Public Sector Economics
2/2021

Vol. 45, No. 2 | pp. 177-303
June 2021 | Zagreb

ISSN: 2459-8860
https://doi.org/10.3326/pse.45.2

Institute of Public Finance

Public Sector Economics

2/2021

Vol. 45, No. 2 | pp. 177-303 | June 2021 | Zagreb

TABLE OF CONTENTS

Articles

Effects of grants from EU funds on business performance of non-financial corporations in Croatia

DOMAGOJ ŠELEBAJ, MSc*
MATEJ BULE, MSc*

Article**
JEL: C14, D22, H81
https://doi.org/10.3326/pse.45.2.1

* All views presented in this paper are the authors' own and do not necessarily reflect the official position of the Croatian National Bank. The authors would like to thank two anonymous reviewers and colleagues from the Croatian National Bank for their useful suggestions.
** Received: June 1, 2020
Accepted: February 10, 2021

The article was submitted for the 2020 annual award of the Prof. Dr. Marijan Hanžeković Prize.

Domagoj ŠELEBAJ
Croatian National Bank, Trg hrvatskih velikana 3, 10000 Zagreb, Croatia
e-mail: domagoj.selebaj@hnb.hr
ORCiD: 0000-0002-4639-2973

Matej BULE
Croatian National Bank, Trg hrvatskih velikana 3, 10000 Zagreb, Croatia
e-mail: matej.bule@hnb.hr
ORCiD: 0000-0002-8789-0805

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

Abstract

This paper quantifies the impact of grants from EU funds on non-financial corporations performance in Croatia. For the purposes of the research, three different data sources were used, which were merged into a single enterprise level database. Enterprises for the control group were selected using propensity score matching method, while the quantifications of effects in the years after receiving the support were estimated using difference in differences method. Also, the dose-response relationship between the relative size of the received grant and the level of impact on performance indicators was assessed. The research showed that the use of EU funds has a strong and positive effect on the observed indicators, such as employment, operating income, labour productivity or total factor productivity and capital intensity. At the same time, the level of impact significantly depends on the relative size of grant received from EU funds.

Keywords: EU funds, propensity score matching, difference in differences

1 INTRODUCTION

Apart from access to the common European market, one of the most important economic benefits arising from Croatia's membership in the European Union (EU) is the eligibility to use EU funds. Since Croatia, just like the majority of new member states, is classified as an underdeveloped country, the amount of funds it received is substantially larger than the amounts it pays into the shared European budget. In 2019 alone, end beneficiaries received EUR 1.9 billion, or 3.6% of Croatia's GDP, from EU funds on various grounds, while Croatia's contribution to the shared budget amounted to around EUR 0.5 billion, or 1.0% of GDP (authors' calculation based on data by the Ministry of Finance and the Croatian National Bank). It should be pointed out that Croatia is yet to enter the final stage of the utilization of funds from the 2014-2020 budgetary period, in which the payments to end beneficiaries for contracted projects are expected to reach their peak.

However, support in such large amounts of grants is bound to have certain direct and indirect effects, which are harder to measure than is the case with direct financial benefit. Apart from the problem of data accessibility (especially at the micro-level), an additional burden is the fact that grants from EU funds are used to finance a wide variety of various social areas and economic sectors with divergent objectives and potential effects – from family farms or projects with a social element aimed at the wider population or non-profit associations all the way up to large infrastructural projects managed by the state or local government units or projects by non-financial corporations.

To the authors' best knowledge, this is the first-ever paper to quantify the effects of grants from EU funds on end beneficiaries in Croatia or, more specifically, on the business performance and features of Croatian non-financial corporations. As such, it represents a giant leap in the analyses conducted thus far and substantially contributes to the national professional literature on the topic of support from EU

funds. Apart from quantifying the effects of the grant, the paper also elaborates on additional research questions such as the probability of obtaining EU funding and the ratio between the size of the support received and its impact level (dose-response). Since this ratio between the size of the received grant and the level of its impact has practically not been researched before, this piece of research also provides a substantial scientific contribution.

Finally, the conclusions arising from the results of this research can assist the competent bodies when adopting policy decisions regarding the allocation of available grants from EU funds. Namely, non-financial corporations represent a section of the national economy which is a significant beneficiary of EU funds; their case would make valuable testing ground for the assumption that the use of EU grants might have a positive effect on the performance of many enterprises, thus contributing to the competitiveness of the national economy, or at least partially alleviate the consequences of certain structural deficiencies of this sector, such as high indebtedness or low productivity rates (cf. Martinis and Ljubaj, 2017; Gelo and Družić, 2015).

Even though the results of the analysis conducted show that these grants do have a significant positive effect on the performance of corporate beneficiaries, several additional recommendations for economic policy management can be highlighted. For instance, it is important to highlight that the age of an enterprise and the number of its employees are some of the key estimators of the probability of obtaining support. Such findings are far from unexpected, but more effort should be put in making funds more accessible to younger enterprises or start-ups, since access to funding is one of the most common problems faced by such enterprises. In addition, it has been shown that, regardless of the fact that the support comes in the form of a grant, the use of funds has a negative effect on relative profitability of business, which poses a challenge for market profitability of the funded projects and leaves room for moral hazard. For this reason, greater focus should be placed on profitability issues during the grant allocation procedure. One of the more important markers of efficiency is the relative size of the support, hence this factor should also be taken into account during the allocation procedure.

2 OVERVIEW OF RELEVANT LITERATURE AND CONTRIBUTION OF RESEARCH

The issue of potential effects of cohesion policy is one that frequently comes up in applied econometric research. Darvas et al. (2019) identified over 1,000 different pieces of research dealing with various aspects of cohesion policy such as efficacy, convergence, inequality, management and many others. Since the main objective of cohesion policy is reducing the development gap between individual regions, or convergence of underdeveloped regions, as well as stimulating general economic growth, literature is dominated by the issue of efficacy of EU's cohesion policy for achieving these objectives (for an overview of previous research, see e.g., Hagen and Mohl, 2009; Marzinotto, 2012; Pienkowski and Berkowitz,

2015; Crescenzi and Giua, 2017). However, the results are far from uniform. Depending on the sample size, time period, conceptual and methodological framework, the majority of papers unveil a positive effect of cohesion policy on regional growth and convergence (e.g., Cappelen et al., 2003; Esposti and Bussoletti, 2008; Ferrara et al., 2016). Despite finding positive effects, some pieces of research nevertheless challenge its efficacy (Dall'Erba and Le Gallo, 2008; Bouayad-Agha et al., 2011; Becker et al., 2013), i.e., they argue that cohesion policy is only tentatively efficient in meeting its objectives (e.g., Ederveen et al., 2002; Ederveen et al., 2006; Rodriguez-Pose and Fratesi, 2004). On the other hand, some pieces of research also claim that cohesion policy has a negative effect on economic growth (Fagerberg and Verspagen, 1996; Breidenbach et al., 2016).

The majority of conducted research, including the ones listed above, use individual countries or NUTS regions as the observation unit. This approach is subject to criticism from various sides, the most important being the issue of endogeneity (Hagen and Mohl, 2009). Endogeneity arises due to the fact that an individual region's ability to qualify for grants from cohesion funds is defined by its economic size, meaning that the per capita GDP of regions that are eligible for obtaining grants from cohesion funds is substantially lower than the EU average. However, regions that were initially underdeveloped may experience sharper growth due to convergence only, regardless of the grants obtained from the Cohesion Fund (Cappelen et al., 2003).

Research looking at the efficacy of cohesion policy on an aggregate level is countered by literature examining the potential effects of EU funds on the performance of enterprises that are the beneficiaries of grants through cohesion policy. Due to lack of data, microeconomic research is still very limited, although such an approach would eliminate the endogeneity issue that is inherent to aggregate research. Only a few papers assessed the potential effects of grants from cohesion funds on a limited set of enterprise performance indicators, primarily the trends in the number of employees and enterprise productivity, expressed either as total factor productivity (TFP) or labour productivity.

The majority of research conducted at enterprise level used a quasi-experimental approach of propensity score matching and the difference in differences method and discovered positive effects of obtaining a grant from cohesion funds on trends in employment numbers, revenue and/or productivity (see Moral Arce and Paniagua San Martín, 2016; Fattorini et al., 2018; Hartsenko and Sauga, 2013). Benkovskis et al. (2018) used microdata from Latvian enterprises to examine the effect of grants from the European Regional Development Fund on a much wider set of performance indicators. In their research, they used the propensity score matching technique, which has shown that obtaining the grant led to an increase in the enterprises' capital intensity as well as employee numbers not long after receiving the support, while the effect on the productivity trend was also positive but became evident only three years into the grant. Apart from this, the effects of the grant

were not homogeneous for all enterprises; enterprises that were slightly larger, but also less productive, before receiving the grant benefited more from the grant.

Bachtrogler and Hammer (2018) examined the effects of the use of EU grants from the 2007-2013 financial perspective on the performance of enterprises in 25 member states. The results of their analysis, derived through the propensity score matching method, have shown that corporate beneficiaries of grants in all countries under consideration recorded a substantial increase in employee numbers, revenue and fixed asset value, while on the other hand, evidence showing an increase in total factor productivity has been limited. The results presented in other papers are far from unambiguous. In one of the first papers that attempted to quantify the use of EU grants against the performance of non-financial corporations, Zwaan and Merlevede (2013) used grant beneficiaries from the processing industry in all EU member states in the 2000-2006 period as a case study and concluded that obtaining the grant did not affect the enterprises' employment numbers and productivity.

All pieces of research referred to above failed to take into account the effect of the magnitude of the received support from EU funds on the trend in selected performance indicators. Rather, they merely considered the fact that the enterprise became a beneficiary of the grant. Apart from being one of the first attempts to quantify the obtained grants from EU funds against performance indicators of enterprises in general, the main contribution of this paper is that it is, to the authors' best knowledge, the first paper to assess the effect of the size of the received support from EU funds on business performance indicators of enterprises. In addition, this research complements previous national literature studying EU funds in Croatia from various aspects, literature which is, due to Croatia's late EU accession, still quite modest. Areas and topics covered so far include the impact of EU funding on national research capacities, challenges of public procurement for EU-funded projects, absorption capacities for EU funds, the effect of cohesion policy on regional development in Croatia, the role of EU funds in the development of rural tourism, aid received from the European budget by local and regional self-government units or the question of whether SMEs are familiar with funding possibilities from EU funds (see Šostar and Marukić, 2017; Poljičak, 2017; Kotarski, 2016; Maleković et al., 2018; Medić et al., 2017; Ott et al., 2018; Sikirić et al., 2015; Visković and Udovičić, 2017; Bartoluci et al., 2018; Kersan Škabić and Tijanić, 2017). In addition, this research also complements previous literature dealing with the effect of public support provided to non-financial corporations, whose source of funding is not the shared European budget but rather national budget or budgets of local and regional self-government units (see Srhoj et al., 2018). Public support to private non-financial corporations funded by taxpayers' money is an especially sensitive social issue because of questionable efficiency of such programmes and the issue of social justice. For this reason, any research on this topic can be highly relevant.

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

3 DATA SOURCES AND DATA ADJUSTMENTS

This research uses three different data sources at enterprise level with different time series durations, which have been aligned and connected into a unique database covering the period 2012-2018, the first database of its kind. All data regarding the allocation of funds to end beneficiaries have been retrieved from the database maintained by the Ministry of Finance, which keeps track of all payments to beneficiaries of EU support on a monthly basis. This database also includes a code of the fund from which the grant was allocated. Data on monthly payments for individual enterprises have been aggregated at the annual level and connected to the database of annual financial statements maintained by the Financial Agency (Fina). Fina's database of annual financial statements contains detailed information derived from the enterprises' closing balance sheets, profit and loss accounts but also other non-financial features of enterprises conducting business in Croatia, such as the number of employees, head office, ownership structure based on the proprietor's residential status, etc. The third database used in the present research is the Court Register of Businesses Operators in Croatia, which contains data on the year each enterprise was established. This database was used to ascertain the enterprises' age.

By merging three different data sources, we created a new, unique database with 774,449 observations for the 2012-2018 period. Our sample identified 1,921 unique enterprises that became a beneficiary of a grant from EU funds in the observation period. However, further analysis required major adjustments. The number of corporate beneficiaries includes a certain number of public enterprises and entities that are registered as an enterprise but are owned by the state or local and regional self-government units. Such enterprises were excluded from the analysis due to having drastically different business objectives, which might ultimately affect the results of the analysis. This reduced the number of beneficiaries to 1,685 enterprises. We also excluded all enterprises that did not have a single employee in the observation period or failed to achieve positive value of their operating income, leaving us with 1,643 corporate beneficiaries.

Since the main objective of the analysis was to assess the medium-term effects of the grants on corporate beneficiaries' business performance and features, which for the purpose of the research implies that performance data is available for the period of at least two years after initially receiving the grant, we also needed to exclude enterprises that obtained their first grant in 2017 or 2018 from the main part of the analysis. The time distance to make an impact assessment for such enterprises has not been long enough, since data on their performance in 2019 and 2020 is not available. This had a major impact on the number of corporate beneficiaries under observation. Having conducted the process of database cleaning and exclusions referred to above, we were left with 476,685 observations for the empirical analysis, collected from 227 enterprises that obtained support for co-funding their projects from EU funds. Appendix 3 shows that the enterprises remaining in the sample after all the adjustments are slightly older, more productive, with more capital intensity,

more indebtedness, more export intensity and more employees than the overall sample of enterprises that received grants from EU funds.

The paper considered twelve indicators in total, some of which have been directly taken from primary sources since some values, such as operating income, fixed assets values, values of exported and imported goods and services, are, in accordance with accounting standards, a component of the enterprises' profit and loss account, final balance sheet and other financial statements. All other indicators have been derived from data sources referred to above, using the standard calculation method applied in previous professional literature that is based on data processing at enterprise level. For instance, the employment indicator has been calculated on the basis of completed hours of labour in order to account for the fact that some enterprises provide for overtime hours, while some enterprises have part-time employees, which can skew the true representation of the employment rates at individual enterprises. On the other hand, by analysing only operating income rather than total revenues, we avoid the possibility of quantifications being affected by one-off exceptional revenue, including the support from EU funds itself.

The calculation method for all other indicators (labour productivity, added value, capital and export intensity, indebtedness, profitability and enterprise age) is provided in appendix 1. In addition, appendix 2 provides a detailed explanation of the calculation method for total factor productivity based on the Cobb-Douglas production function. It is also important to note that some of the nominal variables have been deflated to exclude the effect of price changes, which means that only their real changes were taken into account (the deflators used are also described in appendix 1). In conclusion, all variables and indicators used, with the exception of enterprise age, are observed as their logarithmic transformations.

4 METHODOLOGY

4.1 ECONOMETRIC MODELS AND TECHNIQUES USED

The empirical analysis used has widely been applied in previous similar papers – the so-called average treatment effect on treated method (ATT). The causal treatment effect, in this case receiving support from EU funds, can be defined as the difference between a potential outcome in an enterprise's observable performance upon receiving support and a potential outcome that would have occurred had the support not been received, or, in mathematical terms:

$$ATT = E\left[\Delta Y^{1}_{i,\,t+s} \mid EU = 1\right] - E\left[\Delta Y^{0}_{i,\,t+s} \mid EU = 1\right] \tag{1}$$

The first term in the equation $E\left[\Delta Y^{1}_{i,\,t+s} \mid EU = 1\right]$ denotes a change in the group of indicators under observation for enterprises that received support in the period t, i.e., between one year prior to receiving the grant (t-1) and t+s years after receiving the grant. The second term in the equation $E\left[\Delta Y^{0}_{i,\,t+s} \mid EU = 1\right]$ marks a hypothetical growth rate of the indicators under scrutiny for the same group of enterprises which would have occurred had the support not been received. Since the

defined outcomes for the group populated by corporate beneficiaries are not observable in hypothetical conditions (i.e., not having received support), the crucial evaluation problem is to find a group of enterprises for which such trends can be approximated to a high extent. In other words, in order to estimate the average treatment effect on treated (ATT), we should find a control group of enterprises (those that have not received any grant from EU funds), whose initial features are quite similar to the group of enterprises that have received grants.

The first step entails calculating the probability of obtaining a grant from EU funds as a function of observable enterprise features in the period prior to receiving support – features which are considered to affect the probability of receiving the grant. When observing the initial features prior to receiving the treatment itself, if there is no significant effect of non-measurable or unobservable features, the selection bias is reduced, i.e., it is assessed as statistically non-significant. The probability above is referred to as propensity score and is calculated through the following probit regression (Rosenbaum and Rubin, 1983):

$$P(EU_{i,t} = 1) = F\,(X_{i,t-1}, Control_{i,t}) \tag{2}$$

where $EU_{i,t}$ denotes an indicator variable in case enterprise i is a beneficiary of grant from EU funds, F indicates the standard normal distribution function, while $X_{i,t-1}$ designates the vector of performance indicators and other features under scrutiny within one year prior to receiving the EU grant. It encompasses the productivity indicators (total factor productivity and labour productivity), enterprise age, employee numbers, capital and export intensity and the indebtedness coefficient. In addition, the vector $Control_{i,t}$ also expands the estimation with standard control variables for the year and the activity that the enterprise under observation conducts (to the second digit level of National Classification of Activities – NACE).

The estimated probability of receiving support from EU funds is used in the second step for enterprise matching. The probability of starting a project that is co-financed from EU funds for enterprise i in sector k in period t is labelled $p_{i,k,t}$. One or several control enterprises j with the smallest absolute difference in the estimated propensity score is then matched with the enterprise that received the treatment by using the nearest neighbour method.

$$\left|p_{i,k,t} - p_{j,k,t}\right| = \underset{j \in \{EU_{i,k,t} = 0\}}{min}\left(\left|p_{i,k,\,t} - p_{j,k,t}\right|\right) \tag{3}$$

In order to ensure higher comparability of business results and enterprise features, an additional condition was introduced – that all matched enterprises should belong to the same NACE class and the same year, as per Bachtrogler and Hammer (2018) and Benkovskis (2018). To ensure robustness and higher reliability of obtained results, matching is done in such a manner that each enterprise that received the treatment is matched with 1, 2, 5 and 10 most similar enterprises, which then form the control group. In alternative model specifications, the matching is conducted by

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

using a pre-defined caliper value, i.e., maximum tolerated difference in the estimated propensity score between the treated enterprises and the control group enterprises. If no control enterprise is located within the defined caliper, the matching is deemed as not having been conducted and such enterprises from the treated group are excluded from further analysis. In addition, matching is conducted without replacement; considering a large number of potential control enterprises, this prevents each control enterprise from being matched with more than one treated enterprise. The quality of the matching exercise is usually assessed by comparing the mean values of the variables under observation before and after matching. If the matching leads to no statistically significant difference, the balance condition has been met and the exposure to grant allocation can be considered random.

Having estimated the probability of receiving treatment and having matched enterprises that obtained grants from EU funds with enterprises in the control group, the final step serves to calculate the average effect of the treatment on the treated enterprise by applying the standard difference in differences method. The first step in the difference in differences method is to calculate the growth rates of the variable under observation for both enterprise groups. The average difference between these growth rates is calculated as:

$$ATT^{DID} = \frac{1}{N_T} \sum_{i \in T} \left[\Delta Y^{T}_{i,t+s} - \sum_{j \in C(i)} \omega_{i,j} \Delta Y^{C}_{j,t+s} \right] \quad (4)$$

where N_T indicates the number of enterprises that received grants from EU funds, $0 < \omega_{i,j} < 1$ is the weight for the control group of enterprises generated by the matching algorithm, s indicates the number of years for which the change in performance indicators or features is observed, starting from *t-1* (one year prior to receiving support) until $t+s$ after receiving support, whereby $s \in \{0,1,2\}$. If the difference in growth rates of the observable performance variables or enterprise features turns out to be positive and statistically significant, we can say that the effect of the treatment (co-financing through grants from EU funds) had a positive effect on the observable performance indicators of the enterprise in the period after receiving the treatment.

Finally, apart from providing an answer to the question which features of enterprises increase the probability of obtaining grants from EU funds and whether such a benefit enhances the growth of observable performance indicators, the third objective of the present paper is to understand whether there is a difference in the causal effects of co-financing considering the relative size of the grant. A more appropriate methodology for answering this question is the propensity score binary effect generalization method for a treatment variable that is considered a continuous variable (Hirano and Imbens, 2005). By applying the generalised propensity score, we can estimate the dose-response function and determine whether the causal effects of the received support on the change in the variables under observation vary depending on the different relative size of the allocated grant from EU funds. Only a small number of previous applied research used such a

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

method at enterprise level, while they mostly applied it for exploring the connection between export intensity and productivity growth (Fryges and Wagner, 2008) or the intensity of different support types on the growth of indicators under observation such as employment rate, revenue or productivity (see e.g., Cerulli and Poti, 2014; Dai and Cheng, 2015; Dai et al., 2017; Becker et al., 2019). To the authors' best knowledge, this is the first attempt of using the above method for assessing the effects of co-financing through grants from EU funds.

The methodology referred to above is usually implemented in three steps. The first step entails an assessment of the generalised propensity score on a sample of the treated enterprises, based on the relative amount of the grants received from EU funds. The treatment variable under scrutiny, T_i, indicates the annual amount of grants received from EU funds expressed as a share in the enterprise's operating income in the period of one year prior to receiving the grant (*t-1*). Based on Hirano and Imbens (2005), we assume normal distribution of the treatment variable considering the vector of selected control variables:

$$T_i \mid X_i \sim N\left(\beta_0 + X_i\beta_1, \sigma^2\right) \tag{5}$$

whereby X_i is the same vector of the control variables used in the binary propensity score estimation. Since the empirical distribution of the relative amount of the grants received fails to meet the normality assumption, the analysis used its logarithmic transformation. The generalised propensity score is then estimated by applying the least squares method:

$$\hat{R}_i = \frac{1}{\sqrt{2\pi\hat{\sigma}^2}} exp\left(-\frac{1}{2\hat{\sigma}^2}\left(T_i - \hat{\beta}_0 - X_i\hat{\beta}_1\right)^2\right) \tag{6}$$

The second step entails an estimation of the conditional outcome expectation. Concretely, this refers to the average growth rate of the variables under scrutiny one year and two years after receiving the grant, as a function of the observable treatment levels and the estimated generalised propensity score, by using their squared approximation:

$$E[\Delta Y_i \mid T_i, R_i] = \alpha_0 + \alpha_1 T_i + \alpha_2 T_i^2 + \alpha_3 R_i + \alpha_4 R_i^2 + \alpha_5 T_i R_i \tag{7}$$

By using the assessed parameters from equation (7), the final step entails an estimation of the dose-response function, i.e., the average potential outcome of the vector of the variables under observation depending on the various relative levels of the received treatment *t*:

$$\hat{E}[\Delta Y(t)] = \frac{1}{N}\sum_{i=1}^{N}(\hat{\alpha}_0 + \hat{\alpha}_1 t + \hat{\alpha}_2 t^2 + \hat{\alpha}_3\hat{R}(t, X_i) + \hat{\alpha}_4\hat{R}\left(t, X_i\right)^2 + \hat{\alpha}_5 t\hat{R}(t, X_i)) \tag{8}$$

whereby N is the total sample size. Since dose-response is a non-linear function of the relative size of treatment *t*, one of the main advantages of the approach used is the fact that no restrictions are assumed in advance regarding the connection

between the continuous treatment intensity and outcome (Fryges and Wagner, 2008). The dose-response function is estimated for each distribution percentile at treatment *t* level on the [5,35] interval, which empirically contains relative amounts of the received grants. Since such an approach, similar to the binary propensity score, takes into account differences in features before receiving support, the estimated differences in average outcomes for two different treatment intensities can be interpreted as causal effects of the differences in intensity of support received from EU funds.

4.2 SELECTION OF VARIABLES FOR PROBIT MODEL

The selection of variables for the probit model mostly reflects key features and previous knowledge regarding the utilization of grants from EU funds by non-financial corporations. It is a known fact that a substantial amount of funds made available for funding projects of non-financial corporations from ESI funds is aimed at stimulating capital investment in production capacities. For this reason, beneficiaries of EU grants are more likely to come from capital intensive sectors. For this reason, sector of economic activity is a control variable in the model, while the enterprise's capital intensity level has been included as one of the independent variables. In addition, since the participation in a public tender for the award of grants from EU funds and drafting the tender documentation requires substantial administrative capacities, we can assume that the grant beneficiaries are slightly older enterprises with a higher number of employees and larger administrative capacities. These assumptions were also tested by means of the model's independent variables. Furthermore, the model tests whether higher or lower productivity, average salary levels and profitability level affect the probability for a selected enterprise to become grant beneficiary. Business conditions are often driven by social and economic conditions in the enterprise's immediate surroundings, which makes regional affiliation another control variable in the model.

The majority of professional literature on the topic of the effect of grants from EU funds uses most of the variables described above in probit models. However, having in mind specific circumstances of Croatian non-financial corporations, this research introduced additional independent variables in the probit model, which have, for one reason or another, been estimated to affect the probability of obtaining a grant. As highlighted in the competent ministries' programme documents related to the policies of using grants from EU funds, Croatia has virtually no risk capital market, while a relatively small number of SMEs are not in a position to obtain bank funding (OP Competitiveness and Cohesion 2014-2020, September 2017). In addition, high indebtedness levels are one of the most pressing structural problems of the non-financial enterprise sector (see Martinis and Ljubaj, 2017). We can therefore assume that, due to relatively high indebtedness levels, many enterprises are unable to obtain regular bank funding or obtain sufficient bank funding to finance their development projects in full. In such circumstances, EU funds are seen as an alternative source of funding, which is a hypothesis that was tested in the model.

In July 2013, Croatia became a full EU member state, which opened up the common European market to many Croatian exporters and had a strong impact on the growth of the overall export of goods and services in years immediately following the accession. We can assume that exporters are in the greatest need for expanding their business and their production or other capacities, which raises the probability of obtaining EU funding. In addition, exposure to international competition that comes with taking part in international markets makes exporters the most competitive part of national economy, which makes them substantially different from non-exporters (see Valdec and Zrnc, 2014, 2019).

5 ECONOMETRIC ANALYSIS RESULTS

5.1 RESULTS OF PROBIT MODEL AND PROPENSITY SCORE MATCHING

Results of the probit model presented in table 1 are in line with the above hypotheses. Grant beneficiaries are more likely to be older enterprises with more employees and greater capital and export intensity of business. They are also enterprises with higher indebtedness levels but also with higher profitability. On the other hand, labour productivity and total factor productivity were not shown as statistically significant determinants of receiving a grant from EU funds, whereas in the case of average salary and import intensity, this depends on the sample used.

In line with the methodology described above, the obtained results of the probit model were used for matching the enterprises in the control group. As shown in the table in appendix 3, matching has been successful and differences in arithmetic means of selected indicators between the corporate beneficiaries and their control group counterparts are not statistically significant, which was not the case before matching. All cases recorded more or less identical results, even when a strict pre-defined caliper value is used, i.e., maximum tolerated difference in the estimated propensity score between the treated enterprises and the control group enterprises (table in appendix 3).

Table 1

Results of probit model

Indicator	Basic pattern		Extended pattern	
	Marginal effects	Standard error	Marginal effects	Standard error
Labour productivity	0.076	(0.074)	0.044	(0.032)
TFP	0.009	(0.065)	0.017	(0.030)
Enterprise age	0.013***	(0.003)	0.004***	(0.001)
Employment rate	0.221***	(0.028)	0.186***	(0.014)
Capital intensity	0.024**	(0.011)	0.022**	(0.003)
Indebtedness rate	0.046***	(0.016)	0.045***	(0.007)
Average salary	0.093*	(0.057)	0.011	(0.016)
Profitability	0.078***	(0.022)	0.052***	(0.009)
Export intensity	0.047***	(0.016)	0.023***	(0.007)

Indicator	Basic pattern		Extended pattern	
	Marginal effects	Standard error	Marginal effects	Standard error
Import intensity	-0.002	(0.019)	0.033***	(0.008)
Control variables				
year	Yes		Yes	
NACE sector	Yes		Yes	
region	Yes		Yes	
Number of corporate beneficiaries	227		1,643	
Number of observations	476,682		482,503	
McFadden Pseudo R^2	0.3251		0.2665	

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively. The basic pattern pertains to 227 corporate beneficiaries that received their first EU grant no later than 2016. These enterprises were used throughout the analysis. On the other hand, the extended pattern pertains to all corporate beneficiaries after sample adjustments, including those that received their first grant after 2016.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

5.2 RESULTS OF THE DIFFERENCE IN DIFFERENCES METHOD

As visible in tables 2 and 3, the quantifications of the effects of receiving grants from EU funds show that EU grants had a strong positive effect on the majority of the twelve observable indicators of business performance and features for corporate beneficiaries. However, the effect of the grant was not equally apparent throughout the observed period; rather, for the majority of indicators it gradually increased as more time passed from the initial allocation. For some variables, the effect in the first two years (*t* and *t+1*) was non-existent or not statistically significant and only became evident in the last year under observation (*t+2*).

For measuring the effect of EU grants on the trends in the corporate beneficiaries' outputs, we selected two indicators – change in operating income and change in total added value. As visible from table 2, obtaining an EU grant had a strong positive effect on the growth dynamics of operating income and total added value, both in the year the support was received and in the two years that followed. The results show statistical significance in all calculations conducted with more enterprises in the control sample as well as when caliper is used (for additional calculations see appendix 4 below). Depending on the number of enterprises in the control sample, an enterprise's operating income rises up to 20% quicker in the year the grant was allocated (*t*) than is the case with enterprises in the control sample, between 20% to 30% quicker in the year following the year of allocation (*t+1*), while two years after the allocation (*t+2*) this difference grows above 30%. The results for the total added value indicator are very similar to operating income quantifications and their effect also rises as more time passes from the initial allocation of the support.

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

Table 2

Results of the analysis of selected indicators by applying the difference in differences method

Indicator	Period	Number of nearest neighbours			
		No caliper		Caliper (0.05)	
		1	5	1	5
Operating income	t	0.213***	0.163**	0.319**	0.138***
	t+1	0.173*	0.257**	0.290***	0.270***
	t+2	0.286***	0.295***	0.236*	0.317***
Added value	t	0.167***	0.126***	0.141**	0.102***
	t+1	0.213***	0.240***	0.311***	0.244***
	t+2	0.332***	0.353***	0.388***	0.321***
Fixed assets	t	0.513***	0.502***	0.488***	0.516***
	t+1	0.610***	0.659***	0.721***	0.679***
	t+2	0.580***	0.658***	0.868***	0.636***
Employment rate	t	0.076***	0.069***	0.103***	0.080***
	t+1	0.106***	0.129***	0.235***	0.167***
	t+2	0.141***	0.180***	0.270***	0.201***
Labour productivity	t	0.080*	0.050	0.031	0.014
	t+1	0.094*	0.100**	0.054	0.061
	t+2	0.175***	0.158***	0.098	0.103**
TFP	t	0.062	0.033	0.018	-0.002
	t+1	0.059	0.084	0.092	0.072
	t+2	0.160**	0.171***	0.161**	0.139***
Number of treated observations		226	226	219	215
Number of control observations		218	985	212	933

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively. Statistical significance was determined by means of a bootstrapping procedure with 500 repetitions.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

We might wonder what aspect of the corporate beneficiary changed in the observation period after receiving support that caused the quicker output growth. This can be caused, on the one hand, by a stronger growth of business capacities or, on the other hand, by quicker growth of labour productivity and total factor productivity. The obtained calculations can lead to the conclusion that the notably quicker growth of outputs with corporate beneficiaries is a combination of both options referred to above, i.e., both more intense growth of labour productivity and stronger increase of total factor productivity.

Corporate beneficiaries throughout the observation period recorded up to 70% more dynamic growth of the value of fixed assets relative to enterprises in the control group. Even though this is quite a substantial difference, it is also not unexpected considering the purpose of the grants from EU funds referred to above, where one of the priorities is stimulating capital investment in production capacities. Despite being notably weaker than in the case of fixed assets, the effect on

employment growth dynamics was also quite significant, but in the case of employment indicators the effect growth becomes apparent as more time passes from the initial allocation. In line with this, corporate beneficiaries recorded 7% to 8% more intense growth of total employee numbers in the year the grant was allocated (*t*) compared to enterprises in the control group, while in the following year (*t+1*) this effect grew to the 10%-16% range, depending on the calculation used, while in the last year under observation (*t+2*), the total employee numbers increased by as much as 22%.

Considering the above, we should ask the question about the trends in labour productivity and total factor productivity. The results suggest that the year the support was obtained (*t*) as well as the following year (*t+1*) recorded more intense growth of labour productivity and total factor productivity compared to enterprises in the control group, but the obtained results were not statistically significant in all calculation combinations with more enterprises in the control sample, so these results should be taken with a degree of caution. However, the last year under observation (*t+2*) recorded a notably more intense growth of both productivity indicators with high statistical significance for both quantifications, most notably with total factor productivity. The growth in labour productivity recorded by corporate beneficiaries two years after obtaining support was up to 17% higher, while the growth of total labour productivity was up to 18% higher than was the case with enterprises in the control group.

These results related to productivity indicators can partially be explained through the assumption that enterprises need longer time to train new employees or perhaps use new machinery and equipment in its full capacity, which is why the effect on productivity becomes apparent only near the end of the observation period. However, the results related to the productivity trends are highly significant, since they show that the grants from EU funds not only facilitate more intense enterprise growth but also affect productivity growth rates, which makes the corporate beneficiary more competitive both on the domestic and international market.

In addition, it is a well-known fact that grants from EU funds may only be used to co-finance projects, while the remaining funds need to be collected from other sources. For this reason, this research also monitors indebtedness level trends of corporate beneficiaries and enterprises in the control group. As visible in table 3, the obtained results verify the assumption regarding the quicker growth of indebtedness, i.e., corporate beneficiaries' indebtedness levels throughout the three-year observation period have grown notably quicker than was the case with enterprises in the control group, while the effect enhances as more time passes after obtaining support. Apart from indebtedness levels, an additional issue is whether enterprises undergo other structural changes in business performance. For instance, does the grant obtained from EU funds enable corporate beneficiaries to pay higher salaries than enterprises from the control group? Quantifications obtained in this regard are extremely low and are not statistically significant. On the other hand, the

results show that, despite employee numbers growing, corporate beneficiaries' capital intensity is even higher, i.e., the effect of the grant is stronger on the capital factor than on the labour factor.

Table 3

Results of the analysis of selected indicators by applying the difference in differences method

Indicator	Period	Number of nearest neighbours			
		No caliper		Caliper (0.05)	
		1	5	1	5
Indebtedness rate	t	0.156*	0.176***	0.179*	0.171**
	t+1	0.267**	0.274***	0.324***	0.264***
	t+2	0.334**	0.294***	0.300**	0.296***
Average salary	t	0.005	-0.008	0.008	-0.006
	t+1	-0.026	-0.007	-0.022	-0.003
	t+2	0.035	0.021	0.044*	0.029
Capital intensity	t	0.539***	0.503***	0.444**	0.510***
	t+1	0.567***	0.577***	0.547**	0.551***
	t+2	0.476**	0.507***	0.657***	0.453**
Profitability	t	-0.034	-0.057	-0.081	-0.098
	t+1	-0.143	-0.115	-0.197**	-0.214***
	t+2	-0.136	-0.169*	-0.320***	-0.255***
Export intensity	t	-0.084	-0.011	0.015	-0.004
	t+1	-0.166*	-0.083	-0.037	-0.045
	t+2	-0.161	-0.058	0.027	-0.007
Import intensity	t	0.021	0.005	0.113	0.066
	t+1	0.005	-0.003	0.168	0.074
	t+2	0.094	0.131	0.191	0.159*
Number of treated observations		226	226	219	215
Number of control observations		218	985	212	933

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively. Statistical significance was determined by means of a bootstrapping procedure with 500 repetitions. Additional calculations with control samples comprising 2 and 10 nearest neighbours are provided in appendix 4 below.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

However, with regard to corporate beneficiaries' profitability, no unambiguous reply can be provided. The obtained results show that profitability growth recorded by corporate beneficiaries in the years after receiving the support is notably slower than the growth recorded by enterprises in the control group, which may, at first sight, seem contrary to the previous results for other performance indicators, which showed a highly positive effect. Several explanations can be provided. In this research, we used the relative indicator of profitability – return on assets (ROA), which means that relative profitability, i.e., the total utilization rate of an asset unit, recorded slower growth or drop, but the enterprise's profitability in absolute terms grew.

Namely, the projects under consideration may be of questionable profitability if they were financed by the enterprise's own funds or debt capital because the rise in operating income due to expansion of business would not cover the costs of depreciation and servicing of new debt. In addition, every project assumes a certain return rate for the investor; if the European projects under observation were funded only by the enterprise's own and/or debt capital instead of EU grants, they would be unable to meet the required return-on-investment rate and would be seen as less profitable. On the other hand, another explanation is possible, one that is closely connected to the capital budgeting theory, which assumes that in limited financing situations an enterprise would pursue the most profitable projects at the expense of less profitable ones. EU support provides an enterprise with an additional source of capital which can be used to materialise even less profitable projects. This would make relative profitability decrease or grow at a slower pace relative to enterprises in the control sample, whereas absolute profitability would grow. However, this does not mean that in more developed financial market conditions, where small and medium enterprises have more access to financing, such projects would not be materialised.

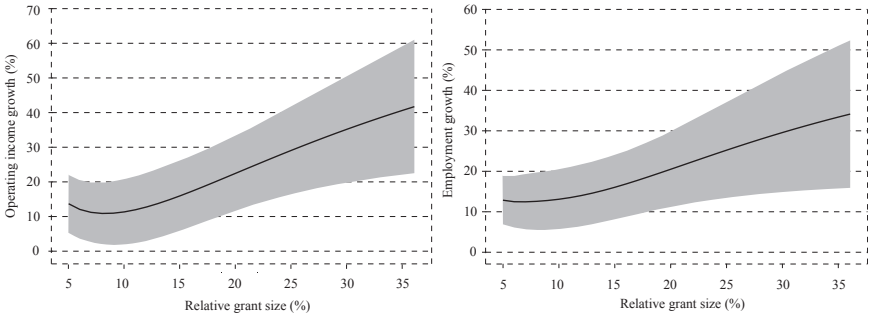
Finally, positive economic effects of support from EU funds are often disputed through assumed strong import growth. Since the results show that EU grants genuinely facilitate an increase in enterprises' business capacities and sales rates, it would be reasonable to expect import rates to record intense growth considering the Croatian economy being import-dependent. However, it is still unknown whether import growth is disproportionate to enterprise growth, i.e., whether import rates grow at a quicker pace than sales revenue, which would represent a growth in import intensity or import dependence of the enterprise under observation. The obtained results show that corporate beneficiaries did not record growth neither in their export nor import intensity in the years after receiving support.

5.3 ESTIMATE OF THE RELATIONSHIP BETWEEN SIZE OF SUPPORT AND LEVEL OF IMPACT (DOSE-RESPONSE)

An additional question to be answered is whether there is a difference in the level of the impact depending on the size of the received support, i.e., what is the lowest amount of grant that gives rise to positive effects on corporate beneficiaries' business performance. Findings related to the ratio between relative size of the received grant and level of impact can have notable policy implications, in this case competent bodies that, together with EU institutions, create policies for allocating grants from EU funds. Public grants always run into the risk of becoming inefficient or unattractive for the target group when the programme attempts to enhance its outreach at the expense of relative size of the support.

Figure 1

Estimate of the relationship between grant size and impact level on trends in operating income (left) and total employment rate (right)



Note: The solid black curve depicts the conditional expectation of growth rates of the indicator under observation with the provided relative intensity of treatment and estimated generalised propensity score. The shadowed sections represent the ceiling and floor values of the 95% confidence interval calculated through the bootstrapping method with 500 repetitions.

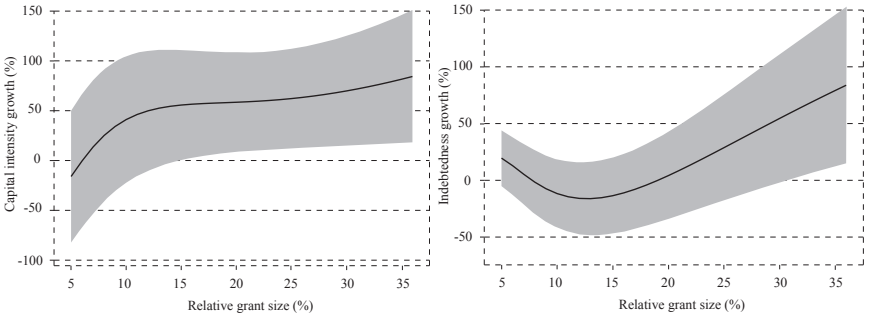
Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

Figure 1 shows the results of the estimate regarding the effects of EU grants on trends in employment numbers and operating income for enterprises under observation in relation to the relative size of the received grant. As visible in the figures above, the curve starts out flat for both indicators, which leads to the conclusion that grants whose relative size is below 10% of a corporate beneficiary's operating income have a roughly equal and relatively weak effect on trends in employment numbers and operating income of enterprises under observation in the period after receiving the grant. However, above this threshold the effect of the grant is more prominent and grows more extensively as the relative size of the received grant increases. For instance, enterprises that received a grant in the amount of 35% of their operating income can expect their operating income to grow four times quicker while their employment numbers on the basis of hours of labour could grow three times quicker. However, growth of the grant size is accompanied by an increase in confidence intervals. For this reason, all conclusions should be taken with a degree of caution.

These results can partially be explained by the fact that enterprises apply to public tenders for a variety of business reasons. Low-impact grants are mostly used by enterprises whose objective is to enhance their current performance, e.g., by procuring new machinery or equipment to replace old or less efficient machinery, but not necessarily for expanding their business. Such enterprises are not in dire need for new recruits, which is part of the reason why the employment rate curve starts out flat. Conversely, beneficiaries of relatively large grants are those enterprises that use EU funds to co-finance the expansion of their business or boost their production and sales numbers, which is why they need a substantially larger grant to finance a capital intense investment and recruit additional employees.

Figure 2

Estimate of the relationship between grant size and impact level on trends in corporate beneficiaries' capital intensity (left) and indebtedness levels (right)



Note: The solid black curve depicts the conditional expectation of growth rates of the indicator under observation with the provided relative intensity of treatment and estimated generalised propensity score. The shadowed sections represent the ceiling and floor values of the 95% confidence interval calculated through the bootstrapping method with 500 repetitions.

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

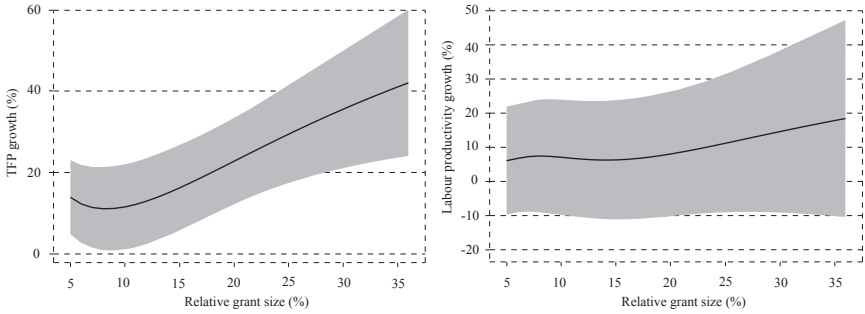
Such an explanation is supported by the obtained results regarding the trends in corporate beneficiaries' capital intensity and indebtedness levels. As visible in figure 2 (left), the effect on the growing trend of capital intensity is the strongest up to grant size of 10%, as seen by the steep incline of the curve, while the effect above this threshold is still quite strong but with the curve much flatter. Taking into account the method for calculating capital intensity of business as the ratio between the value of fixed assets and employment rates expressed in hours of labour, the previous hypothesis can be corroborated. The commercial reason behind taking a relatively smaller grant is the enhancement of current business, for instance by procuring new machinery, which increases the value of the enterprise's fixed assets (because existing equipment has already been depreciated), while there is no need for new employees. For this reason, the capital intensity of business, expressed through the ratio above, grows. However, in cases where an enterprise uses EU support to finance the expansion of its business activities, for instance, by procuring new equipment and recruiting new employees, the business capital intensity grows more steadily and the curve is flatter.

The estimate of the relationship between the relative size of the grant and effect on the trends in enterprises' indebtedness levels leads to more-or-less the same conclusions (figure 2 right). Enterprises that implement financially less substantial projects (projects worth up to 10% of operating income), apart from co-financing provided by the EU, usually cover the rest of the required amount from their own revenues. In such cases, the received grant increases the value of the enterprise's property on the asset side and capital on the liability side, while the level of debt financing remains the same, which ultimately leads to a drop in indebtedness levels expressed as the share of commitments in sources of financing. On the other hand, projects that

are used for substantially expanding enterprises' business activities carry a greater financial burden notwithstanding EU support. The remaining amount of co-financing cannot be covered from the enterprise's own resources and enterprises resort to debt financing of the remaining amount, which increases their indebtedness indicator and the curve of the estimated effect changes direction after crossing the 10% relative grant size benchmark. Despite being merely indicative, these conclusions should be taken with a degree of caution due to relatively wide confidence intervals caused by a relatively small number of observations.

Figure 3

Estimate of the relationship between grant size and impact level on trends in total factor productivity (left) and labour productivity (right)



Note: The solid black curve depicts the conditional expectation of growth rates of the indicator under observation with the provided relative intensity of treatment and estimated generalised propensity score. The shadowed sections represent the ceiling and floor values of the 95% confidence interval calculated through the bootstrapping method with 500 repetitions.

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

Finally, productivity indicators provide no unambiguous conclusions (figure 3). Namely, as was the case with all indicators described above, the effect on total factor productivity trends grows notably after the relative size of the grant grows above the 10% threshold of the enterprise's operating income. However, in the case of labour productivity, the curve is almost completely flat all the way up to relative grant size of 20% of operating income, with extremely wide confidence intervals. Despite limitations of the conducted analysis, the majority of the indicators considered demonstrate a positive relationship between relative size of the grant and level of impact, especially when relative grant size is higher than 10% of the enterprise's operating income.

This is an important conclusion in the context of overall efficiency and cost-effectiveness of the public policy under observation, more specifically the allocation of public grants from EU funds to the non-financial corporation sector. Since these grants are often very substantial in financial terms and cover up to 85% of the applied project value, there is a certain moral hazard risk – a situation in which an enterprise uses the grant to increase its production capacities for virtually no cost,

despite there being no commercial reason for such a decision had the project been financed through the enterprise's own resources. We already discussed the issue of cost-effectiveness of European projects considering the obtained results regarding the effect of the grant on relative profitability trends. However, the results we obtained with regard to the causal relationship between grant size and impact level, especially when it comes to stronger growth of operating income in parallel to the growth of relative grant size, support the hypothesis that the grant allocation programme is, in fact, efficient.

In conclusion, the obtained results can be compared to similar research conducted for other countries. In general, one can say that the results are very similar and that other pieces of research also reveal several positive effects of receiving grants from EU funds on a variety of enterprises' performance indicators. If we compare our results to those in Benkovskis et al. (2018) or Bachtrogler and Hammer (2018), we can see that the findings are quite similar, in that the effect on employment numbers, revenue and capital intensity becomes visible soon after obtaining the grant. On the other hand, none of these papers was able to find an unambiguous effect on productivity. Bachtrogler and Hammer (2018) discover a short-term rise in enterprises' productivity levels only for a few countries and only depending on the variable definition. Similar to the present research, Benkovskis et al. (2018) find positive effects on productivity trends only after a few years have passed from receiving the grant.

6 CONCLUSION

This paper tried to answer several research questions, primarily the question regarding the effects of receiving grants from EU funds on business performance of non-financial corporations. The results show that the support obtained from EU funds had a strong positive effect on the majority of the twelve selected performance indicators and business features of corporate beneficiaries. If we look at the individual indicators, the obtained results show that corporate beneficiaries, when compared to enterprises in the control group, recorded a notable growth in outputs in the period after receiving the grant, expressed as either trends in operating income or total added value generated. The intensification of the enterprises' output growth dynamics arises due to quicker growth of production factors, i.e., labour and capital. In addition, the analysis also determined significant and positive effects of the obtained EU grant on the enterprises' productivity, expressed as either labour productivity or total factor productivity, especially two years after receiving the grant ($t+2$).

The research has also shown that the grants resulted in structural changes, which led to the corporate beneficiaries' performance becoming more capital intense. At the same time, we recorded quicker growth of indebtedness levels since EU grants are used only for co-financing projects while the remaining amounts must be covered from other sources. In addition, the results show that profitability growth recorded by corporate beneficiaries in the years after receiving the grant is notably

slower, which may, at first sight, seem contrary to the previous results for other performance indicators, which showed an extremely positive effect.

Apart from demonstrating the effect of grants received from EU funds, the paper also determined which business features of enterprises affect the probability of obtaining EU support. Results of the probit model showed that grant beneficiaries are more likely to be older enterprises with more employees and greater capital and export intensity of business. They are also enterprises with higher indebtedness levels but also with higher profitability. Average salary, labour productivity and total factor productivity as well as import intensity of business all failed to reach statistical significance for the probability of receiving the grant.

Finally, the paper estimated the relationship between the relative size of the grant and its level of impact. These results demonstrated the existence of a causal relationship and that the impact grows as the relative grant size grows, but only in cases when the grant exceeds 10% of operating income the enterprise collected in the year before receiving the grant. To the authors' best knowledge, this is the first professional paper to use the method above on the case of grants from EU funds.

As a conclusion, we should highlight that the slower utilization rate of grants from EU funds kept the focus of the public and competent authorities on improving the results regarding total utilization, considering the opportunity cost that would be incurred if such large amounts would remain unallocated. However, the utilization dynamics was substantially improved in the past several years and reached the average utilization rate at EU level according to some measures. For this reason, the competent authorities' next objective should be increasing the utilization rate in such a manner that the funds are allocated to those areas where they were successfully utilised. Research and analyses dealing with the effect of the grants on end beneficiaries are extremely important in this context. However, the significance of EU funds for Croatia is not reflected in the number of such analyses. This research is an attempt to improve the quality of public debate that should ultimately aim to improve the existing policy of using grants from EU funds.

Disclosure statement
No potential conflict of interest was reported by the authors.

REFERENCES

1. Ackerberg, D., Caves, K. and Garth, F., 2006. Structural identification of production functions. *MPRA Paper*, 38349.
2. Bachtrogler, J. and Hammer, C., 2018. Who are the beneficiaries of the structural funds and the cohesion fund and how does the cohesion policy impact firm-level performance? *OECD Economics Department Working Papers*, No. 1499. https://doi.org/10.1787/67947b82-en
3. Bartoluci, M. [et al.], 2018. Sredstva EU fondova u funkciji razvoja ruralnog turizma u Hrvatskoj. *Acta Economica Et Turistica*, 4(1), pp. 63-78.
4. Becker, B., Vanino, E. and Roper, S., 2019. Knowledge to money: assessing the business performance effects of publicly-funded R&D grants. *Research policy*, 48(7), pp. 1714-1737. https://doi.org/10.1016/j.respol.2019.04.001
5. Benkovskis, K., Tkacevs, O. and Yashiro, N., 2018. Importance of EU Regional Support Programmes for Firm Performance. *Latvijas Banka Working Papers*, No. 2018/01.
6. Bouayad-Agha, S., Turpinn, N. and Vedrine, L., 2011. Fostering the development of European regions: A spatial dynamic panel data analysis of the impact of cohesion policy. *Regional Studies,* 47(9), pp. 1573-1593. https://doi.org/10.1080/00343404.2011.628930
7. Breidenbach, P., Mitze, T. and Schmidt, C. M., 2016. EU Structural Funds and Regional Income Convergence – A sobering experience. *CEPR Discussion Paper*, No. 11210. https://doi.org/10.2139/ssrn.2758674
8. Cappelen, A. [et al.], 2003. The impact of EU regional support on growth and convergence in the European Union. *Journal of Common Market Studies*, 41(4), pp. 621-644. https://doi.org/10.1111/1468-5965.00438
9. Cerulli, G. and Poti, B., 2014. *Public support intensity and company R&D performance: Evidence from a dose-response model*. 54th Congress of the European Regional Science Association: "Regional development & globalisation: Best practices", 26-29 August 2014.
10. Crescenzi, R. and Giua, M., 2017. Different approaches to the analysis of EU cohesion policy. In: J. Bachtler [et al.], eds. *EU cohesion policy. Reassessing performance and direction.* London: Routledge. https://doi.org/10.4324/9781315401867
11. Dai, M., Li, X. and Lu, Y., 2017. How Urbanization Economies Impact TPF of R&D Performers: Evidence from China. *Sustainability*, 9(10), pp. 1-17. https://doi.org/10.3390/SU9101766
12. Dai, X. and Cheng, L., 2015. The effect of public subsidies on corporate R&D investment: An application of the generalized propensity score. *Technological Forecasting & Social Change*, 90(Part B), pp. 410-419. https://doi.org/10.1016/j.techfore.2014.04.014
13. Dall'Erba, S. and Le Gallo, J., 2007. Cohesion policy, the convergence process and employment in the European Union. *Czech Journal of Economics and Finance*, 57, pp. 324-340.

14. Dall'Erba, S. and Le Gallo, J., 2008. Regional convergence and the impact of European structural funds over 1989-1999: A spatial econometric analysis. *Papers in Regional Science*, 87(2), pp. 219-244. https://doi.org/10.1111/j.1435-5957.2008.00184.x
15. Darvas, Z., Mazza, J. and Midoes, C., 2019. How to improve European Union cohesion policy for the next decade. *Bruegel Policy Contribution*, (8).
16. De Zwaan, M. and Merlevede, B., 2013. Regional policy and firm productivity. *European Trade Study Group (ETSG) Working Paper*, No. 377.
17. ECB, 2014. Micro-based evidence of EU competitiveness: The Compnet database. *ECB Working paper series*, No. 1634.
18. Ederveen, S. [et al.], 2002. Funds and games: The economics of European cohesion policy. *ENEPRI Occasional Paper*, No. 3.
19. Ederveen, S., De Groot, H. L. F. and Nahuis, R., 2006. Fertile soil for structural funds? A panel data analysis of the conditional effectiveness of European cohesion policy. *Kyklos*, 59(1), pp. 17-42. https://doi.org/10.1111/j.1467-6435.2006.00318.x
20. Esposti, R. and Bussoletti, S., 2008. Impact of Objective 1 funds on regional growth convergence in the European Union: A panel data approach. *Regional Studies*, 42(2), pp. 159-173. https://doi.org/10.1080/00343400601142753
21. Fagerberg, J. and Verspagen, B., 1996. Heading for divergence? Regional growth in Europe reconsidered. *JCMS: Journal of Common Market Studies*, 34(3), pp. 431-448. https://doi.org/10.1111/j.1468-5965.1996.tb00580.x
22. Fattorini, L., Ghodsi, M. and Rungi, A., 2018. Cohesion Policy Meets Heterogeneous Firms. *WIIW Working Paper*, No. 142. https://doi.org/10.2139/ssrn.3488374
23. Ferrara, A. R. [et al.], 2016. Assessing the impacts of cohesion policy on EU regions: A non-parametric analysis on interventions promoting research and innovation and transport accessibility. *Papers in Regional Science*, 96(4), pp. 817-841. https://doi.org/10.1111/pirs.12234
24. Fryges, H. and Wagner, J., 2008. Exports and Productivity Growth: First Evidence from a Continuous Treatment Approach. *Review of World Economics*, 144, pp. 695-722. https://doi.org/10.1007/s10290-008-0166-8
25. Galuscak, K. and Lizal, L., 2011. The Impact of Capital Measurement Error Correction on Firm-Level Production Function Estimation. *Czech National Bank Working Papers*, No. 2011/09.
26. Gelo, T. and Družić, M., 2015. Ukupna faktorska produktivnost sektora hrvatskoga gospodarstva. *Ekonomska misao i praksa*, 2(2015), pp. 327-344.
27. Hagen, T. and Mohl, P., 2009. Econometric evaluation of EU Cohesion policy – A survey. *ZEW Discussion Paper*, No. 09-052.
28. Hartsenko, J. and Sauga, A., 2013. The role of financial support in SME and economic development in Estonia. *Business and Economic Horizons,* 9(2), pp. 10-22. https://doi.org/10.15208/beh.2013.6

29. Hirano, K. and Imbens, G. W., 2004. The propensity score with continuous treatments. *Applied Bayesian modeling and causal inference from incomplete-data perspectives*, pp. 73-84. https://doi.org/10.1002/0470090456.ch7
30. Kersan Škabić, I. and Tijanić, L., 2017. Regional abrorption capacity of EU funds. *Economic research - Ekonomska istraživanja*, 30(1), pp. 1192-1208. https://doi.org/10.1080/1331677X.2017.1340174
31. Kotarski, V., 2016. European funding – Impact on Research Capacity in Croatia. *Review of Innovation and Competitiveness: A Journal of Economic and Social Research*, 2(3), pp. 47-64. https://doi.org/10.32728/ric.2016.23/3
32. Levinsohn, J. and Petrin, A., 2003. Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies*, 70(2), pp. 317-341. https://doi.org/10.1111/1467-937X.00246
33. Maleković, S., Puljiz, J. and Keser, I., 2017. *The Impact of Cohesion Policy on Croatia`s Regional Policy and Development*. Zagreb: Institute for Development and International Relations.
34. Martinis, A. and Ljubaj, I., 2017. Prekomjerni dug poduzeća u Hrvatskoj: mikroprocjena i makroimplikacije. *HNB Istraživanja,* I-52.
35. Marzinotto, B., 2012. The growth effects of EU Cohesion policy: A meta-analysis. *Bruegel Working Paper*, No. 2012/14.
36. Medić, M., Hadrović Zekić, B. and Sabljo, V., 2017. Impact of EU Funds on Regional Development. In: U. Bacher [et al.], eds. *Interdisciplinary Management Research XIII*, pp. 1060-1077.
37. MINGO, 2017. *Operativni program Konkurentnost i kohezija 2014.-2020. – tehničke izmjene.* Zagreb: MINGO.
38. Moral Arce, I. and Paniagua San Martin, M., 2016. An impact evaluation of the EU funds on research and development in Spanish companies in 2007-2011. *Papeles de Trabajo del Instituto de Estudios Fiscales*, No. 7.
39. Olley, G. S. and Pakes, A., 1996. The dynamics of productivity in the telecommunications equipment industry. *Econometrica,* 64(6), pp. 1263-1297. https://doi.org/10.2307/2171831
40. Ott, K., Bronić, M. and Stanić, B., 2018. EU grants to Croatian counties, cities and municipalities 2015-2016. *Newsletter: an occasional publication of the Institute of Public Finance*, No. 114.
41. Pienkowski, J. and Berkowitz, P., 2015. Econometric assessments of Cohesion Policy growth effects: How to make them more relevant for policy makers? *European Commission Working Paper*, No. 02/2015.
42. Poljičak, A., 2017. The synergy of public procurement and management for projects financed from the European structural and investment funds. *Journal of Accounting & Management*, 7(1), pp. 57-68.
43. Rodriguez-Pose, A. and Fratesi, U., 2004. Between development and social policies: The impact of European structural funds in Objective 1 regions. *Regional Studies*, 38(1), pp. 97-113. https://doi.org/10.1080/0034340031000163226

44. Rosenbaum, P. R. and Rubin, D., 1983. The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, 70(1), pp. 41-55. https://doi.org/10.1093/biomet/70.1.41
45. Sikirić, S., Sikirić, A. and Vašiček, D., 2015. Lokalni proračun i programsko planiranje u funkciji financiranja projekata iz EU fondova. *Business Consultant / Poslovni Konsultant*, 7(51), pp. 31-42.
46. Šostar, M. and Marukić, A., 2017. Challenges of public procurement in EU funded projects. *Journal of Contemporary Management Issues*, 22(2), pp. 99-113. https://doi.org/10.30924/mjcmi/2017.22.2.99
47. Srhoj, S., Škrinjarić, B. and Radas, S., 2018. Bidding against the odds? The impact evaluation of grants for young micro and small firms during the recession. *Radni materijali EIZ-a*, 2(2018), pp. 5-37.
48. Valdec, M. and Zrnc, J., 2015. The direction of causality between exports and firm performance: microeconomic evidence from Croatia using the matching approach. *Financial Theory and Practice*, 39(1), pp. 1-30. https://doi.org/10.3326/fintp.39.1.1
49. Valdec, M. and Zrnc, J., 2019. Karakteristike hrvatskih izvoznika iz prerađivačkog sektora i oporavak izvoza tijekom velike recesije – rezultati istraživanja modula za trgovinu Istraživačke mreže za konkurentnost (CompNet). *HNB Pregledi P-42*.
50. Viskovic, J. and Udovičić, M., 2017. Awareness of SMEs on the EU Funds Financing Possibilities: The Case of Split-Dalmatia County. *KnE Social Sciences*, 1(2), pp. 319-332.
51. Wooldridge, J. M., 2009. On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters*, 104(3), pp. 112-114.

APPENDIX 1

LIST OF VARIABLES USED IN THE ANALYSIS

Variable name	Description	Note
Revenue	Real value of operating income	Deflated by GDP deflator
Employment rate	Total number of employees based on hours of labour	-
Fixed assets	Real value of fixed assets	Deflated by GDP deflator
Age	Number of years passed since the establishment of the enterprise	-
Added value	Difference between operating income and value of intermediary inputs and other costs of sold products	Deflated by implicit added value deflators to the second digit level of the National Classification of Activities (NACE). Energy costs have been deflated by the implicit added value deflator for the electricity, gas, steam and air conditioning supply sector
Labour productivity	Ratio between added value and number of employees	-
Total factor productivity	Residual of the Cobb-Douglas production function	See appendix 2 for more details on calculation methodology
Capital intensity	Ratio between fixed assets and number of employees	-
Profitability	Ratio between period profit and total assets	-
Indebtedness rate	Ratio between non-current liabilities and total commitments	-
Average salary	Ratio between total gross employee costs and number of employees	Deflated by implicit added value deflators to the second digit level of the National Classification of Activities (NACE)
Export intensity	Ratio between revenue from sales abroad and operating income	-
Import intensity	Ratio between import value and operating income	-
Regional affiliation	Divided into five regions: Eastern Croatia, Central Croatia, Northern Croatia, Adriatic Croatia and the City of Zagreb	An enterprise's geographic affiliation is classified into regions, which have been defined on the basis of the first version of the new NUTS-2 classification in Croatia (Institute for Development and International Relations, 2018). This classification is used here solely for analytical purposes

PUBLIC SECTOR ECONOMICS
45(2) 177-207 (2021)

APPENDIX 2

METHODOLOGY FOR CALCULATING TOTAL FACTOR PRODUCTIVITY INDICATORS

The starting point for calculating total factor productivity is the standard Cobb-Douglas production function, which can be expressed based on added value in logarithmic form as:

$$rva_{it} = a_{it} + \beta_K k_{it} + \beta_L l_{it} + \beta_M m_{it} + \varepsilon_{it}$$

where rva_{it} represents each enterprise's real added value, a_{it} denotes its efficacy level or residual, k_{it} represents fixed assets real value, l_{it} is total employment based on hours of labour, m_{it} denotes real value of material inputs used in the production process, while ε_{it} stands for estimate error. The methodology for calculating total factor productivity follows the approach developed by Olley and Pakes (1996) and its upgrade proposed by Levinsohn and Petrin (2003), Ackerberg et al. (2006), Wooldridge (2009) and Galuscak and Lizal (2011), i.e., the estimate is a third-level polynomial model in the following form:

$$\begin{aligned} rva_{it} = {} & \beta_0 + \beta_1 k_{it} + \beta_2 k_{i(t-1)} + \beta_3 m_{i(t-1)} + \beta_4 k^2_{i(t-1)} + \beta_5 m^2_{i(t-1)} \\ & + \beta_6 k^3_{i(t-1)} + \beta_7 m^3_{i(t-1)} + \beta_8 k_{i(t-1)} m_{i(t-1)} + \beta_9 k_{i(t-1)} m^2_{i(t-1)} \\ & + \beta_{10} k^2_{i(t-1)} m_{i(t-1)} + \gamma Year_t + \omega L_{i(t-1)} \end{aligned}$$

This approach is unique for using observable values of production inputs (after one year) as instruments for unobservable production shocks, which is important for controlling for simultaneity bias. The simultaneity bias arises due to the fact that, even though total factor productivity levels are not observable, they are known within an enterprise. In other words, any enterprise will, in any given period, select the optimal combination of production inputs in line with its production function after observing its own productivity levels. Ignoring the fact that labour, capital and material inputs are correlated to unobservable productivity at enterprise level can lead to inconsistent estimation of the production function (ECB, 2014). Since labour and total factor productivity are determined simultaneously, while material assets take time to develop, the instrumental variable used for measuring labour is its value one year after receiving the grant. The terms used in the estimated equation include material inputs and fixed assets up to third level and their interaction terms in order to account for their possible non-linear connection. The estimate also includes indicator control variables for the year, while standard errors have been grouped at enterprise level. For implementing the approach above, we use the generalized method of moments (GMM), similar to Wooldridge (2009).

After estimating the production function elasticity coefficients, the final step entails calculating total factor productivity, i.e., production function residual, of each enterprise through the following formula:

$$TFP_{it} = a_{it} = rva_{it} - (\hat{\beta}_0 + \hat{\beta}_1 k_{it} + \hat{\omega} L_{i(t-1)} + \hat{\gamma} Year_t)$$

APPENDIX 3

ARITHMETIC MEAN DIFFERENCES BETWEEN ENTERPRISES IN THE TREATED AND CONTROL GROUPS

Indicator	Before adjustments	Before merger	Number of nearest neighbours							
			No caliper				Caliper (0.05)			
			1	2	5	10	1	2	5	10
Labour productivity	0.580***	0.729***	-0.042	0.000	-0.032	-0.036	-0.032	0.047	0.014	-0.010
Enterprise age	4.431***	6.573***	0.430	0.560	0.459	0.295	1.157	0.513	0.783	1.147*
Employment rate	1.530***	1.791***	-0.145	-0.075	-0.020	0.040	0.023	-0.050	0.084	0.209**
TFP	1.066***	1.168***	-0.053	-0.005	-0.030	-0.023	-0.130	-0.027	0.008	0.032
Capital intensity	3.022***	3.790***	-0.123	0.005	-0.013	-0.016	-0.086	0.017	-0.019	0.032
Export intensity	0.970***	1.515***	0.091	0.093	0.116	0.126	-0.101	0.174	0.154	0.220*
Indebtedness rate	0.648***	0.955***	-0.063	-0.027	-0.044	-0.018	0.007	-0.095	-0.068	0.036
Number of treated observations	1,921	226	226	226	226	226	219	219	215	213
Number of control observations	772,528	441,846	218	417	985	1,787	212	411	933	1,694

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

APPENDIX 4

ANALYSIS RESULTS FOR SELECTED BUSINESS PERFORMANCE INDICATORS THROUGH THE DIFFERENCE IN DIFFERENCES METHOD WITH CONTROL GROUP OF 2 AND 10 NEAREST NEIGHBOURS

Indicator	Period	Number of nearest neighbours			
		No caliper		Caliper (0.05)	
		2	10	2	10
Operating income	t	0.200***	0.182***	0.219**	0.210**
	t+1	0.300**	0.309***	0.288***	0.292***
	t+2	0.328***	0.324***	0.308***	0.346***
Added value	t	0.148***	0.134***	0.125**	0.129***
	t+1	0.248***	0.256***	0.227***	0.256***
	t+2	0.328***	0.375***	0.326***	0.364***
Fixed assets	t	0.506***	0.482***	0.470***	0.465***
	t+1	0.632***	0.695***	0.735***	0.748***
	t+2	0.582***	0.709***	0.709***	0.722***
Employment rate	t	0.073***	0.071***	0.080***	0.081***
	t+1	0.123***	0.142***	0.166***	0.160***
	t+2	0.187***	0.184***	0.220***	0.202***
Labour productivity	t	0.067	0.055	0.032	0.041
	t+1	0.113*	0.100**	0.045	0.083*
	t+2	0.123**	0.175***	0.087*	0.149***
TFP	t	0.057	0.039	0.026	0.024
	t+1	0.109*	0.089*	0.046	0.081*
	t+2	0.147***	0.189***	0.112**	0.169***
Indebtedness rate	t	0.189**	0.200***	0.165**	0.200***
	t+1	0.348***	0.287***	0.317***	0.301***
	t+2	0.336***	0.289***	0.277**	0.297***
Average salary	t	-0.003	0.005	-0.002	0.009
	t+1	0.016	-0.003	0.019	0.001
	t+2	0.014	0.029	0.023	0.042
Capital intensity	t	0.511***	0.474***	0.432***	0.457***
	t+1	0.557***	0.603***	0.620***	0.660***
	t+2	0.416***	0.571***	0.541***	0.585***
Profitability	t	-0.028	-0.052	-0.083	-0.105
	t+1	-0.101	-0.130*	-0.145*	-0.183**
	t+2	-0.178*	-0.192**	-0.214**	-0.259***
Export intensity	t	-0.024	-0.010	-0.018	0.013
	t+1	-0.079	-0.079	-0.096	-0.055
	t+2	-0.102	-0.071	-0.089	-0.001
Import intensity	t	0.025	0.026	0.052	0.022
	t+1	0.021	0.052	-0.001	0.034
	t+2	0.163	0.121	0.075	0.128
Number of treated observations		226	226	219	213
Number of control observations		417	1,787	411	1,694

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively. Statistical significance was determined by means of a bootstrapping procedure with 500 repetitions.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

APPENDIX 5

GENERALISED PROPENSITY SCORE (GPS) ESTIMATES

Indicator	Coefficient	Standard error
Employment rate	-0.495***	0.085
Capital intensity	-0.074**	0.031
Labour productivity	-0.191**	0.085
TFP	7.69E-10	5.38E-10
Age	0.095	0.121
Export intensity	0.016	0.054
Indebtedness rate	0.148***	0.052
Number of observations	217	

*Note: *, ** and *** mark statistical significance levels of 10%, 5% and 1% respectively. Statistical significance was determined by means of a bootstrapping procedure with 500 repetitions.*

Source: Authors' own calculation based on data by the Ministry of Finance, Financial Agency and Court Registry.

Public sector cost accounting and information usefulness in decision-making

ANDRIJANA ROGOŠIĆ, Ph.D.*

Article**
JEL: M41, H72
https://doi.org/10.3326/pse.45.2.2

* The author wants to thank the two anonymous reviewers for insightful comments and suggestions.
** Received: November 23, 2020
Accepted: February 8, 2021

Andrijana ROGOŠIĆ
University of Split, Faculty of Economics, Business and Tourism, Cvite Fiskovića 5, 21000 Split, Croatia
e-mail: arogosic@efst.hr
ORCiD: 0000-0003-0532-527X

PUBLIC SECTOR ECONOMICS
45(2) 209-227 (2021)

Abstract

This paper explores the use of accounting information at the local and regional government level in Croatia. Accountants provide cost accounting information mainly on request from internal users. The usefulness of this information is observed from the accountant viewpoint, in order to perceive accountants' understandings of how decision-makers use accounting data. A questionnaire was used as a research instrument in order to assess the level of accounting information use and usefulness among governing politicians and other public managers. Empirical results indicate that the legal representatives of the budgetary users (public managers) are more inclined than governing politicians to use accounting information in decision-making. Cost accounting information is most useful for planning and control and least beneficial when prices of public services are being set. Public sector cost accounting in Croatia is well implemented and constraints on its further development are not highly in evidence.

Keywords: public sector accounting, cost accounting, public management

1 INTRODUCTION

The accountability of politicians and public managers for their management of public finances has been studied from various aspects (e.g. Ranson, 2003; Bovens, Schillemans and Hart, 2008; Samaratunge, Alam and Teicher, 2008; Ngwakwe, 2012; Bach, 2020). Saliterer and Korac (2013: 503) argued that boundaries between public sector, private sector, and non-profit organizations are fading because "the delivery of public services is increasingly characterized by hybrid forms of organization, variously described as partnerships, collaborations, networks, alliances and, most prominently, as public-private partnerships". These alterations in governance structures question the traditional meaning of accountability and lead to a shift towards accountability based on performance, where accounting information becomes important. Moving from cash-based towards accrual-based public sector accounting could contribute to a new aspect of public accountability that should support the assessment of efficiency and effectiveness of public organizations. The use of accounting-based performance information to rationalise decision-making may lead to better public service performance (George et al., 2020). Thus, the increase of public sector service performance should positively affect perceived accountability.

Many countries have been introducing changes in public sector accounting during the last two decades. These changes have made the use of financial information more important in the public sector (Jorge, Jorge de Jesus and Nogueira, 2019: 542). The first step in accounting reform is a shift from cash-based to accrual-based accounting. Accrual based public sector accounting enabled more appropriate public management by providing relevant information for decision-making (Ezzamel et al., 2005; Jorge, Jorge de Jesus and Nogueira, 2019; George et al., 2020).

Public sector accounting should be a support in "delivering more appropriate, more accountable and better public management, as well as strengthening democratic

processes" (Ezzamel et al., 2005: 58). Therefore, it is necessary that key public sector stakeholders, including politicians, are familiar with accounting information if they want to make it the basis of debate. In most democracies, public managers and politicians are expected to use accounting information (Guarini, 2016). So far, scholars (Ter Bogt, 2004; Askim, 2007; Liguori, Sicilia and Steccolini, 2012; Liguori and Steccolini, 2018; Salitater et al., 2019; George et al., 2020) have examined the use of accounting information by politicians and/or public managers but the view of public sector accountants on this matter has largely been underestimated (Ouda and Klischewski, 2019). However, since public sector accountants are providers of accounting information, their opinion on its use and usefulness might well be more objective.

This paper explores implementation of public sector cost accounting as a source of relevant information for politicians and public managers in the decision-making process. The usefulness of cost accounting in public entities is also examined. Furthermore, the obstacles of public sector cost accounting development are investigated from the accountants' perspective.

The reminder of paper is organised as follows. The next section consists of a review of the literature on public sector financial accounting with the emphasis on the use of accounting information by politicians and other public managers. Prior studies on public sector cost accounting are summarised in the third section. Based on the conceptual and empirical insights, hypotheses are formulated and explained in the fourth section. The research methodology is explained in the fifth section where the elaborated results are presented. Concluding remarks are stated in the final section.

2 PUBLIC SECTOR ACCOUNTING AND THE USE OF ACCOUNTING INFORMATION

Historically, public sector accounting was cash based due to the budgeting purposes. Budgeting, as a planning and control mechanism, is still an important process at all levels of government. The budget can be defined as "a political act which translates political goals into appropriations of financial resources" (Liguori, Sicilia and Steccolini, 2012: 905). However, public sector accounting systems worldwide have undergone significant changes during recent decades. Countries have introduced accrual and modified accrual financial accounting for governmental entities although some of them still use cash-based accounting (for instance at central government level). In order to make public sector accounting information comparable, the International Public Sector Accounting Standards (IPSAS) were developed but even though they have been available more than two decades, they are only partially adopted in some countries. On the other hand, the European Commission (EC) has taken serious steps by establishing harmonized public sector accounting standards for EU member countries (Mann et al., 2019). Since the IPSAS have been criticized for being too similar to the accounting standards for the private sector, the EC initiated the development of the European Public Sector Accounting Standards (EPSAS). EPSAS are not yet published and therefore not in use. Nevertheless, EU member

PUBLIC SECTOR ECONOMICS
45(2) 209-227 (2021)

countries have gradually undergone a transformation of their public sector accounting. This modernization of public sector accounting system has been often translated into an increased focus on performance information. Performance information normally entails the quantity and quality of government activities and services as well as efficiency and effectiveness (Van Helden, 2016). Lau, Lonti and Schultz (2017: 182) argued that public sector productivity (which has a significant impact on the performance of national economy and societal well-being) "cannot be understood without the ability to measure it, which requires good quality and, if possible, internationally comparable input and output measures of public sector services". Therefore, the role of accounting information in this context should not be underestimated. Contemporary public sector accounting is complex and offers wide range of financial information.

There are several users of accounting information in the public sector such as citizens (also referred in the literature as the public), public managers, legislative and other governing bodies, investors and creditors, internal and external auditors, and economic and financial analysts. Governing politicians are considered the primary users of public sector budgeting and financial information since they are representatives of citizens and therefore the decision-makers (Giacomini, Sicilia and Steccolini, 2016; Jorge, Jorge de Jesus and Nogueira, 2019; Ouda and Klischewski, 2019). Van Helden (2016: 535) pointed out that politicians often face complexities in decision-making, as when they are choosing among different options in order to solve a problem or when they are accepting the proper information sources. Ezzamel et al. (2005: 58) noted that there is "a danger to democracy where accounting information is extensively used in decision-making but, at best, only understood, or partially understood, by a small number of politicians". Ter Bogt (2004) found out that politicians in Dutch municipalities rely much more on information from informal and oral sources than on data from the annual reports, budgets, and interim reports (which contain formal, written, largely numeric accounting information). Giacomini, Sicilia and Steccolini (2016: 488) noticed that the level of political conflict affects the quantity and the type of information used. Accounting information is used for the sake of reassurance when there is little political conflict but when political conflict rises, this information could be misused in rhetoric. Ezzamel et al. (2005) investigated the use of accounting information among the politicians in the Northern Ireland Assembly and commented that many political decision makers are unaware of the meaning of some significant accounting information. Empirical research on Austrian parliament members (Salitater et al., 2019: 839) revealed that some politicians stated, "… more frequent reports on the progress toward outcome targets would make sense if the quality of performance information were higher". There are also governing politicians who believe that it is the right but also the duty (of parliament members) "to proactively seek performance information more frequently" (Salitater et al., 2019: 839). A study on small Italian municipalities showed that politicians used both financial and non-financial information to reach the final decision especially when they are faced with high pressure from the citizens (Giacomini, Sicilia

and Steccolini, 2016: 488). Financial and non-financial information is nowadays encompassed by the integrated report that represents a new form of reporting. An integrated report focuses on value creation process and includes information on environmental, social and governance (ESG) activities; this represents a new trend in public sector reporting (Manes-Rossi and Orelli, 2020).

Analysing relationship between accounting and accountability in the South African public sector, Ngwakwe (2012: 414) noticed that the main factors inhibiting public financial accountability and service delivery are: limited accounting knowledge and financial skills, corruption, political "godfatherism" and insufficient transparency in public financial management.

3 COST ACCOUNTING IN PUBLIC ENTITIES

Cost accounting is an accounting subsystem that is usually considered an internally oriented accounting procedure. Unlike financial accounting, cost accounting is not mandatory in any organisation. The main task of cost accounting is to provide information about costs and processes to managers and other, mainly internal, stakeholders (Bertoni, De Rosa and Dražić Lutilsky, 2017: 110). Thus, data delivered by cost accounting should be decision-relevant information.

Accountants who work in public sector cost accounting must carefully design the reports on costs, which should be tailored according to public management needs and preferences. Because of its significance to efficient and effective public management, senior government officials now have an important role in the implementation and further development of cost accounting (IFAC, 2000).

In order to implement advanced cost accounting techniques and methods public sector entities should apply accrual accounting (Bertoni, De Rosa and Dražić Lutilsky, 2017; Jovanović, Dražić Lutilsky and Vašiček, 2019). A comprehensive cross-country study (IFAC, 2000) has revealed that for governments employing a modified accrual-based accounting, a stand-alone cost accounting system is quite easy to implement if they have asset registers that can be used to calculate amortization and depreciation. Thus, governments with accrual-based financial accounting are in a position to develop useful managerial cost information (through cost analysis available from their cost accounting records). National regulations and a proactive approach are also playing a crucial role in the application of cost accounting (Jackson and Lapsley, 2003; Dražić Lutilsky and Dragija, 2012).

Public sector cost accounting has several basic management functions (Dražić Lutilsky, Vašiček and Vašiček, 2012: 419):

- Budgeting – Budgets can be defined and carried out on a cash basis or on an accrual basis. Incurred costs are comparable with budgets if they are formulated on an accrual basis;
- Cost control and cost reduction – Information on costs enables identification of non-value-added activities that must be reduced;

- Pricing and fee setting – Information on costs is important in the decision-making process for setting prices and user fees for government-provided goods and services;
- Performance measurement – Cost efficiency measures of service efforts and measures of accomplishments as well as other measures provide the combination of financial and non-financial feedback on the success of public sector entities;
- Programme evaluation – The cost of government programmes combined with suitable performance measurements can be of assistance to the public and legislators in assessment of the programmes;
- A wide range of economic choice decisions – Comparison of costs between alternatives is required when public sector manager has to make a choice, for instance to accept or reject a proposal for a government capital project or whether to continue delivering a particular public service.

According to the analysis performed by IFAC Public Sector Committee (2000) the extent of public sector cost accounting application and development varies from country to country. The usage often depends upon the objectives of the different types of public sector entities. A study on Swiss sub-national governments (Flury and Schedler, 2006) revealed that accounting information on the cost-performance relationship is necessary for budgeting and performance agreements. Empirical research carried out on Portuguese local government showed that due to difficulties in data collection and interpretation in cost accounting systems, cost information is moderately used in decision-making (Carvalho, Gomes and Fernandes, 2012). In the past, cost accounting in United States (U.S.) government entities was viewed as a significant aid for dealing with fiscal stress but nowadays it also helps in setting adequate rates (for services that are provided via user charges). In addition, cost accounting provides accurate information that puts performance into perspective, and enables strategic decision-making (Mohr, 2015). When analysing cost accounting in some European universities, Dražić Lutilsky and Dragija (2012: 43) summarised the benefits of the full costing application and these are: better and efficient resource allocation, improved strategic decision-making, more comprehensible internal data, and greater objectivity in decision-making basis for budget allocation. On the other hand, the adoption of cost accounting can face many obstacles. Jovanović, Dražić Lutilsky and Vašiček (2019: 3765) analysed cost accounting in the Croatian and Slovenian healthcare systems and found out that implementation of full costing method has several constraints among which IT support is perceived as the most important (in both countries) followed by the lack of financial resources. Bertoni, De Rosa and Dražić Lutilsky (2017) compared cost accounting practices in public hospitals in Italy and Croatia and concluded that there are differences in accounting legislation in those two countries that affect the recording of the costs and cost allocation as well. According to their findings, a Croatian public hospital has greater use of cost accounting information in the decision-making process (for allocation of budget funds, for planning and cost control, for the approval of the implementation of specific programs, when

purchasing the assets, for monitoring the effectiveness of the services provided and fiscal accountability, when employing, when determining the price of public health services) than an Italian hospital.

Portugal began reforms of the public sector accounting system at the beginning of the 1990s (as a segment of a broader set of New Public Management initiatives). Local Portuguese governments have introduced decentralized organizational structures with a focus on financial management practices that require the implementation of cost accounting, so the shift to the new accounting system was in order (Carvalho, Gomes and Fernandes, 2012: 308). The adoption of accrual-based financial accounting in Australia, New Zealand and United Kingdom has also triggered the increased use of cost accounting (IFAC, 2000). The size of governmental entities also seems to be the driver of cost accounting implementation. Mohr (2015: 101) stated that the size of U.S. cities (in terms of population) determines the use of cost accounting in these municipalities "because larger-population cities tend to have more roads, more sewers, more parks and more of everything for which it is useful for leaders to have accurate costs". Thus, if a public sector entity provides more services and more overhead costs are incurred, the greater the likelihood that cost accounting will be needed and therefore implemented. On a national level, the adoption of accrual accounting seems to be the main prerequisite for cost accounting implementation.

Cost accounting is a dynamic system that should be continuously developed in order to fulfil its purpose (IFAC, 2000; Carvalho, Gomes and Fernandes, 2012; Dražić Lutilsky, Vašiček and Vašiček, 2012; Dražić Lutilsky and Dragija, 2012; Mohr, 2015; Bertoni, De Rosa and Dražić Lutilsky, 2017). The improvement of financial management in the public sector depends on the skills of the management and its capacity for the usage of financial and non-financial information. In public sector practice, this particularly applies to the usage of cost and management accounting as well as financial and non-financial indicators (Dražić Lutilsky and Dragija, 2012: 34). The use of financial data would be improved if data visualisation and dashboards were included in the accounting reports. These accounting reports for internal users should also contain internal checks that provide red flags for closer scrutiny. Improved data-sharing across accounting and performance management systems could enable data analytics to provide more frequent reporting and more intuitive data analysis to support decision-makers.

Recent studies on cost accounting in the public sector (Jackson and Lapsley, 2003; Baird, 2007; Järvinen, 2009; Dražić Lutilsky, Vašiček and Vašiček, 2012; Dražić Lutilsky and Dragija, 2012; Bertoni, De Rosa and Dražić Lutilsky, 2017; Mohr, Raudla and Douglas, 2018; Tuccillo and Agliata, 2018; Labrador and Olmo, 2019; Priyatmo and Akbar, 2019) strongly recommend the adoption of activity-based costing (ABC). This contemporary accounting method could provide relevant information: for instance, to optimize service processes, to decide whether to outsource some services or whether to introduce new services and close some departments. The most

evident advantage of the application of the ABC method is that it provides more realistic cost estimates through precise cost identification and cost allocation (Bertoni, De Rosa and Dražić Lutilsky, 2017: 123). Therefore, public sector managers and politicians as decision-makers should benefit from public cost accounting development as long as they are willing to use the wide scope of the provided accounting information. On the other hand, the implementation of ABC entails some pre-conditions (like knowledge, skills and availability of data). It is difficult to apply the ABC method to areas other than the most straightforward service delivery of the public sector entity. Thus, ABC method should be used only in targeted functions where these pre-conditions are met; otherwise, it can give rise to a tremendous amount of investment with little return. It needs to be developed from a decision-maker (user) perspective rather than an accounting (supply) perspective, at least in the public sector. The increasing call for the inclusion of environmental, social and governance considerations in budgetary decision-making should eventually instigate a complete overhaul of existing ABC methodologies. Lau, Lonti and Schultz (2017) acknowledged that reliable cost accounting is the key to measuring productivity in the public sector. They also proposed three steps for the improvement of cost accounting in the public sector that begins by harmonizing accounting methods in order to ensure consistency in measuring costs. The next step is the design of a new public sector financial IT system that should not only be an accounting tool, but must also support productivity measurement. Finally, it is necessary to use "feedback/knowledge of public managers to understand which cost data are meaningful and useful to improve productivity in their specific area of work" (Lau, Lonti and Schultz, 2017: 193).

4 HYPOTHESES

As already stated, accounting information is produced for both internal and external users. While financial accounting provides information for external users (that are outside of the entity) as well as for the internal users (who work within an organisation), cost accounting does it mainly for the decision-makers (as internal users). Management is the main internal user of accounting information because of the leadership role that requires facts and figures in order to make a decision. Decision-makers in the public sector are governing politicians and public managers. According to Flury and Schedler (2006: 233) politicians require full costing information, while public managers are more inclined to variable cost information.

Ouda and Klischewski (2019) pointed out that behavioural and cognitive aspects affect the use of accounting information. According to Guraini (2016: 500) the availability of accounting data does not always lead to its correct interpretation or proper use. Van Helden (2016) stated that budgets and interim accounting reports are not likely to be used by politicians unless they find them useful in debates on controversial projects or programmes. Previous studies (Ezzamel et al., 2005; Liguori, Sicilia and Steccolini, 2012; Guarini, 2016; Jorge, Jorge de Jesus and Nogueira, 2019) suggested that politicians lack the expertise required for using complex accounting information. Consequently, politicians underestimate the value of accounting information for the political activities. Politicians are accountable for

the definition of organisational mission and plans, and, on the other hand, public managers (as administrators) are held responsible for the execution of those plans and are driven by the search for effectiveness and efficiency (Liguori, Sicilia and Steccolini, 2012). Therefore, it is reasonable to assume that:

H_1: There is a difference in the usage level of accounting information in decision-making and management between public managers and representatives of local and regional governments.

The difference between the use and the usefulness of accounting information is already distinguished in the accounting literature. Van Helden (2016) argued that information usefulness is supposed to be driven by user needs. Sometimes accountants provide accounting information (which is normally considered to be useful information to its users) that is not useful for the matter in hand or the task to be performed. Therefore, it is the use that determines the usefulness of accounting information. According to Askim (2007) performance information is the second best source of information for decision-making to set issues on the political agenda. He found out that performance information gives politicians control over the municipality's implementation of political decisions and a good idea about how well the municipality meets the needs of the local population. Public service performance can be improved by using performance information because it contributes to accountability and provides information to rationalize decision-making (George et al., 2020: 15). Planning and control are common examples of accounting information usefulness (Van Helden, 2016) which are scarcely examined in public sector so it can be assumed that:

H_2: The level of the use of accounting information in decision-making affects the cost planning, cost control and cost analysis as well as cost accounting application even for pricing purposes.

5 METHODOLOGY AND RESULTS

The empirical research is based on an online survey. To collect data, a structured questionnaire was designed according to the conceptual framework and empirical results of previous studies (Van Helden, 2016; Liguori, Sicilia and Steccolini, 2012; Guarini, 2016; Jorge, Jorge de Jesus and Nogueira, 2019; Jovanović, Dražić Lutilsky and Vašiček, 2019) regarding the use of accounting information in public sector management. The questionnaire consists of closed questions measured by 5-point Likert-type scale (where 1 represents "absolutely disagree" and 5 is for "absolutely agree" with the offered statement). The link to the questionnaire was sent to the e-mail addresses of 500 public sector accountants in Croatia who work for local and regional governments as well as related public entities (like schools, hospitals, museums, etc.) that are known as budgetary users. During June and July 2020, 178 respondents filled out the questionnaire so the response rate was 35.6%. The collected data were analysed using the IBM – SPSS 23 programme. Univariate statistics were used to validate the hypotheses.

Public sector accounting system in Croatia is unified and all public entities apply the modified accrual-basis system. This means that revenues are recorded on a cash

basis (according to the inflows of cash and cash equivalents) and the expenses are recorded at the moment when the transaction or business event appears (regardless of the moment of payment). Therefore, public sector entities in Croatia do not account for the costs of depreciation and amortisation of assets (Dražić Lutilsky, Vašiček and Vašiček, 2012; Jovanović, Dražić Lutilsky and Vašiček, 2019).

Instead of asking decision-makers, in order to assess their use of accounting information, this survey was only addressed to public sector accountants although accountants can also have some implicit bias (e.g. an inflated view of the importance of their work; a supply-driven perspective does not indicate whether or not it is actually used; and lack of exposure to actual decision-making instances to assess the extent to which financial data is used). When asked about the use of accounting information by their legal representative (major, municipal major, prefect or other public manager) for decision-making and management purposes, accountants acknowledged the high level of usage: 49.4% of accountants evaluated the use of accounting information by their superiors (politicians and public managers) with the highest mark (5) and 27% with the next highest mark (4), while 17.4% assessed it as 3, and the rest (6.2%) acknowledged a low level of the usage.

Descriptive statistics on usefulness of cost accounting information and the level of cost accounting implementation are presented in table 1.

Table 1

Descriptive statistics on public sector cost accounting and its usefulness

	N	Minimum	Maximum	Mean	Std. deviation
Pricing	178	1	5	3.37	1.274
Cost planning	178	1	5	4.34	0.883
Cost control	178	1	5	4.28	0.927
Cost analysis	178	1	5	4.19	0.988
Interim reports	178	1	5	4.25	1.093
Cost accounting (overall)	178	1	5	4.22	0.964
Valid N (listwise)	178				

Source: Author's calculation.

Since accountants are providers of accounting information, they are also a relevant party to assess the usefulness of this information. According to the empirical results (table 1) cost accounting information is the most useful for cost planning (mean value is 4.34). This finding was expected since budgeting is traditionally the fundamental role of public finance. Cost control is also highly estimated (mean value is 4.28). Cost analysis is often performed in many Croatian public sector entities (mean value is 4.19) while the use of accounting information for pricing purposes is evaluated slightly lower (mean value is 3.37).

The results (table 1) also indicate that many public sector entities in Croatia provide additional (interim) accounting reports, besides mandatory financial statements, for

the internal users only (mean value is 4.25). Accountants acknowledged that the level of usage of cost accounting system is rather high (mean value is 4.22).

Since public managers (also known in the literature as public administrators), who are the head of the public sector entities classified as budgetary users, use accounting information for different purposes than governing politicians, it was assumed that there is the difference in the usage level of accounting information for the separate purposes of decision-making and management. This hypothesis is verified using the Mann-Whitney U-test. This non-parametric test was used in order to compare differences between two independent groups: a public organisation with public managers in charge and organisations run by representatives of local and regional governments.

Table 2

The rank differences of the accounting information use

	Type of public sector entity	N	Mean rank	Sum of ranks
Representative's use of accounting information	1 (local and regional government)	28	70.2	1,965.5
	2 (budgetary users)	150	93.1	13,965.5
	Total	178		

Source: Author's calculation.

Table 3

Results of the Mann-Whitney U-test

	Representative's use of accounting information
Mann-Whitney U	1,559.500
Wilcoxon W	1,965.500
Z	-2.336
Asymp. Sig. (2-tailed)	0.019

Grouping variable: Type of public sector entity.

Source: Author's calculation.

Since the legal representatives of budgetary users (public managers) are pressured to deliver the planned activities within the budget it was expected that they would use accounting information in decision-making and management more often than the representatives of local and regional governments (politicians). The findings (tables 2 and 3) indicate that there is a difference in ranks of the use of accounting information between politicians and public managers (p-value is 0.019). This result is in line with prior theoretical assumptions by Flury and Schedler (2006) and Liguori, Sicilia and Steccolini (2012) who presumed that in their pursuit for efficiency and effectiveness public managers would be using accounting information more than governing politicians (although in a broader sense they are also public managers).

The second hypothesis was statistically tested using the Kruskal Wallis test (tables 4 and 5). This rank-based nonparametric test was performed in order to determine

PUBLIC SECTOR ECONOMICS
45(2) 209-227 (2021)

if there are statistically significant differences between a representative's use of accounting information (as an independent variable) on the ordinal dependent variables (various aspects of accounting information usefulness).

Table 4

The rank differences of the accounting information usefulness and level of cost accounting implementation

	Representative's use of accounting information	N	Mean rank
Pricing	1	5	26.10
	2	6	48.00
	3	31	64.79
	4	48	87.76
	5	88	105.59
	Total	178	
Cost planning	1	5	81.60
	2	6	15.00
	3	31	70.23
	4	48	66.24
	5	88	114.51
	Total	178	
Cost control	1	5	65.20
	2	6	17.33
	3	31	73.08
	4	48	75.18
	5	88	109.40
	Total	178	
Cost analysis	1	5	94.60
	2	6	14.83
	3	31	59.19
	4	48	75.41
	5	88	112.66
	Total	178	
Interim reports	1	5	63.60
	2	6	29.58
	3	31	80.74
	4	48	80.54
	5	88	103.03
	Total	178	
Cost accounting (overall)	1	5	67.00
	2	6	15.83
	3	31	64.63
	4	48	72.48
	5	88	113.85
	Total	178	

Source: Author's calculation.

Table 5
Results of the Kruskal Wallis test

	Pricing	Cost planning	Cost control	Cost analysis	Interim reports	Cost accounting (overall)
Chi-Square	28.740	58.973	39.760	52.374	22.536	53.586
df	4	4	4	4	4	4
Asymp. Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Grouping variable: Representative's use of accounting information.
Source: Author's calculation.

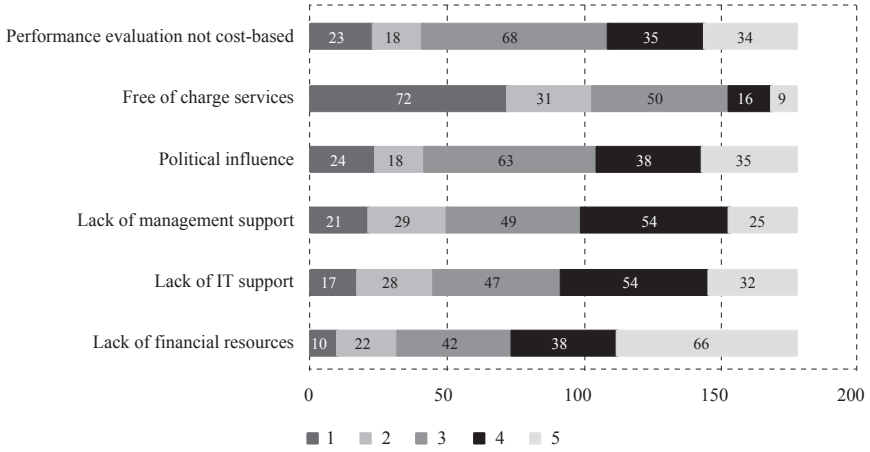
Findings (tables 4 and 5) indicate that the usage level of accounting information for management and decision-making purposes of the legal representatives of public sector entities determines its usefulness (p-value in all cases is 0.000). The level of the use of cost accounting information affects price setting decisions, which is consistent with a previous study (Flury and Schedler, 2006; Bertoni, De Rosa and Dražić Lutilsky, 2017). As expected, the usage level of cost accounting information is related to the level of cost planning and cost control, which is similar to previous research results (Van Helden, 2016; Bertoni, De Rosa and Dražić Lutilsky, 2017) as well as cost analysis. Furthermore, the usage level of cost accounting information is related to the level of discretionary interim accounting reporting. Theses empirical results indicate that the level of implementation of public sector cost accounting is determined by the use of accounting information.

The implementation level of public sector cost accounting in Croatia from the accountants' perspective is rather high (mean value is 4.22) according to results presented in table 1. Nevertheless, cost accounting is a dynamic category, constantly developing. As already stated, the use of the ABC method is the next step of public sector cost accounting evolution. Only 14 out of 178 (7.87%) respondents answered that they have implemented the ABC method. The reason for this finding might be the fact that further development of public sector cost accounting faces several obstacles (graph 1).

The obstacles for the further development of cost accounting are not perceived as serious limitations. On the scale of 1-5 accountants replied that the main constraint of public sector cost accounting development is the lack of financial resources (mean value is 3.72). The lack of IT support (mean value is 3.31), and political influence (mean value is 3.24) represent moderate constraints. The view that performance evaluation is not cost-based is also an obstacle, although minor, in cost accounting development (mean value is 3.22). The lack of support from public managers and governing politicians, who act as management, is slightly perceived (mean value is 3.19). Most of the accountants (58%) did not agree that the public sector does not need cost accounting due to the free of charge services it provides (mean value is 2.21). A previous similar study (Jovanović, Dražić Lutilsky and Vašiček, 2019: 3765) showed that IT support is the main constraint of cost accounting implementation in public hospitals followed by the lack of financial resources that is similar to these results.

Graph 1

Development obstacles of public sector cost accounting



Source: Author's calculation.

6 CONCLUDING REMARKS

The paper contributes to the rather scarce literature on public sector cost accounting and its usefulness. The empirical analysis was conducted on a data sample drawn from public entities in Croatia. The primary data were obtained through a questionnaire addressed to public sector accountants in order to determine the level of the use (by their management) and usefulness of accounting information.

Financial accounting in the public sector worldwide has undergone significant changes in the new millennium. The transition from cash-based to accrual-based accounting is not completed in many countries but it is expected soon, since the EU is preparing EPSAS for all member states. Croatian public sector entities are obliged to apply modified accrual accounting and although it has several constraints regarding cost recognition (comparing to the full accrual accounting), the level of the current development stage of cost accounting system is high. Accountants in the Croatian public sector provide to their management (legal representatives who are in this study referred as governing politicians and public managers) interim reports that are optional according to current regulations. The empirical results regarding the interim accounting reports shed light on the usage of accounting information by politicians in local and regional governments and public managers. The interim reports are provided on request from governing politicians and public managers indicating the high level of understanding and use of accounting information in Croatia. Accountants who are employed in the public sector estimated the current level of overall implementation of cost accounting as very good although only 7.87% use the ABC method. The obstacles for further development of public sector cost accounting are not strongly perceived. The respondents recognised the lack of financial means as the greatest constraint of cost accounting development followed by the lack of IT support. Most of them did not agree that public sector cost accounting is

unnecessary since public services are free of charge. Moreover, cost information is essential when setting prices in the public sector.

This study provides an understanding of accounting information use in the public sector, highlighting the usage difference between governing politicians and other public managers. The findings indicate that public managers (legal representatives of entities classified as budgetary users) are better users of accounting information than governing politicians (prefects, mayors and municipal mayors). The reason for this inference may be that public managers are facing more pressure to obtain efficacy and effectiveness so they rely more on accounting information to make rational decisions. Both of these internal users of accounting information rely on this kind of data and figures in decision-making process. The usage level of cost accounting information in decision-making affects cost planning, cost control, cost analysis, preparation of interim reports as well as overall cost accounting system. Therefore, the use of accounting information determines the level of cost accounting implementation in public sector.

A limitation of this study is related to the fact that it did not include the assessment of accounting knowledge of the governing politicians and public managers who use information provided by accountants. Therefore, the future research should examine the understanding of accounting terminology since most public managers and politicians have different educational backgrounds unlike managers in the private sector because it is expected that they must have great financial skills (due to an excellent accounting knowledge) in order to succeed. In addition, an in-depth analysis should include the quality, relevance, presentation and the user demand of financial data in public sector as explanatory variables. Furthermore, forms and processes for data reporting that would improve usability and relevance should be recommended. The follow-up survey should explore the dialogue between public sector accountants and decision-makers as well as perceptions of data and reporting quality, relevance and usefulness as drivers of the actual use of accounting data.

Disclosure statement

No potential conflict of interest was reported by the author.

REFERENCES

1. Askim, J., 2007. How do politicians use performance information? An analysis of the Norwegian local government experience. *International Review of Administrative Sciences*, 73(3), pp. 453-472. https://doi.org/10.1177/0020852307081152
2. Bach, S., 2020. Fiscal councils' impact on promoting transparency and accountability in public finance management. *Public Sector Economics*, 44(3), pp. 355-384. https://doi.org/10.3326/pse.44.3.4
3. Baird, K., 2007. Adoption of activity management practices in public sector organizations. *Accounting and Finance*, 47(4), pp. 551-569. https://doi.org/10.1111/j.1467-629x.2007.00225.x
4. Bertoni, M., De Rosa, B. and Dražić Lutilsky, I., 2017. Opportunities for the improvement of cost accounting systems in public hospitals in Italy and Croatia: A case study. *Journal of Contemporary Management Issues*, 22 (Special issue), pp. 109-128.
5. Bovens, M., Schillemans, T. and Hart, P. T., 2008. Does public accountability work? An assessment tool. *Public Administration*, 86(1), pp. 225-242. https://doi.org/10.1111/j.1467-9299.2008.00716.x
6. Carvalho, J. B. D. C., Gomes, P. S. and Fernandes, M. J., 2012. The main determinants of the use of the cost accounting system in Portuguese local government. *Financial Accountability & Management*, 28(3), pp. 306-334. https://doi.org/10.1111/j.1468-0408.2012.00547.x
7. Dražić Lutilsky, I. and Dragija, M., 2012. Activity Based Costing as a means to full costing – Possibilities and constraints for European universities. *Journal of Contemporary Management Issues*, 17(1), pp. 33-57.
8. Dražić Lutilsky, I., Vašiček, V. and Vašiček, D., 2012. Cost planning and control in Croatian public sector. *Economic Research-Ekonomska Istraživanja*, 25(2), pp. 413-434. https://doi.org/10.1080/1331677x.2012.11517515
9. Ezzamel, M. [et al.], 2005. Accounting, accountability and devolution: A study of the use of accounting information by politicians in the Northern Ireland assembly's first term. *The Irish Accounting Review*, 12(1), pp. 39-62. https://doi.org/10.4324/9780203926635
10. Flury, R. and Schedler, K., 2006. Political versus managerial use of cost and performance accounting. *Public Money & Management*, 26(4), pp. 229-234. https://doi.org/10.1111/j.1467-9302.2006.00530.x
11. George, B. [et al.], 2020. Institutional isomorphism, negativity bias and performance information use by politicians: A survey experiment. *Public Administration*, 98(1), pp. 14-28. https://doi.org/10.1111/padm.12390
12. Giacomini, D., Sicilia, M. and Steccolini, I., 2016. Contextualizing politicians' uses of accounting information: reassurance and ammunition. *Public Money & Management*, 36(7), pp. 483-490. https://doi.org/10.1080/09540962.2016.1237128
13. Guarini, E., 2016. The day after: newly elected politicians and the use of accounting information. *Public Money & Management*, 36(7), pp. 499-506. https://doi.org/10.1080/09540962.2016.1237135

14. IFAC, 2000. *Perspectives on Cost Accounting for Government - International Public Sector Study*. New York: International Federation of Accountants.
15. Jackson, A. and Lapsley, I., 2003. The diffusion of accounting practices in the new "managerial" public sector. *The International Journal of Public Sector Management*,16(4/5),pp.359-372.https://doi.org/10.1108/09513550310489304
16. Järvinen, J., 2009. Shifting NPM agendas and management accountants' occupational identities. *Accounting*, *Auditing & Accountability Journal*, 22(8), pp. 1187-1210. https://doi.org/10.1108/09513570910999283
17. Jorge, S., Jorge de Jesus, M. A. and Nogueira, S. P., 2019. The use of budgetary and financial information by politicians in parliament: a case study. *Journal of Public Budgeting, Accounting & Financial Management*, 31(4), pp. 539-557. https://doi.org/10.1108/jpbafm-11-2018-0135
18. Jovanović, T., Dražić Lutilsky, I. and Vašiček, D., 2019. Implementation of cost accounting as the economic pillar of management accounting systems in public hospitals – the case of Slovenia and Croatia. *Economic Research-Ekonomska Istraživanja*, 32(1), pp. 3754-3772. https://doi.org/10.1080/1331677x.2019.1675079
19. Labrador, M. and Olmo, J., 2019. Management accounting innovations for rationalizing the cost of services: The reassessment of cash and accrual accounting. *Public Money & Management,* 39(6), pp. 401-408. https://doi.org/10.1080/09540962.2019.1583910
20. Lau, E., Lonti, Z. and Schultz, R., 2017. Challenges in the measurement of public sector productivity in OECD countries. *International Productivity Monitor*, 32, pp. 180-195.
21. Liguori, M. and Steccolini, 2018. The power of language in legitimating public-sector reforms: When politicians "talk" accounting. *The British Accounting Review*, 50(2), pp. 161-173. https://doi.org/10.1016/j.bar.2017.09.006
22. Liguori, M., Sicilia, M. and Steccolini, I., 2012. Some Like it Non-Financial …. *Public Management Review*, 14(7), pp. 903-922. https://doi.org/10.1080/14719037.2011.650054
23. Manes-Rossi, F. and Orelli, R. L., 2020. Reflections on New Trends in Public Sector Reporting: Integrated Reporting and Beyond. In: F. Manes-Rossi and R. Levy Orelli, eds. *New Trends in Public Sector Reporting. Public Sector Financial Management.* Cham: Palgrave Macmillan, pp. 195-205. Cham. https://doi.org/10.1007/978-3-030-40056-9_10
24. Mann, B., Lorson, P. C., Oulasvirta, L. and Haustein, E., 2019. The quest for a primary EPSAS purpose – Insights from literature and conceptual frameworks. *Accounting in Europe*, 16(2), pp. 195-218. https://doi.org/10.1080/17449480.2019.1632467
25. Mohr, Z. T., 2015. An analysis of the purposes of cost accounting in large U.S. cities. *Public Budgeting & Finance*, 35, pp. 95-115. https://doi.org/10.1111/pbaf.12059
26. Mohr, Z. T., Raudla, R. and Douglas, J. W., 2018. Is Cost Accounting Used with Other NPM Practices? Evidence from European Countries. *Public Performance & Management Review*, 41(4), pp. 696-722. https://doi.org/10.1080/15309576.2018.1480391

27. Ngwakwe, C. C., 2012. Public sector financial accountability and service delivery. *Journal of Public Administration*, 47(1), pp. 311-329.
28. Ouda, H. A. G. and Klischewski, R., 2019. Accounting and politicians: a theory of accounting information usefulness. *Journal of Public Budgeting, Accounting & Financial Management*, 31(4), pp. 496-517. https://doi.org/10.1108/jpbafm-10-2018-0113
29. Priyatmo, T. and Akbar, R., 2019. Analysis of the Prospect of Implementing Activity-Based Costing (ABC) in Governmental Organisations: A Study at the State Treasury Office Jakarta IV. *Journal of Accounting and Investment*, 20(1), pp. 1-22. https://doi.org/10.18196/jai.2001105
30. Ranson, S., 2003. Public accountability in the age of neo-liberal governance. *Journal of Education Policy*, 18(5), pp. 459-480. https://doi.org/10.1080/0268093032000124848
31. Saliterer, I. and Korac, S., 2013. Performance information use by politicians and public managers for internal control and external accountability purposes. *Critical Perspectives on Accounting*, 24, pp. 502-517. https://doi.org/10.1016/j.cpa.2013.08.001
32. Saliterer, I. et al., 2019. How politicians use performance information in a budgetary context: New insights from the central government level. *Public Administration*, 97, pp. 829-844. https://doi.org/10.1111/padm.12604
33. Samaratunge, R., Alam, Q. and Teicher, J., 2008. Public sector reforms and accountability: The case of south and Southeast Asia. *Public Management Review*, 10(1), pp. 101-126. https://doi.org/10.1080/14719030701763237
34. Ter Bogt, H. J., 2004. Politicians in search of performance information? – Survey research on Dutch aldermen's use of performance information. *Financial Accountability & Management*, 20(3), pp. 221-252. https://doi.org/10.1111/j.0267-4424.2004.00387.x
35. Tuccillo, D. and Agliata, F., 2018. The ABC as Tool for Decision Making in Public Administrations. *Open Journal of Accounting*, 7(2), pp. 125-138. https://doi.org/10.4236/ojacct.2018.72009
36. Van Helden, J., 2016. Literature review and challenging research agenda on politicians' use of accounting information. *Public Money & Management*, 36(7), pp. 531-538. https://doi.org/10.1080/09540962.2016.1237162

APPENDIX

SURVEY ITEMS[1]:

1. I work as an accountant in:
    a. Local or regional government (town, city, county)
    b. Public institution (e.g. school, hospital, museum, theatre)
2. Besides mandatory financial statements, we also prepare additional interim reports.
3. Cost accounting in our organisation is well applied and useful.
4. Do you apply activity based costing (ABC)?
5. Legal representative relies on accounting information in decision-making process.
6. Price setting of public service in our organisation is based on accounting information.
7. We carefully plan our costs.
8. We have good cost control.
9. We perform cost analysis in detail.
10. Please assess the following constraints of the further cost accounting development:
    a. Performance evaluation is not cost-based.
    b. Public services are free of charge so there is no need for cost accounting.
    c. Political influence does not support cost accounting.
    d. There is a lack of management support.
    e. There is a lack of IT support.
    f. There is a lack of financial resources.

[1] Note: Most of the survey items are closed questions (statements) measured by 5-point Likert-type scale (except questions no. 1 and 4).

Long-term cash flows of mandatory and voluntary pension funds in Croatia and their impact on asset allocation

EVA HORVAT, MBA*
MLADEN LATKOVIĆ, MSc*

Article**
JEL: G11, G18, G19, G23
https://doi.org/10.3326/pse.45.2.3

* The authors thank two anonymous reviewers for their helpful comments and suggestions for improvement of the article. The views expressed in this paper are solely those of the authors and do not necessarily represent those of the company in which they are employed.
** Received: October 26, 2020
Accepted: January 22, 2021

Eva HORVAT
Raiffeisen Mandatory and Voluntary Pension Funds Management Company Plc, Petrinjska 59, 10000 Zagreb, Croatia
e-mail: eva.horvat@rmf.hr
ORCiD: 0000-0002-1000-2988

Mladen LATKOVIĆ
Raiffeisen Mandatory and Voluntary Pension Funds Management Company Plc, Petrinjska 59, 10000 Zagreb, Croatia
e-mail: mladen.latkovic@rmf.hr
ORCiD: 0000-0002-2463-0184

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

Abstract

In this paper we analyse expected liquidity driven changes in asset allocation of Croatian mandatory and voluntary pension funds based on long-term cash flow projections. For mandatory pension funds, expected long-term cash flow are simulated taking into account the life-cycle scheme, changes in the default fund for undecisive newcomers, expected returns of funds and certain demographic and economic assumptions. Analogously, cash flow simulations of voluntary pension funds are simulated, with an additional scenario of short-term outflows due to the possibility of withdrawing earlier. The growing need for liquidity of pension funds is expected to impact their asset allocations through the endeavour for more liquid portfolios even in a baseline scenario. In the case of more severe assumptions of various parameters of the model, the liquidity-driven reallocation is expected to influence long-term returns of pension funds that experience negative or low net inflows, and subsequently lead to negative liquidity premium.

Keywords: pension funds, defined contribution system, life-cycle investing, asset allocation, liquidity

1 INTRODUCTION

The asset allocation of mandatory pension funds (MPF) in the Republic of Croatia is currently adjusted to the proxy life-cycle investment model introduced in 2014 (Mandatory Pension Funds Act, 2014). There are three categories of mandatory pension funds with different risk profiles. A category funds, which are the most risky, are structured as balanced risk profile funds with maximum allocation of 65% in equity markets (80% if all alternative investment funds are used to generate equity exposure). Category B funds have a moderately conservative risk profile with a maximum allocation of 40% in equity markets (50% if all alternative investment funds are used to generate equity exposure). Category C is represented by conservative pension funds that invest exclusively in fixed income instruments. Other investment limits for mandatory pension funds, along with limits that stipulate diversification among individual issuers, are mainly related to the exposure to different asset classes (e.g., maximum exposure to corporate bonds, municipal bonds or money market instruments) as well as currency exposure.

On the other hand, the asset allocations of Croatian voluntary pension funds (VPF) are not adjusted to the life-cycle investment model and generally not subject to asset allocation limits, aside from limits assigned by management companies themselves during the establishment of those funds through risk profiles predefined in their prospectus (Voluntary Pension Funds Act, 2014). However, on the market in the Republic of Croatia there are voluntary pension funds with different risk profiles, comparable with the risk profiles of the three available categories of mandatory pension funds.

The main objective of pension funds management companies is to achieve the best risk/return outcome for pension funds, i.e. to optimize, in the long run, their expected returns vs. expected risk. However, in the investment decision process, pension funds management companies have to take into account the liquidity of their portfolios in order to be able to provide payments of accumulated savings for affiliates who fulfil the conditions for retirement. In addition to the liquidity risk of assets, i.e. the possibility of selling assets without significant price impact, there is also a cash flow liquidity risk, i.e. the possibility of misbalancing the short-term liquid assets of funds and their short-term liabilities that originate from payments of accumulated savings.

The legislative changes that introduced the proxy life-cycle scheme for mandatory pension funds in August 2014, and subsequent changes in enrolment process for new affiliates in October 2019, have significantly affected mandatory pension funds' cash flows. The latter change established three periods of accumulation: an affiliate is within A category until 10 years before retirement, then is transferred to a B category fund for 5 years and then to the C category for the last 5 years. The latest legislative change is equally as significant as the former one. If the fund category is not chosen by a new affiliate within a specified period, then Central Registry of Affiliates establishes their membership in a randomly chosen fund within the given category. Before the legislative change that started in October 2019, the default fund enrolment was to one of the B category funds and after that it was one of the A category funds. This means that the youngest cohort group of affiliates were enrolled into a fund dedicated to the older cohort group for more than 5 years after introduction of proxy life-cycle scheme.

Similar legislative changes that affect cash flows of voluntary pension funds were also introduced recently. The first change was introduced in 2014 with the possibility of activating variable annuity payments from a voluntary pension fund (unit-linked annuity), i.e. without the need for a member to withdraw the whole of their accumulated savings. The second change was introduced in 2019 with the extension of 3rd pillar retirement age from 50 to 55 years, available, however, only to newcomers. Both of these changes facilitated the burden of possible substantial outflows for voluntary pension funds, either in providing an opportunity for members to choose a variable annuity, while keeping most of their savings at least for some time in a pension fund, or to postpone their decision on the withdrawal of accumulated savings. However, the ability to withdraw savings from the Croatian 3rd pillar as early as at the age of 50 (only for members enrolled before January 2019) or 55 is still a substantial distance from the official 65 years of age for 2nd pillar retirement (as of the time of writing this article).

These structures of possible transfers of accumulated savings in both pillars, moving savings from one fund to another or even withdrawing them much earlier than expected, might affect expected risk/return trade-off for 2nd and 3rd pillar pension funds due to the liquidity issues (a fund manager would usually try to minimize the

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

money market portion of a pension fund portfolio in order to achieve the best risk/return trade-off on the long run). The cash flow liquidity risk comes primarily from the misbalance of cash inflows from current members and outflows in the case of those who withdraw their savings. However, asset liquidity risk might arise from these cash flow imbalances, i.e. expected insufficient or even negative cash flows for a certain periods might force a changes in asset allocation of a pension fund from less liquid instruments to more liquid instruments in order to mitigate those possible imbalances. Current asset allocation of pension funds in Croatia (HANFA reports) shows a significant proportion of investment in domestic capital markets that have significantly lower asset liquidity than developed markets.

Therefore, given the constant requirements for maintaining adequate liquidity of pension funds in relation to their expected cash flows, in this article we analyse long-term cash flow dynamics and its possible impact on future pension funds asset allocations, and the expected decrease in their long-term returns due to a shift in asset allocation towards more liquid asset classes.

The article is organized as follows: in the second chapter we give a short overview of the Croatian 2nd pillar and an analysis of legislative changes that influence cash inflows, MPFs' expected asset allocation and risk/return profiles and present simulations of long-term cash flows and their impact on MPFs' asset allocation. The third chapter gives a short overview of the Croatian 3rd pillar with appropriate legislative changes that influence VPF cash inflows, expected asset allocation and risk/return profiles of VPFs and present simulations of cash flows and their impact on VPF asset allocation. Finally, the last chapter presents an analysis of the research results.

2 MANDATORY PENSION FUNDS

2.1 SHORT OVERVIEW AND DEVELOPMENT

Mandatory pension funds (MPF) in Croatia started operating with the pension reform in the form of the 2nd pillar implemented in 2002 (Mandatory and Voluntary Pension Funds Act, 2002). At the beginning, in a new multi-pillar mandatory pension scheme only affiliates under 50 years of age could participate, with the additional possibility that those between 40 and 50 years of age could opt-out (a significant proportion of non-mandatory participants did not choose the multi-pillar scheme). Initially, fund management companies managed only one MPF dedicated to all cohort groups, i.e. irrespective of their age or personal affiliations to certain risk profiles.

Since payments of contributions to the 2nd pillar are mandatory (in the amount of 5% of affiliate gross salary), and due to the restriction on participants' age imposed at the beginning, the net inflows to MPFs in first 15 to 25 years were expected to be strongly positive. As a result, and with the additional assistance from the gradual increase in inflows due to the rise in gross salaries in Croatia over time and strong positive realized funds' returns, MPFs overall assets experienced constant growth since their inception.

Moreover, growth is expected to continue at a steady rate until a significant proportion of the first mandatory-in-2nd pillar cohort group, i.e. those who were 35 to 40 years of age at the beginning of the reform, start to retire, which is expected between 2027 and 2032. As of the end of 2019, total asset under management (AuM) in the 2nd pillar reached HRK 112.6 billion (EUR 15.1 billion), which represents 28% of Croatian GDP.

At the beginning of the 2nd pillar pension scheme the steady positive net inflows enabled fund managers to engage in truly long-term investment policies – almost a textbook example of modern portfolio theory investment vehicle – with the possibility of earning an additional liquidity premium (resulting from buying and holding illiquid assets) above the premium resulting from strategic asset allocation decisions.

The first major shift in the 2nd pillar pension scheme came with legislative changes in 2014 that introduced the proxy life-cycle pension scheme, i.e. different categories of MPFs – A, B and C, dedicated to specific cohort groups. In August 2014, one large MPF was split into three funds of different categories. Particular categories differ from each other according to their risk profiles, i.e. investment structures and the consequently expected long-term returns. Furthermore, affiliates cannot choose the funds' categories arbitrarily due to restrictions on age imposed by the risk profile of a fund. The main characteristics of A, B and C categories of MPFs are shown in table 1.

Table 1

Main characteristics of different mandatory pension funds' categories

		Category A	**Category B**	**Category C**
Membership Up to number of years until retirement		10	5	No restrictions
Risk profile		Balanced	Moderately conservative	Conservative
The most important investment limits	Minimum percentage of the fund's net assets in government debt securities and money market instruments	30	50	70
	Maximum percentage of the fund's net assets in equity	65	40	Investment in equity is not allowed
	Minimum percentage of the fund's net assets denominated or settled in domestic currency (HRK)	40	60	90

Source: Mandatory Pension Funds Act (2014).

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

However, the split into the A-B-C scheme in 2014 did not turn out to be optimal as the majority of affiliates stayed in the B fund, the default option for those who fulfilled the age condition. Only a handful of affiliates opted for the riskier A category fund (0.28% of total membership) despite public recommendations that younger cohort groups should opt for that category. The split resulted in only 0.52% of AuM being placed in category A funds and 2.2% in category C funds.

Moreover, the default option for newcomers who did not decide to choose a fund in a short period after first employment (subsequently redistributed randomly by a central registry to one of the funds managed by the different companies) within the 2014 legislative changes remained category B funds, although the life-cycle scheme design clearly recommends that the youngest cohort groups should start with the riskiest choice. In addition, the vast majority of newcomers (around 99%) historically did not choose a fund by themselves, meaning that effectively almost all of them were enrolled in one of the B category funds. By the end of September 2019, as a result of the initial split and redistribution choices, the AuM of category A funds reached only the very modest 0.71% of total assets, while category C funds reached an also very modest 5.01% of total assets. The redistribution to a category B fund remained in force for more than 5 years until the 2019 legislative changes, starting with the October 2019 redistribution, diverted no-fund-decision-newcomers to one of the A category funds.

As a result of the introduction of the life-cycle scheme in 2014 and subsequent changes in redistribution policy in 2019, and together with the retirement of the first mandatorily-in-2nd pillar cohort group, in the next decade a complex situation with cash flows is expected to appear between different MPFs categories. It is our goal to analyse expected cash flows in the 2nd pillar, through simple approximations that will reveal the major trends, and subsequently estimate the liquidity-implied changes in asset allocation for different MPF categories. Also, we estimate that the current liquidity of domestic assets are one or two orders of magnitude smaller than the liquidity of assets on developed markets, which might imply asset reallocation towards developed markets and subsequently a different risk/return trade-off with the possible outcome of a *loss* of liquidity premium in the long term.

The same reasoning of liquidity-implied changes in asset allocation for VPFs is analysed in subsequent chapters. Therefore, our next task is to establish a reasonable choice of asset allocation structures, i.e. strategic asset classes, for a particular type of a pension fund, along with their risk/return trade-offs and correlations between them.

2.2 ASSET ALLOCATION OF MANDATORY PENSION FUNDS

The asset allocation structure of MPFs from 2002 onward shows a traditionally high share of domestic investments, particularly in Croatian government bonds. As of the end of 3Q 2020, more than 80% of funds' assets in category B and C funds are invested in the domestic market and for category A funds that figure is close to 70%. One of the main reasons for the high inclination to domestic assets

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

in MPFs is certainly the limit for currency exposure (see table 1). However, we also note a significant out-performance of Croatian government bonds in the period from April 2002 until September 2020, in terms of risk/return trade-off, with respect to other asset classes, i.e. their realized return vs. risk ratio was three times higher[1] than for foreign equity or fixed income developed market asset classes. More on the efficiency and performance of Croatian mandatory pension funds can be found elsewhere (Novaković, 2015; Matek and Radaković, 2015; Matek, Lukač and Repač, 2016; Draženović, Hodžić and Maradin, 2019).

The share of assets invested in equities in relation to assets invested in other asset classes also shows that MPFs did not utilise the maximal exposure to equities allowed by investment limits. As of the end of 2Q 2020, the exposure of category A funds to equities was around 45% and that of B funds around 25%[2] (C funds cannot invest in equities). Although MPFs have recorded a slight increase in exposure to equities over time, they continued to invest predominantly in fixed income securities.

In order to simplify further analysis, and taking into account the current as well as expected asset allocation of MPFs, we are going to use the simple breakdown of asset allocation in terms of four major asset classes (i.e., they will be treated as distinctive risk factors due to different expected premiums, risks and low correlations): domestic fixed income, domestic equity, foreign fixed income and foreign equity. Furthermore, in order to calculate pension funds expected net inflows, accumulated savings, expected returns and risks, below we define expected long-term returns and volatilities of these four risk factors as well as their mutual correlations.

The expected long-term returns of pension funds mostly depend on the strategic asset allocation of their portfolios, i.e. on the allocation to fixed income securities (bonds) and equity securities (shares) in their portfolios. These expectations can be derived either through analysing the average realized returns over previous periods (Dimson, March and Staunton, 2020) or through analysing drivers of their future values. In addition, one might utilize expectations from various market participants in order to establish their own expectations. Here, we use the last two methods, due to the short history of the domestic market and expected changes in risk premiums for domestic asset classes due to the convergence of Croatia toward the European Monetary Union.

Expected returns and volatilities for selected asset classes are presented in table 2. For foreign equity and fixed income markets, estimations are based on market consensus (see, e.g., Horizon Actuarial Services, 2020), while for the Croatian

[1] Measured by proprietary Croatian government bonds index of Raiffeisen Mandatory and Voluntary Pension Fund Management Company vs. indices for broad developed equity and fixed income markets. In a period April 2002 till September 2020, Croatian government bonds exhibited 6.9% annual rate of return vs. 4.5% annual volatility.

[2] Estimation according to semi-annual reports of mandatory pension funds' portfolios published on management companies' web pages.

market an estimate of premiums is used with respect to their developed market counterparts in order to account for the higher expected risk of Croatian assets. Assumptions about the correlations are given in table 3, and they are estimated by observing the trends in the correlations of returns on various asset classes as well as from those derived from various market participants.

Table 2

The expected returns and volatilities for fixed income and equity asset classes on Croatian (HR) and developed (DM) capital markets (in %, annualized)

		Expected	
		Return	**Risk**
HR	Fixed income	1.50	5.00
	Equity	6.00	20.00
DM	Fixed income	1.00	3.50
	Equity	5.00	16.50

Source: Estimations by the authors.

Table 3

Assumptions for correlations between asset classes

		HR		DM	
		Fixed income	**Equity**	**Fixed income**	**Equity**
HR	Fixed income	1.00	0.10	0.70	0.20
	Equity	0.10	1.00	0.10	0.50
DM	Fixed income	0.70	0.10	1.00	-0.10
	Equity	0.20	0.50	-0.10	1.00

Source: Estimations by the authors.

Taking into account the regulatory limits on the exposure to equity for MPFs of various categories (see table 1), we assume the targeted asset allocation in equity and fixed income asset classes for funds A, B and C. The allocation to equity is arbitrarily increased for category A and B funds from their current asset allocations, i.e. we do not want to match them, rather to adjust them to possibly higher values in order to analyse the impact of liquidity in more adverse situations. Assumptions about the asset allocations of MPFs are shown in table 4.

Table 4

Expected asset allocation of MPFs in equity and fixed income asset classes (in % of funds' assets)

	A	**B**	**C**
Equity	60	30	0
Fixed income	40	70	100

Source: Estimations by the authors.

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

For category A fund we have selected a more balanced asset allocation, while the allocation for the category C fund is completely conservative. Furthermore, we assume that funds invest their assets in Croatian and foreign markets, according to the allocation shown in table 5. Also, we can notice an increased exposure to domestic market vs. developed markets, as in the current situation. The larger proportion of developed market equity in category B fund than of domestic equity comes from the fact that current assets of those funds are too large to create an effective exposure on the relatively low capitalization of the Croatian market.

TABLE 5

Expected asset allocation of MPFs to Croatian (HR) and developed market (DM) asset classes (in % of funds' assets)

		A	B	C
HR	Fixed income	30	60	90
	Equity	30	10	0
DM	Fixed income	10	10	10
	Equity	30	20	0
Total		100	100	100

Source: Estimations by the authors.

Based on the assumptions on expected real returns, risks, correlations and the asset allocations of MPFs portfolios, shown in tables 2 to 5, and by using the equation for portfolio total return, R_P, and portfolio risk, σ_P:

$$R_P = \sum_i w_i R_i \tag{1}$$

$$\sigma_P^2 = \sum_{ij} w_i w_j \sigma_i \sigma_j \rho_{ij} \tag{2}$$

where w_i represents the share of an asset class in the portfolio, R_i and σ_i are its expected return and expected risk respectively, while ρ_{ij} is the expected correlation between the ith and jth asset classes, we calculate the expected returns and risks for a particular fund (table 6).

TABLE 6

The expected returns and volatilities of MPFs (in %, annualized)

Expected	A	B	C
Risk	9.91	6.10	4.75
Return	3.85	2.60	1.45

Source: Authors' own calculations.

The results presented in table 6 show that the expected returns and volatilities are the highest for a category A fund, and by decreasing the share of equity in the portfolios of category B and C funds their expected returns and risks both decline.

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

2.3 CASH FLOW ANALYSIS OF MANDATORY PENSION FUNDS

In order to establish expected long-term cash flows for MPFs, first we have to analyse expected enrolment rate in the 2nd pillar scheme and subsequently determine the retirement rate. Our analysis is based on the data taken from membership database of Raiffeisen Mandatory Pension Funds. However, we assume that the sample size of those funds (market share 29.4% as of 3Q 2019) is high enough for conclusions drawn from this source to be applicable to all Croatian MPFs.

For current members we use their expected retirement age from the database and assume they are following the life-cycle path determined by the law. In other words, a member will stay in category A fund until they reach 55 years of age, then they are transferred to B category fund for next 5 years, until they reach 60 years of age, and finally at 60 they are settled in a C category fund until retirement at 65. Although certain members could choose another path through the life-cycle scheme, taking earlier retirement or dying earlier, we assume that the number of those members is not significant for this analysis.

Moreover, for the sake of simplicity, we assume that all future newcomers in the 2nd pillar scheme have the same age of 25 and that they will follow the same life-cycle path described above. In reality newcomers have a wide range of ages when they join the 2nd pillar. However, that would only smooth our abrupt transition scheme and would not contribute significantly to membership dynamics over the long term.

In order to address long-term demographic development that presumably can strongly influence the overall sustainability of a pension scheme, in the simulation of the membership base we use a parameter that describes the rate of increase of newcomers to the system, i.e. the enrolment rate. In a baseline scenario, the annual enrolment rate is set to 0.3%. Positive growth rate is the result of optimistic labour participation that assumes effective labour market policies and immigration, the details of which are not the subject of this paper.

Results of simulation for long-term membership dynamics for the 2nd pillar are shown in figure 1. From figure 1 we see that legislative changes from 2014 and 2019 have a strong impact on membership base for a particular category of MPF. As soon as category B funds lost their default choice for no-fund-decision-newcomers in October 2019, their membership base started to decline at a considerable rate, which we expect to continue until 2050, when it will slow down due to transition of current newcomers in category A funds to category B funds. The situation for the membership base of category A funds is inverse to that of the B category. On the other hand, category C funds have not had any significant long-term change in their membership base as they were not affected by legislative changes.

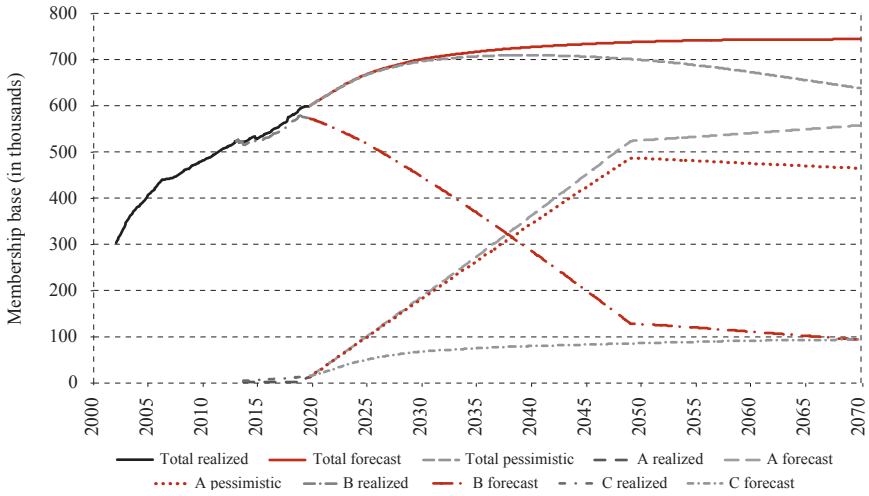
From membership dynamics, we can construct expected long-term inflows and outflows for a particular MPF category. Here, we also assume a constant long-term increase in average gross salary, without attempting to address a possible increase of contribution rate (unchanged at 5% contribution of gross salary to the

PUBLIC SECTOR ECONOMICS 45(2) 229-255 (2021)

2nd pillar since inception), and set that parameter to 1.0% as a baseline scenario. We also take into account the different average contributions in particular categories, e.g. members of category C fund have the largest contributions to MPFs due to their expected higher salaries. On the other hand, analysis of expected outflows takes into account accumulated savings for particular cohort groups, modelled with the expected long-term returns derived in the previous chapter. More on methods used to calculate accumulated savings can be found elsewhere (Šorić, 2000; Latković and Liker, 2009; Kovačević and Latković, 2015).

Figure 1

Realized and expected long-term membership dynamic (number of members at the end of period) for 2nd pillar proxy life-cycle scheme in Croatia



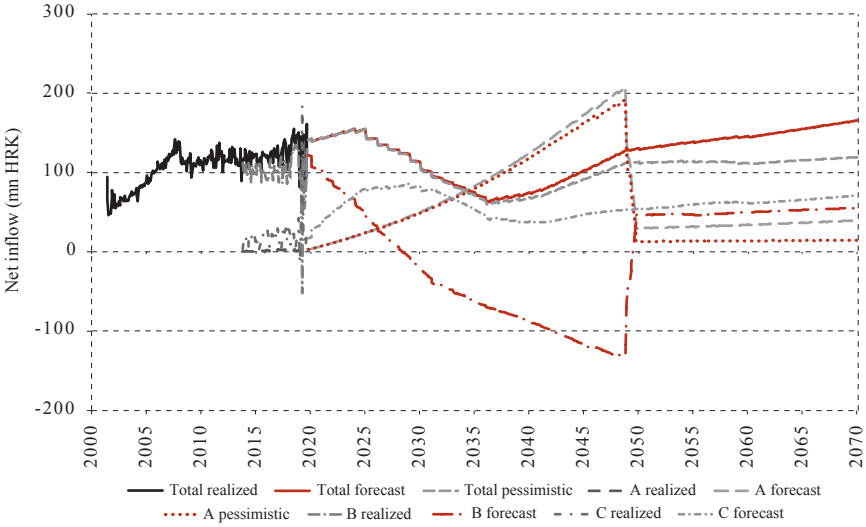
Source: Authors' own calculations.

Results of simulation for long-term net inflows for the 2nd pillar are shown in figure 2. From figure 2 we see that after October 2019 there is a steady increase in net inflow for category A funds, which abruptly finishes in 2050 when, according to our assumptions on membership dynamics, the majority of 2019 cohort group of newcomers will be transferred to category B funds. In reality, the transition will not be as abrupt as our simulation shows, rather, a smoothed version of the transition is expected to occur due to the different ages of newcomers when they join the 2nd pillar. After this transition period, we expect that net inflows to category A funds will saturate to some steady positive level. We also note that this conclusion depends on the assumptions of a net positive effect due to the favourable combination of the rate of change in number of newcomers to the 2nd pillar, rate of change of gross salaries and long-term returns of category A funds. Below, we will discuss some unfavourable scenarios in order to understand the possible reasons for asset reallocations in category A funds due to liquidity issues.

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

FIGURE 2

Realized and expected long-term net inflows (in mn HRK) to 2nd pillar proxy life-cycle scheme in Croatia



Source: Authors' own calculations.

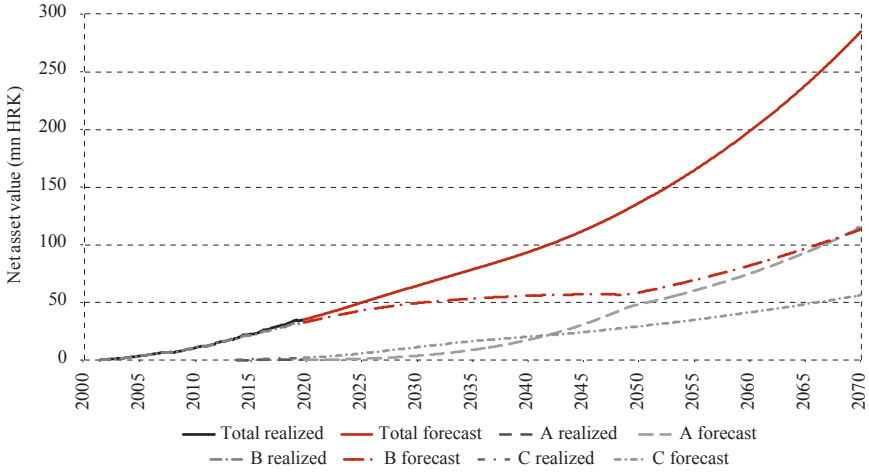
On the other hand, net inflow for category B funds looks almost like a mirror reflection of net inflow for category A funds. No longer supported by no-fund-decision-newcomers, and approaching the period when the first mandatory-in-the 2nd pillar cohort group will have to be transferred to category C funds, net inflow of category B funds gradually dries up and becomes negative up to the point when suddenly the cohort group of 2019-newcomers will start to transfer their accumulated savings to category B funds. After this transition period, we also expect that net inflows to category B funds will saturate to some steady positive level and, as is a case for category A funds, be strongly dependent on the favourable combination of the parameters mentioned above. As with category A funds, in reality the transition will not be as abrupt as depicted and a smoothed version of the transition is expected to occur.

Net inflow for category C funds turns out to be more complex as those funds are going through several phases. In the next several years, category C funds will exhibit stronger net inflows due to transfers of members from the cohort group aged between 40 and 50 at the start of the reform in 2002: the distribution of membership age for this cohort group decreases rapidly when approaching the age of 50 due to the recommendations from the authorities in 2002 to opt out of the 2nd pillar if personal salaries are not high enough. After this cohort group retires, the next, first mandatory-in-the 2nd pillar, cohort group starts to increase outflows due to its longer period of accumulation in category B funds. Finally, after 2040, when mandatory-in-the 2nd pillar newcomers of the 2002 cohort group start to arrive in category C funds, and all effects that can be attributed to the way the 2nd pillar was formed in 2002 vanish, net inflows start to stabilize at a certain level, as in category A and B funds.

The influence of net inflow on MPFs net asset value can be seen in figure 3. Due to the negative expected net inflows, the value of assets for category B funds is expected to gradually saturate until 2050, while at the same time category A funds are expected to rise with a strong rate until the same year. After 2050, both A and B, are expected to experience increased outflows. Eventually, it is expected that category A funds will at some point overtake assets of category B funds due to the higher expected returns.

Figure 3

Realized and expected net asset values (in mn HRK) for 2nd pillar proxy life-cycle scheme in Croatia



Source: Authors' own calculations.

Previously, we indicated that the above stated conclusions on net inflows for MPFs depend on the assumptions of three parameters that are embedded in the calculations, namely, rate of change in number of newcomers to the 2nd pillar, rate of change of gross salaries and MPFs/long-term returns. Here, we are not going to stress long-term returns because decreasing returns imply also a decreasing amount of accumulated savings (liabilities in collective investment schemes usually follow the value of assets). Rather, we analyse unfavourable changes in the first two parameters, as one of them can be considered essentially demographic (newcomer growth rate) and the other economic (gross salary growth rate).

The effect of a lower newcomer annual growth rate than assumed in the baseline scenario (0.3%) can be seen in figure 1 where we use a negative annual growth rate of 0.2%. Total membership starts to decrease after two decades and category A funds membership is highly affected (effects for category B and C funds are not shown as they are not significant). At the same time, overall MPF net inflows decrease significantly after 2050 with the main contribution coming from category A funds (B and C are not depicted for the same reason as before). Here, the conclusion is that in the future, category A funds also might experience diminishing cash flows. The effect on asset values is not significant in this case.

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

The effect of a lower annual gross salary growth rate than assumed in the baseline scenario (1.0%) on net inflows is almost the same as in the previous scenario, if we assume gross salary growth rate of 0.5%. However, the combined effect of negative newcomer annual growth rate of 0.2% and lower annual gross salary growth rate of 0.5% pushes net inflows of category A funds towards slightly negative values. Our analysis shows that future cash flows of category A funds are quite sensitive to demographic and economic factors. In the following chapter, we analyse the liquidity shortages implications for asset allocation of MPFs and subsequently to their expected returns.

2.4 LIQUIDITY-DRIVEN CHANGES IN ASSET ALLOCATION FOR MANDATORY PENSION FUNDS

In order to address liquidity shortage in a particular MPF, we assume the simplest choice that in a future could be performed by fund managers, and that is the reallocation of assets with lower liquidity (presumably domestic) to assets of higher liquidity (presumably developed markets) in order to minimize market impact on asset prices. Our assumption also implies we do not expect in a near future that domestic assets will improve their liquidity as compared to developed market assets.

We also note that asset reallocation is not the only choice to reduce liquidity issues as high fixed income allocation funds have the advantage of collecting accrued interest on those securities, which may strongly reduce liquidity issues. Moreover, a gradual switch from growth stocks to value stocks that pay dividends more regularly may help to reduce the liquidity burden for the equity part of the pension funds' portfolios. However, since it is not possible reliably to estimate the liquidity of asset classes in the future, or future cash flows generated by coupons of fixed income instruments and dividends of shares, in the following we will simply assume that reallocation will occur in a certain amount.

Therefore, in table 7 we propose expected changes in asset allocation for particular MPF categories, where we reallocate, with respect to compositions denoted in table 5, mostly in category B funds, due to the higher rate of negative cash flows. We note that reallocation amounts do not depend only on expected cash flows, they depend on and are tightly interconnected with the liquidity of particular asset classes and also depend on the value of assets of particular pension fund in that period.

Table 7

Expected liquidity-driven asset allocation of MPFs in asset classes (in % of funds' assets)

		A	B	C
HR	Fixed income	25	45	80
	Equity	20	5	0
DM	Fixed income	15	25	20
	Equity	40	25	0
Total		100	100	100

Source: Estimations by the authors.

PUBLIC SECTOR ECONOMICS 45(2) 229-255 (2021)

The proposed reallocations resulted in risk/return profiles shown in table 8. As expected, the returns of all MPF categories are lower than returns that would exist if there were no liquidity shortages. The difference between portfolio returns obtained after liquidity-driven reallocation and those without expected liquidity shortage – denoted as liquidity premium – is negative for MPFs: for category A funds it is equal to 12 bp, for category B funds it is 13 bp and for category C funds it amounts to 5 bp.

Table 8

The expected returns and volatilities of MPFs after liquidity-driven reallocations (in %, annualized)

Expected	A	B	C
Risk	9.63	5.86	4.52
Return	3.73	2.48	1.40

Source: Authors' own calculations.

These results depend on assumed expected long-term returns for particular asset classes and the amount of reallocations needed to reduce funds' liquidity risk. The obtained results also imply that in the fourth and fifth decade of this century category B funds are expected, not just to forgo the usual positive liquidity premium, but also to bear a negative liquidity premium. The same disadvantage could be also expected for category A funds in the event of adverse demographic or economic scenarios, but not in a near future.

In the following chapters, we analyse the expected cash flows for voluntary pension funds in Croatia and implications for their future asset allocations.

3 VOLUNTARY PENSION FUNDS

3.1 SHORT OVERVIEW AND DEVELOPMENT

Open-ended voluntary pension funds (OVPFs) and closed-ended voluntary pension funds (CVPFs) in Croatia, the 3rd pillar of the multi-pillar pension scheme, were introduced in 2002 together with the MPFs. OVPFs are available to everyone, i.e. membership is allowed to anyone who wants to pay contributions on a voluntary basis. On the other hand, CVPFs have a sponsor (a company, association of a profession or a trade union) that has an obligation to pay contributions for members of closed-ended fund. At first, only OVPFs were established, but a few years later, the first CVPFs were formed. As of the end of 3Q 2020 there were 8 OVPFs and 20 CVPFs in Croatia, managed by four pension companies, with more than 380 thousand members (336 thousand in OVPFs) and HRK 6.3 billion (EUR 835 million) of AuM (HRK 5.2 billion in OVPFs).

The risk profiles of OVPFs are not regulated by the law as mandatory funds are. Rather, management companies defined OVPFs' risk profiles and offered them on the market. Several management companies have established OVPFs that vary in their risk profiles, from balanced to conservative, in a way similar to that of the risk profiles of the A-B-C categories of the 2nd pillar. In the case of CVPFs, the risk

profile of a fund, together with the targeted asset allocation, is subject to an agreement between a management company and a sponsor.

To encourage savings in VPFs, the Croatian state has provided two benefits for their members: state incentives on contributions paid and tax relief. However, those benefits have been changed several times since the beginning of the pension reform which also affected cash flows of the VPFs.

First, voluntary pension savings were encouraged by 25% of state incentives on contributions paid to a fund, up to a maximum of HRK 1,250 per person in one calendar year. In 2011, the state incentives were reduced to 15% up to a maximum of HRK 750 per member per year. The reduction of incentives influenced VPFs' cash flows through the smaller inflow of the incentives themselves, and additionally by discouraging new payments as the voluntary pension savings become less attractive. However, in 2011, 32% members fewer than the year before enrolled in OVPFs. Second, at the beginning, there was tax relief for all members' contributions up to HRK 12,000 per year, together with life insurance and supplementary health insurance premiums paid in the same year. However, tax relief for members was abolished in 2010 and a new tax relief was introduced for employers who pay contributions to VPFs on behalf of their employees, up to HRK 6,000 per year.

When a member retired from the 3rd pillar, if she/he had used a tax relief, she/he had to pay a tax on insurance income, amounting to 15% of the tax relief used. This tax burden lasted from 2002 to 2010 and then was reduced to 12%. With the latest amendments to the law in 2019, insurance income tax was abolished, so everyone who used tax relief no longer have to pay any income tax, and that was an incentive by itself. Although the income tax paid by the members was not significant, regulatory changes of this incentive positively affected and stimulated both employers and members to save in VPFs, if for nothing else, then for the sake of simplifying the process.

The cash flows of VPFs were also affected by legislative changes in 2014, which later changed further in 2019, due to the extra possibilities created for the pay-outs of accumulated savings from the 3rd pillar. Until 2010, all members who decided to retire had to transfer their accumulated savings to a pension insurance company. In 2010, legislative changes required only members' savings above HRK 10,000 (approx. EUR 1,320) to be transferred to a pension insurance company, otherwise savings could be paid out directly to members. After major legislative changes in 2014, management companies had to provide the possibility of payments in the form of a variable annuity (i.e. unit linked), paid through VPF at least in period of 5 years, for those members with savings up to HRK 50,000 (approx. EUR 6,600), and along with an already established lump-sum payment up to HRK 10,000. This legislative change had a significant influence on VPFs' cash flows since the majority of members who decided to opt out from the 3rd pillar had chosen that opportunity. With the latest changes in 2019, the maximum amount was increased to

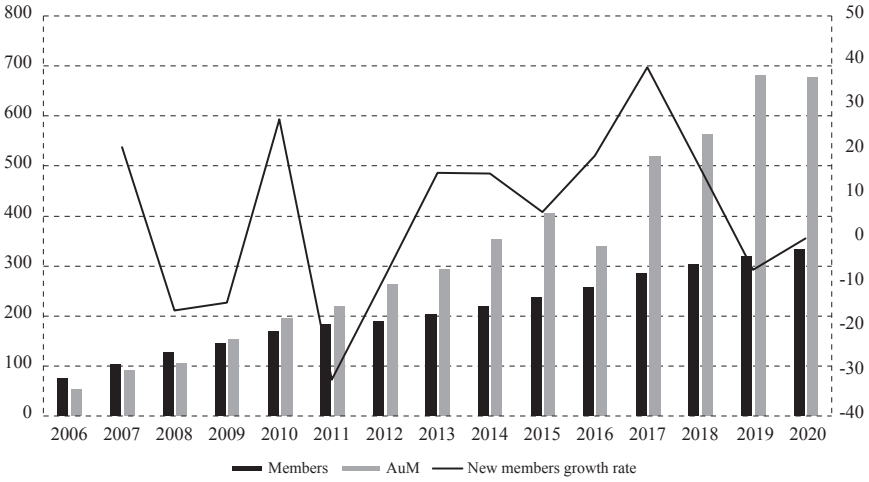
HRK 100,000 (approx. EUR 13,200), and was provided to everyone regardless of the amount of accumulated savings. With possibility of providing variable annuities, VPFs could delay the pay-outs, thus seemingly improving the expected cash flows. Furthermore, with the latest legislative changes a lump-sum payment up to HRK 10,000 is no longer possible for newcomers which also constitutes a positive influence on VPFs cash flows.

The earliest retirement age was initially set as up to 50 years of age. With the 2019 legislative changes, the retirement age from 3rd pillar has been changed from 50 years to 55 years, however also only for newcomers. Therefore, it will take a significant period when this shift in retirement age start to improve VPF cash flows.

As contributions to VPFs are voluntary, it is very important to observe past developments and the behaviour of members in times of crisis. The net inflows to OVPFs from the beginning were always positive. Observing the period from 2006 (figure 4), we can conclude that the number of members, the amount of contributions and assets under management has grown steadily, but not at equal growth rates.

Figure 4

OVPFs membership base (left axis, in 000), AuM (left axis, in EUR mn) and new members growth rate (right axis, in %)



Source: HANFA reports.

During political, economic or financial crises capital markets almost regularly respond with low or negative returns. OVPFs' total membership base, which grew at an average rate of 5.9% per year, during the periods of crises, e.g. between 2008-2009 and 2011-2012, recorded negative growth rates (2008: -16.3%, 2009: -14.5%, 2011: -31.9%, 2012: -8.6%). Moreover, during the same period, an increased number of members decided to use their accumulated savings from OVPFs. When compared with the year before, the increase in withdrawals was

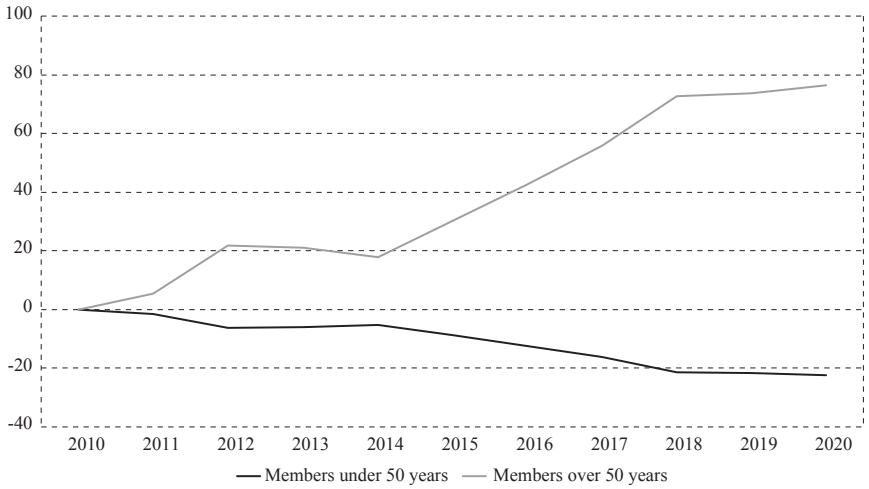
83% in 2008, 124% in 2009 and 148% in 2012, which is more than the average long-term withdrawal rate of 44%. Also, members' contributions to OVPFs usually decrease during crises (total contributions paid in 2009 was down 5% and in 2012 it was down 7% from the previous year). Such events have a strong impact on expected VPFs cash flows and have to be taken into account by fund managers during the process of establishing strategic asset allocations of VPFs.

Presumably, the most important impact on expected VPFs cash flows is made by the retirement age, which is here quite unpredictable (up to the estimation from historical data). Moreover, there are no clear resemblances between retirement age in the 1st and 2nd pillar (which occur at the same time) and retirement age in the 3rd pillar. Although the design of multi-pillar pension scheme assumes an equal retirement age for every pillar (currently 65 years of age), it is not obvious why the 3rd pillar should follow the same accumulation-retirement path as the first two pillars.

The goal of the 3rd pillar is not just to provide an additional annuity – it is also designed to provide an option for postponing an early retirement from first two pillars in the event of disability or job loss, or simply due to decreasing salary or increased costs of living, in the period close to retirement. Therefore, in order to address the impact of the retirement age in the 3rd pillar on expected cash flows, it is important to observe the age structure of VPF members, the ratio of members younger and older than 50 years of age, and their share in total assets of VPFs. We notice that the share of people older than 50 years of age in OVPFs has increased over time; the share of people younger than 50 in 2010 was 77.3% while as of 3Q 2020 the ratio of younger to older people is 60% to 40%.

Figure 5

Trend in age structure of OVPFs in Croatia – growth rate of members under 50 years and members over 50 years old (in %)



Source: HANFA reports.

3.2 ASSET ALLOCATION OF VOLUNTARY PENSION FUNDS

In the following, we only analyse the structures of OVPFs since data on CVPFs were not widely available until very recently. Observing the asset allocation of OVPFs' portfolios from 2006 until 3Q 2020, we notice that the allocation into domestic assets has been decreasing, while allocation in foreign assets has been increasing. As of the end of 3Q 2020, 83% of total assets were allocated to the domestic market. Here, we reiterate that one of the main reasons for such asset allocation are the good results that the funds achieved by investing in domestic bonds during the period from 2002 to 2020. Also, VPFs allocation to equities, both domestic and foreign, has been increasing over time. As the end of 3Q 2020, OVPFs exposure to equities was over 22%. This gradual change in OVPFs asset allocation reflects, among others, the development of the Croatian capital market. However, fixed income instruments still dominate in OVPFs' asset allocation structure.

In the following analysis, since the structures of open-ended VPFs are very similar to A-B-C categories of MPFs, we use the same asset classes for VPFs as we used for MPFs. Also, the expected long-term returns, volatilities and correlations for those asset classes are the same as for MPFs (tables 2 and 3).

In order to assess the unique asset allocation structure of all Croatian OVPFs, we analyse their risk profiles and market shares in terms of net asset value. Consequently, we assume a moderately conservative asset allocation structure with the assumed targeted asset allocation shown in table 9. In addition, assumed targeted asset allocation is further divided between Croatian and developed markets as shown in table 10.

Table 9

Expected asset allocation of OVPFs in equity and fixed income asset classes (in % of funds' assets)

	OVPF
Equity	25
Fixed income	75

Source: Estimations by the authors.

Table 10

Expected asset allocation of OVPFs in Croatian and developed market asset classes (in % of funds' assets)

		OVPF
HR	Fixed income	45
	Equity	15
DM	Fixed income	30
	Equity	10
Total		100

Source: Estimations by the authors.

PUBLIC SECTOR ECONOMICS
45(2) 229-255 (2021)

Based on the assumptions on expected returns, risks, correlations and the asset allocations of OVPFs' portfolios, we obtain the expected return and risk for VPFs that are shown in table 11.

Table 11

The expected returns and volatilities of OVPFs (in %, annualized)

Expected	OVPF
Risk	5.41
Return	2.38

Source: Authors' own calculations.

3.3 LONG-TERM CASH FLOW OF VOLUNTARY PENSION FUNDS

When simulating the long-term cash flows of VPFs, one has to take it into account that, unlike to MPFs, VPFs do not follow a life-cycle path. Furthermore, the most important parameters influencing long-term cash flows of VPFs can be only assumed or asserted from the data as they are not strictly stipulated. For this analysis, we used data from published reports on VPFs (HANFA reports) and data from the Raiffeisen Voluntary Pension Fund database. We assume that the sample size of that fund (market share 30.18% as of 3Q 2019), similarly to assumptions for MPFs, is high enough for conclusions drawn from this source to be applicable to all Croatian OVPFs. The baseline scenario assumes a steady development of voluntary pension savings, i.e. a linear growth of most factors influencing cash flows.

As already mentioned, the age structure of members in VPFs is very important. The fact that total membership is constantly changing in favour of older members leads us to consider the further aging of VPF members. The rate at which this change is projected to occur in baseline scenario is 0.2% per year, decreasing for those younger than 50 and increasing for those older than 50. At the same time, it is projected that the share of those over 65 in total membership will decrease by 0.1% per year, as we assume that after retirement from the 1st and 2nd pillar most of them will naturally want to retire from the 3rd pillar as well.

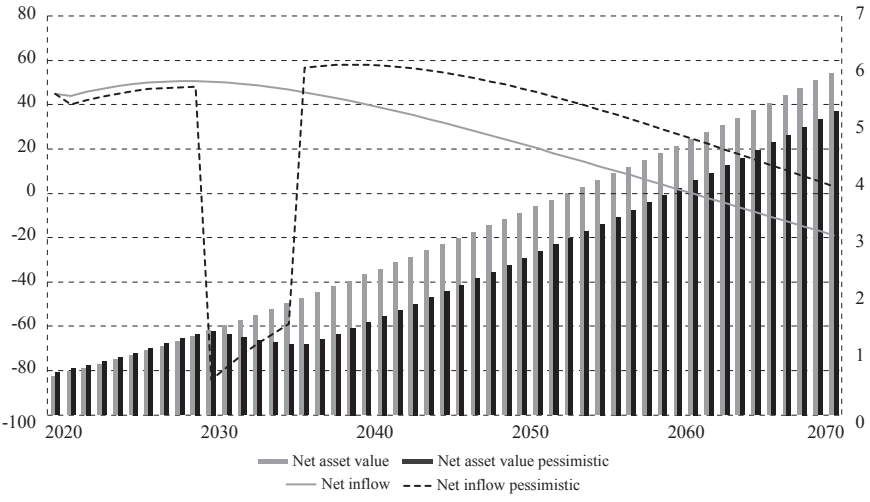
As a consequence of the change in age structure, we anticipate an increase of the share in total asset of those who have more than 60 years at a rate of 0.1% per year. Currently, they hold a 50.1% share in total assets. An increase of 0.1% per year will result in a 52.6% market share in 2070. On the other hand, we anticipate a 0.02% reduction in the share of total assets of members over 65 years of age. The number of those who will exit VPFs every year is the most influential factor of the long term cash flow forecast. As members stay longer in a fund, they have more accumulated funds and, as they are older on average, more of them will leave. Therefore, it is expected that pay-outs will increase over time. Also, we have to take into account older members with no balance or a very small balance on their account. Finally, we assume 50% of those older than 65 will opt out from the 3rd pillar every year.

As of 3Q 2020 the share of members older than 50 who decided to opt out was approximately around 10% (average since 2006). As the retirement age in VPFs has increased to 55 (only for newcomers from 2019 further), this will influence the share of opt-outs among those older than 50, however with a lower intensity at first. Therefore, we predict 12% of those older than 50 will opt-out from VPFs every year. The assumed share of opt-outs and their share in the total assets of VPFs, give us projected amounts for pay-outs.

In simulation of the membership base, beside those who will opt out, we assume the rate of increase of new members in VPFs. In a baseline scenario, we assume a (not overly optimistic) growth of membership by 2% every year. The assumption is based on the historical developments where the growth rate of new members in the period from 2006 on, varied from -32% to +38%, with the average rate of 5.9%. For expected contributions we assume an average payment of HRK 2,000 per year per member, which is a calculation based on the average payments of all members since 2006. We also assume that state incentives in the future will amount to 15%, and the right to state incentives is exercised by 81% of members, which is also a calculation based on data for the last 5 years. Results of our simulation for long-term net inflow and assets of VPFs are shown in figure 7.

Figure 6

VPFs net inflow (left axis, in EUR mn), VPFs net inflow pessimistic (left axis, in EUR mn), VPFs net asset value (right axis, in EUR bn) and VPFs net asset value pessimistic (right axis, in EUR bn)



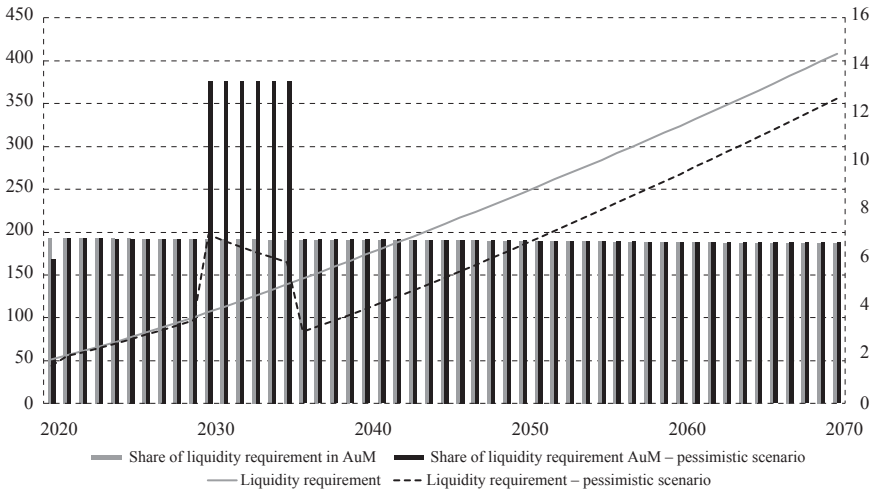
Source: Authors' own calculations.

From figure 6 we see how, after reaching a peak around 2030, due to increasing pay-outs over the years, net inflow records a steady decline in the following period. Around 2060, net inflow becomes negative, i.e. pay-outs exceeds contributions to VPFs. On the other hand, net asset value growth is steady throughout

the years until 2070. If the time period were extended for another decade, we would see that net inflow would return to positive territory after 2080. However, we cannot exclude unsustainability of the system in a very long run due to the sensitivity of simulations to input parameters.

Figure 7

VPFs liquidity requirement (left axis, in EUR mn), VPFs liquidity requirement pessimistic (left axis, in EUR mn), share of liquidity requirement in AuM (right axis, in %), share of liquidity requirement pessimistic in AuM (right axis, in %)



Source: Authors' own calculations.

The nominal growth of assets required for pay-outs and their share in total AuM are shown in figure 7. In the case when more assets are needed for liquidity, the targeted asset allocation of a VPF is expected to change. In that case, due to higher requirements for additional liquidity, the expected return of the fund is lower since highly liquid assets generally do not have attractive returns. However, in this scenario, the share of liquidity requirement in AuM decreases slightly over the years, and remains in the range between 6.85% and 6.50%. The OVPFs in a baseline scenario would not have to change their risk profile regardless of the nominal liquidity requirement increase.

In a pessimistic scenario we analyse the influence of unfavourable economic developments on the long-term cash flow of VPFs. This situation could be caused by some economic crisis, serious demographic issues, distrust in the financial or pension system, etc. We assume that this period will happen in 2031 and last for 6 years (stress period). For other periods, assumptions will stay the same as in baseline scenario. As already confirmed, during the crisis period, VPFs will experience a lower growth rate of newcomers, lower contributions and most important, increased demand for pay-outs. For the pessimistic scenario we use adverse values of parameters for this particular 6 year period. We assume that opt-outs of

PUBLIC SECTOR ECONOMICS 45(2) 229-255 (2021)

those older than 50 will rise to 25% (baseline scenario: 12%), growth rate of newcomers decreases to 1% (baseline scenario: 2%), and average payment falls to HRK 1,500 (baseline scenario: HRK 2,000). Our analysis shows the net inflow is very sensitive to those factors. Dashed lines in figure 6 show how net inflows look during the stress period, i.e. how suddenly they become negative.

In figure 7 it is shown, also with a dashed line, how the liquidity requirement rises sharply, both nominally and in terms of total assets. It is immediately clear that VPFs cannot maintain the same investment structure and will have to reallocate to assets with higher liquidity. Therefore, the targeted asset allocation structure changes and the expected return decreases during the stress period.

3.4 LIQUIDITY-DRIVEN CHANGES IN ASSET ALLOCATION FOR VOLUNTARY PENSION FUNDS

The liquidity issue for VPFs may force fund managers to reallocate VPF assets from lower liquidity assets (presumably domestic) to higher liquidity assets (presumably developed markets), as we discussed already for MPFs, in order to minimize market impact on asset prices during the crisis period. Table 12 shows the assumed new asset allocation for VPFs. Consequently, expected returns and volatilities for this new VPF allocation are shown in table 13.

TABLE 12

Expected liquidity-driven asset allocation of OVPFs in asset classes (in % of funds' assets)

		OVPF
HR	Fixed income	35
	Equity	10
DM	Fixed income	40
	Equity	15
Total		100

Source: Estimations by the authors.

TABLE 13

The expected returns and volatilities of OVPFs after liquidity-driven reallocations (in %, annualized)

Expected	OVPF
Risk	5.08
Return	2.28

Source: Authors' own calculations.

The lower return of OVPFs is a result of liquidity shortages. Due to the move in asset allocation structure, the difference between returns obtained after liquidity-driven reallocation and those without expected liquidity shortage (the liquidity premium) amounts to -0.10% during the stress period. We conclude that during

period of crisis, VPFs may deviate from their targeted assets allocation strategies, which ultimately may lead to reduced returns that are reflected on the savings of all members.

The results obtained here for OVPFs can be also applied for CVPFs after accounting for eventual differences in age structures of their members as well as specific risk profiles and size in net asset values.

4 CONCLUSION

In this paper we analysed Croatian 2nd and 3rd pillar pension scheme long-term cash flows and liquidity-driven changes in asset allocation that are expected to induce negative liquidity premiums for pension funds. For mandatory pension funds, long-term cash flow fluctuations are determined by the age distribution of affiliates at the start of the 2nd pillar in 2020, transition to the proxy life-cycle scheme introduced in 2014, as well as the change in the default fund for indecisive newcomers in 2019. Although calculations are based on data from mandatory pension funds managed by one fund management company, they are expected to be valid for all 2nd pillar pension funds in Croatia.

Simulations are carried out on the membership base for all three categories (A, B and C) of mandatory pension funds taking into account the statutorily determined life-cycle path for transferring between particular fund categories, as well as the enrolment rate in category A funds as the main parameter for the long-term demographic sustainability of 2nd pillar. From the membership base, simulations are carried out on net inflows by taking into account gross salary growth rate as well as accumulated savings for particular cohort groups. Also, in order to calculate accumulated savings, the expected long-term returns of mandatory pension funds are determined by assuming portfolio allocation of a particular category fund to four different asset classes (domestic and developed markets, equity and fixed income) with respective expected returns, volatilities and correlations.

The obtained long-term net inflows to mandatory pension funds show that category B funds are expected to sustain a relatively long period of negative cash flows. Assuming that liquidity shortages are addressed by reallocation from less liquid domestic assets to substantially more liquid assets on developed markets, a negative liquidity premium is calculated for all three categories, i.e. under assumed reallocations, for category A it is 12 bp, for category B funds it is 13 bp and for category C funds it amounts to 5 bp. Also, in a scenario of adverse demographic or economic conditions, modelled through negative enrolment rate to the 2nd pillar and a lower gross salary rate increase, we showed a significant sensitivity of net inflows for A and B categories that could further enlarge the negative liquidity premiums obtained in the baseline scenario.

We also note that asset reallocation is not the only way to reduce liquidity issues. High fixed income allocation funds have the benefit of collecting accrued interest

on those securities, which may strongly reduce liquidity issues. Moreover, a gradual switch from growth stocks to value stocks that pay dividends more regularly may help to reduce the liquidity burden for the equity part of the pension funds' portfolios. Nevertheless, it is almost certain that in a decade, pension fund managers will have to adjust portfolios of category B funds in a manner suitable to address the liquidity shortage for the foreseeable next two decades, which could have significant influence on the domestic capital market due to the fact that Croatian mandatory pension funds are the most significant local institutional investors.

We also caution the reader that analysis provided in this paper for 2nd pillar funds should not be viewed as a revelation of a problem, rather a challenge for future pension fund managers. We expect that the benefits gained through introduction of the life-cycle scheme in 2nd pillar will more than compensate for the possible liquidity premium lost in a necessary path from one-size-fits-all investment vehicles to something that is a proxy for gliding path investment vehicles. Moreover, proponents of a true gliding path approach to life savings (Vukorepa, 2011, 2012; Potočnjak and Vukorepa, 2012) would probably appreciate the results presented in this article as a justification for a further pension scheme reform that has the potential to eliminate some of proxy life-cycle inefficiencies (Kovačević and Latković, 2015; Azoulay, Kudryavtsev and Shahrabani, 2016; Kudryavtsev, Shahrabani and Azoulay, 2017) or risks imposed on their beneficiaries (Kovačević and Latković, 2015).

In this paper we also analysed the net inflows of the Croatian 3rd pillar, specifically open-ended voluntary pension funds, since data on closed-ended are not widely available. Although calculations for the 3rd pillar are also based on data from a voluntary pension fund managed by one fund management company, they are expected to be valid for all open-ended voluntary pension funds in Croatia due to the market share of this fund. In the short overview of the 3rd pillar in Croatia, we presented its historical perspective and the most important legislative changes that influenced 3rd pillar cash flows, i.e. retirement age, tax treatment and incentives on savings in the 3rd pillar. The retirement age in the 3rd pillar or withdrawals (opt-outs) is the most important factor that determines voluntary pension funds' cash flows. Besides that, as well as the enrolment rate and contribution rate to 3rd pillar funds, their cash flows are also dependent on new possibilities introduced in 2014 for pay-outs in a form of variable annuity payments.

By analysing behaviour of members in the 3rd pillar during periods of crises, we concluded that such events tend to decrease enrolment rates (negative growth rate of newcomers) and average contributions, while more members will decide to opt out. We also analysed the asset allocation of open-ended voluntary pension funds' portfolios from 2006 until 3Q 2020. In this paper we assumed a moderately conservative asset allocation for a typical open-ended voluntary pension fund with an assumed distribution between Croatian and developed markets equity and fixed income instruments.

We carried out simulations of cash flows for two scenarios – a baseline scenario and an adverse one. The baseline scenario assumed a steady development of voluntary pension savings with model parameters that match current trends for 3rd pillar open-ended funds. Result of the baseline scenario simulation shows how, after reaching a peak around 2030, due to increasing pay-outs over the years, net inflow records a steady decline and becomes negative around 2060 when pay-outs exceed contributions. On the other hand, net asset value growth is steady throughout the years until 2070. However, we couldn't exclude unsustainability of the system in a very long run due to the sensitivity of simulations to input parameters. However, in a baseline scenario net inflow would return to positive territory after 2080 if we extended the simulation for another decade. We also showed the nominal growth of assets required for pay-outs and share of those assets in net asset value of a fund. We calculated that the liquidity requirement for 3rd pillar open-ended funds in terms of net asset value decreases slightly over the years, and remains in the range between 6.85% and 6.50%. We also concluded how in the baseline scenario 3rd pillar open-ended funds are expected not to change their risk profiles regardless of the nominal increase of liquidity requirements.

In a more adverse scenario we analysed the influence of unfavourable economic developments on long-term cash flows of 3rd pillar open-ended funds. We assumed such events will happen for a relatively short period and for other periods we left assumptions the same as in the baseline scenario. We also assumed that opt-outs of those older than 50 will rise significantly, the growth rate of newcomers will decrease and the average contribution will fall substantially. An analysis showed how net inflows during the stress period suddenly become negative, liquidity requirement rises sharply, both nominally and in terms of net asset value. We concluded that under those circumstances, 3rd pillar open-ended funds are expected to reallocate assets to more liquid investments. Such a reallocation will decrease expected returns of 3rd pillar open-ended funds and induce a negative liquidity premium that, under assumed reallocations, amounts to -0.10% during the stress period. Negative liquidity premium as it is presented in this article should be acknowledged only as information and not a recommendation to legislators or supervisors as this issue requires further thorough analysis.

Disclosure statement
No potential conflict of interest was reported by the authors.

REFERENCES

1. Azoulay, Y., Kudryavtsev, A. and Shahrabani, S., 2016. Accumulating approach to the life-cycle pension model: practical advantages. *Financial Theory and Practice*, 40(4), pp. 413-436. https://doi.org/10.3326/fintp.40.4.3
2. Dimson, E., March, P. and Staunton, M., 2020. *Credit Suisse Global Investment Returns Yearbook 2020*. Zurich: Credit Suisse Research Institute.
3. Draženović, B., Hodžič, S. and Maradin, D., 2019. The Efficiency of Mandatory Pension Funds: Case of Croatia. *South East European Journal of Economics and Business*, 14(2), pp. 82-94.
4. HANFA, 2020. *HANFA reports*. Zagreb: Croatian Financial Services Supervisory Agency.
5. Horizon Actuarial Services, 2020. *Survey of Capital Market Assumptions: 2020 Edition*. Atlanta: Horizon Actuarial Services.
6. Kovačević, R. and Latković, M., 2015. Risk analysis of the proxy life-cycle investments in the second pillar pension scheme in Croatia. *Financial Theory and Practice*, 39(1), pp. 31-55. https://doi.org/10.3326/fintp.39.1.2
7. Kudryavtsev, A., Shahrabani, S. and Azoulay, Y., 2017. Frequency of Adjusting Asset Allocations in the Life-Cycle Pension Model: When Doing More Is Not Necessarily Better. *Bulletin of Applied Economics*, 4(1), pp. 13-33.
8. Latković, M. and Liker, I., 2009. Sensitivity Analysis of the Pension System. *Financial Theory and Practice*, 33(4), pp. 445-461.
9. Matek, P. and Radaković, M., 2015. Is active management of mandatory pension funds in Croatia creating value for second pillar fund members? *Financial Theory and Practice*, 39(3), pp. 245-278. https://doi.org/10.3326/fintp.39.3.1
10. Matek, P., Lukač, M. and Repač, V., 2016. Performance appraisal of Croatian mandatory pension funds. *Financije i pravo*, 4(1), pp. 7-30.
11. Novaković, D., 2015. Evaluation of the financial performance of pension funds in Croatia. *Ekonomski vjesnik/Econviews - Review of Contemporary Business, Entrepreneurship and Economic Issues,* 28(1), pp. 199-212.
12. Potočnjak, Ž. and Vukorepa, I., 2012. Modeling of life-cycle portfolios in capital-funded pension systems with defined contributions. *Economic Trends and Economic Policy*, 22(130), pp. 29-59.
13. Šorić, K., 2000. Izračun mirovine na temelju individualne kapitalizirane štednje. *Računovodstvo i financije*, (5), pp. 75-87.
14. Vukorepa, I., 2011. *Mirovinski sustavi: kapitalno financiranje kao čimbenik socijalne sigurnosti.* Doctoral dissertation. Zagreb: Faculty of Law.
15. Vukorepa, I., 2012. *Mirovinski sustavi - kapitalno financiranje kao čimbenik socijalne sigurnosti*. Zagreb: Faculty of Law.
16. Zakon o dobrovoljnim mirovinskim fondovima (Voluntary Pension Funds Act), NN 19/14, 29/18, 115/18. Zagreb: Narodne novine.
17. Zakon o obveznim i dobrovoljnim mirovinskim fondovima (Mandatory and Voluntary Pension Funds Act), NN 49/99, 63/00, 103/03, 177/04, 140/05, 71/07, 124/10, 114/11, 51A/13. Zagreb: Narodne novine.
18. Zakon o obveznim mirovinskim fondovima (Mandatory Pension Funds Act), NN 19/14, 93/15, 64/18, 115/18, 58/20. Zagreb: Narodne novine.

Revisiting the effect of statutory pension ages on participation and the average age of retirement in OECD countries

DAVID TURNER, MSc*
HERMES MORGAVI, Ph.D.*

Article**
JEL: J26, J21
https://doi.org/10.3326/pse.45.2.4

* We are grateful for the comments on and discussion of previous empirical work at Working Party No.1 (WP1) of the OECD's Economic Policy Committee, particularly from the Chairman, Arent Skjaeveland, which stimulated the further research summarised here. We are also grateful for comments on an earlier version of the current paper from WP1 delegates, Luiz de Mello, Alain De Serres, Christian Geppert and two anonymous referees as well as Veronica Humi for preparing the document for publication.
** Received: September 29, 2020
Accepted: January 2, 2021

David TURNER
OECD Economics Department, 2 Rue André Pascal, 75016 Paris, France
e-mail: david.turner@oecd.org
ORCiD: 0000-0003-3196-0672

Hermes MORGAVI
OECD Economics Department, 2 Rue Andre Pascal, 75016 Paris, France
e-mail: hermes.morgavi@oecd.org
ORCiD: 0000-0001-8427-3919

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

Abstract

Cross-country estimation work consistently finds that coefficients on statutory pension ages are positive and highly statistically significant in explaining labour force participation at older ages. However, the estimated effects are surprisingly modest when translated into the implied effect on the average effective age of retirement, which typically only increases by about 2 months for every year by which the statutory retirement age increases. This paper shows that grouping countries with similar pension systems, allowing for time heterogeneity and introducing other modelling choices, can improve the estimates of the effect of changes to the pension system. In countries in which there are alternative early retirement pathways or voluntary private pension systems, the effect of changes in statutory retirement ages tends to be dampened. However, for other countries, the effect of changes in statutory pension ages can be around two to three times larger than the typical finding from pooled country estimations.

Keywords: statutory retirement ages, participation, labour supply, older workers

1 INTRODUCTION

Many OECD governments have enacted, or are contemplating, future increases in statutory pension ages, in order to contain the rising fiscal costs of ageing, in the context of increasing life expectancy. Empirical cross-country estimation work consistently finds that coefficients on these statutory pension ages are positive and highly statistically significant in explaining labour force participation at older ages. There is also a degree of consistency in the magnitude of the estimated effects across studies although the effect is surprisingly modest when translated into the implied effect on average retirement ages: an increase in statutory pension ages by one year is typically estimated to increase the average effective retirement age by between one and a half and two and a half months. A careful re-appraisal of the magnitude of these effects appears warranted, especially given the vociferous opposition that pension reforms sometimes provoke.

This paper reconsiders the magnitude of these effects by reviewing relevant multi-country studies and by conducting sensitivity analysis around recent empirical work published by the OECD. A broad conclusion is that multi-country studies may seriously underestimate the effect of changes to the pension system, at least for some countries, by not sufficiently allowing for heterogeneity across time and across countries as well as through other modelling choices. For other countries, where the effects of changing legislated ages in the pension system may indeed be modest, this may be indicative of the need to tackle alternative early retirement pathways, or because voluntary private pension systems play an important role in retirement decisions.

The remainder of the paper is organised as follows. The next section briefly reviews a selection of recent multi-country studies that model labour force participation in terms of explanatory variables that include summary parameters of the pension

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

system. Section 3 compares the effects of changing statutory pension ages based on these studies with the much larger effects, that can be derived from simple stylised calculations. Section 4 attempts to reconcile these results by conducting sensitivity analysis around recently published OECD econometric estimations. The policy implications of the findings are briefly discussed in section 5.

2 A BRIEF REVIEW OF MULTI-COUNTRY STUDIES

Many cross-country panel studies by OECD and IMF authors have estimated the impact of pension systems, including the role of statutory retirement ages, on labour force participation at older ages. These studies invariably find that coefficients on statutory retirement ages are statistically significant at conventional levels of significance, but it is more difficult to assess how important the magnitude of these coefficients is from a policy perspective or to compare the coefficients across studies. This is partly because the dependent variable often differs across studies (for example different age groupings are considered or the functional form of the dependent variable differs), but more fundamentally it is difficult to assess whether the size of these coefficients are "small" or "large" from a policy perspective because no obvious benchmark is provided. To overcome these problems the current paper evaluates these effects using a common metric (as described in detail in appendix A), namely the effect on the average effective age of retirement, measured in months, of raising statutory pension ages by a single year.

Earlier studies, with sample periods mainly covering the 1970s to 1990s, emphasised the importance of modelling the interaction between the old-age pension system and other social protection and labour policies. Blöndal and Scarpetta (1999) demonstrate the importance of unemployment-related and disability schemes in explaining the participation rate of males aged 55-64 in OECD countries over the period 1971-95. The importance of these *de facto* early retirement schemes, helps to explain why the effect of statutory retirement ages in their pooled regressions, although statistically significant, are calculated (by the present authors, see appendix A) to be small: an increase in statutory pension ages by 1 year implies an increase in the average effective retirement age by only 1.1 to 1.4 months. Duval (2004) also found that social transfer programmes outside the old-age pension system, which were particularly prevalent in most continental European countries, acted as *de facto* early retirement schemes with a marked impact on the participation rate of men aged 55-59, but also with effects on the participation rate of men of older ages. In addition, statutory pension ages are found to have a statistically significant impact on the participation of men in the age groups 60-64 and 65-69, but the size of the implied effect on the average effective age of retirement is again modest (according to calculations by the current authors, see appendix A): an increase in the statutory retirement age by 1 year only raises the effective age of retirement by 1.4 months.

The effect of increases in statutory pension ages has also been evaluated as part of a much broader exercise to assess the impact of a range of structural labour market policies and institutions on participation or employment, over sample periods which typically begin in the 1980s. A recent OECD study, Gal and Theising (2015), used

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

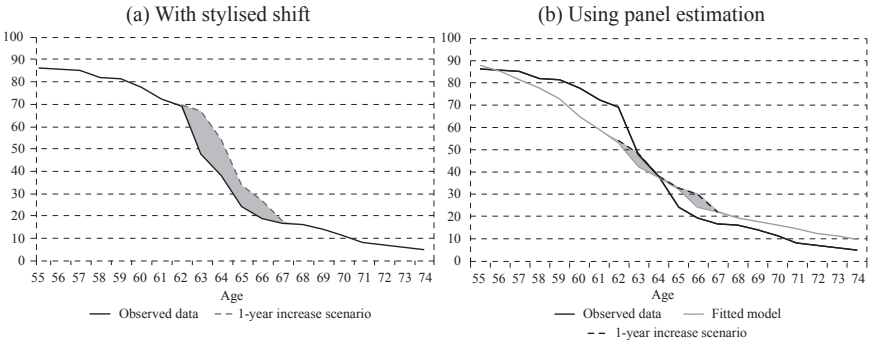
cross-country panel regressions to assess the effectiveness of a range of structural labour market policies in promoting employment in OECD countries. As part of this study, separate cross-country panel regressions are estimated to explain the employment rate of the group aged 55-64 and it is reported that the statutory retirement age lifts the employment rate of the elderly "by a statistically and economically significant margin". However, in comparison with the effectiveness of all other structural labour market policies using these same results, carried out by comparing the effect of a "typical" change in each policy instrument, the statutory pension age is found to have the smallest effect on the aggregate employment rate of any structural policy considered (Egert and Gal, 2017). Such a modest effect is confirmed by calculations in this paper, which suggest the estimated coefficient implies that an increase in the statutory pension age by one year would result in an increase in the average effective retirement age of only 1.4 months (see appendix A). A similar wide-ranging IMF study, Grigoli, Koczan and Tapalova (2018), considers the effect of a broad range of policies, institutions and secular trends on aggregate labour force participation. As part of this study, a panel regression to explain labour force participation of those aged over 55 in 23 advanced economies finds a statistically significant effect from the statutory pension age, which prompts a comment from the authors that "incentives for retirement have a powerful effect on labour force attachment". However, following a hypothetical one-year increase in the statutory retirement age, this coefficient implies an increase in the average effective age of retirement of only 2.2 months (see appendix A).

A recent OECD study, Geppert et al. (2019), considers the determinants of labour force participation, distinguishing participation effects by both sex, education and single year of age. This study is of particular interest here because it provides the baseline for the analysis in the remainder of this paper (and so is described in further detail below). Nevertheless, a key finding for present purposes is that, despite the more detailed modelling of participation, an increase in the statutory pension age by one year only raises the average effective age of retirement by 2.4 months.

In summary, the results from cross-country panel regressions consistently imply that the statutory retirement age has only a rather modest effect on the average effective retirement age, which would seem to be at odds with the importance usually given to pension reforms. These findings of modest effects also seems to be contradicted by quantifications based on pension reforms in individual countries. Siebold (2019) analyses the concentration of retirements around statutory ages in Germany and concludes that "an increase in the normal retirement age from 65 to 66 is predicted to lead to an increase in average actual retirement ages by 4 months". Mastrobuoni (2009) discusses a policy change in the United States that increased the normal age of retirement from 65 to 67 and raised the penalty for claiming retirement benefits before then, concluding that an increase in the normal retirement age by 2 months delays effective retirement by around 1 month. Staubli and Zweimüller (2013) analyse pension reforms in Austria that increased the early retirement age from 60 to 62 for men and from 55 to 58 for women, concluding that this increased employment by 10 percentage points among affected men and by 11 percentage points among affected women.

Figure 1

Comparing policy effects of a stylised shift in participation and econometric predictions – Effect of a one-year increase in statutory retirement ages on participation rates, German males, 2015 (%)



Note: Both panels illustrate the estimated effect of a one-year increase in both the statutory minimum and normal retirement ages. Panel A uses a stylised shift in the actual age-participation profile, whereas panel B uses the baseline pooled-country estimated equation reported in Geppert et al. (2019). The size of the effect on labour force participation and the average retirement ages is proportional to the shaded area.

Source: Authors' calculations.

Before a further estimation to try to resolve these apparent contradictions, it is helpful to visualise the problem with a concrete example. A rough estimate of the effect of a change in statutory pension ages can be gauged by considering a stylised shift in the age-participation profile. For some countries, there is a pronounced drop in labour force participation between the minimum age of retirement[1] and the normal age of retirement,[2] as illustrated for the case of German men in figure 1, panel A. For the purposes of a stylised calculation, it is assumed that an increase in statutory pension ages by one year simply shifts the age-participation profile between these two ages by one year (as illustrated by the dashed line in figure 1, panel A). This is achieved by assuming that: participation rates at each age before the original minimum retirement age remain unchanged; for subsequent ages, the percentage change in the participation rate between each age and the following one is shifted up one year; and participation rates after the new normal retirement age remain unchanged. The total increase in the participation rate from such a stylised calculation, represented by the shaded area in panel A, is equivalent to an increase in the participation rate of the group aged 55-74 of 2.1 percentage points, and translates into an increase in the average retirement age of 5.1 months.This stylised calculation can be compared with the effect of an alternative computation using the baseline model fitted by pooled economic estimation in Geppert et al. (2019), (figure 1, panel B). Firstly, it should be noted that the fitted model from the pooled estimation implies a more gradual fall in participation than the more

[1] The minimum retirement age is defined as the age at which an individual who entered the labour market at age 25 and had a full career becomes eligible for a (reduced) pension from a mandatory pension scheme.
[2] The normal retirement age is defined as the age at which an individual who entered the labour market at age 25 and had a full career becomes eligible for a full pension from all mandatory pension schemes.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

sudden drop from the minimum retirement age in the actual data. Then, applying the policy shock of increasing statutory pension ages results in a more modest shift in participation, equivalent to an increase in the participation rate of the age group 55-74 of 0.7 percentage points, equivalent to an increase in the average retirement age of only 1.5 months. The much larger (more than three-fold) increase from the stylised calculation compared to using the pooled econometric estimate is illustrated by the shaded area being much larger in panel A than panel B.

3 REASONS WHY PENSION EFFECTS MAY BE UNDER-ESTIMATED IN MULTI-COUNTRY STUDIES

3.1 THE BASELINE MODEL

In order to try to reconcile the stylised calculations of the effect of an increase in statutory retirement ages with the results from pooled estimations, this section reports a series of variant pooled estimations. The starting point is the baseline equation reported in Geppert et al. (2019), which is reproduced here as equation [1] in table 1.[3] An important distinguishing feature of this recent study is that the dependent variable is the participation rate by *single* year of age (rather than by five-year, or larger, age grouping), for each age between 55 and 74, distinguishing also by the level of education (low, medium and high) as well as by gender. The data cover 26 countries, mostly in the European Union, but also Switzerland, Canada and the United States. The participation rate ($PR_{i,s,a,e,t}$) is modelled by country i, sex s, age a, education level e and year t using the following equation:

$$PR_{i,s,a,e,t} = \alpha_i + \gamma_s + \theta_a + \rho_e + \gamma_s\rho_e + \gamma_s\theta_a + \rho_e\theta_a + \sum_j \beta_j X_{i,s,a,e,t,j} \qquad (1)$$

where a_i is a country fixed effect, y_s a gender fixed effect, θ_a an age fixed effect, ρ_e an education fixed effect, $y_s\rho_e$ a sex-education interaction effect, $y_s\theta_a$ a sex-age interaction effect, $\rho_e\theta_a$ an education-age interaction effect, the X_j are explanatory variables of interest and β_j their associated coefficients. The sample period spans 1990 to 2017, but the panel is unbalanced.

Explanatory variables include direct policy drivers, secular trends and control variables:

- The direct policy drivers are statutory retirement ages (minimum and normal) and pension wealth. The latter captures policy-driven financial retirement incentives, but is not fully comprehensive. Both indicators consider only mandatory retirement pension systems and not the full array of social security programmes that may affect the retirement decision, notably unemployment insurance and disability schemes, nor the effect of voluntary private pension schemes.
- Secular trends include life expectancy as well as the percentage of a population group with tertiary education.

[3] This is also equation [1] of table 2 in Geppert et al. (2019), which is the equation they chose for a subsequent historical decomposition analysis.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

– The unemployment gap is included as a control variable, but as a five-year moving average to account for the sluggish response of participation to cyclical developments.

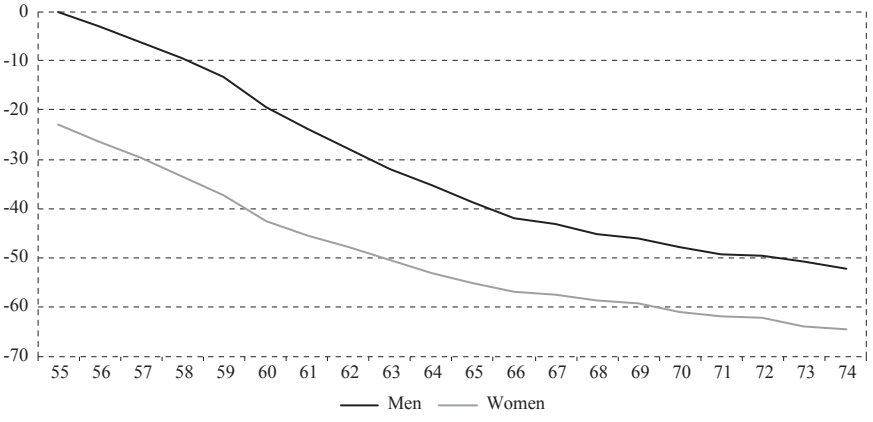
In subsequent sections of this paper, variant estimations are undertaken around the baseline equation with a focus on the sensitivity of the estimated coefficients on statutory retirement ages and their implications for average effective retirement ages and labour force participation following a reform in statutory pension ages.

3.2 MODELLING ISSUES

Age fixed effects are included in the baseline model (as they often are in pooled regressions modelling participation) in order to capture social-cultural influences that may be similar across countries, but are difficult to capture with more specific quantitative explanatory variables. These age fixed effects show a steeper drop between the ages of 60 and 65, when most old age pensions are first claimed, than either before 60 or after 65 (figure 2); for men, the rate of decline in the age fixed effects over the ages 60 to 65 is more than three times the rate of decline after 65. While these fixed effects are intended to capture influences that are entirely separate from the pension system, it is also arguable that such social-cultural norms are conditioned by the ages at which old-age pension systems typically operate. Replacing these fixed effects with either a linear or a quadratic age variable – which might seem a more natural choice for modelling other gradually evolving social-cultural considerations exogenous to the pension system – increases the explanatory power and coefficients on estimated statutory pension ages. It consequently increases the estimated average retirement effect by about one-third (figure 3, panel A; and from a comparison of equations (2) and (3) with the baseline equation (1) in table 1).

Figure 2

Age fixed effects in the baseline model – Effect on labour force participation at different ages (percentage points)



Note: Age fixed effects from the baseline model, taken as equation [1] in table 1 of Geppert et al. (2019).

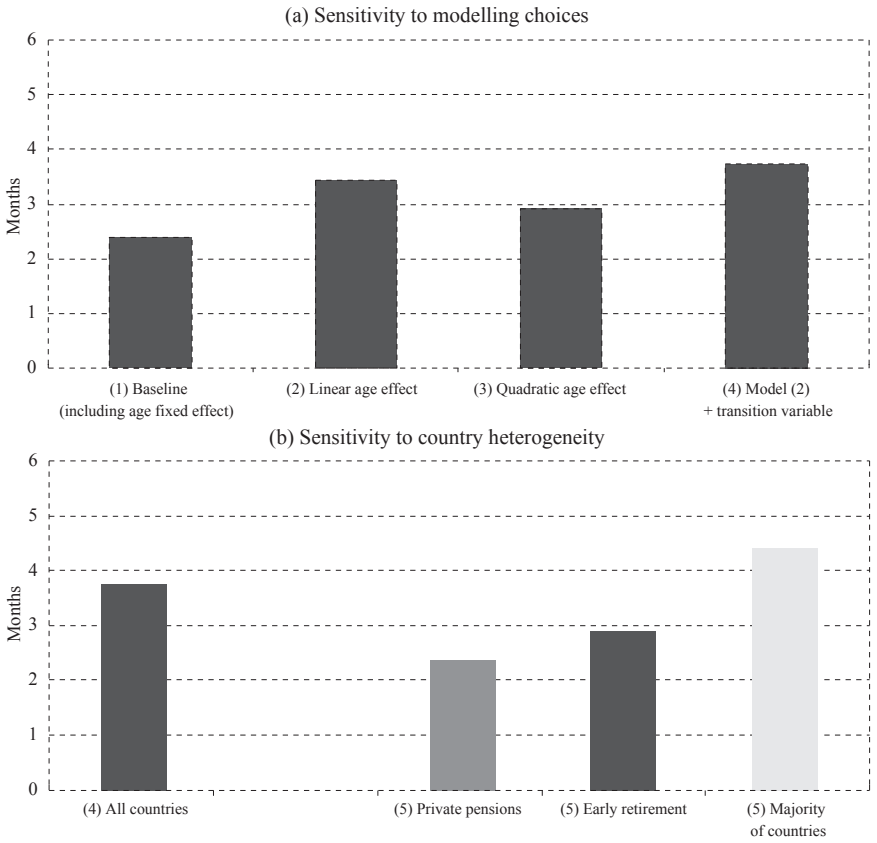
Source: Authors' calculations.

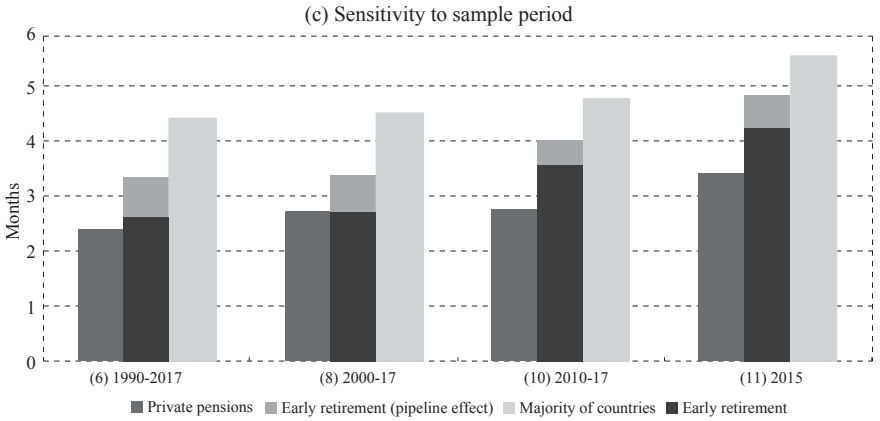
PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

In the baseline model, the influence of statutory retirement ages is modelled with two sets of dummy variables (figure 4, panel A): the first takes the value of unity at ages equal to and above the minimum retirement age; the second takes the value of unity at ages equal to and above the normal retirement age. This implies an abrupt effect on participation at the minimum and normal retirement ages (figure 4, panel B). An alternative way of modelling the effect of statutory retirement ages is to include a "transition to retirement" variable, which implies a more gradual effect on participation between the minimum and normal retirement ages (figure 4, panels C and D). The replacement of the dummy variables by the transition variable generates a similar goodness-of-fit, but a slightly larger effect of the statutory retirement ages on participation (figure 3, panel A; and a comparison of equations (2) and (4) in table 1).

FIGURE 3

Estimated effect on the average effective retirement age of an increase in the statutory retirement age of one year

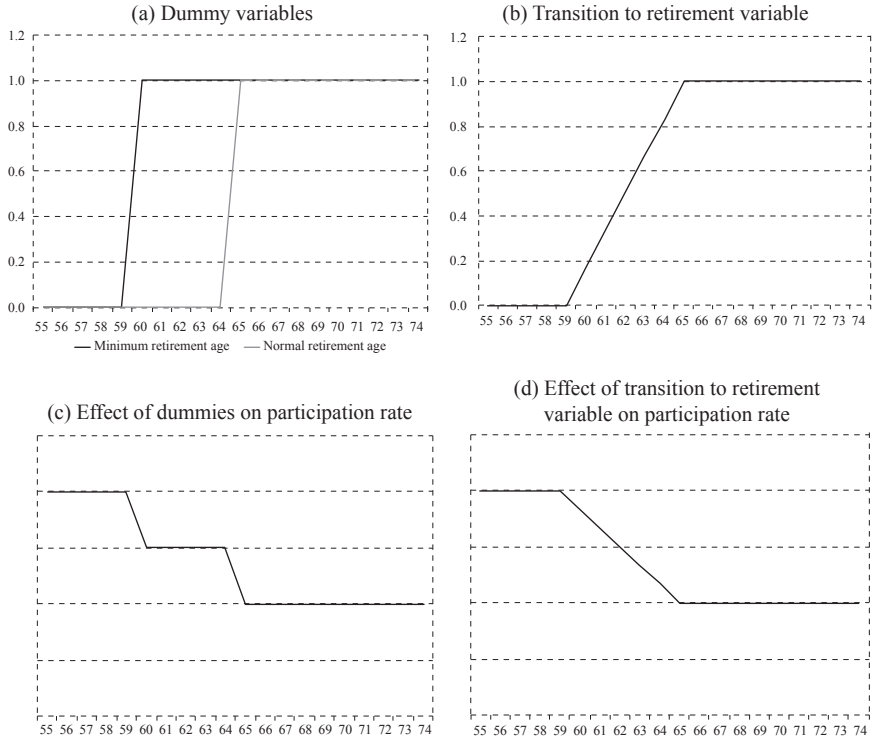




Note: The number in brackets at the start of each label on the x-axis refers to the equation number in table 1. Successive bars in each panel show the effect of changing one characteristic relative to previous bars.

FIGURE 4

Modelling of statutory retirement ages



Note: The figures illustrate alternative ways of modelling statutory retirement ages when the minimum retirement age is 60 and the normal retirement age is 65.

Source: Authors' calculation.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

A final modelling issue relates to possible multicollinearity: if statutory pension ages have broadly increased with life expectancy (indeed in some cases, reforms have explicitly linked the two), then including both variables in any regression may result in an identification problem, which may contribute to a lower coefficient on statutory retirement ages. While this sounds reasonable, on the current dataset, statutory retirement ages have not kept up with life expectancy in most countries. Moreover, there is large variation in this difference across countries, which would suggest that multicollinearity ought not to be a problem (see figure 6 in Geppert et al., 2019). Moreover, variant equations in which the life expectancy variable was either dropped or replaced with a time trend did not result in a higher coefficient on the statutory pension age variables. Nevertheless, the possible link between these variables should not be ignored in interpreting the results: for example, it seems quite likely that if life expectancy were to stop increasing, then changing the statutory retirement age might be less effective.

TABLE 1

Variant pooled estimations explaining labour force participation

Dependent variable is labour force participation by single age, distinguishing by gender and education

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
% of population with tertiary education	0.13**	0.13**	0.13**	0.13**	0.11**	0.11*	0.11**	0.12**	0.13**	0.1*	-0.03
Life expectancy at 65	2.11***	2.01***	2.01***	2.11***	2.19***	2.14***	2.09***	2.91***	2.87***	3.26***	3.22***
Pension wealth (ratio to final earnings)	-0.81*	-1.46***	-0.83*	-1.55***	-1.21***	-1.01**	-0.55	-0.96***	-0.48	-0.66**	-0.81
Age		-2.98***	-17.65***	-2.82***	-2.95***	-3.86***	-13.85***	-3.82***	-13.29***	-3.7***	-3.62***
Age^2			0.12***				0.09***		0.08***		
Unemployment gap (% pts of labour force)	0.34*	0.44**	0.39**	0.4*	0.4*	0.43**	0.39**	0.58**	0.54**	0.42	0
Dummy above minimum retirement age	-4.92***	-9.47***	-6.86***								
Dummy above normal retirement age	-5.06***	-3.34	-6.42***								
Transition-to-retirement				-14.22***	-19.78***	-20.92***	-19.05***	-21.89***	-20.06***	-25.29***	-29.12***
Transition*dummy for private pension countries					12.55***	12.30***	10.27***	12.81***	10.97***	14.79***	14.97***
Transition*dummy for early retirement countries					6.96**	17.11***	14.02***	17.45***	14.31***	17.47***	17.30***
Pipeline to retirement (early retirement countries): first year						-6.26***	-4.45**	-6.70***	-4.79**	-7.28**	-6.14***
second year						-5.60*	-4.38*	-5.05*	-4.04	-6.62**	-8.03**
Number of countries covered	26	26	26	26	26	26	26	26	26	26	26
Sample period	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	1990-2017	2000-2017	2000-2017	2010-2017	2015-2015
Adjusted R^2	0.882	0.867	0.877	0.867	0.873	0.876	0.883	0.882	0.888	0.899	0.908
Implied effect of raising statutory retirement ages by one year											
On participation rate, age 55-74 (% points):	0.7	1.1	0.9	1.2	1.2	1.2	1.0	1.2	1.0	1.3	1.6
Majority of countries					1.4	1.4	1.1	1.4	1.2	1.5	1.7
"Early retirement" countries					0.9	1.0	0.8	1.1	0.9	1.3	1.5
"Private pension" countries					0.7	0.8	0.7	0.9	0.7	0.9	1.1

Dependent variable is labour force participation by single age, distinguishing by gender and education

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
On average retirement age (months):	2.4	3.4	2.9	3.7	3.7	3.8	3.2	4.0	3.2	4.3	5.0
Majority of countries					4.4	4.4	3.6	4.5	3.7	4.7	5.5
"Early retirement" countries					2.9	3.3	2.7	3.4	2.8	4.0	4.8
"Private pension" countries					2.4	2.4	2.1	2.7	2.1	2.7	3.4

Notes to table 1:
No asterisks: p-value > 0.10
** p-value ≤ 0.10*
*** p-value ≤ 0.05*
**** p-value ≤ 0.01*
All equations are estimated with OLS.
All equations include country fixed effects, gender fixed effects, an education fixed effect, a gender-education interaction effect, gender-age interaction effect and an education-age interaction. No equations include time fixed effects.
The unemployment gap is a five-year moving average. The pension wealth variable is described in more detail in Geppert et al. (2019), as are other variables in the baseline model (1).
Model (1) is the baseline model in Geppert et al. (2019) and is the only equation to include age fixed effects.
Model (2) = Model (1), but replaces age fixed effects with a linear age variable.
Model (3) = Model (1), but replaces age fixed effects with a quadratic age variable.
Model (4) = Model (2), but replaces dummy variables for ages above the minimum and normal retirement ages with a "transition to retirement" variable, which is a function of age and takes a value equal to: zero for ages below the minimum retirement age; one for ages above or equal to the normal retirement age; and for ages between the two statutory ages it assumes a value between zero and one proportional to the distance between them (see the main text for further explanation).
Model (5) = Model (4), but differentiates the coefficient on the "transition to retirement" variable for three groups of countries through the addition of a variable which is the product of the transition variable and two distinct dummy variables. A first dummy variable is created for countries (Canada, Ireland, United Kingdom and United States) where voluntary private pension systems are important. A second dummy variable is created for countries where there is some evidence of the prevalence of early retirement outside the old-age pension system (France, Greece, Italy, Poland, the Netherlands and Spain). The third group of countries, referred to in the lower part of the table as the "Majority of countries" have no dummy variable.
Model (6) = Model (5), but the early retirement coefficient on the "transition to retirement" variable is differentiated only for individuals with low or medium education. Two additional variables are added for individuals with low or medium education in early retirement countries only, namely: 1-year and 2-year pipeline to retirement variables defined using dummy variables at the age two years and one year preceding the minimum age of retirement, respectively.
Model (7) = Model (6) but with quadratic, rather than linear, age effects.
Model (8) = Model (6) but estimated on the sample 2000-17.
Model (9) = Model (7) but is estimated on the sample 2000-17.
Model (10) = Model (6) but estimated on the sample 2010-17.
Model (11) = Model (6) but is estimated only on the year 2015.
The basis for the calculations in the lower part of the table summarising the implied effect on the participation rate of those aged 55-74 and on the average age of retirement from increasing the statutory age of retirement by one year is given in the appendix.

3.3 SAMPLE ISSUES: COUNTRY GROUPINGS

The estimates from pooled regression represent average responses across countries, but, if there is great heterogeneity in pension systems across countries, this might be unrepresentative of any particular country. This section explores the sensitivity of the coefficients on statutory retirement ages to changes in the composition of the country sample by grouping countries based on the particular characteristics of their pension systems.

As noted above, a focus of earlier studies of older age participation was the influence of other social transfer systems, outside the old-age pension system, in providing *de facto* early retirement pathways. Around the mid-1990s, there was a shift of emphasis from compensation to integration in sickness and disability policies across many OECD countries (OECD, 2010). While this has undoubtedly resulted in the tightening of early retirement pathways, it is likely that they still play a role in some countries.

For some countries, the average "effective" retirement age is less than the "minimum" retirement age (the age at which a worker is first entitled to a pension), suggesting that the use of alternative early retirement pathways is widespread and likely to dampen the effect of any changes to the old age pension system. For the purposes of the current estimation, countries are characterised as having a prevalence of early retirement opportunities if the average effective retirement age is below the minimum retirement age for both men and women over the period 2012-17. Among the countries in the baseline sample, this includes Greece, Spain, France, Italy, Poland and the Netherlands.[4]

In those countries where voluntary private pensions are important – here taken to include Canada, Ireland, the United Kingdom and the United States – changes to the statutory ages of the mandatory system are likely to have smaller effects on labour force participation.[5]

In order to allow for differential effects from changes in statutory ages for these different groups of countries, two distinct dummy variables are created (one for

[4] This classification of countries for which early retirement pathways are considered important is not clear-cut. For example, if the criteria is extended to be that the average retirement age is below the minimum retirement age for either men or women (rather than both), then Belgium, Luxembourg and the Slovak Republic would also be included. Ebbinghaus (2006) finds evidence confirming marked early retirement patterns for Italy, France and the Netherlands, with respect to Nordic and Anglophone countries over the period 1970-2005, but additionally finds such evidence for Germany. Duval (2004) additionally identifies Austria, Germany, Luxembourg and Portugal as having important alternative early retirement pathways. However, as discussed in section 4.4, it is possible that early retirement pathways have been tightened in some of these countries since the studies were published. For example, as documented in Börsch-Supan and Jurges (2012), policy changes in the 2000s substantially tightened access to early retirement pathways in Germany. In any case, sensitivity analysis varying the criteria for selecting this group of countries does not much affect the overall estimation results, although clearly it does have important policy implications for the countries concerned.

[5] For the purposes of the current estimation, countries are characterised as having an important voluntary private pension system if voluntary private pensions cover a large share of the working population and the replacement rate from such schemes is at least 60% of that in the public mandatory pension scheme. Using data from tables 5.3 and 9.1 in OECD (2019), this group includes Canada, Ireland, the United Kingdom and the United States.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

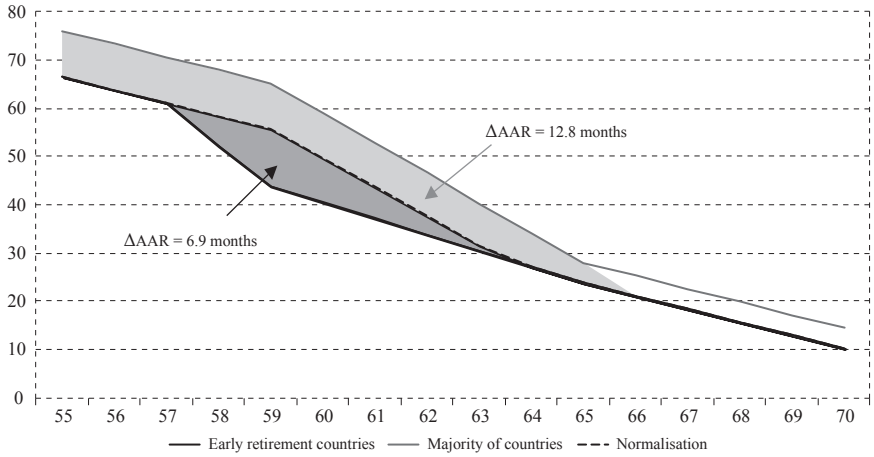
countries where private pensions are important and one where there is evidence that alternative early retirement pathways are important) and interacted with the transition-to-retirement variable previously described. Allowing for this differential effect leads to a marked dispersion in the effect of changes in statutory retirement age on average effective retirement (figure 3, panel B; and comparing equations (4) and (5) in table 1). Countries that are not classified as having important private pension systems or alternative early retirement pathways – hereafter referred to as the "*majority of countries*" – show an effect on the average effective retirement age; this is two-and-a-half-times that of countries where private pensions are important and nearly half as much again as early retirement countries.

Some alternative early retirement pathways may work by providing a "*pipeline*" to retirement under the regular old age pension system. That is, other social security programmes may provide a strong incentive to retire a year or more in advance of the statutory retirement age and then when the statutory retirement age is reached retirement is possible under the old age pension system. Some evidence for such a pipeline effect is found in the previously classified "early retirement" countries because two pipeline variables – defined as dummy variables in the year immediately preceding the minimum retirement age and two years preceding the minimum retirement age – are highly statistically significant for these countries. Further estimation suggest that individuals with low and medium education are more prone to early retirement than those who are highly educated, confirming the findings of Siegrist et al. (2006) and Fischer and Sousa-Poza (2011). Thus, including the early retirement dummies and pipeline variables only for individuals with low or medium, rather than high, education further improves the fit of the estimated model (equation (6) in table 1). Similar pipeline variables when included for either "private pension" countries or the majority of other countries are smaller and statistically insignificant (and so are not included). The pipeline variables for the early retirement countries boost the effect of an increase in the statutory retirement age if the pipeline variables shift with the change in the statutory retirement ages (compare equations (5) and (6) in table 1), as assumed in the lower part of table 1.

While not the focus of the current paper, the variant equations can also be used to provide a crude estimate of the effect on participation and the effective age of retirement from the elimination of alternative early retirement possibilities for a typical country, although better country-specific estimates are likely to be obtained by considering the detail of individual schemes on a country-by-country basis. To generate such an estimate it is assumed that: the pipeline variables are eliminated; the coefficient on the transition-to-retirement variable becomes the same in the "early retirement" countries as the majority of countries; and the average country fixed effects in the "early retirement" countries becomes the same as in the majority of countries. On this basis, elimination of alternative early retirement possibilities might be expected to increase the average effective age of retirement by up to 20 months for workers with low and medium education (figure 5), which is equivalent to an overall aggregate increase of 18 months.

FIGURE 5

The simulated effect of eliminating early retirement pathways – Stylised age-participation profile of low- and medium-educated workers



Note: The chart compares a stylised age-participation profile of low and medium-educated workers in countries classified as "early retirement" countries with those in the majority of countries. The profiles are generated using equation (6) in table 1, using: differential responses to the minimum and normal statutory ages of retirement, which for the purposes of this example are assumed to be 60 and 65: the pipeline effects (for early retirement countries only); common linear age effects; a constant difference between the two groups of countries equal to the difference in the average country fixed effects for each group. The black dashed line (and black shaded area) simulates the effect of eliminating early retirement pathways on the assumption that the response of early retirement countries to statutory ages becomes the same as the majority of countries and the pipeline effects are eliminated. A shift to the gray line (and gray shaded area) further assumes that eliminating early retirement pathways would also imply the average country fixed effect for early retirement countries becomes the same as for the majority of countries. These two effects combined would imply an increase in the average participation rate for the age group 55-74 of 6 percentage points and an increase in the average age of retirement (ΔAAR) by 20 months.

3.4 SAMPLE ISSUES: TIME PERIOD COVERAGE

The sensitivity of results to the sample estimation period is investigated, not least because there has been, since the mid-1990s, a tendency towards the tightening of early retirement pathways in many OECD countries. Börsch-Supan and Coile (2018) documenting pension reforms in 12 major OECD countries, report that public programs that offer a pathway to retirement outside the old age pension system have been tightened in nine of the 12 major OECD countries they consider, usually with a series of reforms.

The example of Germany is illustrative of the effect that tightening early retirement pathways can have on the age profile of the participation rate and hence the sensitivity of estimation results to the sample period. Over the period 1990-2012, the minimum and normal retirement ages were unchanged, after which the normal retirement age increased modestly. Over the same period, the effective retirement age fell over the first half of the 1990s and then steadily rose in the following years (figure 6, panel B). This can be partially explained by several reforms carried out in the 1990s and in

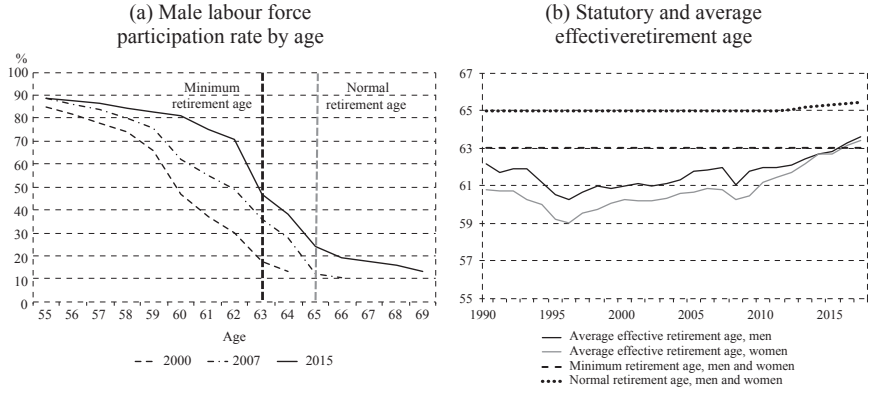
PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

the 2000s, which reduced the incentive to early retirement, as discussed in more detail in Börsch-Supan and Jurges (2012). Between 2003 and 2005, the Hartz reforms "dramatically shortened the duration of unemployment benefits, especially for older individuals and made unemployment benefits insurance much less attractive as a substitute for early retirement". This was accompanied by shifting the age limit for old-age pensions due to unemployment to age 63 (from 60). In 2007, the limit for old-age pensions for the disabled was shifted to 65 years. The cumulative effects of the implementation of these reforms are evident in the evolution of the age profile of the participation rate. In the year 2000, the steepest fall in participation rate for men was between the ages of 59 and 60, well before the minimum age of 63 (figure 6, panel A). However, by 2015 the steepest fall is at the minimum retirement age of 63, with further steep falls until the normal age of retirement at 65.[6] Thus, the tightening of early retirement pathways means that the influence of the old age pension system is much more apparent in the age-profile of participation.

Shortening the sample estimation period – from 1990-2017 to 2000-17 to 2010-17 and to a single year 2015 – further increases the estimated coefficients on statutory pension ages (figure 3, panel C; and a comparison of equations (6) to (11) in table 1). The implied effect on the average age of retirement from a one-year increase in statutory pension ages rises for all country groups identified in the estimation as the sample period is shortened, but by most for the early retirement countries.[7] Thus shortening the sample estimation period from 1990-2017 to 2010-17, raises the average age of retirement effect from 4.4 to 4.7 months for the majority of countries, but from 3.3 months to 4.0 months for early retirement countries, and only from 2.4 to 2.7 months for private pension countries.

Figure 6

The evolution of labour force participation and retirement ages in Germany



Source: OECD (2019), Eurostat and authors' calculations.

[6] This also helps to explain why Germany had a large positive residual in the historical decomposition analysis to explain the change in participation rates between 2002-2017 in Geppert et al. (2019), since their model did not factor in the effect of tightening early retirement pathways on boosting participation.

[7] The United States and Canada, here classified as countries where private pensions are important, are also two (of the three) major OECD countries considered by Börsch-Supan and Coile (2018) that have not tightened early retirement pathways since the 1980s.

4 POLICY DISCUSSION AND CONCLUSIONS

With many OECD countries already facing the prospect of rising debt burdens in the wake of the current corona-crisis, increasing statutory retirement ages would seem an obvious policy response to cope with the rising fiscal costs associated with ageing populations, particularly if life expectancy continues to increase. At the same time, such policy changes have often faced vociferous opposition, perhaps because they are easily understood and impact so widely, suggesting that weighing the benefits and costs will be important for any policy-maker considering action.

The current paper suggest that the results from multi-country panel regressions are likely to seriously understate the benefits of changes in the statutory retirement age in terms of the positive effects on labour force participation and the average age of retirement, perhaps by a factor of two to three, unless they carefully take into account heterogeneity across countries and through time. A sensitivity analysis of previous cross-countries empirical estimates shows that some modelling choices can be the cause of such under-estimation:

- Estimated age fixed effects show a marked drop between the ages of 60 and 65, when most old age pensions are first claimed. Replacing these fixed effects with either a linear or a quadratic age variable increases the coefficients on estimated statutory pension ages.
- Grouping countries according to the characteristics of their pension systems, rather than pooling all countries together, improves the goodness of fit of the estimates and returns coefficients that better reflect the impact of changes in statutory pension ages. In those countries where voluntary private pensions are particularly important, changes to the statutory ages in any mandatory system are likely to have smaller effects on labour force participation. For some other countries the average effective retirement age is much less than the "minimum" retirement age (the age at which a worker is first entitled to a, usually reduced, pension), suggesting that the use of alternative early retirement pathways is prevalent and likely to dampen the effect of any changes to the old age pension system. If the estimation allows for heterogeneous coefficients, the estimated effect of changing the statutory retirement age is substantially reduced for both groups of countries, whereas the effect for the majority of other countries significantly increases.
- Many countries have tightened access to alternative early retirement pathways outside the old age pension system, so that shortening the sample period may also lead to estimates that better represent the effect of current and future changes in the statutory age of retirement. Indeed, consistently with this explanation, the estimated coefficients on statutory pension ages increase as the estimation sample is shortened to include only the most recent years.

These effects lead to the conclusion that, for the majority of OECD countries considered in this paper, an increase in the statutory retirement age by one year might currently be expected to increase the average effective age of retirement by four to five months, which compares with estimates of around two months from a

selection of cross-country estimations reviewed earlier in the paper. For countries where alternative early retirement pathways are important, the effect of an increase in statutory retirement ages is dampened. The extent of this dampening effect depends on whether alternative social security programmes act as a pipeline to retirement under an old age pension (with the pipeline shifting as statutory pensions ages change) or are an independent alternative to it. In the latter case, the responsiveness of the average age of retirement could be reduced by one third. A simulation of the effect of eliminating early retirement pathways based on the estimated equations, suggests that the participation rate of the age group 55-74 could be raised by up to 6 percentage points, equivalent to an increase in the average effective age of retirement of 18 months, whereas to achieve a similar effect without eliminating early retirement pathways would require an increase in the statutory retirement age by about four and a half years. Thus, tightening access to early retirement pathways would not only increase the responsiveness of the labour market to changes in the old age pension system, but lead to a substantial one-off increase in labour force participation and the average retirement age.

For countries where private pensions have a dominant role, the responsiveness of the average effective age of retirement to a change in statutory retirement ages is unsurprisingly found to be much lower, typically about half the response of the majority of countries. However, even for these countries it is possible that the long-run responsiveness of participation is understated, if changes in the public system eventually come to be reflected in private systems, albeit with a lag.

From the point of view of econometric methodology, this example provides a salutary warning about the dangers of trying to identify policy effects from pooled estimation coefficients, without taking into account heterogeneity across countries and through time, and from a focus on the statistical significance of coefficients rather than their magnitude and the plausibility of any implied policy effect.

Disclosure statement

Neither author has reported a conflict of interest.

REFERENCES

1. Blöndal, S. and Scarpetta, S., 1999. The Retirement Decision in OECD Countries. *OECD Economics Department Working Papers*, No. 202. https://doi.org/10.1787/565174210530
2. Börsch-Supan, A. and Coile, C., 2018. Social Security Programs and Retirement Around the World: Reforms and Retirement Incentives - Introduction and Summary. *NBER Working Papers*, No. 25280. https://doi.org/10.3386/w25280
3. Börsch-Supan, A. and Jürges, H., 2012. Disability, Pension Reform and Early Retirement in Germany. In: D. Wise, ed. *Social Security Programs and Retirement around the World: Historical Trends in Mortality and Health, Employment, and Disability Insurance Participation and Reforms.* University of Chicago Press.
4. Duval, R., 2004. Retirement Behaviour in OECD Countries: Impact of Old-Age Pension Schemes and Other Social Transfer Programmes. *OECD Economic Studies*, (2), pp. 7-50. https://doi.org/10.1787/eco_studies-v2003-art8-en
5. Ebbinghaus, B., 2006. *Reforming Early Retirement in Europe, Japan and the USA*. Oxford: Oxford University Press. https://doi.org/10.1093/0199286116.001.0001
6. Égert, B. and Gal, P., 2017. The quantification of structural reforms in OECD countries: A new framework. *OECD Economics Department Working Papers*, No. 1354. https://doi.org/10.1787/2d887027-en
7. Fischer, J. and Sousa-Poza, A., 2011. The Institutional Determinants of Early Retirement in Europe. *SSRN Electronic Journal*. http://dx.doi.org/10.2139/ssrn.895081
8. Gal, P. and Theising, A., 2015. The macroeconomic impact of structural policies on labour market outcomes in OECD countries: A reassessment. *OECD Economics Department Working Papers*, No. 1271. https://dx.doi.org/10.1787/5jrqc6t8ktjf-en
9. Geppert, C. [et al.], 2019. Labour supply of older people in advanced economies: the impact of changes to statutory retirement ages. *OECD Economics Department Working Papers,* No. 1554. https://doi.org/10.1787/b9f8d292-en
10. Grigoli, F., Koczan, Z. and Tapalova, P., 2018. Drivers of Labor Force Participation in Advanced Economies: Macro and Micro Evidence. *IMF Working Papers*, No. 18/150. https://doi.org/10.5089/9781484361528.001
11. Mastrobuoni, G., 2009. Labor supply effects of the recent social security benefit cuts: empirical estimates using cohort discontinuities. *Journal of Public Economics*, 93(11-12), pp. 1224-1233. https://doi.org/10.1016/j.jpubeco.2009.07.009
12. OECD, 2019. *Pensions at a Glance.* Paris: OECD.
13. OECD, 2010. *Sickness, Disability and Work: Breaking the Barriers: A Synthesis of Findings across OECD Countries*. Paris: OECD. https://doi.org/10.1787/9789264088856-en
14. Scherer, P., 2002. Age of Withdrawal from the Labour Force in OECD Countries. *OECD Labour Market and Social Policy Occassional Papers*, No. 49. https://doi.org/10.1787/327074367476

15. Siegrist, J. [et al.], 2006. Quality of work, well-being, and intended early retirement of older employees-baseline results from the SHARE Study. *European Journal of Public Health*, 17(1), pp. 62-68. http://dx.doi.org/10.1093/eurpub/ckl084

16. Staubli, S. and Zweimüller, J., 2013. Does raising the early retirement age increase employment of older workers? *Journal of Public Economics*, 108, pp. 17-32. https://doi.org/10.1016/j.jpubeco.2013.09.003

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

APPENDIX
ALGEBRA RELATING ESTIMATED COEFFICIENTS ON STATUTORY RETIREMENT AGES TO THE AVERAGE EFFECTIVE AGE OF RETIREMENT

A1 The relationship between aggregate and single-age participation rates

The aggregate participation rate of the age group 55-74, $PR^{55\text{-}74}$, is related to single-age participation rates, PR^a, according to:

$$PR^{55-74} = \sum_{a=55}^{74} \theta^a PR^a \qquad \text{(A1)}$$

where θ^a is the share of the population of age a among the total population aged 55-74. For simplicity, it is assumed that the population is equally distributed over the ages 55-74, so $\theta^a = 1/20$ for all a, so:

$$PR^{55-74} = \sum_{a=55}^{74} PR^a \,/\, 20 \qquad \text{(A2)}$$

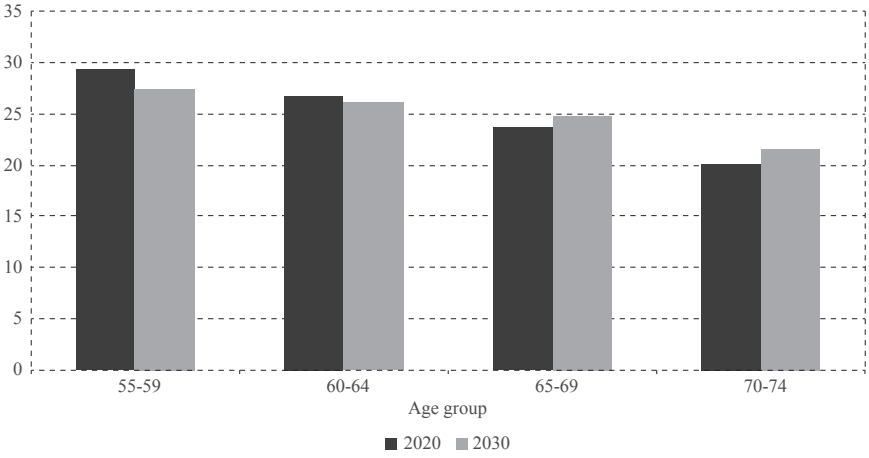
Similarly, the aggregate participation rate of the age group 55-64, $PR^{55\text{-}64}$, is related to single-age participation rates as:

$$PR^{55-64} = \sum_{a=55}^{64} PR^a \,/\, 10 \qquad \text{(A3)}$$

The assumption that the population is evenly distributed over the ages 55-74, is approximate for the typical OECD country and is likely to become an even better approximation over the next 10 years (figure A1).

Figure A1

Older age population distribution of the average OECD country – Size of age group as a percentage of age group aged 55-74 (%)



Note: Shares are calculated as unweighted averages of OECD countries.

Source: United Nations population estimates and projections.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

For the average OECD country, the proportion of the population in each of the age groups 60-64 and 65-69, which are likely to be most immediately affected by changes to statutory retirement ages, are close to being 25% of the population aged 55-74.

A2 Evaluating an estimated equation for participation modelled by single age

Suppose the single-age participation rate, PR^a is modelled as:

$$PR^a = -\beta_{min} D_{min} - \beta_{norm} D_{norm} + other\ variables \quad \text{(A4)}$$

where $D_{min}(D_{norm})$ are dummy variables taking the value of unity at ages equal to and above the minimum (normal) retirement age $a_{min}(a_{norm})$ and "*other variables*" captures the effect of all other explanatory variables, which are assumed to remain unchanged following a pension reform.[8]

Then consider a reform that raises the minimum and normal retirement ages by one year. This is modelled by changing the dummy variables D_{min} and D_{norm}: the dummy variable D_{min} changes from 1 to 0 at the pre-reform minimum retirement age (but is unchanged at all other ages); and, similarly, D_{norm} changes from 1 to 0 at the pre-reform normal retirement age (but is unchanged at all other ages). Given (A4), the change in each dummy variable in only one year then raises older age participation by:

$$\Delta PR^{55-74} = -(\beta_{min} + \beta_{norm})/20 \quad \text{(A5)}$$

So if $\beta_{min} = \beta_{norm} = -5$, as in the baseline model (see equation (1) in table 1), then:

$$\Delta PR^{55-74} = +10/20 = 0.5pp \quad \text{(A6)}$$

A3 Effects on the average retirement age

The average age of retirement (AAR) is the sum of each year of age weighted by the proportion of individuals leaving the labour force at that age. A simple "static" calculation of ARR, ignoring deaths, assuming the age structure is stable, that nobody retires before age 55 and everyone retires by age 75, is given by:[9]

[8] The assumption that "*other explanatory variables*" are unaffected by the pension reform is a convenient simplification here. In the equations estimated in the full paper there is also an effect on participation from pension wealth and if the age-profile of pension wealth also shifts (as is likely) following a reform, then there will also be an effect from this channel. This second wealth channel is quantified in table 2 and in all calculations reported in the main paper, but not included in the algebra here, both because it is country-specific and because on average the effect on the participation rate and average age of retirement is relatively small. For example, for the baseline model (equation (1) in table 1), considering the effect on the average age of retirement from raising statutory pension ages by one year: the effect coming from the statutory retirement dummies alone is 1.6 months, but including an additional effect from pension wealth (assuming the age-profile is shifted up one year) only increases this estimate to 1.8 months.

[9] See Scherer (2010) for a proof of this static formula, which requires only cross-sectional data. He also points out that this static calculation will be different and potentially misleading compared to a dynamic calculation that allows for the evolving age structure of the population. The static calculation is used here because of it computational simplicity and because the only interest here is in evaluating the effect of a marginal change in the AAR in response to a policy change.

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

$$AAR = \sum_{a=55}^{75} \frac{PR^{a-1} - PR^{a}}{PR^{54}} . a \tag{A7}$$

Now consider a reform that changes participation by ΔPR at each age, where "Δ" denotes the change following the reform, then the change in average retirement age is given by:

$$\Delta AAR = \sum_{a=55}^{75} \frac{\Delta PR^{a-1} - \Delta PR^{a}}{PR^{54}} . a \tag{A8}$$

Expanding the RHS of (A8) gives:

$$\begin{aligned} \Delta AAR = \left(\frac{1}{PR^{54}}\right) \cdot \Big[& \left(\Delta PR^{54} - \Delta PR^{55}\right)55 + \ldots + \left(\Delta PR^{min-1} - \Delta PR^{min}\right) \cdot a_{min} \\ & + \left(\Delta PR^{min} - \Delta PR^{min+1}\right) \cdot a_{min+1} + \ldots + \left(\Delta PR^{norm-1} - \Delta PR^{norm}\right) \cdot a_{norm} \\ & + \left(\Delta PR^{norm} - \Delta PR^{norm+1}\right) \cdot a_{norm+1} + \ldots \left(\Delta PR^{74} - \Delta PR^{75}\right) \cdot 75 \Big] \end{aligned} \tag{A9}$$

Assuming the same model as described by (A3) above, the effect of a reform to increase statutory retirement ages by one year will be: firstly, to increase participation at the (pre-reform) minimum age of retirement by $-\beta_{min}$ so that $\Delta PR^{min} = -\beta_{min}$; and secondly, participation increases by $-\beta_{norm}$ at the (pre-reform) normal age of retirement, so that $\Delta PR^{norm} = -\beta_{norm}$. The participation rate at all other ages remains unchanged, so that $\Delta PR^{a} = 0$ for all $a \neq a_{min}$ *or* a_{norm}. Substituting into (A7) the change in AAR, as a result of the reform, is given by:

$$\begin{aligned} \Delta AAR = \left(\frac{1}{PR^{54}}\right) \cdot \Big[& (0-0) \cdot 55 + \ldots + (0 - \beta_{min}) \cdot a_{min} + (\beta_{min} - 0) \cdot a_{min+1} \\ & + \ldots + (0 - \beta_{norm}) \cdot a_{norm} + (\beta_{norm} - 0) \cdot a_{norm+1} + \ldots (0-0) \cdot 75 \Big] \end{aligned} \tag{A10}$$

Further simplifying gives:

$$\Delta AAR = \left(\frac{1}{PR^{54}}\right) \cdot \left[\beta_{min}\left(a_{min} - a_{min+1}\right) + \beta_{norm}\left(a_{norm} - a_{norm+1}\right)\right] \tag{A11}$$

$$\Delta AAR = -\frac{\left(\beta_{min} + \beta_{norm}\right)}{PR^{54}} \tag{A12}$$

Then if the average participation rate at age 54 is 75% (which is close to an unweighted OECD average for 2018) and if $\beta_{min} = \beta_{norm} = -5$ as for the baseline equation in table 1, substituting into (A12) gives an estimate of the change in AAR for a one year increase in statutory retirement ages of:

$$\Delta AAR = +\frac{10}{75} = 0.13 \; years = 1.6 \; months \tag{A13}$$

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

The estimated effect reported in table 1 for the baseline equation is based on this calculation plus a (small) separate addition to allow for the effect of pension wealth (which brings the total effect up to 2.4 months).

A4 Using a transition-to-retirement variable instead of dummies

Suppose instead of defining dummies at the minimum and normal retirement ages a transition-to-retirement age variable is defined to be zero before the minimum retirement age, unity above the normal retirement age, so that:

$TRANS\_RET^a = 0$ if $a < a_{min}$; $TRANS\_RET^a = 1$ if $a > a_{norm}$;

and a fraction between these two ages, as follows:

$TRANS\_RET^a = (a + 1 - a_{min})/(a_{norm} + 1 - a_{min})$ if $a_{min} \leq a \leq a_{norm}$;

Then instead of estimating (A3), the following equation is estimated:

$$PR^a = -\beta_{trans} \cdot TRANS\_RET^a + other\ variables \tag{A14}$$

Then the effect of an increase in both minimum and normal retirement ages by one year will affect participation at all ages between the (new) minimum and normal retirement ages, but the total change in the transition variable will be unity:

$$\sum_{a=55}^{74} \Delta TRANS\_RET^a = 1.0 \tag{A15}$$

Consequently, instead of (A3) the change in the aggregate participation rate at older ages is given by:

$$\Delta PR^{55-74} = -\beta_{trans} / 20 \tag{A16}$$

So, rather than (A12), the change in the AAR is given by:

$$\Delta AAR = -\frac{\beta_{trans}}{PR^{54}} \tag{A17}$$

A5 Evaluating an timated for anticipation modelled as an age group aggregate

Instead of participation being modelled by a single year of age, the older age participation rate is often modelled in other studies as a single variable for a particular age group such as the participation rate for those aged 55-64, so that:

$$PR^{55-64} = \gamma_{ret} \cdot RET + other\ variables \tag{A18}$$

where RET is a statutory retirement age. Then the effect of a 1-year shift in the statutory retirement age is given by:

$$\Delta PR^{55-64} = \gamma_{ret} \tag{A19}$$

PUBLIC SECTOR ECONOMICS
45(2) 257-282 (2021)

An expression for the aggregate participation rate of the age group 55-64, PR^{55-64}, in terms of the single-age participation rates was previously derived in (A3), so the effect of the change in policy will be as follows:

$$\Delta PR^{55-64} = \sum_{a=55}^{64} \Delta PR^{a} \,/\, 10 \tag{A20}$$

The effect of a change in policy, denoted by Δ, on the average age of retirement is given by expression [A9], which can be applied to the age group 55-65 and re-written as:

$$\Delta AAR = \left(\frac{1}{PR^{54}}\right)\Big[\left(\Delta PR^{54} - \Delta PR^{55}\right)\cdot 55 + \left(\Delta PR^{55} - \Delta PR^{56}\right) \cdot 56 + \ldots + \left(\Delta PR^{62} - \Delta PR^{63}\right)\cdot 63 + \left(\Delta PR^{63} - \Delta PR^{64}\right) \cdot 64 + \left(\Delta PR^{64} - \Delta PR^{65}\cdot 65\right)\Big]$$

$$\Delta AAR = \left(\frac{1}{PR^{54}}\right)\Big[\Delta PR^{54}\cdot 55 + \Delta PR^{55}\cdot\left(56-55\right) + \ldots + \Delta PR^{62}\cdot\left(63-62\right) + \Delta PR^{63}\cdot\left(64-63\right) + \Delta PR^{64}\cdot\left(65-64\right) - \Delta PR^{65}\cdot 65\Big]$$

$$\Delta AAR = \left(\frac{1}{PR^{54}}\right)\Big[\left(\Delta PR^{54}\right)\cdot 55 + \Delta PR^{55} + \ldots + \Delta PR^{62} + \Delta PR^{63} + \Delta PR^{64} - \Delta PR^{65}\cdot 65\Big]$$

But if everyone is assumed to retire between the ages 55 and 64, $\Delta PR^{54} = \Delta PR^{65} = 0$ then:

$$\Delta AAR = \sum_{a=55}^{64} \frac{\Delta PR^{a}}{PR^{54}} \tag{A21}$$

Combining (A21) and (A20) to eliminate $\sum \Delta PR^{a}$ gives:

$$\Delta AAR = 10\frac{\Delta PR^{55-64}}{PR^{54}} \tag{A22}$$

Then substituting $\Delta PR^{55-64} = \gamma_{ret}$ from (A19) gives an expression for the change in the average retirement age in years, following a change in the statutory age of retirement, which can be applied to an aggregate participation equation:

$$\Delta AAR = \gamma_{ret}\frac{10}{PR^{54}} \tag{A23}$$

A6 Computing the implicit effect on the average age of retirement in other studies

- Expression [A23] is used to compute the average age of retirement for most of the studies reported in table 1 of the main paper, on the assumptions that PR^{54} = 85% for men and PR^{54} = 75% for the total population (which are close to unweighted averages for OECD countries in 2018).
- Blöndal and Scarpetta (1999) report a coefficient γ_{ret} of between 0.8 and 1.0 on regressions where the dependent variable is the male participation rate for those aged 55-64. So using (A23) and assuming PR^{54} = 85%, this gives a value for ΔAAR of between 1.1 and 1.4 months, as reported in section 2.
- The panel regressions reported by Duval (2004) consider the determinants of the *percentage change* between successive 5-year groups of male participation rates. Estimated coefficients on the statutory pension age determining the percentage change in participation between ages 55-59 and 60-64 and between 60-64 and 65-69 are 1.63 and 1.17, respectively (see model B in table 2 of the paper). Assuming that typical male participation rates for the age groups 55-59 and 60-64 are 80% and 60%, respectively, raising the statutory pension age by one year (assuming no effect on the age group 55-59) will raise the average participation rate of the entire age group 55-69 by about $(0 \cdot 5 + 80/100 \cdot 1.63 \cdot 5 + 60/100 \cdot 1.17 \cdot 5)/15 = 2/3$ of a percentage point. Adapting the formula in (A23), this implies an increase in the average age of retirement of $2/3 \cdot 15 \cdot 1/PR^{54}$ years. Further assuming PR^{54} = 85%, this gives a value for ΔAAR of 1.4 months, as reported in section 2.
- Egert and Gal (1999) report a coefficient γ_{ret} of 0.85 on a regression where the dependent variable is the employment rate for those aged 55-64 (male and female). So, using (A23) and assuming that a change in statutory retirement ages leaves the older age unemployment rate unchanged (so that the change in the employment rate is reflected in the labour force participation rate) and PR^{54} = 75%, gives a value for ΔAAR of 1.4 months, as reported in section 2.
- Grigoli, Koczan and Tapalova (2018) report a coefficient γ_{ret} of 0.66 on a regression where the dependent variable is the participation rate for those aged 55+. Using (A23) and PR^{54} = 75% gives a value for ΔAAR of 1.1 months. However, a further scaling adjustment needs to be made because the dependent variable in this case is the participation rate of those aged 55+ (not 55-64 as in (A17)). Assuming that the changes in labour force participation from historical changes in the statutory retirement age in their sample mainly occurred over the ages 55-64, then to be comparable with the other calculations, the result needs to be scaled up by the inverse of the share of the population aged 55-64 relative to the population aged 55+. For OECD countries this share is currently about one-half, so the final estimate for ΔAAR is 2.2 (=1.1/0.5) months, as reported in section 2.

An overview of the taxation of residential property: is it a good idea?

MARTA RODRIGUEZ-VIVES, Ph.D.*
MIGUEL ANGEL GAVILAN-RUBIO, Ph.D.*

Preliminary communication**
JEL: H21, H24, H71, R31, R38
https://doi.org/10.3326/pse.45.2.5

* The opinions expressed herein are those of the authors and do not necessarily reflect the views of the ECB, Bank of Slovenia or the Eurosystem. We want to thank three anonymous referees for their suggestions for improving this work. Likewise, the authors want to express their gratitude to the participants and the discussants of the 4th Public Sector Economics Conference (Zagreb, 24 October 2019) where a preliminary version of this article was discussed. Any errors are the sole responsibility of the authors.
** Received: May 29, 2020
Accepted: February 8, 2021

Marta RODRIGUEZ-VIVES
Principal Economist at Fiscal Policies Division, European Central Bank, Sonnemannstrasse 20, 60314 Frankfurt am Main, Germany
e-mail: marta.rodriguez@ecb.europa.eu
ORCiD: 0000-0003-1190-6599

Miguel Angel GAVILAN-RUBIO
Researcher at Analysis and Research Division, Bank of Slovenia, Slovenska 35, 1505 Ljubljana, Slovenia
e-mail: Miguel-Angel.Gavilan-Rubio@bsi.si
ORCiD: 0000-0002-0001-9663

PUBLIC SECTOR ECONOMICS
45(2) 283-303 (2021)

Abstract

This article examines the taxation of property in the residential market as a potential revenue-raising tool in public finance. Economists generally consider taxing property to be less distortionary than taxing other tax bases. It ranks well in terms of trade-offs across long-term growth and inequality considerations. Although countries have different societal preferences, recourse to property taxation is not generally widespread. Using panel data methods and stochastic frontier analysis, we provide evidence that government revenue from property taxation is relatively inelastic to house price and quantity developments, and that countries with a higher implicit tax rate tend to be more efficient at collecting the revenue. Despite the increase of prices since 2014, low revenues can be the result of low effective tax rates and outdated house valuation systems.

Keywords: property tax, households, housing policies, housing prices, wealth inequality

1 INTRODUCTION

Developments in housing markets impact economic growth, wealth inequality (affecting household investment decisions and indebtedness) and financial stability (a house can be a collateral asset for banking lenders).

The government sector plays a relevant role in the dynamics of real estate markets. First, governments pursue housing policy objectives aimed at the provision of adequate and affordable housing.[1] There are several tools at the disposal of governments, such as taxation, social housing and regulations. Fiscal policies can also impact household indebtedness through the tax incentives it creates for holding property or contracting mortgages. In particular, several countries provide tax reliefs (either deductions or tax credits, which are typically capped) for mortgage principal repayments and/or for interest payments.

Second, property taxation is also a valuable tool used by governments to generate income, which is the focus of this article. It is not straightforward to find the best combination of revenue raising fiscal instruments to finance public spending in a budget (Rodríguez-Vives, 2019). Taxes are generally not desirable as they distort markets, but property taxation is seen as a potential revenue-raising tool in a relatively growth- and equity-friendly manner. This particularly holds true in a case in which there is a need for consolidation in order to keep public finances sustainable. Property taxation appears to be relatively growth-friendly as it mainly taxes immovable bases.[2] Property taxes also have special features compared to others, such as their visibility and relatively inelasticity (i.e. recurrent property taxes).

[1] For more details, OECD (2019a) and its "Public policies towards affordable housing" section.

[2] See Acosta-Ormaechea and Yoo (2012). According to Roeger and Veld (2010), property taxes are considered the most growth-friendly type of tax. The authors set a model with a tax on housing property, in which increments in this tax negatively affect housing investment. However, it does not directly distort the provision of the inputs to production and household consumption decisions. Moreover, by making investments in productive capital relatively more attractive than investment in housing, it leads to a higher stock of productive capital and more production.

PUBLIC SECTOR ECONOMICS 45(2) 283-303 (2021)

Moreover, property taxation is currently attracting more attention from policy-makers as its yields are still relatively low compared to the taxation of other goods. For instance, Norregaard (2013) concludes that taxing immovable property has a potential for revenue growth of around 2% of GDP in developed countries. Country recommendations by international institutions (e.g., the European Commission, OECD) generally include shifting taxes from (lower wage) labour to taxes less detrimental for long-term growth, such as property taxes (ECB, 2017). Hence, increasing the recourse to property taxation could provide a potential source for government revenue by broadening tax bases, tax rates and/or abolishing tax exemptions. However, a greater recourse to housing taxation may have some undesirable outcomes as well, such as dampening housing investment cycles (Cavalleri, Cournède and Ziemann, 2019).

This article approaches the policy question of taxing property from different angles.[3] Section 2 discusses the advantages and disadvantages of taxing property. Section 3 presents some stylized facts on property tax revenues across developed countries. Section 4 proposes an econometric model analysing the revenue potential of taxing property. Section 5 outlines a set of conclusions.

2 TAXING PROPERTY

In the OECD taxonomy, property taxes are divided into two broad groups: recurrent taxes and other taxes (non-recurrent property taxes). Recurrent taxes on the property are typically paid annually, at sub-national level and linked to some measure of the value of the property. However, other taxes, such as taxes on financial and capital transactions, are paid when the ownership of the property changes hands. Table A1 in the appendix shows the different taxes applicable in the life cycle of the housing market and the economic rationale behind them. Section 3 shows substantial heterogeneity on how countries levy recurrent and other property taxes.[4]

Following the economic rationale, property taxation ranks high in terms of growth and equity effects in relation to other fiscal instruments. In particular, other property taxes are one of the best possible choices if there are needs for consolidation, after subsidies and pensions, according to the generic hierarchy of consolidation instruments (OECD, 2013a; Cournède, Goujard and Pina, 2013). Recurrent property taxes rank in the middle of tax instruments, after income taxation and environmental taxes. Arnold (2008) finds that recurrent property taxes appear to be the most growth-friendly, followed by consumption and personal income taxes. Corporate income taxes appear to have the most negative effect on GDP per capita. Grdinić et al. (2017) find in a panel of 20 countries that personal income taxes have the highest negative impact on economic growth, while property taxes

[3] Although taxing property refers to both residential and commercial property, this article focuses on residential property and the household sector.

[4] The taxpayers can be households, individuals, or corporations. Also, the property can either refer to residential or commercial real estate. Although a more granular assessment is warranted, this is outside the scope of this paper. Instead, we refer to taxing property in a generic way, focusing on the household sector and residential real estate by default.

showed the least negative impact. The authors find that a revenue-neutral growth-oriented tax reform would shift part of the revenue base from income taxes (especially corporate taxes) to *recurrent taxes*. In terms of equity friendliness, rises in *other taxes*, such as on net wealth or inheritances and gifts, are typically seen as improving the progressivity and fairness of the tax system (IMF, 2018; Bahl and Martínez-Vasquez, 2008).

From the lifecycle of a property, there are different taxing options depending on the economic transaction involved: buying, holding, renting, selling or bequeathing (table A1 in the appendix).

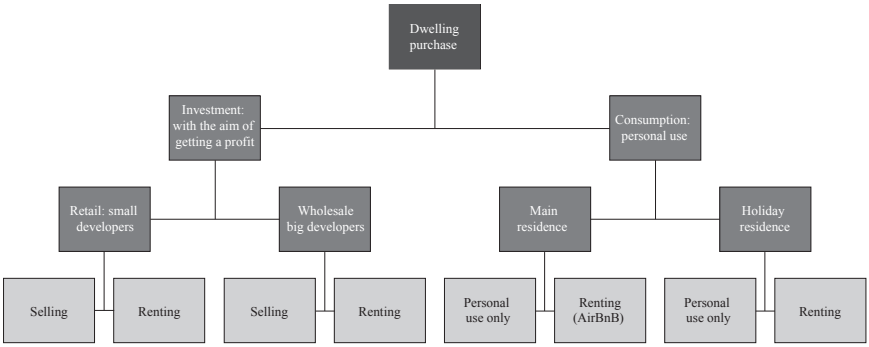
Taxing property also raises complex distributional questions. On the one hand, analysing the income inequality levels in the society (e.g. Gini coefficient) is an important indicator of the effectiveness of the government action in the economy. More progressive tax systems make the post-tax income distribution more equal (e.g. Förster, Llena-Nozal and Nafilyan, 2014). On the other hand, household (net) wealth, which is composed of real and financial assets, is also a crucial topic. In the euro area, around 65% of households have accumulated real estate wealth.[5] Household main residence (HMR) is the most significant component of real assets in the euro area (60.3% in 2017), followed by other estate real assets (24.1% in 2017). The conditional median for HMR rose by 2.7% to €165,700 in 2017 from 2014, albeit there was strong heterogeneity across countries and income distributions. A significant influence on real estate wealth accumulation is related to the changes in the value of the underlying asset (e.g. capital gains on real estate holdings). Moreover, housing is considered one of the key dimensions for measuring well-being (OECD, 2013b).

An alternative way for policymakers to look at whether real estate is undertaxed is to compare how property is taxed relative to other investment or consumption goods. This fact makes the taxation of owner-occupied properties a concept that is relative to other assets. Figure 1 illustrates the dichotomy of a dwelling purchase. Housing is more than an investment good as it provides a habitat to households, so owner-occupied or holiday homes can also be seen as a (durable) consumption good. Hence, several policy objectives that may justify housing being undertaxed, such as addressing market failures in low homeownership ratios and increasing social cohesion. However, second homes providing rental income can, on the other hand, be seen as only investment goods. In national accounts, household purchases of dwellings are accounted for as investment (gross fixed capital formation) and not as consumption expenditure. Moreover, the owners of dwellings are regarded as producing housing services either for themselves or for tenants.[6]

[5] According to the third wave of the ECB's Household Finance and Consumption Survey (HFCS), which refers to 2017 data – for more details see Household Finance and Consumption Network (2020).

[6] Housing services provided by homeowner-occupiers are imputed as being equal to the rents they would have paid for comparable housing. It implies that the production of services (rental or imputed) from owner-occupied (imputed) and tenant-occupied dwellings (rental) are part of GDP. The arbitrariness lies in the imputation method. According to Lequiller and Blades (2014), a long-term upward trend in homeownership would automatically produce a downward trend in the total value of actual rents (and thus in GDP, all things being equal) and make it difficult to compare the output of different countries because homeownership rates vary across countries.

FIGURE 1
Housing dichotomy and the use of dwellings after purchase



Source: Own representation.

As an investment, real estate competes with alternative investments in terms of returns, i.e. pension funds, financial assets, or opening a business. In theory, tax systems should provide a level playing field for asset portfolio choices, tax neutrality, as it is called, to foster the efficiency and fairness of the system. However, the OECD (2018) remarks on the lack of neutrality in the 40 countries where the marginal effective tax rates (METRs) on different assets were calculated. Their results show that the most tax-favoured assets are pension funds, owner-occupied residential property, and savings accounts. However, rental property is often subject to relatively high METRs due to the application of progressive marginal personal income tax (PIT) rates, capital gains taxes and significant property taxes.

3 PROPERTY TAXATION: STYLIZED FACTS IN ADVANCED COUNTRIES

This section presents the recent stylized facts regarding property taxation. There are several peer comparisons of property tax revenues (e.g. IMF, OECD, European Commission/Eurostat, international consulting and tax companies). Overall, few countries have significantly increased property tax collection in the last decade, although many developed countries have improved their structure or yields in their reform efforts to increase their revenues (e.g. Greece).

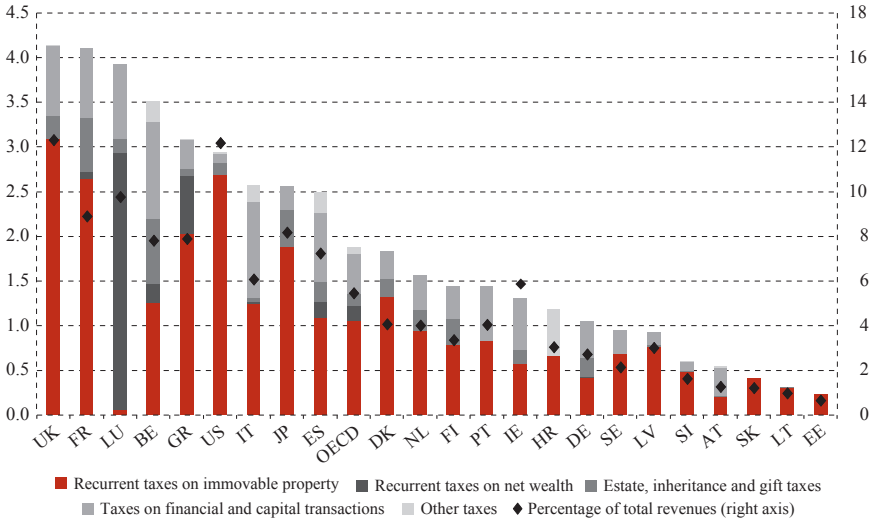
Revenue from taxing property amounts to almost 2% of GDP on average, which represents a small contribution to total revenue, of almost 6%. Figure 2 shows that the contribution of property taxation to total revenues is generally more substantial in countries with higher property tax rates (e.g. the UK, the US, Canada, Greece, France). At the other extreme, there are countries where the contribution of property tax to total government revenue is proportionally and significantly lower than that of their peers (e.g. Croatia, Austria, Estonia, Slovenia).

Albeit there is country heterogeneity in the composition of property taxation, recurrent taxes are far the most extensively used category of property taxation across countries. Capital taxes related to the possession and transfer of immovable

property are also relevant. Although a majority of countries apply inheritance and gift taxes, the amount collected is minimal (below 0.5% of GDP) with some exceptions (e.g. France, Belgium, Japan and the UK). Only a minority of countries tax net wealth or the possession of specific assets.

Figure 2

Components of property tax, percentage of GDP (2018, in %)



Note: For Greece, Japan and the OECD average the data refer to 2017. Recurrent taxes on net wealth include current taxes on capital; capital transactions include taxes on stamp duties; and "other taxes" include other non-recurrent taxes on property (capital levies) and other recurrent taxes on property (current taxes on capital). Own representation.

Source: Authors based on OECD Revenue Statistics database and Eurostat.

Figure 3 illustrates that *recurrent taxes* have substantially increased compared to the pre-crisis levels, with a few notable exceptions (e.g. Croatia, Austria, Estonia, Germany, Luxembourg, Lithuania, Slovakia, Sweden and Japan). By contrast, *other taxes* remain at a level similar to that of before the crisis for most countries. Several countries have experienced an increase in the percentage of other property taxation, which is particularly substantial and recent in the case of the US. This category is becoming, however, less relevant for a group of countries with a high share of homeownership (e.g. Ireland, the Netherlands, Portugal, Spain and the UK).

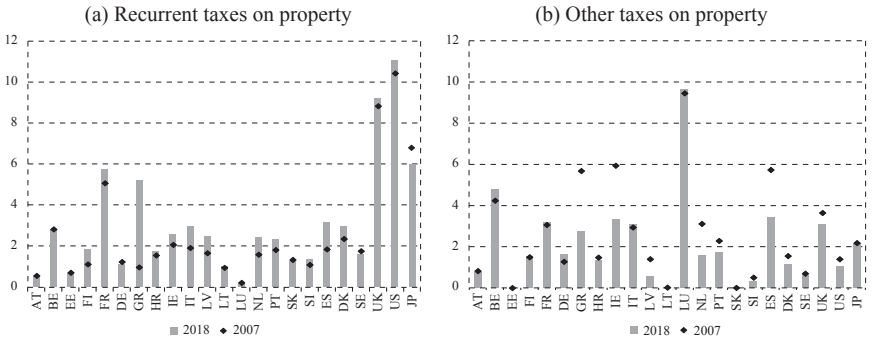
Looking ahead, taxing residential property still seems to be a particularly dynamic source for growth for public revenue collection. Real housing prices have increased in the majority of advanced countries as have the purchases made by households in recent years. Household investment rate in the OECD averaged 6.6% of the gross disposable income of households in 2018 (only 2.2 percentage points below its peak value in 2007). According to figure 4a, we can observe that in some countries, such as in Spain and Greece, the investment rate has not reached 2007 levels yet. Regarding the evolution of house prices, the latest release of

PUBLIC SECTOR ECONOMICS 45(2) 283-303 (2021)

Eurostat (April 2020)[7] points to a continuation of the upward trend initiated in 2014. Moreover, several OECD countries have experienced reductions in house prices with respect to their incomes since 2007, such as in the Baltics, which could be an indication of improved affordability (figure 4b).[8]

Figure 3

Property tax revenue, as percentage of total government revenue (2018 vs. 2007, in %)

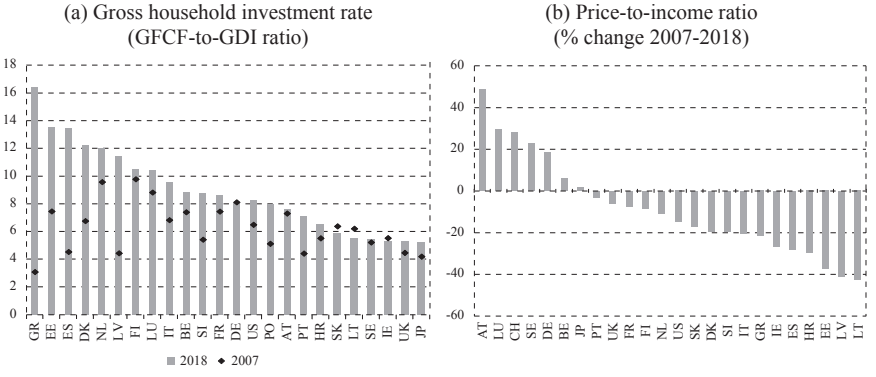


Note: For Greece, Japan and OECD average the data refer to 2017. "Other taxes on property" includes taxes on net wealth, heritage and gift taxes, taxes on financial and capital transactions, other non-recurrent taxes on property and other recurrent taxes on property.

Source: Authors based on OECD Revenue Statistics database and Eurostat.

Figure 4

Residential property developments (in %)



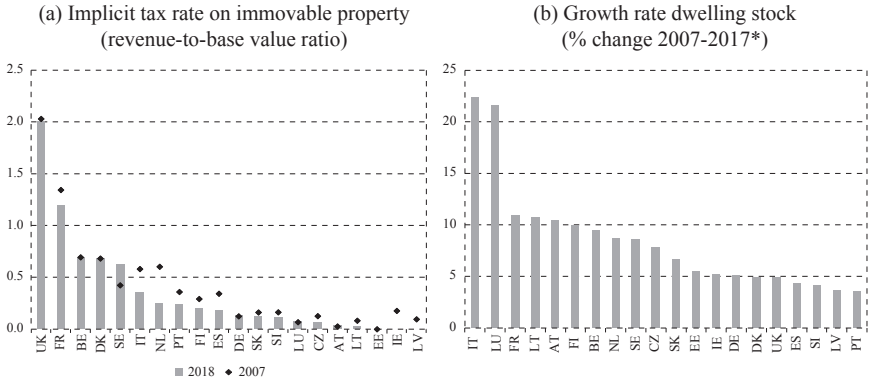
Source: Eurostat, IMF database (IMF.org/housing).

[7] With an average increase of 4.2% in 2019Q4 in comparison to 2018Q4 – according to Eurostat's house price data.

[8] There are some patterns observed when considering the investment rate and prices together. We can observe some countries such as Spain and Greece, where both investment rate and price-to-income ratio have fallen, indicating a lack of demand in the market. By contrast, Germany, Japan and Austria have reached investment rates similar to pre-crisis levels and increases in prices with respect to their disposable incomes.

FIGURE 5

Implicit property tax rate and supply of residential property (in %)



** The last available years for Austria, Italy and Luxemburg are 2016, 2015 and 2013 respectively.*
Source: Barrios et al. (2019), Eurostat and ECB database.

In practice, increasing the recourse to property taxation also faces many political economy obstacles. This tax is particularly unpopular and difficult to implement. The property tax reforms introduced in 2019 were limited in number and scope. The focus has been on increasing taxes on high-value immovable property (OECD, 2019b). Figure 5 illustrates this fact. Comparing the implicit tax rate on immovable property in 2017 with pre-crisis rates, we find that there has been an effort to increase the recurrent revenues from residential properties in the Netherlands, Spain, Portugal, Ireland and Italy. However, the increment in government revenue is not proportional to the increment in the tax base, as we can observe in the growth of dwelling stock in those countries over the same period.

Going forward, the planning of timing, scope and sequencing is essential for reforming property taxation (European Commission, 2012). However, this also requires excellent coordination of the institutional framework in place dealing with the national housing policy (e.g. the ministry of finance/tax department, the financial supervision authority, the national central bank) and the sub-national/ local authorities.

4 AN EMPIRICAL ANALYSIS IN ADVANCED COUNTRIES

In this section, we explore to what extent country differences in implicit tax rates on immovable property between 1995 and 2017 are attributable to fluctuations in the base, via quantity and prices, and some other macroeconomic variables. This exercise also includes the sharp drop in house prices experienced by several countries during 2008-2009 and the more recent recovery in 2014.

4.1 METHODOLOGY

We implement two basic empirical models to look at the relationship between the implicit property tax rate and potential macroeconomic variables. Although the

complexity of the housing market dynamics is not fully captured by the model, the aim of this paper is to focus on the revenue-raising capacity of property taxation from a public finance perspective. We estimate different combinations in two different frameworks: panel data analysis and stochastic frontier analysis. The reduced panel model is given by:

$$Log(IRTRI)_{i,t} = \beta_0 + \beta_1 g_{i,t}^{SD} + \beta_2 g_{i,t}^{\overline{PM2}} + \beta_3 X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where *Log* (*IRTRI*) denotes the implicit recurrent tax rate on immovable property, $g_{i,t}^{SD}$ the growth rate of the stock of dwellings, $g_{i,t}^{\overline{PM2}}$ the growth rate of the average price per square meter, and $X_{i,t}$ a set of macroeconomic variables with potential impact in the explanatory variable; and $\varepsilon_{i,t}$ is an error term with the usual assumptions.

Regarding stochastic frontier analysis, and following Fenochietto and Pessino (2013), we can understand the implicit recurrent tax rate as the output of a production function, which is produced by different inputs. One of the advantages of this methodology is that it assumes that there are inefficiencies. In our case, these inefficiencies would represent the inability of governments to collect the taxes. The frontier model is based on Kumbhakar and Lovell (2000), and is given by:

$$Log(IRTRI)_{i,t} = \beta_0 + \beta_1 g_{i,t}^{SD} + \beta_2 g_{i,t}^{\overline{PM2}} + \beta_3 X_{i,t} + \varepsilon_{i,t} + v_i - u_i \quad (2)$$

where the idiosyncratic component, v_i, is assumed to be independently $N(0, \sigma_v)$ distributed over the observations, and the inefficiency term, u_i, is strictly positive and assumed to be independently half normal, $|N(0,\sigma)|$, and using the σ parametrization of the normal distribution. The expectation is then given by $\mathrm{E}(u) = \sigma\sqrt{2/\pi}$ and variance $\mathrm{var}(u) = \sigma^2\left(1 - \frac{2}{\pi}\right)$.

4.2 THE DATA

We use a compacted version of the data presented in previous sections. The dataset is an unbalanced panel and comprehends 20 EU countries over 23 periods, from 1995 to 2017.[9] The dataset is composed of eight variables: the logarithm of the implicit recurrent tax rate on immovable property, the growth rate of the stock of dwellings, the growth rate of the average price per square meter, the logarithm of the household debt-to-GDP ratio, the logarithm of the GINI index, transfer tax rates, interest tax rates, and the long-term interest rates (LTIR).[10] The implicit recurrent tax rate on immovable property is defined as the ratio of revenue from recurrent taxes on immovable property collected from households to the net stock of dwellings in the household sector.

[9] The 20 selected countries are Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

[10] We initially considered other variables, such as GDP per head (constant PPS) and inflation. These two variables never were significant. However, they did cause high group heterogeneity, serial correlation and collinearity, affecting the overall estimation and performance of the models. We finally decided not to include them in the models.

The variables have been transformed using growth rates and logarithms. These two transformations have the advantages of setting the explanatory variables in the same metric, and of mitigating potential problems with heteroskedasticity and serial correlation, as some variables were non-stationary processes. Table A2 (in the appendix) summarises the main descriptive statistics of each variable used in the regressions, showing the standard deviations in the overall dataset, within and between groups.

4.3 RESULTS

4.3.1 PANEL DATA ANALYSIS

Table 1 shows the results of regressing different combinations of variables on the implicit tax rate using panel data analysis based on equation (1).[11] Given the metric of the variables, the fitted values might not have a straightforward interpretation. However, we find that the sign of these values is consistent.

Both growth rate of the stock of dwellings and growth rate of the average price per square meter negatively affect the implicit property tax rate. While these results seem to be counterintuitive, this is the result of the implicit property tax rate construction. Both variables affect the tax base, i.e., determining the total value of the net stock of dwellings, and this is the denominator of the implicit property tax rate. Presumably, we can assume that both variables also affect the total revenues (the numerator of the implicit property tax rate). However, the negative sign in the regressions suggests that price and quantity elasticities of the revenues are inelastic. This finding implies that the revenue from recurrent taxes on immovable properties increases proportionally less than the value of the tax base. Also, and according to the estimations, the effect via quantities is more significant than the effect via prices, suggesting that a generalised problem in a Europe with a restrictive housing supply is also making governments lose potential revenues. However, these two variables turn to be less significant when we introduce other explanatory variables.

Regarding the effects of the household debt-to-GDP ratio, the results suggest that it has a positive effect on the implicit property tax rate. This result is contrary to the findings from some authors,[12] as it is argued that tax relief on mortgage interest payments results in revenue being lost and constitutes housing tax expenditure, which would imply a negative coefficient in the estimations. However, the intuition behind these results is as follows. The main driver of the average household debt are mortgages, and we could expect two non-exclusive effects to explain the reason for some countries having households that are more in debt.

[11] We performed the Hausman Test for each specification, resulting in Random Effects models in all of them. See the P-values of the Hausman Test at the bottom of the table.

[12] For example, see Fatica and Prammer (2018) and European Commission (2015) for more details.

Table 1

Estimation of implicit recurrent tax rate functions using panel data analysis – random effects (selected EU countries, 1995-2017)

	Log implicit recurrent tax rate on immovable property					
	Model 1 (RE)	**Model 2 (RE)**	**Model 3 (RE)**	**Model 4 (RE)**	**Model 5 (RE)**	**Model 6 (RE)**
Constant	-1.478***	-4.043***	5.356	1.078	0.0953	2.145
	(0.28)	(0.58)	(3.51)	(3.23)	(3.04)	(3.14)
Growth of stock dwellings	-0.1250***	-0.0959***	-0.1310***	-0.1200***	-0.1320***	-0.0869**
	(0.04)	(0.03)	(0.05)	(0.04)	(0.04)	(0.04)
Growth of price of m^2	-0.0076***	-0.0011	-0.0081***	-0.0013	-0.0017	-0.0048
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log HH debt ratio		0.5590***		0.7150***	0.7480***	0.5560***
		(0.11)		(0.18)	(0.18)	(0.17)
Log Gini index			-1.9890*	-1.7090*	-1.4280*	-1.7260**
			(1.04)	(0.96)	(0.86)	(0.87)
Transfer tax rate					-0.0886*	-0.0893*
					(0.05)	(0.05)
Interests income tax rate					0.0077***	0.0077***
					(0.00)	(0.00)
Long term interest rate						-0.0471***
						(0.01)
No of observations	338	337	256	255	255	255
No of countries	19	19	19	19	19	19
R2 overall	0.0258	0.2610	0.0168	0.2190	0.2140	0.1780
R2 within	0.0332	0.0795	0.0736	0.1200	0.1720	0.2040
R2 between	0.0367	0.2960	0.0277	0.2370	0.2130	0.1770
Hausman test[a]	0.8142	0.1058	0.8204	0.5624	0.2053	0.2578

*Note: Standard errors in parentheses. Standard errors are obtained using robust estimations. * p<0.10, ** p<0.05, and *** p<0.01.*

[a] *p-values reported.*

On the one hand, housing prices can be proportionally more extensive than in other countries, which would result in larger mortgages and higher bases. Because most of the recurrent property taxes are defined as rates, this would increase the revenues. On the other hand, it can also be a consequence of a larger fraction of the population having mortgages, which results in a larger fraction of owner-occupied dwellings, facilitating identification of the taxpayer, and making it easier to increase revenues.[13] Along these lines, we should also consider the effect of the Gini index, which is harmful in all the specifications. This result means that countries with a low Gini index have a larger implicit property tax rate. Intuition here is in line with the idea of identifying taxpayers. A more homogeneous society should be related to a larger fraction of owner-occupied dwellings, which makes identification of the taxpayer and increasing revenues easier.

[13] There is currently an excellent tax offshoring debate in the UK, as unknown ownership has severe consequences in the collection of Council Taxes, which could lead to potential revenue losses.

Thus, the empirical evidence suggests that the effects of a larger base and, more significantly, the easier identification of the taxpayer overweight the loss from tax relief on mortgages.

Models 5 and 6 include alternative tax rates. While the effect of the transfer tax rate is negative, which implies that there is a shift from the recurrent tax to the transfer tax, the effect of the interest income tax rate is positive. In the case of the transfer tax, it could be argued that an increment in the property tax rate could lead to a delay in the dynamics of the housing market. Therefore, one could expect a reduction in the implicit recurrent tax rate. However, the result for the interest income tax rate is more interesting. Rises in the interest income tax rate increase the implicit recurrent tax rate because the returns from immovable property are included – the numerator of the implicit recurrent tax rate. Thus, increments in the rate increase revenues.

The last considered variable is long-term interest rates. Its sign is negative, which is the result of its effect on mortgages. Increments in the long-term interest rates make mortgages more expensive, which slows down the market and constrains the collection of revenues. Also, an increment in interest rates might increase the number of applications for tax reliefs (as a consequence of the higher interest payments).

4.3.2 STOCHASTIC FRONTIER ANALYSIS

Table 2 shows the results of regressing the same combinations of variables on the implicit tax rate but using stochastic frontier analysis based on equation (2).[14] This alternative approach has a twofold use. On the one hand, it acts as a robustness check for the panel data analysis. On the other hand, it allows us to analyse the efficiency of the different tax systems (conditional on the selected explanatory variables) by estimating the efficiency scores.

Regarding the first proposition, we find that the signs and the coefficients are very alike in the two methodologies, suggesting that the results are robust to the estimation method. Also, when the values of the coefficients from one specification to the others are compared, there is no significant change. In the case of the growth rate of the stock of dwellings and the growth rate of the average price per square meter, the introduction of a new explanatory variable makes the coefficients smaller, reducing their impact on the explained variable. For these reasons, the interpretation of the results is the same in both cases.

[14] We estimated Time-invariant (TI) and Time-varying decay (TVD) frontiers and, in all feasible cases (some models did not converge when TVD specifications were used), the coefficient related to the Time-varying decay was insignificant, suggesting the use of Time-invariant models.

TABLE 2

Estimation of implicit recurrent tax rate functions using stochastic frontier analysis (selected EU countries, 1995-2017)

	Log implicit recurrent tax rate on immovable property					
	Model 7 (TI)	**Model 8 (TI)**	**Model 9 (TI)**	**Model 10 (TI)**	**Model 11 (TI)**	**Model 12 (TI)**
Constant	1.047***	-1.737***	7.9910***	3.330	2.427	4.475*
	(0.31)	(0.65)	(2.41)	(2.43)	(2.34)	(2.41)
Growth of stock dwellings	-0.1250**	-0.0955**	-0.1310**	-0.1200**	-0.1310***	-0.0854*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Growth of price of m^2	-0.0076**	-0.0012	-0.0080**	-0.0012	-0.0017	-0.0049
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log HH debt ratio		0.5530***		0.7200***	0.7410***	0.5450***
		(0.11)		(0.15)	(0.15)	(0.17)
Log Gini index			-1.9590***	-1.6790***	-1.4390**	-1.7390***
			(0.67)	(0.63)	(0.62)	(0.62)
Transfer tax rate					-0.0904***	-0.0904***
					(0.03)	(0.03)
Interests income tax rate					0.0076**	0.0076**
					(0.00)	(0.00)
Long term interest rate						-0.0476***
						(0.02)
Log sigma2						
Constant	0.4420	0.1680	0.3760	0.0957	0.1400	0.1950
	(0.34)	(0.32)	(0.33)	(0.32)	(0.35)	(0.36)
Log t gamma						
Constant	1.8300***	1.6020***	2.0310***	1.8320***	1.9530***	2.0610***
	(0.40)	(0.39)	(0.38)	(0.38)	(0.41)	(0.42)
mu						
Constant	2.4760***	2.2510***	2.7080***	2.3600***	2.2210***	2.1780***
	(0.44)	(0.42)	(0.52)	(0.48)	(0.41)	(0.40)
No of observations	338	337	256	255	255	255
No of countries	19	19	19	19	19	19
AIC	537.7	506.6	369.4	339	328.8	322.4
BIC	560.6	533.3	394.2	367.3	364.2	361.3
Log likelihood	-262.8	-246.3	-177.7	-161.5	-154.4	-150.2

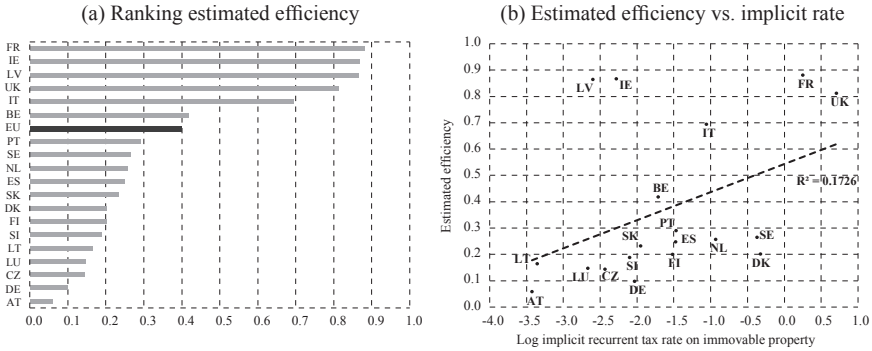
*Note: Standard errors in parentheses. Standard errors are obtained using robust observed information matrix. * p<0.10, ** p<0.05, and *** p<0.01.*

However, and regarding the efficiency analysis according to table 2, the empirical evidence suggests that the higher the implicit property tax rate, the more efficient the tax system is – or the other way around, as we cannot establish a causal relationship between the two variables. This relationship is apparent when we plot efficiency versus the average implicit property tax rate.

PUBLIC SECTOR ECONOMICS
45(2) 283-303 (2021)

FIGURE 6

Estimated efficiency of recurrent tax on immovable property



Source: Authors' construction based on Model 12.

According to figure 6, Austria, Germany, Czech Republic and Luxembourg are the least efficient countries, while France, the UK and Italy are among the most efficient. However, Ireland and Latvia deserve special attention, as they are the only two countries with a low implicit property tax rate, but high efficiency. There are two possible reasons for the results of these two countries. On the one hand, we know that both countries were among those with fewer observations. On the other hand, the estimated functions might be omitting specific characteristics, at a country level, that affect the capacity to increase the tax revenue. In some cases, such as Ireland, the expected revaluation of the local property tax would contribute to tax broadening and tax revenue. These findings support the idea of raising recurrent property tax rates or bases to increase government revenue.

5 CONCLUSIONS

Despite the rise in house prices since 2014, proceeds from property taxation are still somewhat limited in developed countries compared with other government revenue categories. There is a general trend of low collection of property tax. The explanation of this trend seems to be a combination of absence of taxes (e.g. capital gains, wealth), low tax rates (e.g. reduced VAT), and/or the widespread application of tax exemptions (e.g. heritage and gifts). This may lead to low effective tax rates, i.e. the difference between the tax rate and the degree of tax exemptions. Moreover, several countries seem to have outdated house valuation systems and thresholds, which undermines the taxing potential of property taxation. Hence, it is not possible to conclude whether a jurisdiction is over-taxing or under-taxing when compared with peers in advanced countries. Nevertheless, we have provided some rankings of efficiency based on the recurrent taxation and implicit tax rates.

Overall, property taxation can be a useful tool at the disposal of governments for raising revenue and managing public finances. Raising effective property tax rates and bases can help to finance reductions in other more distortionary taxes or for consolidating public finances. This particularly applies to *recurrent property taxes*

according to economic growth considerations and to *other property taxes* based on inequality considerations.

This article does not include the consequences of the COVID-19 pandemic crisis, which may impact household income and the government needs for revenue-raising tools to finance the higher expenditure needed to mitigate the crisis. Potential areas of reform on property tax would also need to balance the adverse equity effects in the most vulnerable groups (e.g. social housing) and population trends (e.g. migration and ageing).

Disclosure statement
No potential conflict of interest was reported by the authors.

REFERENCES

1. Acosta-Ormaechea, S. and Yoo, J., 2012. Tax Composition and Growth: A Broad Cross-Country Perspective. *IMF Working Papers*, 12(257). https://doi.org/10.5089/9781616355678.001
2. Arnold, J., 2008. Do Tax Structures Affect Aggregate Economic Growth? *OECD Economics Department Working Papers*, No. 643. https://doi.org/10.1787/236001777843
3. Bahl, R. W. and Martínez-Vasquez, J., 2008. The Determinants of Revenue Performance. In: R. Bahl, J. Martinez-Vazquez and J. Youngman (eds.) *Making the Property Tax Work: Experiences in Developing and Transitional Countries*. Cambridge: Lincoln Institute of Land Policy, pp. 35-57.
4. Barrios, S. [et al.], 2019. Housing taxation: a new database for Europe. *JRC Working Papers on Taxation and Structural Reforms*, No. 08/2019.
5. Cavalleri, M. C., Cournède, B. and Ziemann, V., 2019. Housing markets and macroeconomic risks. *OECD Economics Department Working Papers*, No. 1555. https://doi.org/10.1787/737133d8-en
6. Cournède, B., Goujard, A. and Pina, Á., 2013. How to Achieve Growth- and Equity-friendly Fiscal Consolidation? A Proposed Methodology for Instrument Choice with an Illustrative Application to OECD Countries. *OECD Economics Department Working Papers*, No. 1088. https://doi.org/10.2139/ssrn.2650018
7. ECB, 2017. The composition of public finances in the euro area. *Economic Bulletin*, (5), pp. 44-62.
8. ECB, 2020. The Household Finance and Consumption Survey: Results from the 2017 wave. *ECB Statistics Paper Series*, (36).
9. Elinder, M. and Persson, L., 2017. House price responses to a national property tax reform. *Journal of Economic Behaviour & Organization*, 144 (December), pp. 18-39. https://doi.org/10.1016/j.jebo.2017.09.017
10. ESRB, 2019. *Methodologies for the assessment of real estate vulnerabilities and macroprudential policies: residential real estate*. Frankfurt am Main: European Systemic Risk Board.
11. European Commission, 2012. Possible reforms of real estate taxation: Criteria for successful policies. *Occasional Papers*, No. 119.
12. European Commission, 2015. Housing taxation: from micro design to macro impact. Criteria for successful policies. *Quarterly report on the euro area*, 14 (1), pp. 27-33.
13. Fatica, S. and Prammer, D., 2018. Housing and the Tax System: How Large Are the Distortions in the Euro Area? *Fiscal Studies*, 39(2), pp. 299-342. https://doi.org/10.1111/1475-5890.12159
14. Fenochietto, R. and Pessino, C., 2013. Understanding Countries' Tax Effort. *IMF Working Paper*, No. 13(244). https://doi.org/10.5089/9781484301272.001
15. Förster, M., Llena-Nozal, A. and Nafilyan, V., 2014. Trends in Top Incomes and their Taxation in OECD Countries. *OECD Social, Employment and Migration Working Papers,* No. 159. https://doi.org/10.1787/5jz43jhlz87f-en

16. Grdinić, M., Drezgić, S. and Blažić. H., 2017. An Empirical Analysis of the Relationship between Tax Structures and Economic Growth in CEE Countries. *Ekonomicky časopis*, 65(5), pp. 426-447.
17. IMF, 2018. *Fiscal Monitor: Capitalizing on Good Times*. Washington: IMF.
18. Kumbhakar, S. C. and Lovell, C. A. K., 2004. *Stochastic frontier analysis*. Cambridge: Cambridge University Press.
19. Lequiller, F. and Blades, D., 2014. *Understanding National Accounts: Second Edition*. Paris: OECD.
20. Norregaard, J., 2013. Taxing Immovable Property, Revenue Potential and Implementation Challenges. *IMF Working Paper*, 13(129). https://doi.org/10.5089/9781484369050.001
21. OECD, 1972. *Global Revenue Statistics Database*. Paris: OECD.
22. OECD, 2013a. Choosing fiscal consolidation instruments compatible with growth and equity. *Economic Policy Papers*, (7). https://doi.org/10.1787/5k43nxq6dzd4-en
23. OECD, 2013b. *How's Life? Measuring Well-being*. Paris: OECD.
24. OECD, 2018. *Taxation of Households Savings*. *OECD Tax Policy Studies*, (25). Paris: OECD.
25. OECD, 2019a. *Affordable Housing Database*. Paris: OECD.
26. OECD, 2019b. *Tax Policy Reforms 2019: OECD and Selected Partner Economies*. Paris: OECD. https://doi.org/10.1787/ea8c26cf-es
27. Piketty, T. and Saez, E., 2013. A theory of optimal inheritance taxation. *Econometrica*, 81(5), pp. 1851-1886. https://doi.org/10.3982/ecta10712
28. Rodríguez-Vives, M., 2019. The quality of public finance: where do we stand? *Economics and Business Letters*, 8(2), pp. 97-105. https://doi.org/10.17811/ebl.8.2.2019.97-105
29. Roeger, W. and Veld, J., 2010. Fiscal stimulus and exit strategies in the EU: a model-based analysis. *European Economy - Economic Papers*, No. 426.

APPENDIX

TABLE A1

Taxing tools in the housing market

Policy tool	Definition	Primary objective	Regulation
Taxation			**ESA 2010**
1. Buying property	*Refers to the one-off transaction tax for the sale of real estate either for the first time or subsequent times. It typically takes the form of stamp duty, VAT (first transaction), transaction tax, or capital acquisition tax. Purchase costs usually are not deductible in the tax declaration. This tax is widely applied in advanced countries as it is administratively appealing since transactions can often be reasonably easily observed. These taxes could also contribute to reducing asset price volatility. However, taxing real estate transactions may also lead to undesirable outcomes, such as adversely impacting labour mobility, reducing house affordability, and ownership ratios.*		
Value added tax (VAT)	VAT on the value of the property, sold for the first time	Generate government revenue Reduce housing demand (especially speculative house purchases)	D.211
Stamp taxes/transfer tax	One-off – Transaction taxes All investors (domestic/foreign); borrowers/equity investors		D.214 B, C Stamp taxes Taxes on financial and capital transactions
2. Holding property	*This involves recurrent taxes on property, usually levied at sub-national/local level. It is particularly appealing as a source of local-government finance since property values reflect the benefits of local public spending. This type of tax is somehow underutilised. It is attractive in the sense that the base is relatively immobile and hard to hide, the tax comes at the top of the hierarchy of long-run growth-friendliness mentioned earlier, and it can be made progressive through a basic allowance or by varying the rate with the value of the property. However, it requires some intense administrative build-up and maintenance of infrastructure. Income from owner-occupied property, whether in the form of imputed rental income or capital gains, is typically untaxed or taxed at low rates. It also includes recurrent taxes on net wealth (assets less liabilities), but they have been declining and only four countries are currently using them.*[15]		
Recurrent taxes on immovable property	Taxes paid annually and linked to the value of the property. Households: Current taxes on capital, other (D.59) Other: Taxes on land buildings or other structures (D.29)	Generate government revenue Finance regional/ local level services	D.59 Current taxes on capital
Recurrent taxes on net wealth	Assets minus liabilities	Inequality	D.59 Current taxes on capital
Other recurrent taxes on property	Other recurrent taxes on capital		D.59 Current taxes on capital

[15] Spain, Iceland, Norway, and Switzerland.

Policy tool	Definition	Primary objective	Regulation
Taxation			**ESA 2010**
3. Renting property	*Residential rental property is typically taxed on a comprehensive basis, in a similar way to interest income. No tax relief is provided upfront, and returns are taxed as they are earned-marked.*		
Rental income	Property income and personal income tax (PIT)	Generate government revenue	D.45 and D.5
4. Selling property	*When people sell residential property for more than the purchase price, they generally realize a capital gain that is subject to taxation as income. The capital gain is defined as the difference between selling and purchase prices, also known as the basis. Capital gains taxes on the sale of residential properties are treated differently depending on the holding period. Long-term capital gains relate to dwellings held for more than a year, and are usually taxed with lower rates and have a tax-free threshold for owner-occupied housing to protect household net wealth. Short-term capital gains are generated when the sale of the dwelling is made within a year, and are usually taxed with higher rates to avoid housing bubbles.*		
Other non-recurrent taxes on property	Capital gains taxes (occasional or exceptional levies on capital or wealth)	Inequality Reduce housing demand and supply	D.91 Capital levies
5. Bequest	*This includes taxes on inheritances and gifts. The yield is usually relatively limited: rates are low, and exemptions and special arrangements create multiple avoidance opportunities. The yield in the countries with the highest returns (about 0.7% of GDP in Belgium and France) suggests its potential as a revenue raising tool. The main policy objective of inheritance taxes is to limit the intergenerational transmission of inequality, but they also produce distortions, which are difficult to assess. Theoretical results on optimal bequest taxation differ widely, but Piketty and Saez (2013) find a positive and relatively high rate.*		
Inheritance and gift taxes	Death duties or taxes on gifts inter-vivos, to be levied on the capital of the beneficiaries	Inequality Generate government revenue	D.91 Taxes on capital transfers

TABLE A2

Summary of panel data variables (selected EU countries, 1995-2017)

Variable		Mean	Std. dev.	Min	Max	Observations
Log implicit recurrent tax rate on immovable property	overall	-1.49	1.21	-3.97	0.78	N=364
	between		1.13	-3.42	0.71	n=19
	within		0.47	-3.75	-0.11	T=19.2
Growth of stock dwellings	overall	1.96	0.99	-1.35	11.89	N=430
	between		0.62	0.27	2.75	n=20
	within		0.80	-2.33	11.48	T=21.5
Growth of price of m^2	overall	5.19	9.30	-37.39	54.96	N=407
	between		2.14	0.92	9.16	n=20
	within		9.07	-41.35	51.00	T=20.4
Log HH debt ratio	overall	4.42	0.82	1.06	5.83	N=454
	between		0.69	2.90	5.59	n=20
	within		0.46	2.50	5.54	T=22.7
Log Gini index	overall	3.42	0.12	3.14	3.66	N=315
	between		0.12	3.21	3.60	n=20
	within		0.04	3.27	3.57	T=15.8
Transfer tax rate	overall	3.68	3.00	0.00	15.00	N=448
	between		2.82	0.00	10.76	n=20
	within		1.23	0.72	16.11	T=22.4
Interests tax rate	overall	24.91	15.48	0.00	62.70	N=460
	between		12.36	2.61	54.91	n=20
	within		9.71	7.94	68.35	T=23
Long term interest rate	overall	4.16	2.16	0.09	14.00	N=424
	between		0.58	3.37	5.46	n=20
	within		2.09	-0.28	13.41	T=21.2

Note: "N" denotes number of observations, "n" number of countries and "T" average period observed per country.

TABLE A3

Estimated tax efficiency by country (selected EU countries, 1995-2017)

Country	Average Log-IRTRIP	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Austria	-3.4233	0.0237	0.0301	0.0402	0.0550	0.0604	0.0592
Belgium	-1.7104	0.0891	0.1144	0.1717	0.2349	0.4260	0.4188
Czech R.	-2.4327	0.0856	0.1272	0.0826	0.1381	0.1579	0.1443
Denmark	-0.3223	0.3748	0.2757	0.2940	0.2245	0.1795	0.2021
Finland	-1.5155	0.1036	0.1254	0.1463	0.1820	0.2047	0.2007
France	0.2522	0.5455	0.6615	0.5756	0.7111	0.8747	0.8814
Germany	-2.0309	0.0583	0.0695	0.0699	0.0923	0.0972	0.0983
Ireland	-2.2790	0.7220	0.8587	0.7228	0.8625	0.8586	0.8674
Italy	-1.0560	0.2788	0.3735	0.4415	0.5668	0.6894	0.6948
Latvia	-2.5971	0.3355	0.3913	0.8366	0.8588	0.8642	0.8650
Lithuania	-3.3523	0.1092	0.1470	0.1130	0.1722	0.1670	0.1651
Luxembourg	-2.6653	0.0541	0.0557	0.1003	0.1074	0.1466	0.1479
Netherlands	-0.9303	0.1735	0.1319	0.2258	0.1857	0.2338	0.2576
Portugal	-1.4678	0.0999	0.1085	0.2491	0.2589	0.2514	0.2909
Slovakia	-1.9490	0.1375	0.2019	0.1566	0.2600	0.2405	0.2327
Slovenia	-2.0983	0.1254	0.1848	0.1183	0.1972	0.2022	0.1889
Spain	-1.4739	0.1103	0.1231	0.1700	0.1939	0.2460	0.2482
Sweden	-0.3691	0.2843	0.2787	0.2614	0.2663	0.2530	0.2655
UK	0.7084	0.8440	0.8444	0.8711	0.8775	0.7489	0.8125
Average	-1.4934	0.2738	0.3013	0.3288	0.3689	0.3919	0.3989

Note: The scores are scaled between 0 and 1.

Institute of
Public Finance