Public investment and corporate productivity in Croatia

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Abstract

Motivated by the weak productivity growth, low investments and unfavourable demographic dynamics in Croatia, the paper investigates the relationship between public investment and the productivity of Croatian firms. Our results suggest that government investments in general have a significant and positive effect on total factor productivity (TFP) at firm level. The positive effect can be established only for private sector companies though, while state-owned enterprises do not seem to benefit significantly from these investments. The latter may be due to the relatively small sample of public firms. However, not every type of public investment is significant for Croatian companies. While investments in transport and R&D tend to enhance productivity throughout the economy, investments in human capital work only at the sectoral level by supporting the productivity of enterprises operating in tourism. Sector-level analysis confirms that all the sectors examined benefit from public investment in transport but also reveals that investments in R&D tend to increase the productivity of manufacturing companies only.

Keywords: total factor productivity, productivity drivers, public investment, Croatia

1 INTRODUCTION

As a consequence of the global financial crisis, the region of Central, Eastern and South-Eastern Europe (CESEE) has experienced a large drop in investment since 2008, though with significant cross-country variances. While Bulgaria recorded a drop in investment-to-GDP ratios of around 15 percentage points between 2008 and 2015, the decline was less than 5 percentage points in the Czech Republic. Over the same period, some countries managed to increase public investment (e.g. Hungary, Slovakia). Croatia, however, has undergone the largest decline in public investment among the new EU member states – from 6 per cent of GDP in 2008 to 3 per cent in 2015 – due in part to its limited capacity to absorb EU structural and cohesion funds and the completion of a number of large public infrastructural projects. The fall was driven by investment in transport, one of the main investment categories, which fell from 2.7 to 0.5 per cent of GDP between 2008 and 2015. Public investment in human capital (i.e. education, health, and housing and community amenities) also declined, but to a lesser degree, from 1.2 to 1.0 per cent of GDP. On the other hand, investment in research and development (R&D) has increased, but only in 2015, and at 0.1 per cent of GDP in 2015 remains rather negligible.[1]

In light of the large volatility in public investment in Croatia in the recent past, the question arises how much the changes (especially those in transport infrastructure) have affected the total factor productivity (TFP) of Croatian firms since 2008. In order to answer this question, the paper examines the main productivity drivers of Croatian enterprises, including public investment, and also differentiates between public and private sector companies. Furthermore, the paper assesses

[1] Source: EUROSTAT.

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whether different types of public investment are equally relevant for all sectors (e.g. public investment in R&D might be important for the productivity of manufacturing companies, but less so for that of construction firms).

The focus on the productivity, and specifically TFP, is justified by three main reasons. First, TFP contributed negatively to the potential growth of the Croatian economy after the global financial crisis and has started to contribute positively only recently (European Commission, 2017). Second, UN (2017) forecasts show that Croatia, like many other European countries, might face a significant decline in population in the coming decades (of more than 17 per cent between 2017 and 2050), which highlights the need for productivity enhancements in order to sustain economic growth. Third, unlike labour or capital productivity, which measure the productivity of a single factor of production, TFP is a comprehensive concept, showing the portion of output not explained by the amount of inputs used in production and thus indicating the efficiency of combining factors of production. As a result, gains in TFP are usually related to technological progress or innovation.

The remainder of the paper is organised as follows. Section 2 reviews related literature. Section 3 outlines the methodology, while section 4 describes the data used. Section 5 reports the results from the econometric analysis. Conclusions are presented in the final section.

2 LITERATURE REVIEW

Because it is such an important issue for public policy, the link between public investment and economic growth has been thoroughly researched. In terms of theory, the relationship is ambiguous. On the one hand, public investment can positively affect growth through raising aggregate demand, potentially crowding in private investment and contributing to the economy's productive capacity. On the other hand, it can also crowd out private investment. In addition, this theoretical seems to translate into an empirical ambiguity, as indicated by the richness of results in the empirical literature (see, e.g. Barro, 1991; Devarajan, Swaroop and Zou, 1996; Cavallo and Daude, 2011; Warner, 2014; Bom and Ligthart, 2014). However, some specific public investments, such as investment in infrastructure or innovation, and productive expenditure, like those in education and health, seem to impact long-term economic growth positively (see Fournier, 2016; Acosta-Ormaechea and Morozumi, 2013; Barbiero and Cournède, 2013).

But how important is public investment for productivity? The question is particularly interesting given the expected population decline and potential labour shortages many developed countries will face. The starting point of this line of research was Aschauer (1989), who found that public investment is a significant predictor of productivity growth. Despite some critical reviews (Aaron, 1990; Gramlich, 1994), Aschauer's findings were often confirmed (Munnel, 1990; Fernald, 1999; Mamatzakis, 2003; Bronzini and Piselli, 2009), with some authors focusing specifically on private sector productivity (Heintz, 2010; Pineda and Rodriguez,

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2006). Still, all these approaches generally relied on aggregate data at the country, regional or industry level; thus, specific channels through which public investments affect productivity at firm level were not revealed.

Mechanisms translating public investment into higher firm productivity could be direct or indirect. For example, public investment in (better quality) roads might reduce transport-related costs for companies. Or, as Kneller and Misch (2014) observe, labour productivity may be affected by health-related public services (e.g. through increased availability of drugs against common diseases), while investment in infrastructure can improve firm productivity through, e.g. potentially lower inventory levels and easier access to a larger number of suppliers. Using a sample of South African firms, the authors find that capital intensity of firms is an important factor in the transmission mechanism, i.e. shifts in public expenditure mix towards more productive ones positively affect productivity of firms that have lower ratio of capital to labour than other firms in their industry and province.

Studies that examine the relationship between public investment and firm-level productivity are rather scarce. To the best of our knowledge, besides Kneller and Misch (2014), there are only two other studies that try to establish similar micro-economic linkages, although their focus was not strictly on firm productivity. Chatterjeey and Narayananz (2016) examined the output elasticities of Indian firms in the formal and informal sectors to government investment in infrastructure, while Iimi, Humphrey and Melibaeva (2015) studied the impact of improving the quality of public infrastructure in five East African countries, associating output elasticities of firms with different infrastructure costs, including transport.

Hence, by pursuing a micro-level approach we are trying to fill the gap in the literature, which would be the main contribution of this paper. Furthermore, we are adding to productivity studies on Croatia, which also appear to be limited. One of them (Anos-Casero and Udomsaph, 2009) revealed positive influence of the quality of infrastructure on the TFP of Croatian enterprises, while the other one (Iootty et al., 2014) examined the contribution of firm dynamics to productivity growth over the period 2008-2012.

3 METHODOLOGY[2]

Following the vast empirical literature, the TFP determinants were estimated by a two-step approach (see, e.g. Escribano and Pena, 2009; Coricelli et al., 2012; Añón-Higón et al., 2014; Fons-Rosen et. al., 2014; Damijan, 2016).

First, in order to calculate the TFP, a production function was estimated on a panel of firms. We assumed that the production function followed the Cobb-Douglas form with endogenous capital and labour:

$$Y_{it} = A_{it} L_{it}^{\beta l} K_{it}^{\beta k} M_{it}^{\beta m} \quad (1)$$

[2] This section draws from Zildzovic et al. (2016:89-90).

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where Y_{it} represents output (sales) of firm i in period t, A_{it} represents the TFP, and L_{it}, K_{it} and M_{it} are inputs of labour (measured as number of employees), capital (measured as book value of fixed assets) and intermediate (material) inputs, respectively, while β_l, β_k and β_m represent output elasticities of these three inputs. Taking natural logs, we get the linear representation:

$$y_{it} = ln\, A_{it} + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m\, m_{it} \tag{2}$$

where lower-case letters refer to natural logarithms of the variables and $ln\, A_{it} = \beta_0 + \varepsilon_{it}$, with β_0 being the average level of productivity of the firm and ε_{it} the deviation from that average. Furthermore, ε_{it} can be decomposed into ω_{it} (the observable component of the TFP, i.e. shock in productivity that a firm can predict when deciding on inputs) and e_{it} (unobservable component of the TFP, which represents measurement error or unexpected productivity shocks).

Under the assumption that $\omega_{it} = g(k_{it}, m_{it})$ is a three-degree polynomial of the capital stock (k_{it}) and intermediate inputs (m_{it}) and that $E(e_{it} | l_{it}, k_{it}, m_{it}) = 0$ (where $t = 1, 2, \ldots T$), Eq. (2) becomes:

$$E(y_{it} | l_{it}, k_{it}, m_{it}) = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m\, m_{it} + g(k_{it}, m_{it}) = \beta_l\, l_{it} + h(k_{it}, m_{it}) \tag{3}$$

where $h(k_{it}, m_{it}) \equiv \beta_0 + \beta_k\, k_{it} + \beta_m\, m_{it} + g(k_{it}, m_{it})$.

Early research estimated Eq. (3) using the ordinary least squares (OLS) method. However, OLS estimates of the unobservable TFP can be correlated with the error term as firms change their factor inputs in anticipation of TFP change.[3] This endogeneity renders OLS estimates inconsistent. The seminal works of Olley and Pakes (1996) (henceforth OP) and Levinsohn and Petrin (2003) (henceforth LP) suggested possible alternatives. However, OP's approach rests only on the subset of firms with positive investments, while relying heavily on proper measurement of the capital variable. LP's approach potentially suffers from an identification problem in the first estimation stage due to collinearity. In order to overcome these issues, Wooldridge (2009) proposes using a single set of moments, built upon the LP method (see also, e.g. Petrin, White and Reiter, 2011; Gal, 2013; Sung and Sang, 2014).

Following Wooldridge (2009), we estimate the industry specific production functions in the following form Eq. (3):

$$y_{it} = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m\, m_{it} + g(k_{it}, m_{it}) + e_{it},\ t = 1,\ldots,T \tag{3.1}$$

and

$$y_{it} = \beta_0 + \beta_l\, l_{it} + \beta_k\, k_{it} + \beta_m\, m_{it} + f(g(k_{it\text{-}1}, m_{it\text{-}1})) + \eta_{it},\ t = 1,\ldots,T \tag{3.2}$$

[3] In other words the error term is expected to influence the decision on factor inputs (labour and capital).

where η_{it} represents the sum of innovations in productivity ($a_{it,}$ where $a_{it} \equiv \omega_{it} - E(\omega_{it} | \omega_{it-1})$) and unobserved TFP ($e_{it}$), whereas the function $f(\cdot)$ is approximated by a three-degree polynomial in g. Under the assumption that ω_{it} follows a random walk, identification is made by just current values and one lag in the conditioning set. In order to identify Eqs. (3.1) and (3.2) in the generalised method of moments (GMM) estimation, two groups of instruments are used – in the first equation the polynomials of $ln\ k_{it}$ and $ln\ m_{it}$ and their one-period lags, and in the second equation lagged $ln\ l_{it}$, lagged $ln\ k_{it}$ and the lagged polynomials of $ln\ k_{it}$ and $ln\ m_{it}$.

Once the coefficients on labour, capital and intermediate inputs are estimated, the firm-level TFP is calculated as:

$$tfp_{it} = y_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_m m_{it} \tag{4}$$

Second, we estimate the impact of the key prospective determinants on TFP growth. In particular, the following panel regression was estimated:

$$tfp_{it} = \alpha + \beta tfp_{i,t-1} + \sum_j \gamma_j X_{jit} + u_i + v_{it} \tag{5}$$

where X_{jit} is a set of TFP determinants (a variety of firm-specific, macroeconomic, institutional and business environment determinants, including public investment), u_i captures firm-specific unobserved effects and v_{it} is the error term. The estimates were obtained by using the first-differenced GMM regression to deal with potential endogeneity.

4 DATA

For the analysis of productivity drivers, the paper uses a panel of 48,129 companies in Croatia, in the period 2007-2015. Firm-level data were obtained from the BvD ORBIS database. Observations with negative values for any of the variables entering the production function (revenues, fixed assets, material costs) were excluded from the sample. Sector- and country-level data come from the EUROSTAT, the Croatian National Bank, and the World Economic Forum (WEF) Global Competitiveness Report. Sectors were defined in line with NACE Rev. 2 classification of economic activities. For data on public investment we used EUROSTAT's functional classification of government expenditure (COFOG), which classifies government expenditure into ten main categories: general public services; defence; public order and safety; economic affairs; environmental protection; housing and community affairs; health; recreation, culture and religion; education; social protection. Details on variables used are given in the table 1.

Table 1

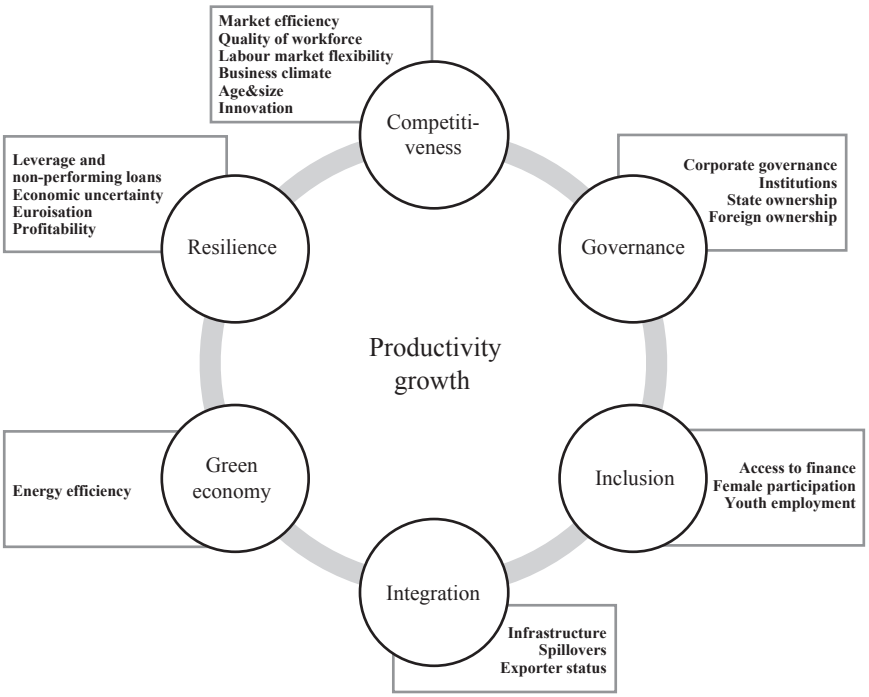
Variable definitions and sources

Variable	Description	Level	Source
Private investment	The firm's fixed assets, adjusted for depreciation and amortization (log, change)	Firm	ORBIS
Total government investment	Gross fixed capital formation within the total general government expenditure (log change)	Country	EUROSTAT
Government investment in human capital	Gross fixed capital formation in education, health and housing and community amenities (log, change)	Country	EUROSTAT
Government investment in transport	Gross fixed capital formation in transport within general government expenditure on economic affairs (log, change)	Country	EUROSTAT
Government investment in R&D	Gross fixed capital formation in research and development within general government expenditure on economic affairs (log, change)	Country	EUROSTAT
Efficacy of corporate boards	Efficacy of corporate boards score in the WEF's Global Competitiveness Index (value 1-7, change)	Country	World Economic Forum
Flexibility of wages	Flexibility of wage determination score in the WEF's Global Competitiveness Index (value 1-7, change)	Country	World Economic Forum
GHG emissions	Ratio of greenhouse gas emissions to gross value added (GVA) by sector (tonne/EUR)	Sector	EUROSTAT
Goods market efficiency	Goods market efficiency score in the WEF's Global Competitiveness Index, assessing the quality of supply-and-demand conditions (value 1-7, change)	Country	World Economic Forum
Hiring and firing practices	Hiring and firing practices score in the WEF's Global Competitiveness Index (value 1-7, change)	Country	World Economic Forum
Institutions	Institutions score in the WEF's Global Competitiveness Index, assessing the quality of public and private institutions (value 1-7, change)	Country	World Economic Forum
Intangible in total assets	Share of intangible in total assets (per cent)	Firm	ORBIS
Market concentration	Herfindahl-Hirschman index, defined as the sum of the squares of market shares of the firms within a sector of economy (log, change), except in the specification for the sector of tourism in which it is the share of the top 5 companies in the sector in total revenues (per cent, change)	Sector	ORBIS
NPLs	Ratio of non-performing to total gross corporate loans, by sector (per cent, change)	Sector	Croatian National Bank
Professional management	Reliance on professional management score in the WEF's Global Competitiveness Index (value 1-7, change)	Country	World Economic Forum
Youth employment	Share of the youth population (age 15-24) in total employment, by sector (per cent, change)	Sector	EUROSTAT

The potential TFP determinants were identified on the base of extensive empirical literature. Except for public investment, other variables can be connected to one of the six transition qualities (competitiveness, governance, resilience, integration, green economy and inclusion)[4], associated with a well-functioning market economy (figure 1).

FIGURE 1

Key productivity determinants



Source: Authors' elaboration.

5 RESULTS

In line with expectations, we find that the TFP of the Croatian corporate sector declined significantly after the global financial crisis, but has started to recover (chart 1). All sectors, except for tourism, experienced a fall in TFP over the period 2010-2012, which was most pronounced in construction, the sector that also saw the fastest recovery later.

In the second step we investigated the TFP drivers, first at the aggregate (total economy) and then at the sector level. Our results indicate that TFP of Croatian firms in general benefits from increasing public investment and closing the transition gaps in the "competitive", "resilient", "inclusive" and "well-governed" qualities (table 2). Higher public investment, a larger share of youth in employment,

[4] This is new concept of the European Bank for Reconstruction and Development (EBRD) for measuring the transition to a market economy. For more detail please visit [http://www.ebrd.com/our-values/transition.html or see EBRD (2018:105-115)].

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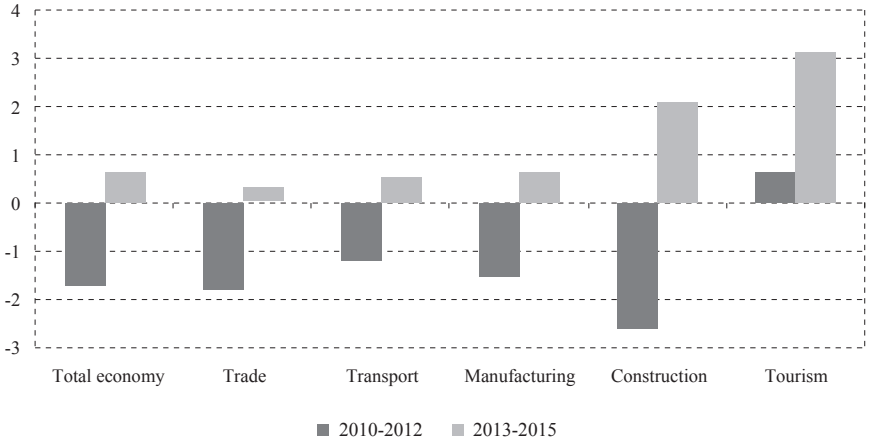
better institutions, higher ratio of intangible to total assets (a proxy for firm-level innovation), as well as more flexible hiring and firing practices seem to improve corporate productivity, while an increase in the share of non-performing loans (NPLs) and market concentration act in the opposite direction.

Chart 1

Estimated three-year average TFP growth rate, total economy and by sector (in %)



Except for concentration, which impacts productivity instantly, other determinants act with a lag of one or two years. Public investment as a whole affects productivity with a 4-year lag. This seems reasonable: while the implementation of public investment projects can boost (construction) employment in the short term, it may take a long time until the projects are finished and the benefits felt by businesses. As expected, investments made by a firm did not prove to be a significant driver of TFP given that they increase capital, i.e. one of the production inputs, which is by definition out of scope of the TFP concept. That is why in the following stages we left out this variable. At the same time, our sample increased threefold as many firms appear not to report the figure on their own investment.

In order to understand better the relative significance of the identified TFP determinants we used standardized coefficients.[5] Government investment and flexibility in hiring and firing workers seem to be of greatest importance for productivity improvements, followed by the quality of institutions and NPLs, and then by youth employment and market concentration. The results suggest that the share of intangible in total assets enhances productivity the least.

In the following stage, we checked if state- and privately-owned enterprises have different productivity drivers. However, since the vast majority (99.5%) of enterprises in the sample have private owners, there is almost no difference between results for the subsample of private companies and the whole sample. Unfortu-

[5] Calculated by multiplying the estimated coefficient by the ratio between the standard deviations of the independent and the dependent variables.

nately, results for the subsample of the remaining 218 state-owned enterprises did not prove to be meaningful, which is why we do not report them.[6]

Table 2

TFP determinants in Croatian corporate sector

Variables	Total economy (1)	Total economy (2)	Private sector
Lagged dep. variable	0.2638*** (0.0266)	0.2385*** (0.0043)	0.2394*** (0.0150)
Private investment (-1)	0.0005 (0.0009)		
Total government investment (-4)	0.0520*** (0.0101)		0.0445*** (0.0046)
Government investment in human capital (-3)		0.0067 (0.0125)	
Government investment in transport (-4)		0.0251*** (0.0036)	
Government investment in R&D (-2)		0.0326*** (0.0091)	
NPLs (-1)	-0.0022** (0.0008)	-0.0014*** (0.0003)	-0.0013*** (0.0003)
Youth employment (-2)	0.0063*** (0.0018)	0.0054*** (0.0009)	0.0057*** (0.0009)
Market concentration	-0.1013** (0.0379)	-0.0860*** (0.0174)	-0.0908*** (0.0178)
Institutions (-1)	0.1033** (0.0336)	0.0735*** (0.0141)	0.0531*** (0.0149)
Intangible in total assets (-1)	0.3430** (0.1119)	0.1551*** (0.0307)	0.1510*** (0.0417)
Hiring and firing practices (-2)	0.0661*** (0.0132)	0.0397*** (0.0070)	0.0637*** (0.0055)
Constant	0.0207** (0.0097)	0.0160*** (0.0028)	0.0180*** (0.0029)
Number of observations	33,107	176,887	175,899
Number of enterprises	15,529	48,129	47,911
Number of instruments	29	30	28

Notes: The dependent variable is the log of TFP. Robust standard errors are in parentheses. For the specification tests, p-values are reported.

, ** and * indicate that the coefficients are significant at the 10, 5, and 1 per cent level, respectively.*

Given the possibility that not all government investments are equally important, we next examined the significance of three different government investments that are usually considered productive – investment in transport, human capital (a sum of investment in health, education, and housing and community amenities, the latter including water supply, street lighting and suchlike) and research and development (R&D). Government spending on salaries in sectors of health and educa-

[6] Some of the variables that were statistically significant previously, now seem not to be and/or have wrong signs. Public investment is significant at 10 per cent level.

tion was not included, although they might be considered investments too since a large part of the productive benefits come from the human input (number and quality of teachers or doctors) and not just from the physical infrastructure. The exercise suggests that two out of these three types of public investment contribute positively to the productivity of Croatian enterprises, i.e. investment in transport and investment in R&D, while investment in human capital does not seem to matter for the corporate sector as a whole. The lag is twice as short in the case of investment in R&D (two years) but investments in transport seem to have twice as big an impact on productivity as investment in R&D.

Finally, TFP determinants were estimated for several sectors to allow for the possibility that individual sectors can have different, sector-specific productivity drivers, and check whether there is a difference in importance of various types of public investment across sectors. For example, public investment in R&D would be expected to be more significant in manufacturing than in tourism. We looked at five sectors for which we thought government investment might matter the most: transport, trade, tourism, construction and manufacturing. The number of enterprises per sector varied between 2,175 in transport and 13,699 in trade.

Tourism has been one of the key sectors in Croatia, supporting the economic recovery after the global crisis with its share in the gross value added increasing the most between 2008 and 2015 (from 4.0 to 5.5 per cent). Our productivity exercise indicates that this sector benefits not only from investment in transport but, as expected in the case of a highly labour-intensive industry, also in human capital. While the former seem to impact productivity much more than the latter, in both cases the identified lags are rather long (four and five years, respectively).[7] However, this is understandable given the long implementation period of transport projects and the several years of training needed for future employees.

The other sector that also benefits from more than one type of public investment is manufacturing. Besides transport, government investment in R&D also tends to enhance the productivity of the enterprises, and the impact of the two investments on the TFP seems to be equally strong. Again, the time lags are rather long – four and three years, respectively.

The productivity of companies in the remaining sectors of trade, transport and construction also increases with an increase of government investment in transport. In addition, this investment appears to be the most important productivity driver in the first two sectors, while coming second in the construction sector, after professional management. Time lags are similar to those previously reported.

Overall, our exercise indicates that public investments, in particular in transport, have a large and statistically significant effect on the productivity of Croatian enterprises in all five sectors. Besides these, two other variables also seem to affect the TFP in all sectors examined – NPLs and youth employment. An increas-

[7] More detailed sectoral results are available on request.

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ing sectoral NPL ratio tends to be associated with falling productivity of the enterprises operating in the sector, while higher youth employment in the sector acts in the opposite direction. The latter is an important finding given the high youth unemployment rates in the country. Market concentration also matters for the majority of sectors – a higher degree of concentration in the sector leads to lower productivity, which is probably due to less incentive to innovate.

Table 3
Key TFP determinates by sector

Sector	Public investment	Well-governed	Resilient	Competitive	Inclusive	Green
Tourism (2,817 firms)	Government investment in transport (-4)		NPLs	Market concentration	Youth employment	
	Government investment in human capital (-5)			Hiring and firing practices		
Manufacturing (7,594 firms)	Government investment in transport (-4)		NPLs	Goods market efficiency	Youth employment	
	Government investment in R&D (-3)					
Trade (13,699 firms)	Government investment in transport (-4)	Efficacy of corporate boards	NPLs	Market concentration	Youth employment	
Transport (2,175 firms)	Government investment in transport (-4)		NPLs	Intangible in total assets		GHG emissions
Construction (5,467 firms)	Government investment in transport (-3)	Professional management	NPLs	Market concentration	Youth employment	

Standardised coefficient: >|3.0| |2.0-3.0| |1.0-2.0| <|1.0|

** Darker shades indicate higher relative importance of the variables, i.e. higher standardized coefficient (showing the impact of one standard deviation change in the variable on productivity).*

There are also several sector-specific TFP determinants. They range from hiring and firing practices in tourism to greenhouse gas emissions in the transport sector. In the case of manufacturing, goods market efficiency also matters, while in trade and transport the same is true for the quality of corporate governance. The significance of the share of intangible in total assets in the transport sector is somewhat less intuitive, but given that standardized coefficient equals zero, economically speaking this variable is of little, if any, importance.

Results across sectors are summarised in table 3. The TFP determinants are grouped according to the transition quality they represent, while cells are shaded according to the economic relevance of TFP determinants within a sector.

6 CONCLUSION

Our results show that public investments, especially in transport and human capital, have a positive and significant effect on corporate productivity in Croatia. These effects are, however, different for various sectors. While investments in transport seem to affect the productivity of all sectors, human capital has a significant effect only in the (most) labour intensive sector, i.e. tourism.

Another important finding is that public investments, as expected, take effect with a considerable lag. This can be up to 4-5 years, e.g. in transport or human capital.

Besides public investments, the productivity of Croatian firms might also benefit from the closing of the transition gaps in the qualities defined as competitive, resilient, inclusive and well-governed. This suggests that improving the transport networks, as well as resolving the corporate over-indebtedness issue and trying to get as many young people employed as possible, should be high on the agenda of Croatian authorities as all these factors tend to increase firms' productivity.

However, in order to have more precise policy recommendations some further research may be warranted. It could be done along several lines. One potential issue that is worth checking is if the effects of public investment are (non)linear. For example, in the case of motorways (where Croatia invested heavily in previous years), the productivity-enhancing effects may reach their peak at a certain level of investment in transport, which is when other investments (e.g. in human capital) may take the lead.

A cross-country comparison of productivity drivers may also be useful in order to check whether results hold when accounting for the countries' income levels, as this can also influence productivity drivers. For example, less developed countries may experience larger productivity improvements from investments in physical infrastructure, given its low quantity and quality, but at a later stage investment in human capital might become the most relevant factor. Including the quality of public investment as a variable can be also justified as higher quantity of investment does not necessarily translate into their higher quality, i.e. better services for economic agents.

As an immediate next step, one could investigate if adding wages and salaries to human capital investments would make a difference in the results. One can argue that in the case of human capital (e.g. health or education) most of the value comes from the employees (e.g. doctors or teachers) who work in the institutions (hospitals or schools) and much less from the institutions themselves; thus capturing only the investments might not be enough.

Disclosure statement

No potential conflict of interest was reported by the authors.

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