An analysis of the determinants of labour productivity in financial sectors in the context of intellectual property rights*

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This paper is intended to assist in clarifying the role of Intellectual Property Rights (IPRs) by providing an empirical analysis of knowledge-intensive financial sectors that have received somewhat less attention in research and policy debates so far. The purpose of the study was to estimate the performance of these financial sectors primarily in the context of labour productivity (output per capita) and intellectual property rights between 1990 and 2010. The first objective of the research was to gain an insight into how and to what extent physical and human capital accumulation and changes in total factor productivity (TFP) affected the growth rate of output per capita at the sector level. A growth accounting approach was applied to conduct calculations for a sample of fourteen OECD countries. The results, on the one hand, point to an increased contribution of auxiliary financial and insurance services to the aggregate performance of the financial sectors. On the other hand, the methodology applied revealed that technological progress in the broad sense (TFP) contributed the most to changes in productivity growth across the financial sectors. At the same time, the secondary objective of the study was to explore the determinants of productivity from the perspective of institutional economics, in the context of which a dynamic panel regression model was applied to determine the impact of intellectual property rights (such as trademarks and patents) on productivity growth. It was found that in long run trademarks tended to correlate negatively with productivity in the financial sectors in the model specifications. The conclusions support the view that the existing intellectual property rights systems are in need of reform in the financial sector.

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1. Introduction

The biggest breakthrough in modern economic history was the period of the industrial revolution in England, which ushered in relatively rapid and sustainable economic growth across the world. The fact that this growth has persisted to date is perhaps one of the most puzzling mysteries of economics. In exploring one of the primary sources of economic development and examining the effects of social norms, culture and beliefs, A. Smith was among the first to advocate the protection of intellectual property as a means to facilitate trade and innovation (*Smith 1759*). Similarly, J. S. Mill held the view that patent monopolies were justified (*Mill 1862*). *Coase* (*1960*) proposed a possible explanation in the one-off production (transaction) cost of inventions, in the absence of which it would not be possible to harness innovation (R&D) processes for the efficient allocation of capital. According to *Jones* (*2002:86*), intellectual property rights benefited inventors by preventing the unrestricted copying of inventions. Thus initially, in an adequately regulated environment, patents, trademarks and other copyrights stimulated the birth of new ideas and inventions.

In the empirical research of the 1950s, Solow's theories ignited interest in technological progress (*Solow 1956*). However, total factor productivity (TFP) – an essential component of economic growth formally deduced by Solow – was to be dismissed for a long time to come as an unexplainable "residual" that exclude the effects of capital accumulation. While in the classical sense, technological progress may appear to be a rather "obscure" process, *Jones* (*2002:36*) held that technological progress should be viewed as a Harrod-neutral – labour augmenting – phenomenon, consistent with employees' acquired and accumulated knowledge over time. Moreover, technology is defined by *Caselli* (*1999*) as a combination of machines and equipment of a certain type and workers who have the skills necessary to use them, and technological progress, in turn, means their continuous improvement. In this context, TFP may also include complex factors that cannot be classified into the "traditional" (capital) factors that determine production, either stemming from improving technological quality, economies of scale or management skills, or bearing on the external effects of production – such as innovation, market competition, regulation, etc.[1]

However, there is no consensus in the literature in respect of the channels through which technological progress exerts its impact mechanisms. The latest trends of growth theory attribute a special role to the phenomenon known as "creative destruction" as a basis for innovation, and to "learning by doing" as a possible determinant of the characteristics of economic growth (*Aghion–Howitt 1992*). Others argue that the benefits of new technologies stem primarily from the

[1] I would like to offer my special thanks to one of the anonymous reviewers for this addendum.

adaptation of existing ones rather than from narrowly interpreted technological progress, including innovation (*Losoncz 2008*).

The impact of technological progress (TFP) on output can also be examined from the aspect of institutional economics. The traditional determinants of the institutional perspective conceived by North distinguished between formal rules and informal constraints, which could influence economic, social and political interactions in market operations. In this context, intellectual property rights – which had gone through an extremely slow and incremental evolution over time – may contribute to economic welfare and a higher level of productivity (*Taylor 1994*). According to *Gould and Gruben* (*1996*), IPRs have a positive impact on growth, which is stronger in more open economies. Clarity is obscured even further by the scepticism toward intellectual property rights; as *Machlup* (*1958*) aptly put it, however, patent systems have been existed for a long time, it would be irresponsible to recommend abolishing it. *Boldrin and Levine* (*2002*) went even further by suggesting that market mechanisms would be more efficient in allocating resources than the patent system. The elimination of intellectual monopolies may reduce transaction costs without hindering technological progress.

Despite the abundance of negative criticism, the patent protection of innovations had been reinforced significantly by the end of the 20th century; however, in the new era of the internet and increased legal costs, the problems have become increasingly evident and quite complex. It has become obvious that in their existing form, patent systems will be less and less capable of meeting the requirements of certain sectors, such as IT, bio-technology, etc. (*Szűcs 2015*). In addition, the findings of empirical studies typically suggest that the existence of patent protection is not necessarily indispensable (*Boldrin–Levine 2009*). Moreover, a significant part of the analyses devoted to intellectual property rights yielded fairly different conclusions when IPRs were examined at the sector level. Intellectual property rights tend to fulfil their role more efficiently in certain sectors (e.g. the pharmaceutical and chemical sectors, etc.) (*Cohen et al. 2000*), and the willingness to patent may vary widely across sectors. The authors attributed this to the complex process of innovations, which are less subject to public and thus can be kept secret more readily than, for example, specific product innovations or innovations related to the accumulation of special financial portfolios. In addition, compared to patenting in other sectors, patent protection in the financial sector is also different in that financial products can be copied relatively easily. Lerner (2008) demonstrated that the number of lawsuits involving intellectual property rights is 30-40 times higher than where no such infringements are involved.

This brief study presents a cross-section analysis of various OECD countries focusing on a segment of the services sector (namely, the financial sector), which has been somewhat neglected so far in the empirical literature due to a lack of sufficient data. The first objective of the study was to gain an insight into how and to what extent physical and human capital accumulation and changes in total factor productivity (TFP) affected the growth rate of output per capita at the sector level. In search of more in-depth explanations, dynamic panel regression models were applied for the period between 1990 and 2010 to test the impact of intellectual property rights (trademarks and patents) on changes in productivity over the long run. In the following sub-chapters, we first present the data available and the applied methods. Finally, we attempt to draw a number of brief conclusions from the results of the analyses, which will hopefully contribute to clarifying the empirical and policy debates on the role of intellectual property rights.

2. A brief note on the data used for the analyses

Financed from European Union resources, a unique, publicly available database has been set up under the KLEMS Project. This project makes it possible to examine, among other factors, economic growth, employment and capital expenditure in around 56 industries. Thanks to the latest update, data for numerous OECD countries are now available until 2011. Individual financial sectors were classified on the basis of the international standard ISIC (Indicators of Activities for Industry and Services) Rev. 3 (*EU 2015*). Besides financial service activities[2] (D64) and insurance, reinsurance and pension funding (D65), this database also distinguishes between activities auxiliary to financial service and insurance activities, such as investment consulting or real estate and portfolio management services (D66).

In order to measure intellectual property rights, further variables are needed. The empirical literature has a long tradition of employing composite indices. *Park* (*2008*), for example, proposed a so-called "GP index", which was used to measure, among other things, the protection of patents and their validity period. The Economic Freedom Index, constructed by the Fraser Institute, has been frequently used as a proxy to measure the enforcement of intellectual property rights (*Gwartney et al. 2000*). Subjectivity is often cited as a legitimate criticism against such indices; therefore, in order to ensure more robustness in our models, for the purposes of this research, data from independent institutions were used, such as the number of applications in a given year. From the statistics database (*WIPO 2015*) of the World Intellectual Property Organisation (WIPO), we first tested trademark data. The Dow Jones, FTSE, and the NASDAQ indices or other intellectual property rights covering S&P-managed portfolios are perhaps among the most widely recognised trademarks, logos, etc. in the financial sectors. Trademarks related to insurance, financial and monetary affairs were derived from Class 36 (*WIPO 2015*), based on the international (NCL) standard under the Nice Agreement (*WIPO 2011*). In addition, for the purposes of our calculations we used the number of patents registered in knowledge-intensive sectors as control variables, relying on (*EUROSTAT*

[2] Division 64 includes various transactions and activities related to traditional lending, deposit collection, etc.

2015) data provided by the European Patent Office (EPO). In the sector of financial services, financial intermediaries (insurance firms, investment funds, etc.) typically seek patent protection for the procedures and methods developed for building investment portfolios, calculating pension benefits, etc.

3. Output, employment and investment in the financial sectors

Before testing the methodologies, a number of descriptive statistics should be examined. *Table 1* provides a comparison of the changes in the sectoral structure of output, employment and investment, based on the averages of the OECD countries under review. Average annual changes in output indicate that output increased by around 2.5 per cent in the period between 1990 and 2010. Growth, however, was more impressive (nearly 7.6 per cent) in industries engaged in activities auxiliary to financial service and insurance activities (D66). Moreover, the sectoral distribution ratios reveal that the contribution of sectors providing traditional financial services (D64) to total output remains unquestionable, despite a decline in the sectoral distribution ratio from 66 per cent to 60 per cent. At the same time, owing to structural changes in output, D66 accounted for an increasingly large share in output (rising to 16 per cent from 8 per cent) in the period examined.

Globalisation changes in employment in recent decades triggered redistribution in nearly every country in the world. *Dachs et al*. (*2003*) essentially attribute this process to the continuously increasing income elasticity of demand for services. Knowledge-intensive financial services show a clear regional concentration of employment in cities (Frankfurt, London, New York, etc.) and countries (United States, United Kingdom, Germany) serving as main financial centres with major stock exchanges (*Schricke et al. 2012*). Based on employment data available in the KLEMS database, the average annual growth rate of employment (0.5 per cent) appears to be fairly moderate in some financial sectors. This, however, merely reflects a shift in employment from D64 and D65 to D66, i.e. the sectors providing auxiliary services, which recorded a significant rise (1.36 per cent) in employment. The growing weight of the sector in the years between 1995 and 2010 is also demonstrated by the increase recorded in labour market penetration (from 16 per cent to 20 per cent) at the expense of the other industries.

Moreover, our analysis of investment activity found that the acceleration observed in D65 and D66 (5 per cent and 8 per cent, respectively) was higher than the average OECD growth rate (3 per cent). Although the combined weight of the two sectors gained increasing significance compared to D64, most of the investment projects (62 per cent) were implemented in the traditional financial sectors.

Data provide clear evidence of an *improvement in the aggregate performance – i.e. economic growth, employment and investment activity – of the financial sectors in the OECD countries under review in the examined period.* Furthermore, descriptive statistics point to *an increasing need for auxiliary financial services, i.e. financial services more geared toward personal interaction.*

Table 1.
Average rates of changes in output, employment and investment and structural developments (%) in the financial sectors vs. OECD averages

Years/Sectors	Total	Financial service activities	Insurance, reinsurance and pension funding	Activities auxiliary to financial service and insurance activities
Output growth (%)				
1990/2010	2.54%	1.83%	1.53%	7.61%
Output distribution (%)				
1995	100%	66.10%	25.54%	8.36%
2000	100%	59.41%	26.73%	13.86%
2005	100%	60.45%	23.82%	15.73%
2010	100%	60.72%	22.52%	16.76%
Average employment growth (%)				
1990/2010	0.50%	–0.15%	–0.06%	1.36%
(%) of total employment				
1995	100%	50.82%	32.30%	16.88%
2000	100%	49.73%	31.83%	18.44%
2005	100%	50.85%	30.77%	18.38%
2010	100%	48.52%	31.32%	20.15%
Average GFCF growth (%)				
1990/2010	3.07%	1.95%	5.56%	8.42%
(%) of total investment*				
1995	100%	74.92%	15.68%	9.39%
2000	100%	64.13%	16.95%	18.92%
2005	100%	68.10%	17.66%	14.24%
2010	100%	62.29%	24.40%	13.31%

Source: own calculations and edited from the EU (2015) KLEMS database
*Note: * for the calculation of the investment-to-output ratio, sectoral GFCF was divided by GVA in the financial sectors.*

4. Performance of the financial sectors according to the growth accounting approach

Naturally, numerous methods can be used to describe the evolution of output, productivity and their determinants. In respect of methodology, our first choice was to apply the technique of growth accounting, which allows for the decomposition of output growth into such components as the accumulation of physical and human capital or technological progress (often referred to as total factor productivity or TFP), the effects of which can be thereby estimated directly (*Jorgenson–Griliches 1967*).

The KLEMS dataset is suitable for testing the methodology in practical terms. The decomposition of growth from a growth accounting perspective requires, on the one hand, the time series of output, which – for the sake of consistency across sectors – is generally measured as real gross value added (GVA) expressed in constant (2005) prices (*cf. Jorgenson et al. 1987, van Ark et al. 2003, etc*.). By definition, gross value added equals GDP adjusted for taxes and subsidies (*Koszerek et al. 2007*). On the other hand, besides the number of employees in individual financial sectors, we also used investment data for the purposes of our research. Investment was calculated for the different financial sectors using the value of gross fixed capital formation[3] (GFCF) measured in real terms. This allowed us to explore the performance of 14 OECD[4] countries in the period 1990–2010.

The methodology can be best explained using a neo-classical Cobb-Douglas production function as a starting point (*Equation 1*).

$$Y_t = A_t K_t^{\alpha} L_t^{(1-\alpha)} \qquad (1)$$

where *Y* means output, replaced for the purposes of our analyses by gross value added (GVA). *K* stands for physical capital stock, represented by real, gross capital formation expressed in constant prices as at 2005. *L* is human capital, capturing the actual number of employees in the financial sectors. For the production process, we used the assumption of constant returns to scale in proportion of the capital and the human factor. While in the real sector the generally accepted value for α is 1/3, this ratio is highly questionable in the financial sectors. With that in mind, in our calculations the proportions of production factors were indexed, for each

[3] As defined by OECD (2015a), GFCF is measured by the total value of a producers' acquisitions, less disposals of fixed assets during the accounting period plus certain additions to the value of non-produced assets, such as improvements in the quality of productivity, research, etc.

[4] For the purposes of this study the following abbreviations are used: Hungary (HUN), Austria (AUT), Belgium (BEL), Czech Republic (CZE), Denmark (DEN), Finland (FIN), France (FRA), the Netherlands (NED), Germany (GER), Italy (ITA), Norway (NOR), Sweden (SWE), Slovenia (SLO) and United States (USA).

country and each financial sector, on the basis of the *OECD* (*2015b*) database in accordance with each year under review.

A denotes TFP at the appropriate time t^t. By rearranging *Equation 1*, we are able to estimate the previously mentioned, “unexplainable” component of output growth known as the Solow residual. This residual is often attributed to institutional effects in the literature, but in our case, it may well be associated with intellectual property rights.

The change in TFP was derived from *Equation 2.*

$$\frac{\dot{A}}{A}=\frac{\dot{Y}}{Y}-\alpha\frac{\dot{K}}{K}-\left(1-\alpha\right)\frac{\dot{L}}{L} \tag{2}$$

In accordance with the methodology, by taking the log (3) and the differential (4) of both sides of *Equation 1*, we receive the discrete-time approximation of the equation.

$$\ln Y_t=\ln A_t+\alpha\ln K_t+\left(1-\alpha\right)\ln L_t \tag{3}$$

$$\ln Y_t-\ln Y_{t-1}=\left(\ln A_t-\ln A_{t-1}\right)+\left(\alpha\ln K_t-\alpha\ln K_{t-1}\right)+\left(\left(1-\alpha\right)\ln L_t-\left(1-\alpha\right)\ln L_{t-1}\right) \tag{4}$$

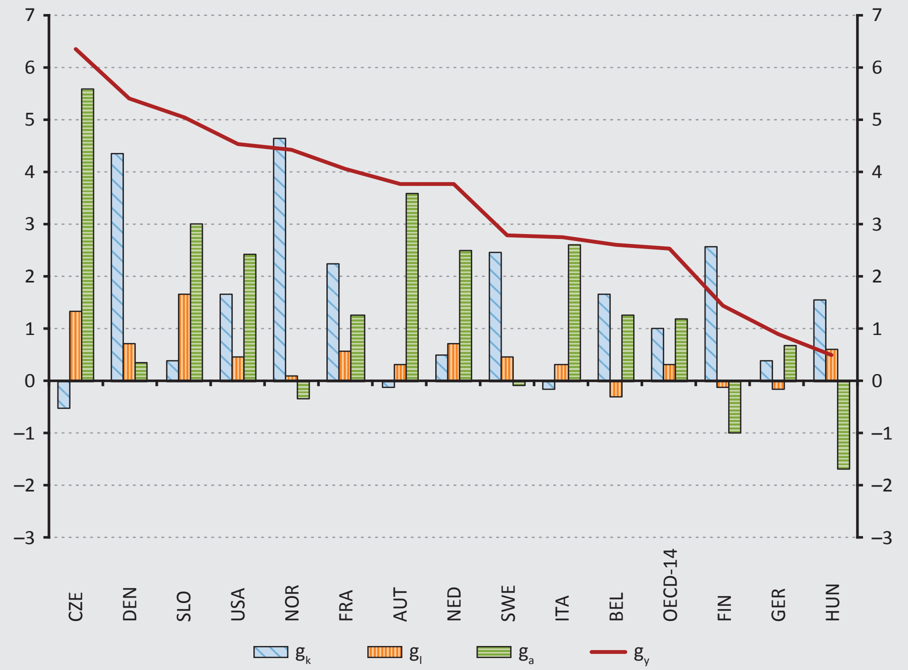
For the sake of simplicity and in line with the differences, we indicate the changes in average output g_y, total factor productivity g_a, physical capital g_k and human capital g_l compared to the previous period.

$$g_y=g_a+\alpha g_k+\left(1-\alpha\right)g_l \tag{5}$$

With the growth accounting method applied, we can now quantify the *percentage points* by which physical (g_k) and human capital stock (g_l), as well as TFP (g_a) contributed to average changes in output (g_y) in the financial sectors. Based on data obtained from the *EU* (*2015*) *KLEMS and OECD* (*2015b*) databases, *Figure 1* presents the average changes in each component in the period 1990–2010.

Modern economic growth is a phenomenon clearly distinct in space and time and has been relatively even so far, without showing signs of a deceleration (*Maddison 1995*). Our findings are consistent with this view in demonstrating that *economic growth moved on a relatively stable growth path* in the financial sectors of each country under review. Once we disregard the fluctuations of the business cycles we also find that the primary determinants of output are not related to the accumulation of production factors (capital and human resources). The growth accounting approach confirmed that in the period 1990–2010 *the total factor productivity, i.e. technological progress in the broad sense, contributed the most to average output* in OECD countries. All of this supports the previous findings

Figure 1.
Determinants (in percentages) of average changes in output (g_y) in the financial sectors of the OECD countries under review between 1990 and 2010, based on *Equation 5.*



Source: Own calculations based on the EU (2015) KLEMS and OECD (2015b) databases.

of *Bosworth et al.* (*1995*) *and Klenow and Rodriguez-Claire* (*1997*) derived from researches based on methodologies similar to the one presented above.[5]

Compared to the average output growth of OECD countries (2.5 per cent), Hungary lagged behind, recording the worst performance (0.5 per cent) among the countries under review. In the financial sectors, the contribution of investment (g_k) and employment (g_l) to output growth was 1.5 and 0.6 per cent, respectively (surpassing the respective average OECD growth of 1 per cent and 0.3 per cent). Hungarian output growth, on the other hand, is likely to be the result of unfavourable total factor productivity developments (which reduced output by 1.6 per cent). Due to the deficiencies of the growth accounting method, we cannot offer an explanation for this phenomenon; therefore, in the remaining part of the paper we propose a number of more sophisticated analyses. At this junction, the main goal – not only

[5] We have arrived at similar conclusions in our previous research on machinery manufacturing (*Csugány–Máté 2012*).

for researchers, but also for policy makers – is to identify which institutions may have the most profound impact on the productivity of financial sectors in the long run (either as obstacles or as drivers).

5. Analysis of the long-term effects of intellectual property rights on productivity in the financial sectors

Using the production function presented in *Equation 1*, we describe the effects of intellectual property rights on productivity across the financial sectors on the basis of *Mankiw et al.* (*1992*) for a very long period, known as the steady state (y*). In this horizon, not only the available capital stock, labour force and technology are subject to change, but also institutional factors (intellectual property rights). The economy, in turn, tends to move toward long-term equilibrium in the model specification.

Firstly, we divide both sides of *Equation 1* by [L] to receive *Equation 6* below:

$$y_t = a_t k_t^{\alpha} \quad (6)$$

where *y* is output per capita at time *t*, and *k*=K/L, reflecting the efficiency of the capital factor. Consistent with the neo-classical model, *k* is the difference between the investment ratio s_k and the labour force growth rate *n*, depreciation *δ* and the presumed *g* ratio of long-term technological progress. In line with the original model, for the sake of simplicity the value of the latter two is assumed to be constant at 0.05. We further assume that *a=A/L* and TFP correspond to the effects of institutional factors such as intellectual property rights. After the appropriate substitutions, we take the log of the equation and the differential of the dependent variable.

$$\ln\left(y^*\right)_t = \alpha \ln\left(s_k\right)_t - \alpha \ln\left(n+g+\delta\right)_t + \gamma \ln\left(IPR\right)_t \quad (7)$$

In the next step, the relationship between intellectual property rights and output per capita is tested in dynamic panel regression models to ensure that the contribution of historic data can also be considered in the financial sectors concerned. In an attempt to confirm the endogenous growth theories, we apply the model specification developed by *Arellano and Bond* (*1991*), as it is capable of explaining the dynamic relationship between the steady state and its explanatory variables over the long run. As suggested by the literature on methodology (*Windmeijeir 2005*), a two-step GMM technique was chosen to address the problem of endogeneity in each case. Based on this methodology, the models include lagged values both for the dependent and the exogenous explanatory variables as instruments. In our case, only a lag by one year was permitted for each variable.

Equation 7 can be written in a dynamic regression model specification as follows:

$$\Delta \ln Y_{it} = \beta_0 + \beta_1 \Delta \ln Y_{it-1} + \beta_2 \ln\left(s_k\right)_{it} + \beta_3 \ln\left(n+g+\delta\right)_{it} + \beta_4 \ln\left(patent\right)_{it} + \beta_4 \ln\left(trmark\right)_{it} + e_{it} \quad (8)$$

Note: Δ – variable in first differences, ln – variable in logarithm, $_{t-1}$ – variable lagged by 1 year.

In the equation, the dependent variable (Y_{it}) is the ratio of output per capita of the financial sectors of country *i* for the period *t*. In accordance with the dynamic model specification, the explanatory variables include productivity change lagged by one year. Based on the neo-classical model, investment in physical capital was substituted by the share of gross fixed capital in sectoral output (s_k). Factors ($n+g+\delta$) denote the growth rate of the labour factor (increased by 0.05). In the models, intellectual property rights are represented by the logarithm of the number of trademarks (*trmark*) and patents (*patent*), while ε is the error term. *Table 2*. presents the standard statistics prepared of the variables.

Table 2.
Mean, standard deviation, minimum and maximum values of the variables of Equation 8.

Variables	Mean	SD	Min	Max
Δln(y)	0.02	0.06	–0.24	0.26
ln(sk)	2.08	0.51	0.60	3.94
(n+g+δ)	0.05	0.03	–0.03	0.18
ln(patent)	6.80	2.29	1.09	10.51
ln(trmark)	6.69	1.43	3.88	9.85

Source: own calculations based on the EU (2015) KLEMS and OECD (2015b) databases.
Note: Δln(y): productivity differential, ln(s_k): investment ratio, (n+g+δ): growth of labour factor increased by the constant, ln(patent) and ln(trmark): logarithm of the number of patents and trademarks.

The panel under review represents unbalanced sample sizes encompassing the period 1990–2010, covering 14 countries and 216 and 83 observations, respectively. In the following section, we set out to test the effects of the neo-classical theory (*Model 1 and Model 2*), trademarks (*Model 3*), and patents (*Model 4*), as well as their combined effect, for productivity. After estimation of the equations, we used numerous standard tests to verify the accuracy of the results. In every case, significant Wald tests confirmed the significance of the dynamic model specifications. Autocorrelation between the observations was ruled out by the Arrelano-Bond (AR) tests. Sargan tests were used to test for the presence of over-identifying problems arising from the instrumenting exercise, and the nullhypotheses assuming their presence were rejected. As regards the presence of stationarity, by using Im-Pesaran-Shin (IPS) standard panel unit root tests we ruled out the possibility of variable shocks being permanent in time. The results of the tests are presented in more detail in *Table 3* below.

Table 3.
Results of dynamic panel regression models based on the estimates of Equation 8

Dependent variable: $\ln(y)_{it}$					
independent variables	1	2	3	4	5
konstans	**0.036**	**–0.234**	**0.037**	**–0.609**	**0.15**
	(5.49)***	(–7.41)***	(0.98)	(–1.89)*	(0.24)
ln(y)it-1	**–0.043**	**–0.203**	**–0.043**	**–0.19**	**0.074**
	(–0.43)	(–4.28)***	(–0.80)	(–3.71)***	(0.40)
ln(sk)it	**0.122**	**0.142**	**0.099**	**0.148**	**0.097**
	(4.62)***	(11.01)***	(6.43)***	(12.91)***	(2.71)***
ln(n+g+δ)it	**–0.664**	**–0.602**	**–0.594**	**–0.613**	**–0.574**
	(–5.13)***	(–6.62)***	(–3.50)***	(–7.57)***	(–2.57)**
ln(trmark)it			**–0.015**		**–0.026**
			(–2.25)**		(–1.78)**
ln(patent)it				0.049	0.047
				(1.25)	(0.53)
Number of observations	83	216	83	216	83
Number of countries	14	14	14	14	14
Wald test	67.5***	246.9***	93.58***	561.42***	12.97***
AR test	(–2.47)**	(–1.99)**	(–1.64)*	(–2.17)**	(–2.07)**
Sargan test	8.78	11.98	9.34	9.91	10.02

Source: Edited from own calculations.
*Note: heteroscedasticity robust z-statistics are in parentheses; p-values *** significant at 1%, ** 5%, * 10%, respectively. Δln(y): productivity differential, $\ln(s_k)$: investment ratio, (n+g+δ): growth of labour factor increased by the constant, ln(patent) and ln(trmark): logarithm of the number of patents and trademarks.*

In dynamic models, the first control variable represents the lagged values of the dependent variable *(Y_{it-1})*. Except for *Model 5* we received negative coefficients, but they correlated significantly only in *Models 2 and 4*. As expected, investment ratios (s_k), showed significantly positive *p*-values in each model. Consistent with the conclusions of the neo-classical growth model, the component capturing employment growth and other (constant) components capturing depreciation and technological progress (*n+g+δ*) showed negative correlation with productivity in all five models.

Using *Models 3, 4 and 5* we can also examine some institutional effects related to intellectual property rights on the basis of data obtained from the *WIPO* (*2015*) and *OECD* (*2015*) databases. Based on *Models 3 and 5*, our calculations indicated that changes in trademarks (*trmark*) correlated significantly and negatively with changes in productivity growth. By contrast, neither model for patents (4 and 5) showed significant statistics. In these cases, the lack of significance merely implies that, *ceteris paribus* (assuming that the previously mentioned explanatory variables are constant), the changes in the number of patents do not entail productivity growth in the financial sectors.

These findings are consistent with the results of *Park* (*2003*) in that they point to patent protection's positive effect on productivity and the negative impact of trademarks and intellectual property rights on productivity in the manufacturing sectors; however, the direct effects of these intellectual property rights were not significant in Park's research. *Hu and Png* (*2012*), in turn, have found a positive correlation between productivity growth and patent rights and patent intensity in certain sectors. *Chen and Puttitanun* (*2005*) have confirmed, through the example of numerous OECD countries, the presence of a U-shaped relationship between IPRs and economic development. All of this indicates that, owing to developing countries' stronger inclination to imitate, the low level of intellectual property rights stimulated productivity growth. Up to a certain level, productivity declines in line with the increase in intellectual property rights as the given country's level of development improves, but afterwards the innovation mechanisms in place prompt an increase in productivity in developed countries once again.

In the "family" of intellectual property rights there are additional protections that are not included in the models due to restricted access to data or the lack of a sector-specific nature. Some intangible assets past the conception phase such as industrial designs or utility models clearly correlate with the increase in productivity. The validity of our conclusions is limited by the bias caused by the exclusion of these variables.

6. Summary and conclusions

Labour markets have shown increased demand for knowledge-intensive services requiring personal interaction (*Schricke et al. 2012*). The most prominent findings of our research provide clear evidence of an improvement in the aggregate performance – i.e. economic growth, employment and investment activity – of the financial sectors in the OECD countries under review in the examined period. Furthermore, descriptive statistics point to an increasing need for auxiliary financial services, i.e. financial services more geared toward personal interaction. *Dachs et al.* (*2003*) attribute the strengthening of the service sectors to the increasing income elasticity of demand. In this context, the realignment observed in the financial sectors presages a shift in the structure of the economy toward these more productive financial sectors, in parallel to the increasing prominence of services.

The application of the growth accounting approach also revealed that economic growth was on a relatively stable growth path in the financial sector of each individual country in the review period. The primary determinants of output, in turn, appear to be factors other than those contributing to the accumulation of production factors (capital and human resources). In the review period (1990–2010) the most significant contribution to average output in OECD countries stemmed from total factor productivity, i.e. technological progress in the broad sense. This supports the previous findings of the research conducted by *Klenow and Rodriguez-Claire* (*2002*) on the basis of a similar methodology. Due to deficiencies in the methodology, however, it is impossible to identify with certainty the institutional factors that may impact the performance of financial sectors.

Thus, we also examined the long-term effects of intellectual property rights on productivity through dynamic panel regression models. Although IPRs appear to function appropriately in certain industries, evidence on the financial sectors suggested otherwise. Our results indicated that the changes in trademarks correlated significantly and negatively with changes in productivity growth. At the same time, neither model for patents yielded significant statistics.

This study was not intended to call into question the utility of intellectual property rights. The innovation activity providing the basis for patents is a complex process with a long history of evolution, the economic effects of which are extremely hard to observe. Although intellectual property rights have been an organic part of the economy for centuries, we cannot draw universal conclusions in respect of the social and economic impact of trademarks and patents.

Despite some recent progress in institutional reforms, significant changes are expected to be required in the period to come. One such change would be the adoption of new legislation that would allow third parties, besides the European Patent Office (EPO), to inspect reports on and raise objections against, as appropriate, the infringement of patents (*Venulex 2011*). In 2013 a framework for uniform patent and court decisions was developed and, headquartered in Paris, a Unified Patent Court (UPC) was established to address irregularities concerning the European License Agreement. *Boldrin and Levine* (*2009*), however, do not recommend the immediate elimination of existing patent systems in view of the potentially substantial financial losses, instead; they propose a multi-step process. Over the long term, an alternative solution could be the reduction of the validity period of intellectual property rights.

In our concluding remarks we should also take mention of possible research directions. The theoretical starting point in this context could be the existence of transaction costs. In examining how political power and the degree of democracy affect economic growth, *Aghion et al.* (*2008*) found that freedom of entry was especially enhancing for economic growth in sectors close to the technological frontier, while it tended to impair productivity in undeveloped sectors. The next research topic to be explored should focus on the effects of such institutions in the sectors providing financial services.

In addition, numerous other phenomena have been observed in global markets in recent decades that contributed significantly to mounting financial market risks and uncertainties in a rapidly changing economic environment (*Tóth 2014*). Therefore, the need to gain an insight into the relationship between intellectual property rights and financial crises – which tend to recur in parallel to the rapid globalisation of the economy – calls for further research.

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