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Harmonised Standards and Firm Productivity: Difference-in-Differences Evidence

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Abstract

Vojtěch Olbrecht: **Harmonised Standards and Firm Productivity: Difference-in-Differences Evidence**

One of the main objectives of the European Union is to enhance the competitiveness of companies within its Member States and that may be supported by further development of the Single Market. Introduction of harmonized standards for production of goods and services encourages companies to take advantage of the Single Market by reducing transaction costs. In other words, the EU is adjusting the economic and legal framework in which companies operate in order to remove existing barriers to its vision of a well-functioning Single Market. This paper researches the relationship between these changes and productivity of microeconomic agents – firms. The analysis uses a panel data regression model with difference-in-differences research design built on a sample of affected and unaffected firms as control groups to be able to extract effect caused by the regulation. The article provides evaluation of individual standards and states the direction of effect at each of those. It can be said that while some standards (mostly those with wide applicability) have a positive relation with productivity and some are insignificant. There can be found also one that has a robust significant negative correlation with productivity.

Key words

Harmonised Standards, Productivity, Difference-in-Differences, Law and Economics, European Union, Legislation

JEL: K20, K33, O12, O24

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Introduction

Competitiveness is one of the greatest issues of the European Union today. The EU is trying to enhance it by a wide variety of tools, one of which is widening of market opportunities for companies, also known as the project of the Single Market that is aiming to raise markets from national to international. A building stone and one of first achievements of the Single Market area is free movement of goods and services. Yet Member States are allowed to impose special (e.g. technical) requirements on imported goods and services in order to protect the health of its citizens, the environment, etc. Imposition of such standards can create legislative non-tariff barriers to free movement and thus can make transactional costs for producers and importing companies prohibitively high, even though it is not intended to be protectionist.

However, there exists an EU "plan to unlock the full potential of the Single Market, creating more opportunities for people and business" (EC, 2016a). For this reason, the EU focuses on legislation that harmonises standards across its Member States and aims to lower transaction costs and enhance competitiveness and performance of its companies. Companies using these standards can benefit from free movement of their goods that are otherwise prohibited to be traded or produced.

The goal of this paper is to provide evidence on the effect of this particular area of legislation and to determine whether or not it has achieved its goal, therefore to perform ex post analysis of the benefit side of regulation. Up to date, it is not known to author that there was any relevant empirical research conducted in this area.

The paper focuses on the effects of harmonisation of standards on microeconomic productivity of companies operating in standardised sectors. The article is not concerned with the specifics of (the adoption of) a particular standard, nor whether the standard has been actually adopted by a company, but more with harmonisation as an EU-guaranteed base which can be used no matter whether these or other standards are in fact used (availability of a standard can increase trade that will in turn increase productivity in an industry that will influence all the companies there – the link between trade and productivity is researched e.g. by Harrison (1996) and Alcala and Ciccone (2001)). Despite this, some authors (Portugal-Perez et al., 2010) argue that it is cost-prohibitive to follow European legislation with other than EU standards.

These standards are of a private nature and therefore similar to e.g. ISO as they are not obligatory for companies to use (EC, 2016b) though they are issued by a public body (third party). Companies can voluntarily decide whether they will use EU standards, other standards or no standards at all.

Therefore, the introduction of EU standard establishes a new base that is available in the affected sector and can be used as a declaration of complying with required characteristics, processes, etc.

The presumable output should be that the harmonisation of standards has a positive effect on corporate productivity. However, it can happen that the effect will be negative – possibly caused by an incorrectly specified standard – or insignificant – the introduction had no effect because of general disinterest in standardisation or availability and usage of other standards with no or low perceived benefits of changing to EU standards. In both of these cases, the effort included in standardisation is higher than its benefits.

The paper is structured as follows: chapter one discusses the basic theoretical foundation, chapter two provides an overview of materials and methods, chapter three introduces empirical results and last chapter concludes the paper.

1 Literature review

The importance of standards, standardisation and their harmonisation has its origins in institutional economics and in theories of economic growth. Prior to the work of Solow (1956), who established the most widely used framework for growth accounting, there was the work of Coase (1937) stressing transaction costs as an important part of economics and one of the possible sources of misallocations that is also very important for the theoretic base of this paper.

Following the work of Solow, there were several adjustments of his model, ranging from endogenizing technological progress (e.g. in Romer, 1986, Romer, 1990, Pack, 1994), to involvement of human capital (Mankiw et al., 1992) and more. The most important to this paper however was the introduction of fundamental factors of economic growth. These factors are able to influence accumulation of production factors (Snowdon and Vane, 2005) used in previous models (e.g. labour, capital and more) and consist of geography, trade, culture and institutions (Xu, 2011). Institutions are "rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (North, 1990, p. 3). Institutions are developed to simplify human interactions and to provide certainty in an otherwise uncertain environment, and contain also law and regulation (Boettke and Candella, 2014, Knack and Keefer, 1995). One area of institutions involves those that facilitate trade (also one of the fundamental factors) among companies and countries that were researched e.g. in Hall and Jones (1999), Barro (1996) and Frankel and Romer (1999).

There are many barriers to trade that may arise on the international market. Taxes, duties, quotas and more are institutions that were more or less eliminated by introduction of the Single Market for

goods and services by the EU as part of the project to enhance competitiveness. Still, though most common barriers are removed, there are barriers consisting of either national legislation or information asymmetry that signifies transaction costs (Williamson, 1985). When individual countries as members of the Single Market do not accept another country's products in order to protect its inhabitants or when business partners do not see a product as reliable by its being made in another country, transaction costs may increase to being unbearably high that the emerging effect would be comparable to a duty or quota.

A harmonised standard is a standard introduced by European Standards Organisations that confirm conformity with European legislation (EC, 2016b). They are similar to non-governmental international standards (such as ISO) in a way that they are voluntary and their usage is not required by legislation. Companies can either use these or other standards or not use any standards at all. The goal of EU standards, is to "ensure interoperability and safety, reduce costs and facilitate companies' integration in the value chain and trade" (EC, 2016c). As noted by the EU, standards should help with productivity and creation of the Single Market, as well as with other ideas (EC, 2016d). EU standards are focused on both producers and importers.

Standards can be viewed as institutions that are developed in order to facilitate transactions in an environment with high information asymmetry and therefore with high transaction costs needed to overcome this asymmetry. There is a possibility of overcoming information asymmetry with signals (Spence, 1973), and standards can provide such signals for potential stakeholders of a company.

The explanation provided above is called external. Companies can also view standards as know-how developed by external organizations that may improve internal processes in order to achieve higher productivity no matter what the external effect would be (Goedhuys and Sleuwaegen, 2013).

Standards can also increase costs as they require producers or traders to alter production for the individual market (Portugal-Perez et al., 2010), but this should not be a case of EU harmonisation of standards as these only harmonise already existing standards and remain voluntary applicable.

Besides private standards, there is also category of public standards (Hobbs, 2010). Though the EU is a public body, its standards as researched in this paper are of a private nature, basically because companies are not legislatively bound to use them. The primary goal of private standards is to reduce transaction costs and information asymmetry (Hobbs, 2010).

Vast literature comprehends private standards research, such as ISO (International Standardization Organization). The results are either positive or insignificant. Corbet et al. (2005) argue for the

positive effect in years following introduction of ISO, and positive results are provided also by Okay and Semiz (2010) and Sharma (2005). On the other hand, some results are confusing as they indicate higher operating performance and not significantly changed business performance (Naveh and Marcus, 2005) or have no effect caused by standardization (Wayhan et al., 2002). Private standards can be theoretically both trade enhancing and reducing (because of specific requirements on suppliers, compliance costs, etc.) (Hobbs, 2010).

There are also studies focused on specified standards for some industries, e.g. Schuster and Maertens (2015) on the food industry and Giacomarra et al. (2016) on the wine industry, or Portugal-Perez et al. (2010) who specifically address harmonisation standards (in electronics), but with effect on trade, not performance or productivity.

2 Materials and Methods

It is a challenging task to research effect caused by legislation. The simplest way to achieve this is by applying the Differences approach by extracting results prior to treatment from results after treatment, but this may (and most probably will) result in biased coefficients. Availability of a control group may actually decrease the bias and account for other-than-treatment effects. For our purposes, the control group should consist of companies operating in a similar environment where it could be possible to expect similar influences.

The research design applied in this paper is Differences in Difference (DD) performed on individual level (firm level) panel data. Treatment group is formed of companies in industry (either 2, 3, or 4-digit NACE Rev. 2) affected by particular regulation, and the control group is formed of all the other companies in the EU, unless specified differently. The control group size is significantly larger than treatment group, which should allow individual differences to disappear. Specification of the control group as within the EU enables one to abstract from characteristics that are used in world-wide studies – e.g. political regime, geography, culture, etc. as these are more or less the same over all observed countries. It is also possible to reduce the control group sample on companies with similar trend and behaviour (similar industry).

Data are retrieved from the Amadeus database (Bureau Van Dijk, 2015) for the years 2004-2013 and sectors A, B and C of NACE Rev. 2. The data sample consists of companies in countries that were members of the EU for a particular year, i.e. a maximum of 27, but due to data limitations, the sample consists of only 25 of them, and the rest were excluded because of missing values on either added value, number of employees or fixed assets (variables used to calculate total factor

productivity) or others. Data are merged with country-specific variables from the Eurostat database (Eurostat, 2016). Unavailable macroeconomic data were replaced by the EU (28) average for the particular year. All data were denominated by using producer prices in NACE Rev. 2. Section C for the year 2010 and all the monetary data are in thousands of EUR, unless stated otherwise. All monetary values are in thousands EUR, if not stated otherwise.

The estimation method is OLS with fixed effects for companies and years that allows control (a) for all time-invariant variables on company level and (b) for all individual-invariant variables at one time. These two effects are needed for three reasons: (1) they enable accounting for unobservable characteristics, (2) their inclusion is needed for the DD approach as they represent dummies for individual (treated or untreated) and time (pre or post treatment) and (3) they enable control for the effect of economic slowdown of the years 2007 and following.

Considering this, the coefficient of DD should consist only of effects that are time and company variant. Therefore, only the effects that occurred in a particular year and particular industry are taken into account. Still, there might be some effects that may bias the DD coefficient. The model tries to eliminate these effects by including time-variant individual-variant variables taken from standard growth literature, as noted below.

This paper focuses on harmonised standards as those recognised by CEN, CENELEC or ETSI (EC, 2016b). These are divided by the EU into the categories Chemicals, Conformity assessment and management systems, Construction, Consumers and workers' protection, Energy efficiency, Electric and electronic engineering, Healthcare engineering, Measuring technology, Mechanical engineering and means of transport, Services and Sustainability. Considered standards were only those that were provided as Base or Repealed legislation. To each of these standards was added Introduction year in a form of (for regulations) shall-apply-from year or entry-into-force year, or (for directives) effect-from year or end-of-transposition-period year. Also, by the text of the legislation, each standard has been linked with the most appropriate NACE Rev. 2 classification that is expected to be influenced directly. An overview of those standards as provided at EC (2016b) is provided in the table below:

Table 1: Overview of standards (EC, 2016b)

Category	Name	Introduction	NACE Rev. 2
Chemicals	Chemical substances (REACH; CS)	2007	20
	Pyrotechnic articles (PA)	2010	2051
Conformity ass. and mng systems	New Legislative Framework (NLF) and Eco-Management and Audit Scheme (EMAS)	2010, 2009	All
Cosmetic products	Cosmetics products (CP)	2013	2042
	Toys safety (TS)	2011	324
Energy efficiency	Ecodesign and energy labelling[1] (EL)	2010, 2011	2751
Electric and electronic engineering	Low Voltage (LVD)	2007	26, 27
	Restriction of the use of certain hazardous substances (RoHS)	2013	26, 27
	Electromagnetic compatibility (EMC)	2007	26, 27
Measuring technology	Measuring Instruments (MI)	2006	2651
	Non-automatic weighing instruments (NAWI)	2009	2829, 2651
Mechanical engineering and means of transport	Gas appliances (GAD)	2009	Not found
	Inspection of pesticide application equipment (PEA)	2011	2020
	Machinery (MD)	2009	28
	Rail system: interoperability (RS)	2010	302
	Simple Pressure Vessels (SPVD)	2009	281

From all of available standards, only those were included that were applicable to NACE Rev. 2 sections A, B, or C and that were introduced in years 2005-2013 so that there would be at least one period before and one period after treatment.

The dependant variable is Total Factor Productivity and the calculation is based on Goedhuys and Srholec (2015). For each company in each year there is calculated:

$$TFP_{it} = \left(\ln Y_{it} - \overline{\ln Y}\right) - \left(\sum_{m} \frac{1}{2}(\omega_{itm} + \overline{\omega_m})\left(\ln I_{itm} - \overline{\ln I_m}\right)\right) \quad (1)$$

where *i* is the number of the company, *t* is time, *m* is input, *Y* is value added, *ω* is the cost share of input, *I* is input and above-lined are means of the overall sample.

This indicator is resistant to outsourcing (as it accounts only for added value, the company cannot change it by outsourcing its production), and to substitution of labour by capital and vice-versa (which is not taken into account in the labour productivity indicator). Data on depreciation are taken

[1] At Ecodesign and energy labelling is also other repealed legislation in years of interest, but the articles considers only Base one because of the increased number of documents.

from real amounts, not from the estimate as originally proposed in Goedhuys and Srholec (2015). Outliers of TFP (1 percentile of largest and 1 percentile of smallest values of overall sample) are excluded.

The regression model is as follows:

$$TFP_{it} = \alpha + \beta_1 Labour_{it} + \beta_2 Capital_{it} + \beta_3 GDP_{it} + \beta_5 Treatment_{it} + \delta_i + \rho_t + \varepsilon_{it} \quad (2)$$

where *Labour* is the number of employees in the logarithm, *Capital* are denominated fixed assets in the logarithm, *GDP* is the country GDP in Euro per inhabitant denominated in the logarithm, *Treatment* is the treatment effect describing whether the particular company belongs to treatment group and is the time after treatment was introduced, δ and ρ are fixed effects (fe) and ε is error term.

The treatment effect is then described as:

$$Treatment_{it} \begin{cases} 0 \; if \; i \; \epsilon \; Control \; group \\ 0 \; if \; t < Time \; of \; treatment \\ 1 \; otherwise \end{cases} \quad (3)$$

Inclusion of other variables than fixed effects and Treatment is motivated by the need for checking for other effects that are time varying and not the same over all companies (time invariant effects and effects affecting all companies the same are accounted for by fixed effects) as described above. Labour and Capital are the basic variables already discussed e.g. in Solow (1956) and generally used by research papers. These two also account for the size of the company that may be changing over time. Other variable (GDP) represents a cycle of the particular economy and the chance of the company participating in RD activities respectively (because GDP is correlated at 87 % with RD expenditures). There may be more control variables included, but most of those are time-invariant (e.g. political framework, culture, education, etc.), so they are already included in company fixed effects. For robustness results, logarithms of activity (turnover/assets), liquidity (current assets / current liabilities) and leverage (shareholder's funds / assets) ratios are also used.

Variables expressed in logarithms are obtained through neglog transformation (Whittaker et al., 2005) so that negative and zero values are taken into account as well. Zero values are replaced by 10^{-15}.

3 Results

The results were obtained in three phases. Firstly, a model with one treatment variable aggregating all occurred changes was estimated. Secondly, there is separate variable for each standard in the model. And lastly, there is estimated one model per standard.

First models have only one treatment variable of interest and that is aggregation of standards. Basic question it answers is whether there has been any change in productivity of companies influenced by any harmonised standard. Due to overlaps of general standards (such as cosmetic products, low voltage, etc.) with the others, only those standards are included that are so specific that they have been tracked down to a 3 or 4 digit NACE code (see Table 1). The treatment variable is dummy standing 1 if at least one NACE industry has been harmonised (in which a company operates) and 0 if otherwise.

Table 3 shows results from the first set of estimates. Model (1) includes only the treatment variable. Model (2) incorporates control variables from the Solow model and GDP to control for the business cycle and model (3) also variables from financial analysis (without profitability). Model (4) adds linear trends to each industry group (2 digit NACE) to control for a possible common trend. Model (5) uses turnover instead of added value in total factor productivity and models (6) and (7) uses one-factor productivity (capital and labour respectively) as a dependant variable. Model (8) uses industry group (2 digit NACE) clustering.

Table 2: Legislation change 3 & 4 digit NACE

VARIABLES	(1) TFP Added Value	(2) TFP Added Value	(3) TFP Added Value	(4) TFP Added Value	(5) TFP Turnover	(6) Productivity Capital	(7) Productivity Labor	(8) TFP Added Value
Legchange	0.0213***	0.0193***	0.00616	-0.000370	-0.0155***	0.123**	-0.795***	0.0188
	(0.00644)	(0.00643)	(0.00633)	(0.00720)	(0.00391)	(0.0595)	(0.144)	(0.0152)
Labour		-0.0360***	-0.204***	-0.207***	-0.222***	0.544***	-2.149***	-0.0363*
		(0.00415)	(0.00376)	(0.00377)	(0.00213)	(0.0190)	(0.0517)	(0.0199)
Capital		0.0242***	0.107***	0.106***	-0.0195***	-1.402***	0.122***	0.0244***
		(0.00199)	(0.00209)	(0.00210)	(0.000903)	(0.0271)	(0.0219)	(0.00558)
GDP		0.501***	0.486***	0.485***	0.368***	0.371***	2.227***	0.500***
		(0.0107)	(0.0102)	(0.0103)	(0.00615)	(0.0871)	(0.162)	(0.0348)
Activity			1.174***	1.166***				
			(0.00836)	(0.00845)				
Liquidity			0.0251***	0.0251***				
			(0.00342)	(0.00342)				
Leverage			1.499***	1.498***				
			(0.0159)	(0.0159)				
Constant	-1.193***	-6.166***	-7.421***	-7.432***	-3.938***	3.134***	-10.12***	-6.155***
	(0.00206)	(0.106)	(0.101)	(0.102)	(0.0597)	(0.837)	(1.573)	(0.367)
Observations	2,143,846	2,143,846	2,083,466	2,072,263	2,962,080	3,175,868	3,159,238	2,132,642
(out of that treatm.)	*51,601*	*51,601*	*47,641*	*47,332*	*67,112*	*74,039*	*73,341*	*51,292*
R-squared	0.011	0.013	0.125	0.127	0.067	0.015	0.018	0.013

Number of company	481,024	481,024	472,111	469,723	638,587	666,263	672,553	478,636
Company FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry trends	NO	NO	NO	YES	NO	NO	NO	NO
Cluster	Company	Company	Company	Company	Company	Company	Company	Industry
Outliers	NO	NO	NO	NO	NO	NO	NO	NO

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1., *Legchange* is the dummy treatment variable, *Labour* is the logarithm of the number of employees, *Capital* is the logarithm of fixed assets, *GDP* is the logarithm of the country's GDP, *Activity*, *Liquidity* and *Leverage* are logarithms of financial analysis ratios. All data are denominated at 2010 prices.

The first table asses only 3 and 4 digit NACE industry standardization changes, therefore very specific changes. The treatment is 1 if at least one "partial" treatment is taking place for a particular firm and year. It can be seen that the effect is decreasing after including more control variables – as it is significant and positive for additional control variables (model 1 and 2), though after including financial analysis variables (model 3) and linear industry trends (model 4), it becomes insignificant. It is interesting to try to look at (5) where TFP is counted from Turnover, not Added Value, as harmonisation has a negative effect on this as well as on productivity of labour (7). If one can assume that TFP consists of labour and capital productivity, it can be deduced that the overall effect on TFP is consisting of a negative effect on labour productivity and a positive effect on capital productivity.

The partial conclusion suggests that harmonisation did not robustly influence the productivity of companies, or at least that the insignificance can be rejected at least in some specification, but not overall.

The second set of models includes standards individually. An advantage to the previous model is that it allows inclusion of all standards (not only those very narrow ones), it allows accounting for different effects of each piece of legislation (there is no assumption of the same effect as in the previous model) and it does not forbid a company to being influenced by only one harmonisation.

Table 3: Individual standards

VARIABLES	(1) TFP Added Value	(2) TFP Added Value	(3) TFP Added Value	(4) TFP Added Value	(5) TFP Turnover	(6) Productivity Capital	(7) Productivity Labor	(8) TFP Added Value
CS	0.0395***	0.0418***	0.00788	0.00271	0.0518***	0.156**	0.933***	0.0418***
	(0.00706)	(0.00706)	(0.00688)	(0.0158)	(0.00472)	(0.0707)	(0.206)	(0.0139)
PA	-0.0519	-0.0574	-0.0540	-0.0571	0.0275	0.264	-2.276*	-0.0571
	(0.0528)	(0.0527)	(0.0433)	(0.0445)	(0.0264)	(0.632)	(1.177)	(0.0394)
CP	0.113***	0.115***	0.0804**	0.0805**	0.0212	0.694**	0.0534	0.118***
	(0.0331)	(0.0331)	(0.0318)	(0.0339)	(0.0136)	(0.322)	(0.437)	(0.0374)
TS	-0.0868*	-0.0902*	-0.102**	-0.103**	-0.0977***	-0.383	-2.388***	-0.0925***
	(0.0499)	(0.0499)	(0.0500)	(0.0509)	(0.0266)	(0.310)	(0.838)	(0.0161)
EL1	0.00931	0.00932	-0.0187	-0.0327	0.00572	-0.0620	-0.453	0.0106
	(0.0311)	(0.0311)	(0.0305)	(0.0312)	(0.0173)	(0.246)	(0.619)	(0.0165)
EL2	-0.0291	-0.0305	-0.0192	0.000759	-0.0354**	-0.472*	-0.920	-0.0291
	(0.0364)	(0.0364)	(0.0350)	(0.0361)	(0.0170)	(0.266)	(0.574)	(0.0217)
LV	0.0327***	0.0289***	0.0149***	0.00262	0.00865**	0.0608	0.281**	0.0287**
	(0.00570)	(0.00566)	(0.00560)	(0.0136)	(0.00397)	(0.0648)	(0.142)	(0.0135)
RHS	-0.0108	-0.00872	-0.00575	-0.0204	-0.0357***	0.0424	-0.765***	-0.00927
	(0.00920)	(0.00920)	(0.00879)	(0.0249)	(0.00398)	(0.0807)	(0.123)	(0.0155)
EMC	-	-	-	-	-	-	-	-
MI	0.0168	0.0210	0.0284*	0.0185	0.0340***	0.842***	2.220***	0.0178*
	(0.0151)	(0.0151)	(0.0157)	(0.0180)	(0.0105)	(0.201)	(0.455)	(0.0105)
NAWI	0.0264***	0.0264***	0.0126	0.00932	0.0202***	0.00514	0.00794	0.0258*
	(0.00878)	(0.00876)	(0.00886)	(0.00943)	(0.00558)	(0.104)	(0.207)	(0.0142)
PEA	0.0428	0.0440	-0.0195	0.000582	0.00409	0.170	-1.177	0.0452**
	(0.0822)	(0.0822)	(0.0837)	(0.0851)	(0.0294)	(0.457)	(1.228)	(0.0174)
MD	0.00181	-0.00214	0.00312	-0.00577	-0.0507***	-0.0167	-1.473***	-0.00194
	(0.00508)	(0.00508)	(0.00501)	(0.0131)	(0.00331)	(0.0531)	(0.118)	(0.0170)
RS	0.0105	-0.0141	-0.0119	0.00909	-0.0362	-0.198	-1.638*	-0.0138
	(0.0395)	(0.0393)	(0.0415)	(0.0453)	(0.0328)	(0.345)	(0.957)	(0.0221)
SPVD	0.0308***	0.0313***	0.00476	0.00505	0.0382***	0.192*	0.536**	0.0308***
	(0.0108)	(0.0108)	(0.0108)	(0.0109)	(0.00714)	(0.103)	(0.271)	(0.00285)
Labour		-0.0363***	-0.205***	-0.207***	-0.222***	0.543***	-2.148***	-0.0365*
		(0.00415)	(0.00376)	(0.00377)	(0.00213)	(0.0190)	(0.0517)	(0.0198)
Capital		0.0242***	0.107***	0.106***	-0.0194***	-1.402***	0.124***	0.0243***
		(0.00199)	(0.00209)	(0.00210)	(0.000903)	(0.0271)	(0.0219)	(0.00557)
GDP		0.501***	0.485***	0.485***	0.369***	0.373***	2.264***	0.500***
		(0.0108)	(0.0102)	(0.0103)	(0.00615)	(0.0871)	(0.162)	(0.0348)
Activity			1.174***	1.166***				
			(0.00836)	(0.00845)				
Liquidity			0.0251***	0.0251***				
			(0.00342)	(0.00342)				
Leverage			1.499***	1.498***				
			(0.0159)	(0.0159)				
Constant	-1.193***	-6.162***	-7.419***	-7.431***	-3.950***	3.116***	-10.49***	-6.151***
	(0.00206)	(0.106)	(0.101)	(0.102)	(0.0597)	(0.837)	(1.576)	(0.366)
Observations	2,143,846	2,143,846	2,083,466	2,072,263	2,962,080	3,175,868	3,159,238	2,132,642
R-squared	0.011	0.013	0.125	0.127	0.068	0.015	0.018	0.013
Number of company	481,024	481,024	472,111	469,723	638,587	666,263	672,553	478,636
Company FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry trends	NO	NO	NO	YES	NO	NO	NO	NO
Cluster	Company	Company	Company	Company	Company	Company	Company	Industry
Outliers	NO	NO	NO	NO	NO	NO	NO	NO

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1., *CS*, *PA* etc. are abbreviations of standards, *Labour* is the logarithm of the number of employees, *Capital* is the logarithm of fixed assets, *GDP* is

the logarithm of the country's GDP, *Activity*, *Liquidity* and *Leverage* are logarithms of financial analysis ratios. All data are denominated at 2010 prices.

Interpretation of results from the second set is easier as it is better to understand individual harmonisation than some abstract overall legislative changes. First of all, it can be seen that five (PA, EL and its second amendment, RS and PEA) out of fifteen standards are insignificant (with minor exemptions at the significant negative effect at productivity of labour or capital or TFP with turnover), so that there is only a slight chance that any of those made significant change in productivity of companies. Secondly, some provide robust evidence of their positive importance on productivity – those are Chemical substances (CS) and Simple Pressure Vessels (SPVD) both which are insignificant only after including financial analysis variables and industry trends, Cosmetic products (CP; with exemption at (5) and (7)), Low voltage (LV) and Electromagnetic compatibility (EMC that has been omitted because of colinearity with LV) which are insignificant only when explaining capital productivity or including trends. Also, one standard provides a robust significant negative relation (Toys safety – TS).

The interpretation of the rest is much less straightforward. Standards for Measuring instruments (MI) and Non-automatic weighting instruments (NAWI) are rather positive as they provide positive and non-significant estimates, and Restriction of the use of certain hazardous substances (RoHS) and Machinery (MD) are rather negative.

It can be seen that wide standards (applicable to the whole 2 digit NACE groups) have more robustly significant results than narrower standards. This complies with the first set of models that did not provide robust evidence as they focused only on narrow standards.

The third set of models is similar to the previous one, but incorporates each standard into a separated regression model, and chooses a sample deliberately, not as all other companies, but as "similar" companies close to the treatment group from the point of view of its industry classification. The rule is that the companies in these models are from the superior NACE group, e.g. the standard that applies to 3 digit NACE 202 is controlled by all the other companies in 2 digit NACE 20.

Table 4: Standards at separate models

VARIABLES	(1) TFP Added Value CS	(2) TFP Added Value PA	(3) TFP Added Value CP	(4) TFP Added Value TS	(5) TFP Added Value EL1	(6) TFP Added Value EL2	(7) TFP Added Value LV	(8) TFP Added Value RHS	(9) TFP Added Value EMC	(10) TFP Added Value MI	(11) TFP Added Value NAWI	(12) TFP Added Value PEA	(13) TFP Added Value MD	(14) TFP Added Value RS	(15) TFP Added Value SPVD
Standard	0.0433***	-0.127**	0.0941*	-0.111**	-0.0378	-0.0466	0.0333***	-0.00762	0.0333***	0.397**	-0.00659	0.0136	0.0283***	0.0387	0.0271**
	(0.00712)	(0.0545)	(0.0561)	(0.0509)	(0.0510)	(0.0615)	(0.00564)	(0.00945)	(0.00564)	(0.165)	(0.0140)	(0.0822)	(0.00467)	(0.0442)	(0.0107)
Labor	0.00957	-0.0116	0.0140	-0.0401*	-0.0753	-0.0755	0.00953	0.00967	0.00953	-0.0293	-0.0266	0.0253	0.00933	0.105***	0.00483
	(0.00610)	(0.0528)	(0.0585)	(0.0239)	(0.0674)	(0.0674)	(0.00610)	(0.00610)	(0.00610)	(0.0614)	(0.0227)	(0.0245)	(0.00610)	(0.0394)	(0.0150)
Capital	0.0107***	0.00950	0.0256	0.0142	0.0508	0.0510	0.0107***	0.0107***	0.0107***	-0.0159	0.0353***	0.00255	0.0106***	0.0514**	0.00933
	(0.00267)	(0.0215)	(0.0251)	(0.0103)	(0.0356)	(0.0356)	(0.00267)	(0.00267)	(0.00267)	(0.0145)	(0.0101)	(0.0110)	(0.00267)	(0.0207)	(0.00582)
GDP	0.495***	0.370***	0.538***	0.474***	0.385***	0.386***	0.494***	0.494***	0.494***	0.527***	0.544***	0.372***	0.494***	0.476***	0.494***
	(0.0148)	(0.0927)	(0.128)	(0.0474)	(0.119)	(0.119)	(0.0148)	(0.0148)	(0.0148)	(0.0800)	(0.0630)	(0.0471)	(0.0148)	(0.105)	(0.0340)
Constant	-5.971***	-4.515***	-6.558***	-5.846***	-4.794***	-4.807***	-5.960***	-5.967***	-5.960***	-5.697***	-6.362***	-4.643***	-5.962***	-6.378***	-5.791***
	(0.146)	(0.966)	(1.304)	(0.465)	(1.195)	(1.193)	(0.146)	(0.146)	(0.146)	(0.789)	(0.639)	(0.470)	(0.146)	(1.025)	(0.343)
Observations	1,044,710	18,044	14,640	74,794	6,845	6,845	1,044,710	1,044,710	1,044,710	17,332	71,022	71,186	1,044,710	20,025	182,628
(out of that treatm.)	*52,700*	*435*	*730*	*1,097*	*2,167*	*1,598*	*103,173*	*12,569*	*103,173*	*14,452*	*16,741*	*380*	*98,537*	*846*	*15,378*
R-squared	0.018	0.007	0.010	0.013	0.021	0.021	0.018	0.018	0.018	0.016	0.015	0.009	0.018	0.021	0.016
Number of company	222,713	3,538	3,108	17,020	1,380	1,380	222,713	222,713	222,713	3,659	14,744	14,139	222,713	4,670	36,951
Company FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry trends	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cluster	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company	Company
Outliers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sample (NACE)	2	205	204	32	275	275	2	2	2	265	282	20	2	30	28

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1., *Standard* is the dummy treatment variable for each individual standard (each column employs a different standard), *Labour* is the logarithm of the number of employees, *Capital* is the logarithm of fixed assets, *GDP* is the logarithm of the country's GDP. All data are denominated at 2010 prices.

CS, CP, LV, EMC and SPVD provides similar positive relation as in the previous table. A positive relation is also established at MI and MD – at MI it confirms a "rather positive" relation from the previous table. A negative relation is confirmed at TS and obtained also at PA that has been insignificant. EL, RoHS, NAWI, PEA and RS are insignificant, though RoHS and NAWI provide rather positive and negative results in the previous table.

Conclusions

This article engages in exploring the effect of a standard's harmonisation on productivity of companies. It complements existing literature by ex post analysis, focusing on microeconomic data and using Difference in Differences research design with panel data that is able to account for several potential biases observed with other designs.

In general, the article finds out that changing the legal environment of heterogeneous standards into more homogeneous was beneficial, but the final effect depends on individual standards. It cannot be said that productivity overall was enhanced or that the effect was null.

While observing individual standards, out of fifteen identified and linked with a particular industry, Chemical substances, Cosmetic products, Low voltage, Electromagnetic compatibility and Simple pressure vessels provide a significant, robust and positive link between their introduction and productivity. It is important to note that three of these five are very wide (linked to 2 digit NACE). Machinery and Measuring instruments are also positive and significant, but results are not so robust. On the other hand, Toys safety provides a robust significant negative relationship with productivity.

Some of the standards do not reveal any significant relation with productivity, thus it can be concluded that the effect was negligible – this is true for Ecodesign and energy labelling, Inspection of pesticide application equipment and the Rail system.

The rest of harmonised standards (Non-automatic weighting instruments, Restriction of the use of certain hazardous and Pyrotechnic articles) do not provide any conclusive evidence as the results are not robust enough to be able to make any claim about the relations.

It is important to state that though the article focuses on providing evidence of a causal claim; the obtained relations are in the most cautious way mere correlations. Though several elements of the research design – such as microdata, panel data structure, Diff-in-Diff research design, control variables and so on – are established in order to rule out problematic issues such as cofounding elements, endogeneity effects etc. and to provide the best evidence up-to-date, it is not possible to

make causal claims without additional examination of the results. The further research can address several causality issues in order to provide evidence that would be closer to natural experiment evidence.

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