be "*t"* for two children's and "*n"* for no children's. *SPn67* represents a single parent household that earns 67% of the average wage and do not have children, *SPt67* represents a similar household with the same income but with two children. Another example is C*n10033*, where 100% represents the income that the head of the household earn and 33% represents the income that the other member of the household earns in comparison to the average wage, they do not have children; *Ct100100* represents couples that have two children and both households earn 100% of the average wage. On each of these dimensions we will consider the average tax rate that is defined as the income tax on gross wage earnings plus the employee's social security contributions less universal cash benefits, expressed as a percentage of gross wage earnings[9]. We expect that this variable will affect positively the software piracy, although with the harmonization that the European Union has set over the years, this positive impact may be marginal.

Software's prices can affect the decisions to purchase or to use illegal software. A good choice would be based upon the prices of both hardware and software. Unfortunately that information can be misleading as in certain cases such as the Microsoft Office or Computer prices they are almost the same across the countries. We used the Harmonized indices of consumer prices (*HICPH)* as a proxy for these prices but also due to the fact that piracy losses are at current prices. We will introduce three measures that reflect the overall costs of living; i) costs of communications - examples of these costs are the price of phone calls and prices of telephones (*HICPHgcomm)*; ii) costs of cultural services - examples are price of music, films, games, books and newspapers (*HICPHgculture*[10]) and iii) overall costs of products (*HICPHgall)*. Harmonized indices of consumer prices (*HICPHs*) give comparable measures of inflation for the countries and country groups where they are produced. They are economic indicators that measure the change over time of the prices of consumer goods and services acquired by households. These variables are expected to have a positive impact as a result of increase of price on goods, in which software is included.

Following Goel and Nelson (2009) and Andrés and Goel (2011) we will use the logarithm of real *GDPpc*[11] as a measure of national income. This is a control variable and is

[9] http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/earn_net_esms.htm
[10] These variables were retrieved in the official web site of the Eurostat and describe the rate of change from one year to another.
[11] *GDPpc* takes into account Purchasing Power Parity and is measured at current prices.

expected to have a negative effect as a result of increased disposable income that allows to purchase goods.

Additional measures of taxation exist (implicit tax rates), they measure the overall tax burden in the Households and represent direct and indirect taxation. The implicit tax rate on labor can be defined as the sum of all direct and indirect taxes, and employees' and employers' social contributions levied on employed labor income divided by the total compensation of employees working in the economic territory increased by taxes on wage bill and payroll.

Another variable that measure the level of taxation, but on products, is the implicit tax rate on consumption. This variable is composed by a VAT component, energy component, tobacco and alcohol component and a "residual". The implicit tax rate on consumption is defined as all consumption taxes divided by the final consumption expenditure of private households on the economic territory. More formally, the numerator is constituted by value added type taxes, taxes and duties on imports excluding VAT, taxes on products except VAT and import duties, other taxes on production and other current taxes Commission (2011, p. 382). We will introduce the relative importance of taxes on labor and consumption relative to GDP. The impact of these taxes is expected to be positive, although they do not measure the direct level of taxation, e.g., they do not measure the actual rate but the importance of the tax on the economy.

Table 5 presents the summary statistics for each variable that will be analyzed. These results show that in some circumstances some households don't pay any type of tax, in the case of *SPt67* and *Ct100*. Family allowances in these households is higher than the actual tax, which explains this negative impact. The negative value of taxes on *SPt67* and *Ct100* indicates that these households not only do not pay taxes but receive a net subsidy from the Government. Higher values of taxes are present when there are no children's. Additional to these statistics we also provide the graphs of software piracy rates and losses for each country. The maximum piracy rate of 98% was in 1997 in Bulgaria, since then, these rates have been decreasing in all countries. Figure 1 presents this decrease on all European Union Countries. Figure 2 presents the evolution of software piracy losses.

Table 5: Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Losses	372	318.86	575.03	0.97	3191
SPn50	402	19.72	7.58	0.15	39.26
SPn100	402	27.20	8.00	6.30	44.95
SPn125	402	29.67	8.26	8.46	48.37
SPn167	402	32.60	8.56	12.67	52.58
SPt67	402	5.29	10.24	-21.56	24.69
SPn67	402	23.04	7.81	3.52	41.39
SPn80	402	24.90	7.94	4.8	43.17
Cn100100	402	27.20	7.92	6.3	44.95
Cn10033	402	23.84	7.59	5.68	41.39
Ct100	402	14.83	8.58	-8.6	31.11
Ct100100	402	23.15	7.52	0.46	41.68
Ct10033	402	17.44	7.59	0.6	36.48
Ct10067	402	20.41	7.63	5.4	39.6
lGDPpc	405	9.77	0.52	8.37	11.15
GDPg	378	4.26	5.82	-18.49	15.91
HICPHall	405	94.55	16.63	5.01	139.62
HICPHgall	377	4.25	9.50	-1.7	154.8
HICPHcommu	404	100.24	21.72	1.81	206.34
HICPHgcommu	377	2.04	18.25	-14	237.5
HICPHculture	404	95.72	12.52	5.74	120.09
HICPHgculture	377	2.83	9.71	-4.9	146.6
Itaxcons	401	21.05	4.47	11.1	34.2
Itaxlab	401	34.66	6.74	18.8	49.3
TaxconsGDP	405	12	1.66	7.3	17.2
TaxconsTotal	405	33.63	6.09	22.8	54
TaxlabGDP	405	17.44	5.31	9	32
TaxlabTotal	405	46.99	7.89	27	62.5
TaxcapTotal	405	19.51	6.71	5.2	35

Notes: Std. Dev. represents the standard deviation; Min the minimum and Max the maximum.

Figure 1: Evolution of Software Piracy rates on the European Union

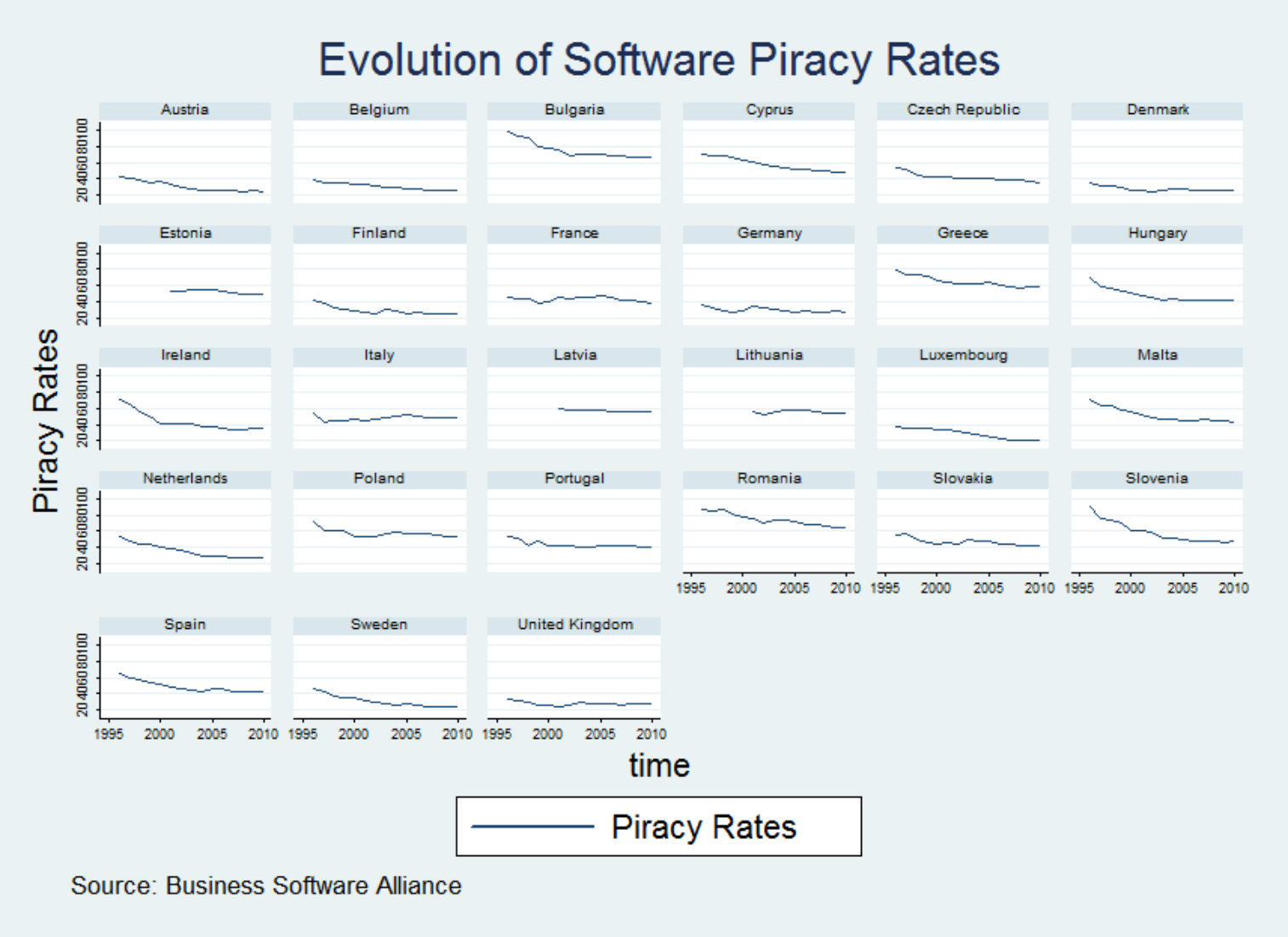
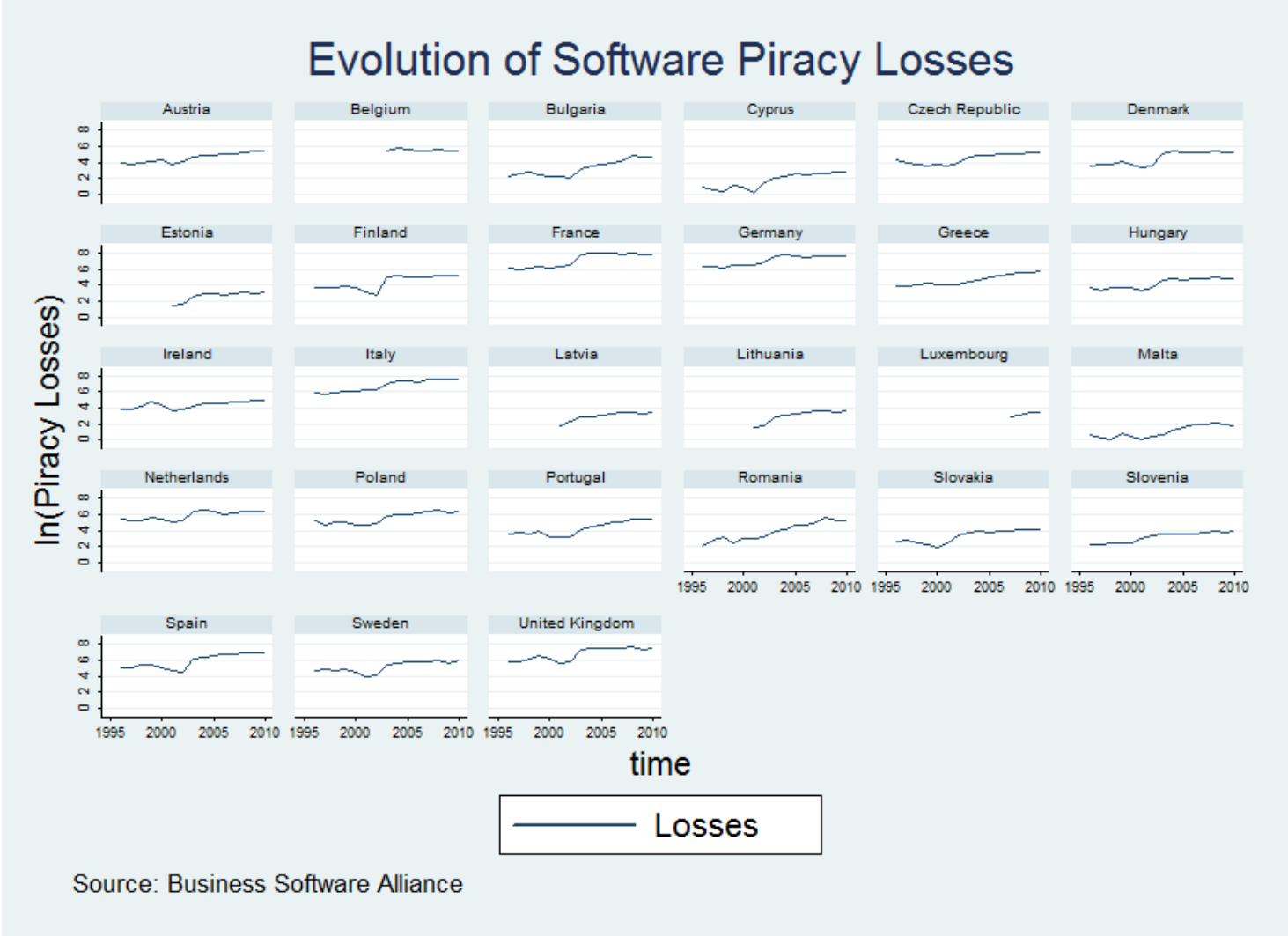


Figure 2: Evolution of Software Piracy Losses on the European Union



4. Empirical Study

When dealing with a panel-data analysis, we must choose the appropriate estimator but also ensure that our variables produce the best results. One problem that can occur in a panel of countries is the existence of one or more variables that are non-stationary. The existence of such variables can be problematic resulting in spurious regressions (Granger & Newbold, 1974). We start by testing the stationarity of the variables using unit-root tests. Next we empirically estimate our model using the fixed effect model following Andrés (2006); Chen, Chen, and Yeh (2010) and Boyce (2011), that showed that based on Hausman tests (Hausman, 1978) the fixed effect was the most appropriate for the analysis.

4.1. Testing the presence of unit roots

To check if our series are stationary we implemented a procedure proposed by Im, Pesaran, and Shin (2003), henceforth IPS. Other tests are available but rely on balanced panels which is not the case. Equation 1 shows a model with a first order autoregressive component:

$$\Delta y_{it} = \alpha_{it} + \phi_i y_{i,t-1} + \epsilon_{it} \quad (1)$$

where $i = 1, \dots, N$ represents the Member States; $t = 1, \dots, T_i$ indexes time; y_{it} is the variables that we want to test; ϵ_{it} is independently distributed normal for all *i* and *t* and has heterogeneous variance σ_i^2. This test assumes that all the panel dataset is non-stationary under the null hypothesis $H_0: \phi_i = 0$ against the alternative hypothesis that some panels are stationary $H_a: \phi_i < 0$. To be able to get significance it is necessary at least 10 observations per country, which is not the case on software piracy losses. In this variable we performed the Fisher type tests Choi (2001) that has the same assumption of the IPS test. In this framework four tests are available: Inverse chi-squared; Inverse normal; Inverse logit and Modified inverse chi-squared. Based on Choi (2001) simulations results, the inverse normal Z statistic offers the best trade-off between size and power. The IPS test is performed on the independent variables.

Table 6 presents the result of these tests for each variable. It can be seen that almost all the variables seem to be stationary or integrated of order zero *I(0)*. The exception goes to the natural logarithm of Gross Domestic Product per capita at Purchasing Power Parity and the Harmonized indices of consumer prices that may be considered as having unit roots. To prevent this problem we introduce the real GDP growth and the inflation rate (*HICPHg*). Both variables are stationary.

After establishing that our regressors are stationary, we can proceed with the fixed effect model.

Table 6: IPS and Fisher type Unit root tests

	Level	1stdifference
Dependent Variable		
ln(Losses)	-1.336*	-12.105***
Independent Variables		
SPn50	-3.871***	-
SPn67	-3.584***	-
SPn80	-4.015***	-
SPn100	-3.349***	-
SPn125	-3.525***	-
SPn167	-3.456***	-
SPt67	-4.637***	-
Cn10033	-3.165***	-
Cn100100	-3.694***	-
Ct100	-4.060***	-
Ct10033	-3.817***	-
Ct10067	-3.428***	-
Ct100100	-3.654***	-
lGDPpc	-0.278	-6.628***
Itaxlab	-3.313***	-
Itaxcons	-3.588***	-
HICPH	0.731	-4.826***
HICPHg	-6.783***	-
HICPHcomm	1.7637	-6.388***
HICPHgcomm	-4.455***	
HICPHculture	2.3157	-4.853***
HICPHgculture	-4.498***	-
TaxconsGDP	-3.620***	-
TaxconsTotal	-3.725***	-
TaxlabGDP	-2.770***	-
TaxlabTotal	-3.786***	-
TaxcapTotal	-4.333***	-

Notes: In the dependent variable we performed the Fisher type test presenting the inverse normal Z statistic. In the Independent variables the IPS test is used and the $Z_{\tilde{t}-bar}$ statistics is presented. It was included a trend and subtracted cross-sectional mean. It was tested under the null hypothesis that all panels contain unit roots against the alternative that some panels are stationary. *** and * corresponds to a significance level of 1% and 10% respectively.

4.2. Empirical results

4.2.1. Effects of taxation on software piracy losses

We start our analysis by introducing the different tax rates on labor applied to households as well as the importance of direct and indirect taxes as a share of GDP. The different regions of Europe will be analyzed when they present significance.

We can specify our dependent variable, software piracy losses *ln(Losses*) as a function of: i) the importance of taxation on labor as a share of GDP (*TaxlabGDP*); ii) the importance of taxation on consumption as a share of GDP (*TaxconsGDP*); iii) the growth

rate of harmonized index of consumer prices index for all products (*HICPHg*); iv) growth of real gross domestic product per capita (*GDPg*); and v) the variable *tax* will assume thirteen different types of households. $tax(h_l)$ will assume the different levels of taxation that each of these households incur. $h_l = 1, \dots, 13$ represents the different types of households that are: *SPn50, SPn67, SPn80, SPn100, SPn125, SPn167, SPt67, Cn10033, Cn100100, Ct100, Ct10033, Ct10067, Ct100100.* Additional to this we include a dummy variable that reflects the change in methodology used by the Business Software Alliance occurred in 2002 *(change)*. The dependent variable is in natural logarithms.

Equation 2 and 3 summarizes the estimated model:

$$\ln(Losses) = \theta_{0i} + \theta_{1t} GDPg_{it} + \theta_{2t} HICPHg + \theta_{3t} TaxconsGDP_{it} + \theta_{4t} TaxlabGDP_{it} + \\ + \theta_5 tax(h_l)_{it} + \theta_6 change_i + \varepsilon_{it} \quad (2)$$

where

$$HICPHg = \theta_{21t} HICPHgall + \theta_{22t} HICPHgcomm + \theta_{23t} HICPHgculture \quad (3)$$

where *i=1,…27* represents the Member States, *t=1996,…,2010* represents the time, ε_{it} represents the error term. *HICPHgall* is the growth of all the prices, *HICPHgcomm* is the growth of prices in telecommunications and *HICPHgculture* is the growth of prices in products such as movies, culture or books.

Estimates of the piracy rates are projected from national income in the non-survey countries. Initially, the surveys only covered 15 countries. From these, only one country of the European Union was present: Spain (*First Annual BSA and IDC Global Software*). In the report of 2010, 32 countries were present in the surveys. From those countries, Czech Republic, Poland, France, Germany, Italy, Netherland, Spain, Sweden and United Kingdom make part of the European Union (*Eight annual BSA and IDC global software piracy study).*

In each of the regressions reported we present the Hansen-test statistic that is a robust version of the Hausman test (Schaffer & Stillman, 2010). The Hausman test assumes under the null hypothesis that the random effect (RE) estimates is consistent. The fixed effects estimator uses the orthogonally conditions that the regressors are uncorrelated with the idiosyncratic error. Additional to this, one of the assumptions of the random effect is that it uses the additional orthogonally conditions that the regressors are uncorrelated with the group-specific error; the Hansen-test treats this assumption as additional orthogonally

conditions (it is a test of over identifying restrictions). Rejecting the null hypothesis favors the fixed effect model.

Table 7: Tax rate on labor on different households in EU27

Variables	1	2	3	4	5
GDPg	0.009	0.009	0.009	**0.010***	0.008
	(1.386)	(1.421)	(1.419)	**(1.904)**	(1.366)
TaxconsGDP	**0.065****	**0.056****	**0.059****	**0.068*****	**0.071****
	(2.402)	**(2.303)**	**(2.304)**	**(2.628)**	**(2.514)**
HICPHgall	**-0.004*****	**-0.004*****	**-0.004*****	**-0.004*****	**-0.004*****
	(-3.756)	**(-3.333)**	**(-3.111)**	**(-3.735)**	**(-3.541)**
SPn50		**0.021****			
		(2.070)			
SPn67			**0.021***		
			(1.876)		
SPn80				**0.019***	
				(1.671)	
Cn10033					**0.018***
					(1.680)
Change	**0.991*****	**1.000*****	**0.995*****	**1.056*****	**0.952*****
	(14.113)	**(14.028)**	**(13.870)**	**(15.061)**	**(14.538)**
Constant	**2.914*****	**2.628*****	**2.515*****	**2.455*****	**2.484*****
	(8.796)	**(6.448)**	**(5.381)**	**(4.936)**	**(4.738)**
Observations	349	346	346	346	346
R^2	0.880	0.882	0.881	0.875	0.877
$\bar{R}^2$	0.875	0.877	0.876	0.871	0.872
Countries	27	27	27	27	27
Hansen-Test	4.9e+04	1543.99	628.96	606.66	471.79
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is *ln(Losses).* All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses. Degrees of freedom of t-distribution for n>120 are: critical values at 10% are 1.645; at 5% is 1.960 and at 1% are 2.576. *, ** and *** represent significance at 10%, 5% and 1% respectively. All EU represent the 27 Member states of the European Union

Table 7 presents the results for the entire sample (EU27). The impact of prices is similar in the different categories of products; we only report the results for the inflation of overall products (In Annex B we report the remaining possibilities). We dropped taxation of households that were not significant (in Annex C we report the remaining cases). Column 2 through 5 shows the estimates for the different types of households, as with previous studies (Chen, Chen and Yeh, 2010); the *GDPg* is not significant in the majority of regressions.

We can observe a negative and marginal impact of inflation on overall products. Many software prices such as productivity suits are constant over the years, not suffering with the inflation of a Country. In fact some software prices decreases over the years;

examples are games and movies. In many software products, Companies internalize the value of VAT, making software prices almost the same across European Countries. These variables were always significant at 1%.

Another important variable introduced was the relative importance of taxes; the positive value of *TaxconsGDP* indicates that all the different types of indirect taxation play an important role in explaining software piracy. Changing these taxes determines the behavior of consumers when facing choices of purchasing goods. This variable was significant which indicates that reducing indirect taxation could be beneficial for reducing piracy, because more disposable income is available to households to spend on goods.

The additional variables that represent taxation of the different households have the expected positive impact, which indicates that they affect negatively the final disposable income that will be used to purchase these types of products. Only on those households that do not have children and earn less than 100% of the average wage are positively and significantly affected.

The positive effect of taxation on Single parents is more severe on households that earn less and this positive value decreases as households earn more. This result indicates that households can allocate more of their disposable income on digital content as their income increases. The same pattern applies to Couples that do not have children, only on households that earn less that 100% of the average wage, significance is present.

Knowing the main results including the EU27, we provide additional regressions in which we compare "Euro" and "Not Euro" zone and the 15 original countries of the EU ("Old") and the "New Countries". Results on household taxation were only significant on "Not Euro" and "New" countries[12]. Table 8 presents the results.

In these regions we also observe the lack of significance of *GDPg* across many regressions. One of the main differences resides in the significance of household taxation across the different regions. We have the countries not belonging to the Euro Zone in which household taxation has a strong coefficient, being significant (column 7 to 10). When the "Euro" Zone is examined (see Annex D), the coefficients are marginal and close to zero. This can be a result of the countries in the sample belonging to the North of Europe that is characterized by a high level of taxation.

[12] The remaining regions are reported in annex.

Table 8: Tax rates on NOT EURO VS NEW Countries

	NOT EURO					NEW				
Variables	6	7	8	9	10	11	12	13	14	15
GDPg	0.008	0.005	0.004	0.008	0.008	**0.009***	0.009	0.008	**0.011****	**0.010***
	(1.361)	(0.868)	(0.710)	(1.194)	(1.184)	**(1.656)**	(1.634)	(1.578)	**(2.025)**	**(1.912)**
TaxconsGDP	**0.099****	**0.051***	**0.058***	0.058	0.073	**0.067****	**0.060****	**0.063****	**0.071****	**0.074****
	(2.554)	**(1.725)**	**(1.712)**	(1.509)	(1.552)	**(2.303)**	**(2.196)**	**(2.281)**	**(2.287)**	**(2.113)**
HICPHgall	**-0.003*****	**-0.004*****	**-0.004*****	**-0.004*****	**-0.004*****	**-0.005*****	**-0.005*****	**-0.005*****	**-0.004*****	**-0.004*****
	(-2.871)	**(-4.100)**	**(-3.524)**	**(-3.471)**	**(-3.395)**	**(-4.818)**	**(-5.317)**	**(-4.965)**	**(-3.933)**	**(-3.823)**
SPn50		**0.025****					**0.025****			
		(2.408)					**(2.685)**			
SPn67			**0.023***					**0.020***		
			(1.818)					**(1.720)**		
SPn80				**0.022***					0.013	
				(1.694)					(0.951)	
Cn10033					**0.022***					0.013
					(1.908)					(0.969)
Change	1.240***	**0.948*****	**0.951*****	**1.084*****	**1.078*****	0.809***	**0.790*****	**0.783*****	**0.891*****	**0.924*****
	(16.673)	**(8.011)**	**(7.906)**	**(12.227)**	**(13.106)**	(12.585)	**(12.459)**	**(12.548)**	**(12.358)**	**(11.877)**
Constant	2.403***	**2.557*****	**2.446*****	**2.364*****	**2.198****	1.747***	**1.440*****	**1.449*****	**1.434****	**1.355***
	(5.153)	**(5.135)**	**(3.814)**	**(3.331)**	**(2.691)**	(5.261)	**(3.871)**	**(3.169)**	**(2.426)**	**(2.064)**
Observations	131	131	131	131	131	155	152	152	152	152
R^2	0.895	0.929	0.925	0.922	0.923	0.902	0.908	0.903	0.898	0.896
$\bar{R}^2$	0.885	0.919	0.916	0.913	0.914	0.893	0.898	0.893	0.888	0.886
Countries	10	10	10	10	10	12	12	12	12	12
Hansen-Test	1039.47	5.7e+08	2605.19	3178.44	2015.02	753.247	8257.18	8283.31	78.65	227.09
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is ln(Losses). All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses. "Not Euro" represents the countries that are outside the Euro Area. "NEW" represents the 10 countries that recently entered in 2004 and 2007.

Table 8, columns 12 to 15 shows the "New" countries, many of these countries have a low flat rate (Bulgaria and Estonia are some examples). Since 2008 Bulgaria has a 10% flat rate tax system (Commission, 2012, p. 66). The region that represents the "Old" countries doesn't have significance, although with similar coefficient sizes (see Annex D).

In all regressions the Hansen-test favors the fixed effect model with a significance of 1%. The dummy variable that represented the change in methodology is positive which indicates that software piracy losses have increased over the years. Also as Figure 2 presented, a dramatic change occurred in 2002/2003, which was captures by this variable.

4.2.2. Additional Results

After establishing that both indirect and direct taxation on households affect positively software piracy, we examine if the relative importance in the Economy of these taxes can also affect this phenomenon. The relative importance of these taxes can be measured as a percentage of total taxation. In many countries, the importance of Capital, Labor and Consumption taxes, accounts for almost one hundred percent of all taxes existing in a country.

Equation 4 describes the general econometric specification that will be used

$$\ln(Losses)_{it} = \theta_{0i} + \theta_1 GDPg_{it} + \theta_2 HICPHgall_{it} + \theta_3 TaxcapTot_{it} + \theta_4 TaxlabTot_{it} + \theta_5 TaxconsTot_{it} + \theta_6 change + \varepsilon_{it} \quad (4)$$

where *TaxcapTot, TaxlabTot* and *TaxcapTot* are the importance of taxes on capital, labor and consumption respectively as a share of total taxation. These three variables cannot be present at the same time as the sum of them equals 100% of total taxation.

So as:

$$TaxcapTot_{it} + TaxlabTot_{it} + TaxconsTot_{it} = 1 \quad (5)$$

To prevent multicolinearity we omit one variable at a time that will serve as a base tax level. For instance if we omit the $TaxconsTot_{it}$, solving the above equation in order to that variable and replacing in equation 4 we get:

$$\ln(Losses)_{it} = (\theta_{0i} + \theta_5) + \theta_1 GDPg_{it} + \theta_2 HICPHgall_{it} + (\theta_3 - \theta_5) TaxcapTot_{it} + (\theta_4 - \theta_5) TaxlabTot_{it} + \theta_6 change + \varepsilon_{it} \quad (6)$$

From equation (6) is easy to check the interpretation of the coefficient as a 1 pp. increase in the share of the respective tax with an associate decrease of 1 pp. in the share of the Consumption Tax (the base case).

Anyway, we report all possible combinations in the regressions that serve as a robustness check. With this omission we can interpret the coefficients of the remaining taxes as the differential impact between a specific tax and the base one. The control variables (*GDPg* and *HICPHgall*) maintained the coefficients.

Table 9 presents the results for the entire sample. Columns 16 to 18 show the different combinations of these taxes. Significance on the variables that represent the importance of taxes was only present when taxation of labor and capital were considered together (column 16); the negative impact of *TaxcapTot*[13] indicates that an increase of the relative importance of capital taxation and a reduction of consumption taxation will lead to less piracy (substitution effect). In spite of this statistical significance, column 17 shows that this result is not strong which can be a result of the complex tax systems and the difficulty in reducing direct taxation.

Table 9: Relative importance of taxation in the EU27

Variables	16	17	18
GDPg	**0.012***	**0.013***	**0.013***
	(1.646)	**(1.685)**	**(1.657)**
HICHgall	**-0.003****	**-0.003****	**-0.003****
	(-2.595)	**(-2.530)**	**(-2.558)**
TaxcapTot	**-0.027***	0.003	
	(-1.667)	(0.172)	
TaxlabTot	-0.030		-0.004
	(-1.556)		(-0.229)
TaxconsTot		0.029	0.026
		(1.508)	(1.599)
Change	**1.265*****	**1.266*****	**1.266*****
	(20.785)	**(20.889)**	**(20.833)**
Constant	**5.592*****	**2.615*****	**2.942*****
	(4.836)	**(3.128)**	**(2.845)**
Observations	349	349	349
R^2	0.845	0.845	0.845
$\bar{R}^2$	0.840	0.840	0.840
Countries	27	27	27
Hansen-Test	3.5e+04	1.1e+04	9853.72
p-value	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is ln(Losses). All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses.

[13] In the European Union, this tax represents on average 19.51% of total taxation. The personal taxation represents, on average, 47% of total taxation which indicates that the rates applied are high. On the other side the rates applied to capital are relatively low.

Table 10 presents the results for the different EU regions that were significant; the "Not Euro" and "Euro" zone.

Columns 19 to 21 present the results for the "Not Euro" Zone. *TaxlabTot* is significant at 5% with a negative impact on piracy which indicates that if we increase the importance of this tax and at the same time decrease the importance of consumption tax (base tax), this will decrease piracy. If we consider the capital tax as the base tax, we observe that *TaxlabTot* maintains its coefficient being significant at 10%. In this case an increase of labor tax and at the same time, a decrease of capital taxation (the base tax) will also lead to less piracy. *TaxconsTot* is significant at 5% with a positive impact when we omit labor tax. In this case an increase of consumption tax and a decrease of labor tax (base tax) will increase piracy although this result is not robust.

Columns 22 to 24 shows the "Euro" Zone, in this situation *TaxlabTot* loses significance. This is an unexpected result as in the Euro Zone the importance of this tax is smaller than those outside the Euro Zone, although this difference is marginal[14].

Table 11 presents the results for the "New" and "Old" countries. Columns 25 to 27 presents the "New" Countries. When we consider the consumption tax as the base one, we can observe that it is possible to reduce piracy choosing capital or labor tax. Both variables are significant with a negative impact. If we increase *TaxlabTot* and reduce consumption taxation (base tax), this will decrease piracy; we can also, in alternative increase *TaxcapToT* and reduce consumption tax. Although this will depend of the advantages and disadvantages of changing one of these taxes.

When we consider both *TaxcapTot* and *TaxconTot, TaxconTot* is positive and significant which indicates that if we increase this tax and decrease the base tax (labor tax), this will increase piracy. Also when the base tax is the capital tax, *TaxconsTot* maintain the significance with a positive impact, an increase of this tax and a decrease of capital tax (the base tax) will increase piracy. Columns 28 to 30 shows the "Old" countries, in this case none of the variables are significant.

[14] On average in the Euro Zone this tax represents 47.7% of total taxation while on the remaining countries this value is of 46.6%.

Table 10: Relative importance of taxation in the Not Euro and EURO Countries

	NOT EURO			EURO		
VARIABLES	19	20	21	22	23	24
GDPg	0.000	0.001	0.000	**0.022****	**0.022****	**0.022****
	(0.047)	(0.172)	(0.064)	**(2.142)**	**(2.149)**	**(2.137)**
HICHgall	**-0.006*****	**-0.006*****	**-0.007*****	**-0.046*****	**-0.046*****	**-0.046*****
	(-3.985)	**(-3.922)**	**(-4.107)**	**(-2.680)**	**(-2.660)**	**(-2.629)**
TaxcapTot	-0.013	0.041		**-0.032***	-0.023	
	(-0.614)	(1.579)		**(-1.775)**	(-1.209)	
TaxlabTot	**-0.054****		**-0.044***	-0.010		0.022
	(-2.447)		**(-1.707)**	(-0.485)		(1.196)
TaxconsTot		**0.052****	0.010		0.009	**0.031***
		(2.299)	(0.495)		(0.434)	**(1.710)**
Change	**1.214*****	**1.220*****	**1.214*****	**1.201*****	**1.202*****	**1.203*****
	(13.781)	**(13.972)**	**(13.864)**	**(12.948)**	**(12.970)**	**(12.935)**
Constant	**6.567*****	1.181	**5.488****	**4.840*****	**3.904*****	1.670
	(5.186)	(1.092)	**(3.144)**	**(4.042)**	**(4.243)**	(1.343)
Observations	131	131	131	218	218	218
R^2	0.894	0.893	0.894	0.835	0.835	0.835
$\bar{R}^2$	0.884	0.883	0.884	17	17	17
Countries	10	10	10	0.827	0.826	0.826
Hansen-Test	1095.60	862.59	828.46	904.727	1072.968	1150.520
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is ln(Losses). All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses. "Not Euro" represents the countries that are outside the Euro Area.

Table 11: Relative importance of taxation in the New and Old Countries

	NEW			OLD		
Variables	25	26	27	28	29	30
GDPg	-0.001	0.000	-0.000	**0.026***	**0.026***	**0.026***
	(-0.088)	(0.052)	(-0.029)	**(1.836)**	**(1.842)**	**(1.832)**
HICHgall	**-0.004*****	**-0.004*****	**-0.004*****	**-0.054***	-0.053	**-0.053***
	(-3.097)	**(-2.985)**	**(-3.061)**	**(-1.671)**	(-1.636)	**(-1.653)**
TaxcapTot	**-0.036*****	0.019		-0.016	-0.022	
	(-3.130)	(0.846)		(-0.455)	(-0.844)	
TaxlabTot	**-0.056****		-0.022	0.006		0.021
	(-2.496)		(-0.974)	(0.204)		(0.821)
TaxconsTot		**0.054****	**0.034*****		-0.008	0.014
		(2.316)	**(2.794)**		(-0.267)	(0.395)
Change	**1.216*****	**1.223*****	**1.216*****	**1.225*****	**1.225*****	**1.227*****
	(12.265)	**(12.186)**	**(12.077)**	**(13.372)**	**(13.498)**	**(13.540)**
Constant	**5.657*****	0.122	2.204	**4.716****	**5.391*****	3.256
	(4.840)	(0.106)	(1.768)	**(2.337)**	**(4.681)**	(1.627)
Observations	155	155	155	194	194	194
R^2	0.871	0.870	0.871	0.858	0.858	0.858
$\bar{R}^2$	0.861	0.860	0.861	15	15	15
Countries	12	12	12	0.850	0.850	0.849
Hansen-Test	703.36	567.91	587.98	1054.141	1061.812	1201.264
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is ln(Losses). All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses. "New" represents the 10 countries that recently entered in 2004 and 2007.

5. Conclusion

This paper analyzed the impact that levels of taxation have on software piracy. Previous econometrics studies have relied on cross-sectional and panel data studies. Our contribution to the empirical literature is in the fact that we introduce a new analysis that studies the effect of taxation on different household types as well as introducing a large panel dataset for the European Union and its different regions. Results are valuable for policymakers, especially within the common market of the European Union.

Results indicate that personal taxation affects differently the households. An increase in taxation on household that have smaller income appear to increase piracy, being this impact more pronounced on these households than those that earn more. These results were also found to hold when the different regions of the EU were considered, although only significant on "Not Euro" and the "New" countries. Having more access to digital content but reduced income can result on using illegal software, for example downloading illegal music's instead of purchasing them.

Further analysis was conducted with the relative importance of personal, capital and consumption tax as a share of total taxation. Results showed that even if it's not possible to reduce the number of taxes or the actual rates applied, there appear to be some benefit in reducing the impact of taxation on consumption. These results were heterogeneous among the different regions. To promote effective measures to prevent piracy it is necessary effective policies aiming at each group of countries and on the different tax types (PIT, CIT and CIT).

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Annex A: Additional Summary Statistics

Table 12: Detailed summary statistics for Euro and Non Euro Zone

	Euro Area					Not Euro Area				
Variable	Obs.	Mean	S. D.	Min	Max	Obs.	Mean	S. D.	Min	Max
Losses	232	371.22	647.08	0.969	3191	140	232.10	417.77	4.843	2181
SPn50	252	18.10	7.39	4.62	36.66	150	22.46	7.11	0.15	39.26
SPn100	252	26.58	8.69	6.3	43.37	150	28.23	6.55	8.83	44.95
SPn125	252	29.36	8.73	8.46	47.71	150	30.17	7.40	11.37	48.37
SPn167	252	32.66	8.69	12.67	50.03	150	32.51	8.34	14.36	52.58
SPt67	252	4.32	9.92	-21.28	24	150	6.92	10.57	-21.56	24.69
SPn67	252	21.86	8.25	4.5	36.92	150	25.01	6.56	3.52	41.39
SPn80	252	23.97	8.61	4.8	42.28	150	26.44	6.39	6.12	43.17
Cn100100	252	26.63	8.56	6.30	44.28	150	28.16	6.61	12.93	44.95
Cn100333	252	22.74	7.97	5.68	38.09	150	25.69	6.53	9.35	41.39
Ct100	252	13.35	7.99	-8.6	28.05	150	17.32	8.98	-6.91	31.11
Ct100100	252	22.57	7.84	0.46	38.66	150	24.12	6.87	7.31	41.68
Ct10033	252	16.40	7.43	0.6	31.03	150	19.18	7.55	4.79	36.48
Ct10067	252	19.60	7.77	5.4	35.28	150	21.77	7.22	5.62	39.6
lGDPpc	255	9.95	0.39	8.67	11.15	150	9.47	0.57	8.37	10.35
HICPHall	255	94.87	12.30	53.71	126.95	150	93.99	22.17	5.01	139.62
HICPHgall	238	2.76	2.01	-1.7	12.2	139	6.82	15.11	-1.2	154.8
HICPHcultture	255	96.53	8.14	60.23	112.56	149	94.34	17.60	5.74	120.09
HICPHgcultute	238	1.46	2.17	-2.6	12.4	139	5.17	15.49	-4.9	146.6
HICPHcomm	255	104.37	21.30	38.86	206.34	149	93.17	20.63	1.81	124.6
HICPHgcomm	238	-.67	5.66	-14	41.4	139	6.69	28.61	-10.7	237.5
Itaxcons	251	20.66	3.84	11.1	29.3	150	21.71	5.30	11.7	34.2
Itaxlab	251	34.09	7.22	18.8	45.3	150	35.63	5.81	34.4	49.3
TaxlabGDP	255	17.47	5.00	9.4	26	150	17.39	5.83	9	32
TaxlabTotT	255	46.58	8.21	27	60.7	150	47.71	7.28	30.2	62.5
TaxlconsGDP	255	11.69	1.40	7.3	15.2	150	12.53	1.93	8.5	17.2
TaxconsTotT	255	32.34	5.82	22.8	44	150	35.81	5.94	24	54
TaxcapTotT	255	21.22	6.56	5.2	35	150	16.62	5.95	6.9	32.9

Notes: S.D represents the standard deviation, Min. the minimum and Max. the maximum.

Table 13: Detailed Summary Statistics for Old and New Countries

	Old Countries					New Countries				
Variable	Obs.	Mean	S. D.	Min	Max	Obs.	Mean	S.D.	Min	Max
Losses	207	519.27	703.61	16	3191	165	67.44	108.90	0.969	648
SPn50	225	20.91	7.85	4.62	39.26	177	18.22	6.95	0.15	31.31
SPn100	225	29.73	7.79	16.49	44.95	177	23.97	7.04	6.3	38.81
SPn125	225	32.63	7.93	18.76	48.37	177	25.90	7.07	8.46	42.52
SPn167	225	36.15	8	21.47	52.58	177	28.09	6.97	12.67	45.14
SPt67	225	7.79	8.87	-21.28	21.41	177	2.12	10.98	-21.56	24.69
SPn67	225	25.01	7.79	11.47	41.39	177	20.53	7.09	3.52	32.32
SPn80	225	27.20	7.94	13.89	43.17	177	21.95	6.91	4.8	32.82
Cn100100	225	29.68	7.80	17.43	44.95	177	24.05	6.88	6.3	38.81
Cn100333	225	25.52	7.82	10.45	41.39	177	21.71	6.73	5.68	34.25
Ct100	225	17.23	7.64	-2.17	31.11	177	11.78	8.75	-8.6	28.97
Ct100100	225	25.63	7.42	11.14	41.68	177	19.99	6.40	0.46	31.74
Ct10033	225	19.50	7.79	2.02	36.48	177	14.82	6.44	0.6	27.8
Ct10067	225	22.77	7.77	6.23	39.6	177	17.41	6.29	5.4	30.84
lGDPpc	225	10.11	0.29	9.38	11.15	180	9.36	0.42	8.37	10.11
HICPHall	225	96.17	9.47	72.68	117.68	180	92.52	22.47	5.01	139.62
HICPHgall	210	2.21	1.13	-1.7	5.4	167	6.95	13.77	-1.2	154.8
HICPHcultture	225	97.90	5.55	76.84	109.43	179	93.00	17.39	5.74	120.09
HICPHgcultute	210	0.83	1.47	-2.6	6.5	167	5.34	14.12	-4.9	146.6
HICPHcomm	225	106.43	12.98	83.84	156.36	179	92.47	27.32	1.81	206.34
HICPHgcomm	210	-1.93	3.11	-14	7.1	167	7.05	26.41	-13.6	237.5
Itaxcons	221	22.10	4.86	12.6	34.2	180	19.77	3.54	11.1	28.2
Itaxlab	221	35.69	7.02	21.6	49.3	180	33.40	6.23	18.8	42.6
TaxlabGDP	225	19.59	5.60	9.7	32	180	14.74	3.38	9	20.8
TaxlabTotT	225	48.50	7.86	32.5	62.5	180	45.12	7.53	27	57.2
TaxlconsGDP	225	11.71	1.57	7.3	16.4	180	12.36	1.71	8.5	17.2
TaxconsTotT	225	29.99	4.66	22.8	41.3	180	38.17	4.38	27.9	54
TaxcapTotT	225	21.68	5.78	10.9	34.9	180	16.81	6.83	5.2	35

Notes: S.D represents the standard deviation, Min. the minimum and Max. the maximum.

Annex B: Additional regressions with different inflations

Table 14: Regressions with the different inflation types

Variables	31	32	33	34	35	36	37	38	39	40
GDPg	0.008	0.008	0.008	**0.009***	0.007	0.008	0.007	0.007	**0.009***	0.006
	(1.259)	(1.279)	(1.270)	**(1.777)**	(1.241)	(1.273)	(1.187)	(1.195)	**(1.645)**	(1.130)
TaxconsGDP	**0.065****	**0.055****	**0.058****	**0.068*****	**0.070****	**0.065****	**0.054****	**0.058****	**0.067*****	**0.070*****
	(2.369)	**(2.232)**	**(2.234)**	**(2.579)**	**(2.466)**	**(2.485)**	**(2.298)**	**(2.324)**	**(2.711)**	**(2.590)**
HICPHgculture	**-0.005*****	**-0.004****	**-0.004****	**-0.004****	**-0.004****					
	(-2.927)	**(-2.366)**	**(-2.454)**	**(-2.549)**	**(-2.544)**					
HICPHgcomm						**-0.002*****	**-0.003*****	**-0.003*****	**-0.002*****	**-0.003*****
						(-4.944)	**(-5.207)**	**(-4.845)**	**(-4.275)**	**(-4.738)**
SPn50		**0.021****					**0.022****			
		(2.043)					**(2.216)**			
SPn67			**0.021***					**0.022****		
			(1.862)					**(2.019)**		
SPn80				**0.019***					**0.019***	
				(1.658)					**(1.781)**	
Cn10033					**0.018***					**0.019***
					(1.663)					**(1.857)**
Change	**0.981*****	**0.991*****	**0.984*****	**1.048*****	**0.942*****	**0.982*****	**0.988*****	**0.982*****	**1.050*****	**0.940*****
	(13.673)	**(13.426)**	**(13.287)**	**(14.775)**	**(14.135)**	**(13.733)**	**(13.746)**	**(13.606)**	**(14.847)**	**(14.093)**
Constant	**2.926*****	**2.647*****	**2.536*****	**2.469*****	**2.503*****	**2.918*****	**2.640*****	**2.522*****	**2.452*****	**2.479*****
	(8.664)	**(6.333)**	**(5.323)**	**(4.890)**	**(4.708)**	**(9.436)**	**(6.982)**	**(5.841)**	**(5.302)**	**(5.124)**
Observations	349	346	346	346	346	349	346	346	346	346
R^2	0.880	0.883	0.882	0.875	0.878	0.880	0.883	0.882	0.876	0.878
Countries	27	27	27	27	27	27	27	27	27	27
$\bar{R}^2$	0.875	0.877	0.876	0.871	0.873	0.875	0.878	0.877	0.871	0.873
Hansen-Test	4.9e+04	1642.431	596.044	629.708	464.450	7.3e+04	1412.206	590.781	586.600	479.283
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is *ln(Losses).* All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses.

Annex C: Regressions with the remaining households types

Table 15: Remaining households for EU 27

Variables	41	42	43	44	45	46	47	48	49
GDPg	**0.011***	**0.014****	**-0.013*****	**0.013****	**0.015****	**0.015****	**0.014****	**0.015****	**0.015****
	(1.817)	**(2.440)**	**(-2.759)**	**(2.055)**	**(2.403)**	**(2.422)**	**(2.430)**	**(2.421)**	**(2.432)**
TaxconsGDP	**0.065****	**0.065****	**0.062***	**0.062****	**0.084*****	**0.078*****	**0.076*****	**0.082*****	**0.086*****
	(2.252)	**(2.157)**	**(1.717)**	**(2.044)**	**(2.948)**	**(3.058)**	**(3.220)**	**(3.034)**	**(2.991)**
HICPHgall	**-0.004*****	**-0.004*****	**-0.007*****	**-0.004*****	**-0.003****	**-0.003*****	**-0.003*****	**-0.003***	**-0.003****
	(-4.139)	**(-4.160)**	**(-8.192)**	**(-3.433)**	**(-2.370)**	**(-2.857)**	**(-2.594)**	**(-2.031)**	**(-2.144)**
SPn100	0.007								
	(0.589)								
SPn125		0.000							
		(0.033)							
SPn167			0.001						
			(0.063)						
SPt67				-0.001					
				(-0.180)					
Cn100100					0.012				
					(1.116)				
Ct100						0.003			
						(0.418)			
Ct10033							0.009		
							(1.011)		
Ct10067								0.011	
								(1.072)	
Ct100100									0.012
									(1.152)
Change	**1.234*****	**1.259*****	**1.102*****	**1.286*****	**1.135*****	**1.134*****	**1.140*****	**1.134*****	**1.141*****
	(20.537)	**(21.341)**	**(20.553)**	**(21.783)**	**(18.888)**	**(18.887)**	**(18.665)**	**(19.009)**	**(18.692)**
Constant	**2.781*****	**2.938*****	**3.091*****	**2.961*****	**2.336*****	**2.697*****	**2.593*****	**2.449*****	**2.357*****
	(4.801)	**(4.978)**	**(4.284)**	**(7.933)**	**(4.060)**	**(7.522)**	**(7.009)**	**(5.024)**	**(4.401)**
Observations	346	346	346	346	346	346	346	346	346
R^2	0.851	0.850	0.861	0.854	0.866	0.866	0.867	0.867	0.867
Countries	27	27	27	27	27	27	27	27	27
$\bar{R}^2$	0.846	0.845	0.855	0.848	0.862	0.861	0.861	0.862	0.862
Hansen-Test	1182.253	1108.583	1244.960	2.4e+04	251.157	1257.545	914.464	408.865	380.457
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is *ln(Losses).* All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses.

Table 16: Remaining households for the countries outside the EURO Zone

Variables	50	51	52	53	54	55	56	57	58
GDPg	0.005	0.005	0.004	0.003	0.009	0.008	0.009	0.008	0.009
	(1.009)	(0.877)	(0.719)	(0.602)	(1.224)	(1.144)	(1.177)	(1.182)	(1.193)
TaxconsGDP	**0.071****	**0.074***	**0.074***	**0.076***	**0.083***	**0.077***	**0.070***	**0.085***	**0.088***
	(1.961)	**(1.808)**	**(1.667)**	**(1.724)**	**(1.730)**	**(1.794)**	**(1.756)**	**(1.820)**	**(1.818)**
HICPHgall	**-0.004*****	**-0.004*****	**-0.004*****	**-0.004*****	**-0.003*****	**-0.004*****	**-0.003*****	**-0.003****	**-0.003****
	(-3.016)	**(-3.465)**	**(-4.065)**	**(-3.478)**	**(-2.693)**	**(-3.136)**	**(-3.166)**	**(-2.120)**	**(-2.027)**
SPn100	0.015								
	(1.162)								
SPn125		0.007							
		(0.620)							
SPn167			-0.002						
			(-0.213)						
SPt67				0.004					
				(0.583)					
Cn100100					0.014				
					(1.018)				
Ct100						0.009			
						(0.904)			
Ct10033							0.012		
							(1.260)		
Ct10067								0.013	
								(1.120)	
Ct100100									0.014
									(1.026)
Change	**1.126*****	**1.117*****	**1.112*****	**1.113*****	**1.147*****	**1.128*****	**1.130*****	**1.140*****	**1.143*****
	(10.767)	**(11.051)**	**(11.227)**	**(11.343)**	**(18.085)**	**(16.799)**	**(17.156)**	**(17.440)**	**(17.977)**
Constant	**2.345*****	**2.546*****	**2.854*****	**2.715*****	**2.252****	**2.569*****	**2.556*****	**2.315*****	**2.223****
	(3.053)	**(3.184)**	**(3.452)**	**(4.490)**	**(2.499)**	**(4.478)**	**(4.939)**	**(3.024)**	**(2.615)**
Observations	131	131	131	131	131	131	131	131	131
R^2	0.918	0.917	0.916	0.917	0.914	0.914	0.915	0.915	0.915
Countries	10	10	10	10	10	10	10	10	10
$\bar{R}^2$	0.909	0.906	0.906	0.907	0.905	0.905	0.906	0.906	0.905
Hansen-Test	3130.502	1.3e+07	3.9e+05	1191.196	6665.099	419.068	4145.801	1.1e+06	1.1e+05
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is *ln(Losses).* All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses.

Table 17: Remaining households for the NEW countries

Variables	59	60	61	62	63	64	65	66	67
GDPg	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **	**-0.016*** **
	(-3.425)	**(-3.269)**	**(-3.134)**	**(-2.742)**	**(-3.337)**	**(-3.081)**	**(-3.207)**	**(-3.143)**	**(-3.193)**
TaxconsGDP	**0.074***	**0.070***	0.064	**0.071** **	**0.078***	**0.071** **	**0.071** **	**0.075** **	**0.079** **
	(1.913)	**(1.793)**	(1.609)	**(1.989)**	**(1.803)**	**(1.989)**	**(2.024)**	**(2.042)**	**(2.096)**
HICPHgall	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **	**-0.008*** **
	(-12.417)	**(-14.285)**	**(-14.908)**	**(-15.217)**	**(-10.975)**	**(-15.299)**	**(-15.214)**	**(-11.960)**	**(-13.031)**
SPn100	0.007								
	(0.488)								
SPn125		-0.001							
		(-0.105)							
SPn167			-0.011						
			(-1.097)						
SPt67				-0.001					
				(-0.163)					
Cn100100					0.010				
					(0.639)				
Ct100						-0.001			
						(-0.229)			
Ct10033							0.002		
							(0.288)		
Ct10067								0.008	
								(0.692)	
Ct100100									0.009
									(0.882)
Change	**0.920*** **	**0.923*** **	**0.929*** **	**0.924*** **	**0.916*** **	**0.924*** **	**0.920*** **	**0.911*** **	**0.910*** **
	(18.832)	**(18.198)**	**(17.989)**	**(19.599)**	**(17.614)**	**(19.408)**	**(19.712)**	**(18.507)**	**(18.774)**
Constant	**1.756** **	**1.984*** **	**2.345*** **	**1.947*** **	**1.620***	**1.956*** **	**1.923*** **	**1.775*** **	**1.671*** **
	(2.488)	**(2.892)**	**(3.426)**	**(4.554)**	**(1.930)**	**(4.665)**	**(4.537)**	**(3.313)**	**(2.970)**
Observations	152	152	152	152	152	152	152	152	152
R^2	0.880	0.880	0.881	0.880	0.880	0.880	0.880	0.880	0.881
Countries	12	12	12	12	12	12	12	12	12
$\bar{R}^2$	0.868	0.867	0.869	0.867	0.868	0.867	0.867	0.868	0.869
Hansen-Test	6.0e+09	2218.358	979.056	361.686	1775.228	2.2e+08	2.7e+04	7663.393	8.2e+05
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Dependent variable is *ln(Losses).* All regressions were estimates with time dummies. Robust *t-statistics* are in parentheses.

Annex D: regressions with the remaining regions

Table 18: The different Households types for the OLD countries

Variables	68	69	70	71	72	73	74	75	76	77	78	79	80	81
GDPg	**0.022***	**0.022***	**0.021***	**0.021***	**0.021***	**0.021***	**0.021***	**0.019***	**0.020***	**0.021***	**0.018***	**0.018***	**0.019***	**0.020***
	(1.777)	**(1.860)**	**(1.764)**	**(1.788)**	**(1.780)**	**(1.816)**	**(1.857)**	**(1.742)**	**(1.776)**	**(1.787)**	**(1.645)**	**(1.755)**	**(1.776)**	**(1.799)**
TaxconsGDP	0.055	0.055	0.062	0.061	0.058	0.058	0.062	0.064	0.062	0.057	0.063	0.065	0.065	0.061
	(0.842)	(0.827)	(0.952)	(0.949)	(0.877)	(0.867)	(0.948)	(0.980)	(0.945)	(0.865)	(0.963)	(1.002)	(1.001)	(0.926)
HICPHgculture	**-0.062****	**-0.062****	**-0.061****	**-0.061***	**-0.061****	**-0.061****	**-0.059***	**-0.068****	**-0.059***	**-0.061****	**-0.062****	**-0.060****	**-0.061****	**-0.061****
	(-2.339)	**(-2.303)**	**(-2.187)**	**(-2.132)**	**(-2.214)**	**(-2.163)**	**(-1.968)**	**(-2.908)**	**(-2.071)**	**(-2.185)**	**(-2.272)**	**(-2.246)**	**(-2.214)**	**(-2.235)**
SPn50		-0.002												
		(-0.145)												
SPn67			0.009											
			(0.517)											
SPn80				0.013										
				(0.746)										
SPn100					0.008									
					(0.501)									
SPn125						0.007								
						(0.378)								
SPn167							0.015							
							(0.693)							
SPt67								0.008						
								(0.983)						
Cn10033									0.015					
									(0.794)					
Cn100100										0.007				
										(0.440)				
Ct100											0.020			
											(0.907)			
Ct10033												0.021		
												(1.019)		
Ct10067													0.018	
													(0.903)	
Ct100100														0.013
														(0.722)
Change	**1.238*****	**1.236*****	**1.245*****	**1.249*****	**1.244*****	**1.243*****	**1.242*****	**1.237*****	**1.255*****	**1.242*****	**1.242*****	**1.259*****	**1.249*****	**1.242*****
	(15.829)	**(17.004)**	**(15.988)**	**(16.042)**	**(16.082)**	**(16.296)**	**(15.749)**	**(15.206)**	**(15.870)**	**(16.001)**	**(14.903)**	**(14.930)**	**(15.310)**	**(15.269)**
Constant	**4.025*****	**4.073*****	**3.725*****	**3.606*****	**3.755*****	**3.757*****	**3.402****	**3.862*****	**3.566*****	**3.800*****	**3.601*****	**3.481*****	**3.505*****	**3.619*****
	(5.115)	**(4.605)**	**(4.002)**	**(3.786)**	**(3.714)**	**(3.267)**	**(2.876)**	**(4.819)**	**(3.532)**	**(3.835)**	**(3.799)**	**(3.594)**	**(3.512)**	**(3.549)**
Observations	194	194	194	194	194	194	194	194	194	194	194	194	194	194
R^2	0.856	0.856	0.856	0.856	0.856	0.856	0.857	0.857	0.857	0.856	0.859	0.859	0.858	0.857
Countries	15	15	15	15	15	15	15	15	15	15	15	15	15	15
$\bar{R}^2$	0.849	0.849	0.849	0.849	0.849	0.849	0.850	0.850	0.850	0.849	0.852	0.852	0.851	0.850
Hansen-Test	1.2e+04	2613.756	1134.045	1526.225	1692.318	1773.026	1942.547	946.576	1230.159	1401.549	1051.507	580.610	525.371	635.569
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Table 19: The different Households types for the EURO Zone

Variables	82	83	84	85	86	87	88	89	90	91	92	93	94	95
GDPg	**0.022** **(2.446)**	**0.023** **(2.302)**	**0.021** **(2.077)**	**0.020** **(2.157)**	**0.021** **(2.200)**	**0.021** **(2.227)**	**0.021** **(2.247)**	**0.022** **(2.287)**	**0.021** **(2.177)**	**0.020** **(2.121)**	**0.021** **(2.220)**	**0.021** **(2.311)**	**0.020** **(2.233)**	**0.020** **(2.245)**
TaxconsGDP	**0.081** **(2.833)**	**0.075** **(2.525)**	**0.073** **(2.472)**	**0.074** **(2.492)**	**0.074** **(2.362)**	**0.074** **(2.249)**	**0.077** **(2.258)**	**0.073** **(2.463)**	**0.073** **(2.445)**	**0.077** **(2.308)**	**0.073** **(2.516)**	**0.073** **(2.525)**	**0.075** **(2.457)**	**0.076** **(2.328)**
HICPHgculture	**-0.048** **(-2.409)**	**-0.048** **(-2.376)**	**-0.049** **(-2.448)**	**-0.049** **(-2.389)**	**-0.049** **(-2.383)**	**-0.049** **(-2.391)**	**-0.049** **(-2.316)**	**-0.048** **(-2.241)**	**-0.049** **(-2.394)**	**-0.049** **(-2.353)**	**-0.049** **(-2.428)**	**-0.049** **(-2.405)**	**-0.049** **(-2.453)**	**-0.049** **(-2.368)**
SPn50		-0.008 (-0.534)												
SPn67			0.006 (0.275)											
SPn80				0.009 (0.445)										
SPn100					0.002 (0.095)									
SPn125						0.001 (0.045)								
SPn167							0.007 (0.319)							
SPt67								-0.002 (-0.400)						
Cn10033									0.001 (0.045)					
Cn100100										0.010 (0.443)				
Ct100											0.000 (0.049)			
Ct10033												0.002 (0.096)		
Ct10067													0.008 (0.422)	
Ct100100														0.006 (0.363)
Change	**1.199** **(13.041)**	**1.174** **(13.453)**	**1.177** **(12.598)**	**1.178** **(12.787)**	**1.179** **(12.820)**	**1.179** **(12.833)**	**1.178** **(12.726)**	**1.181** **(12.861)**	**1.179** **(13.094)**	**1.179** **(12.703)**	**1.178** **(12.853)**	**1.179** **(12.915)**	**1.178** **(12.837)**	**1.179** **(12.944)**
Constant	**2.827** **(8.893)**	**3.097** **(6.833)**	**2.845** **(5.511)**	**2.734** **(4.198)**	**2.910** **(4.220)**	**2.934** **(3.697)**	**2.703** **(2.911)**	**2.970** **(8.727)**	**2.939** **(4.382)**	**2.669** **(3.303)**	**2.958** **(7.915)**	**2.940** **(6.278)**	**2.792** **(4.737)**	**2.800** **(4.374)**
Observations	218	215	215	215	215	215	215	215	215	215	215	215	215	215
R^2	0.839	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836
Countries	17	17	17	17	17	17	17	17	17	17	17	17	17	17
$\bar{R}^2$	0.829	0.826	0.825	0.826	0.825	0.825	0.826	0.825	0.825	0.826	0.825	0.825	0.826	0.826
Hansen-Test	8626.827	1041.778	808.702	853.152	918.880	751.863	823.716	2.7e+04	530.353	732.485	4742.566	2869.755	930.655	975.902
p-value	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Annex E: Unit root Formulas

We present the mathematical expressions used to compute the unit root tests of section (4.1). In this paper we presented $Z_{\tilde{t}-bar}$ in which the output has an asymptotic standard normal distribution.

We rewrite equation (1)

$$\Delta y_{it} = \alpha_{it} + \phi_i y_{i,t-1} + \epsilon_{it} \tag{F.1}$$

Consider

$$\tilde{t}\_bar_{NT} = \frac{1}{N}\sum_{i=1}^{N} \tilde{t}_{iT} \tag{F.2}$$

where

$$\tilde{t}_{iT} = \frac{\Delta y_i' M_\tau y_{i,-1}}{\tilde{\sigma}_{iT}(y_{i,-1}' M_\tau y_{i,-1})^{\frac{1}{2}}} \tag{F.3}$$

We have that $\Delta \boldsymbol{y_i} = (\Delta y_{i2}, \dots, \Delta y_{iT})'$, $\boldsymbol{y_{i,-1}} = \left(y_{i1}, \dots, y_{i,T-1}\right)'$ and $\boldsymbol{M_\tau} = \mathbf{I} - \tau_T(\tau_T'\tau_T)^{-1}\tau_T'$

and

$$\tilde{\sigma}_{it}^2 = \frac{\Delta \boldsymbol{y_i'} \boldsymbol{M_\tau} \boldsymbol{y_i}}{T-1} \tag{F.4}$$

then

$$Z_{\tilde{t}-bar} = \frac{\sqrt{N}\{\tilde{t}_{bar_{NT}} - N^{-1}\sum_{i=1}^{N} E(\tilde{t}_{iT})\}}{\sqrt{N^{-1}\sum_i Var(\tilde{t}_{iT})}} \tag{F.5}$$

Both $E(\tilde{t}_{iT})$ and $Var(\tilde{t}_{iT})$ are obtained by linearly interpolating the values shown in Im et al. (2003).

In the variable in which we performed the Fisher type test we presented the inverse normal Z statistics that has the following mathematical expression.

$$Z = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} \Phi^{-1}(p_i) \tag{F.6}$$

Were $\Phi^{-1}(p_i)$ is the inverse of the standard normal cumulative distribution function and $Z \sim N(0,1)$.

Annex F: The different regions of the European Union

The regions of Europe that will be analyzed here show different stages of development, which can affect the enforcements of laws and Government effectiveness. European Union has grown since its original creation (1952) with the European Coal and Steel Community (ECSC) and the European Economic Community (EEC) formed by Belgium, France, Federal Republic of Germany, Italy, Luxembourg and Netherlands. In 1973 entered Denmark, Ireland and the United Kingdom; later on in 1981 Greece entered. Its geographical domain expanded including many countries, such as Portugal and Spain that entered in 1986. With the Maastricht Treaty (1993) it was established the current name "European Union". Austria, Sweden and Finland joined in 1995. In 2004 10 countries entered: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Malta and Cyprus. In 2007 two more entered, Romania and Bulgaria. They represent two distinct realities (level of economic development, culture and language). Some of the new countries (Estonia, Latvia and Lithuania) came from the Union of Soviet Socialist Republics (USSR).

The Euro Zone is constituted by 17 countries[15], some of which recently entered the European Union. Countries that entered the Euro Zone must obey certain rules that were set in order to prevent inflation. A deficit less than 3% of the GDP, a debt less or equal than 60%, are part of the third stage of European Economic and Monetary Union (EMU) to adopt the euro as their currency. Additional to these criteria they had to obey an inflation rate that had to be at most, 1.5% points above the average of the three best performing Member States of the EU and also the nominal long-term interest rate must not be more than 2 percentage points higher than in the three lowest Member States. The rule of Government debt was relaxed to allow more countries to enter. (For a detailed description see art 104, 121 and 122 of the EC Treaty)

These criteria obey a certain principle; they suppose an average growth rate of 2%, deficit can be above 3% in extraordinary circumstances such as crisis. Unfortunately the crises stroke the European Union with the sovereign debt crisis. The objective of excessive deficit procedures is to prevent and sanction countries that did not meet these criteria. Not one or two countries failed to meet these criteria; almost all of them. Examples are Austria, Italy, Portugal, France, and Ireland. Instead of sanctions it was proposed deadlines to the

[15] Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain.

Member States to meet these criteria. This can affect the use of fiscal policies in order to promote expansionary policies, for example reducing the VAT rate on software products.