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TABLE OF CONTENTS

Articles

- 3 IVA TOMIĆ
Employment protection reforms and labour market outcomes
in the aftermath of the recession: Evidence from Croatia
- 41 IVAN TOMAŠ
Stochastics forecast of Croatian pension system
- 99 ŠIME SMOLIĆ, IVAN ČIPIN and PETRA MEĐIMUREC
How does health associate with employment during later working life in Croatia?
- 117 MARINA TKALEC
History matters: development and institutional persistence of the Habsburg Military
Frontier in Croatia
- Book review**
- 147 JONATHAN HASKEL and STIAN WESTLAKE
Capitalism without capital: the rise of the intangible economy (*Dubravko Mihaljek*)



Employment protection reforms and labour market outcomes in the aftermath of the recession: Evidence from Croatia

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Article**

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Abstract

This paper examines the effects of employment protection legislation (EPL) reforms on employment outcomes in Croatia, testing the available theoretical predictions of partial labour market reforms from the literature. With a push from the EU accession, the reforms liberalised employment protection provisions for both temporary (2013) and permanent (2014) contracts at the end of the six-year long recession thus presenting a distinctive case for policy evaluation. Using Labour Force Survey (LFS) data in the period 2007-2017 and applying the event study method in combination with probit regressions, the main results suggest that EPL reforms from 2013 and 2014 induced a rise in temporary employment, while the effects on overall employment are clearly visible only in the case of the second reform. Moreover, probit regression estimations show that specific groups of the population – females, youths, foreigners, the low-skilled and singles from rural areas – have a higher probability of ending up with temporary contracts, suggesting there is a segmentation on the Croatian labour market.

Keywords: employment protection, reform, recession, temporary employment, policy evaluation, Croatia

1 INTRODUCTION

Easing of employment protection has long been advocated as a way to combat high unemployment, especially at the European level. However, empirical evidence on the effects of labour market flexibilisation on increasing overall employment is not very convincing. One of the reasons for this might be that flexibilisation or liberalisation of labour market legislation has occurred only at the margin, that is, most of the employment protection reforms eased restrictions on the use of temporary contracts while restrictions regarding permanent contracts remained unchanged. This led to distortions on the labour market by encouraging employers to substitute temporary for permanent workers thus creating the so-called dual labour market.

Although temporary contracts are often seen as a natural way of entering the labour market – or as a stepping-stone to permanent employment – and a way to stimulate job creation and reduce unemployment, both theoretical and empirical literature have shown that this is not necessarily the case, but instead that temporary are often substituted for permanent contracts thus increasing worker turnover and possibly even causing a rise in non-employment (Blanchard and Landier 2002; Kahn, 2010; Sala, Silva and Toledo, 2012; Tejada, 2017). In addition, a higher incidence of temporary employment also seems to reduce labour productivity and aggregate welfare (Blanchard and Landier 2002; Cahuc and Postel-Vinay, 2002; Cahuc, Charlot and Malherbet, 2016; Hijzen, Mondauto and Scarpetta, 2017). On the other hand, the literature has clearly shown that some specific groups of workers – including women, young, less educated, and less-skilled workers – are more often employed on temporary contracts (Kahn, 2007). It has also been shown that temporary jobs are lower paid and offer less on-the-job training, while those working

on these jobs are in principle less satisfied (Blanchard and Landier 2002; Booth, Francesconi and Frank, 2002a; Barbieri and Cutuli, 2018).

There is ample evidence of distorting effects of partial or two-tier labour market reforms for more advanced countries; however, empirical analysis for Eastern European and other emerging market countries is still rather scarce. This is especially true in the case of the newest EU member state – Croatia. Even though there are some works that categorize the Croatian labour market as dual (e.g., Franičević, 2011; Brkić, 2015), and even some that try to assess the impact of employment protection legislation (EPL) on labour market outcomes empirically (Tomić and Domadenik, 2012; Matković, 2013), no sound analysis of the direct impact of recent labour market legislation reforms on the Croatian labour market is available. Accordingly, this paper aims to discover possible effects that employment protection legislation reforms have had on labour market outcomes in Croatia. By applying probability regression models and the event study approach to micro data from the Croatian Labour Force Survey (LFS) in the period 2007-2017 it seeks to show whether the EPL reforms from 2013 and 2014 increased the incidence of temporary employment that occurred after that. Given that the reforms might have actually been completely exogenously determined by the need to harmonise Croatian labour market regulations with those of the EU, they do present a distinctive case for policy evaluation. As both reforms were aimed at flexibilisation of the employment protection, their effects on the overall employment are also investigated.

Croatia presents an interesting case to study for several reasons. First, EPL in Croatia has been considered as overly rigid for most of the post-transition period, often being blamed for the rather sluggish labour market. Second, the recession in Croatia lasted for six full years and revealed many weaknesses of the labour market, including downward wage rigidity as the labour market crisis adjustment was mainly effectuated through cuts in employment. Third, EU accession happened in the midst of the recession, and actually led to changes in, among other things, labour legislation. In June 2013 temporary contracts and provisions regulating collective dismissals were liberalized, while in July 2014 a new law liberalized the provisions on permanent contracts. Finally, other features of the Croatian economy, such as its seasonal character or the high importance of the public sector, make an investigation of the impact of employment protection legislation changes on labour market outcomes additionally worthwhile.

There are several contributions of this paper. Firstly, available theoretical predictions of the impact of two-tier labour market reforms on labour market outcomes are empirically tested on a new country case that has some specific features not available in previous studies. Secondly, to the best of my knowledge, this is the first time the event study method is being applied to analyse the impact of EPL reform on labour market outcomes. Event study models are more frequently used in financial econometrics and only recently does applied microeconometrics literature seem to be taking this approach in analysing policy reform effects on labour market

and welfare outcomes (e.g., Simon, 2016; Fuest, Peichl and Siegloch, 2018; Perez-Truglia, 2019) - not, however, in the studies on EPL reforms. Further, as evidence-based policy is notable for its absence in Croatia and given that with the EU accession numerous legal provisions needed to be changed, this paper provides a valuable contribution to the national policy evaluation literature. Finally, since EU accession not only coincided with the reforms, but served as a ‘push factor’ to enact the labour legislation liberalisation, lessons learned in the case of Croatia might be valuable for candidate and future accession countries as well.

The rest of the paper is organised as follows. The next section briefly reviews relevant studies in the literature covering the main issues related to the effects of labour legislation – and especially partial employment protection legislation reforms – on labour market outcomes at the European level. This section also touches upon some of the works related to segmentation on the Croatian labour market, while the section after that describes the labour market and institutional context in Croatia more thoroughly, concentrating particularly on the period between 2007 and 2017. Section four provides a description of the data used and the main empirical strategy, discussing possible shortcomings and ways to deal with them while drawing on the findings from the literature. The fifth section presents the main results, including the event study analysis but also probability regression (probit) estimations with sensitivity analyses that assess several different model specifications in order to further discuss the results obtained and to test the robustness of the presented estimations. Finally, the concluding section provides a brief summary of the main findings and goes on to discuss some of the limitations of the paper, with suggestions for future work.

2 RELATED LITERATURE

The impact of employment protection on labour market outcomes has attracted a lot of attention in the economic literature. Earlier studies actually put rigid employment protection at the forefront of the reasons for high unemployment in Europe, especially in comparison with the US (e.g., Nickell, 1997 or Siebert, 1997). However, the negative effects of rigid EPL on (un)employment have never been entirely confirmed in the literature (Piton and Rycx, 2018; Bentolila, Dolado and Jimeno, 2019) since strict employment protection not only reduces the job destruction rate, but it also – because of expected future firing costs – decreases the job creation rate, thus possibly not changing or even increasing unemployment levels. Nevertheless, many European countries have tried to boost their labour markets by liberalising their labour legislation.

However, most countries approached the problem of high unemployment and rigid labour legislation by relaxing only those provisions related to temporary employment while restrictions regarding permanent contracts remained mostly unchanged (Bentolila, Dolado and Jimeno, 2019), i.e., European countries have conducted reform ‘at the margin’ or they have introduced what is called ‘selective flexibilisation’ (Blossfeld et al., 2012; Barbieri and Cutuli, 2015). This has produced divi-

sions between labour market insiders and outsiders (Eichhorst and Marx, 2019), but it has also introduced additional distortions on the European labour markets, including higher job turnover, loss of productivity and, as expected, higher incidence of temporary employment, while the effect on reducing unemployment has not been confirmed. Therefore, some more recent studies (e.g., Boeri, 2011 or Centeno and Novo, 2012), emphasize that it is not the EPL as such that is the main issue for European labour markets anymore; it is the two-tier or dual labour market that has arisen as a consequence of the partial employment protection reforms¹.

A number of works in the literature in the past two decades developed theoretical models that help in explaining labour market outcomes of the partial EPL reforms. These include, among others, articles by Blanchard and Landier (2002), Cahuc and Postel-Vinay (2002), Boeri and Garibaldi (2007), Sala, Silva and Toledo (2012), Cahuc, Charlot and Malherbet (2016) and Tejada (2017), while Bentolila, Dolado and Jimeno (2019) recently provided a nice overview of both theoretical and empirical findings. Blanchard and Landier (2002), for example – in the case of temporary contracts liberalisation without any change in the costs for regular jobs – predict two main effects: firms will be more likely to hire new workers on temporary contracts to learn about their productivity but they will also be less likely to keep them in regular jobs. They test the model on the French data for young workers and show that the reforms have increased turnover, without a significant reduction in unemployment duration, while the effect on welfare appears to have been negative (Blanchard and Landier, 2002). The Cahuc and Postel-Vinay (2002) matching model suggests that the higher the firing costs, the lower the share of temporary jobs transformed into permanent jobs, thus increasing unemployment and reducing aggregate welfare.

Empirical studies of the partial EPL reforms differ in having either a macro or a micro approach, but also in conducting multi-country or single-country analyses. For example, Kahn (2007; 2010) argues that a micro-approach is more appropriate in this context and provides important empirical findings in a multi-country environment. In his 2007 paper, he finds that more stringent EPL (for permanent contracts) for seven advanced economies increases relative non-employment rates for youth, immigrants, and women, whereas it also increases the incidence of temporary employment for the low-skilled, youth, and both native and especially immigrant women (Kahn, 2007). In Kahn (2010), the author finds that policies making it easier to create temporary jobs on average raise the likelihood that workers will be in temporary jobs by encouraging a substitution of temporary for permanent work in a sample of nine European countries. On the other hand, there is some evidence in his work that reducing restrictions (costs) on permanent contracts can have a positive impact on increasing employment or at least decreasing the risk of temporary employment (Kahn, 2010).

¹ See Saint-Paul (1996), Boeri (2011) or Bentolila, Dolado and Jimeno (2019) for synthesis reports on dualism in (European) labour markets.

Though valuable, multi-country studies often cannot discriminate among some country-specific factors or establish a valid control group (Fuest, Peichl and Siegloch, 2018), and thus single-country articles that focus on partial EPL reforms have increasingly emerged in recent years. These include, for example, Centeno and Novo (2012) for Portugal, Messe and Rouland (2014) for France, Vodopivec, Laporsek nad Vodopivec (2016) for Slovenia, and Hijzen, Mondauto and Scarpetta (2017) for Italy. In an analysis of the Portuguese labour legislation reform from 2004, Centeno and Novo (2012) find that the share of fixed-term contracts, along with excess turnover, has increased in firms with 11 to 20 workers as the reform increased the protection of open-ended employment for workers in those firms. Given the different levels of protection for workers of different ages in France, i.e., protection being more stringent for firms laying off workers aged over 50, Messe and Rouland (2014) analyse the effects of age-specific employment protection reform from 1999 – which increased the costs only for large firms – and find a substantial positive effect of the reform on firms’ incentives to provide training. Vodopivec, Laporsek nad Vodopivec (2016) find that the 2013 reform in Slovenia – which increased the protection of fixed-term contracts while it decreased the protection of permanent contracts – reduced segmentation on the Slovenian labour market and also increased the probability of permanent employment. Similar to Messe and Rouland’s (2014) study for France, Hijzen, Mondauto and Scarpetta (2017) explore different levels of employment protection related to firm size on temporary employment in Italy and find that stronger employment protection in larger firms increases worker turnover as well as the incidence of temporary employment, while it tends to reduce labour productivity.

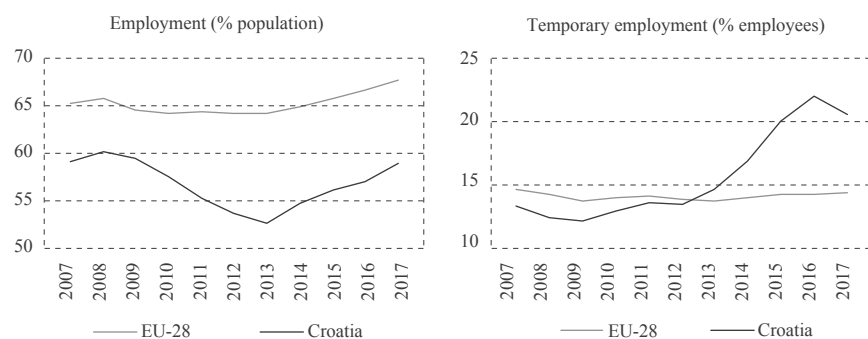
Segmentation or duality of the Croatian labour market has been discussed in the literature for quite some time; however, mostly at a descriptive level (e.g., Račić, Babić and Podrug, 2005; Franičević, 2011; or Brkić, 2015). Nevertheless, there have been two attempts to empirically test the effects of (rigid) labour legislation on labour market outcomes in Croatia. The first is the paper by Tomić and Domadenik (2012) in which the authors show that in the period 1996-2006 there was an adverse selection on the Croatian labour market due to high dismissal costs; however, they also show that educational attainment is of greater relevance for employment and conclude that the impact of firing costs on employment probabilities decreased after the legislative reform in 2003. In the second paper, Matković (2013) examines the “flexicurity” concept in the context of regulatory changes introduced in the early 2000s and suggests that the growth of fixed-term employment slowed and positioned Croatia just below the EU average after the reforms. Additional empirical analysis indicates that the incidence of temporary employment falls mostly on low-skilled and low-paid jobs (Matković, 2013). The present paper tries to fill in the gap in the literature on the impact of EPL on labour market outcomes in Croatia by empirically testing the theoretical propositions of (partial) labour legislation reform set out in the literature.

3 CROATIA: LABOUR MARKET AND INSTITUTIONAL SETTING

After the turbulent 1990s, the Croatian labour market finally stabilized in the first half of the 2000s. However, the global financial and economic crisis revealed all the weaknesses of the Croatian economy. Although it began only in 2009 in Croatia, the recession lasted for six full years with enormous consequences for the labour market (Figure 1). The employment level fell strongly, with some evidence (World Bank, 2010; Franičević, 2011) suggesting that in the early stages this was mainly done through temporary contracts². Vukšić (2014) further emphasizes that labour market adjustment in the crisis happened through cuts in employment in the private sector³, primarily in male-dominated sectors, with decreasing share of youth employment but the rising significance of temporary and part-time employment after 2011.

FIGURE 1

Employment and temporary employment for the population aged 15-64 – Croatia and the EU



Source: Eurostat.

While the economy started to recover at the end of 2014 employment levels are still well below those in 2007/2008⁴. On the other hand, the share of temporary employment among employees has risen to new record levels of over 20% in 2017 in comparison to about 12-14% in the pre-crisis and (early) crisis period, while the incidence of precarious employment (“contracts up to three months”) has been the highest among EU countries ever since 2013 (7.1% of all employees in 2017). Interestingly, although the literature predicts an increase of temporary contracts during a recession (Kahn, 2010), such contracts were much more in evidence with the start of the recovery in Croatia. At the same time, the average share of self-

² Matković (2013) finds that in the pre-crisis period temporary contracts were more frequently used in the peripheral part of the private sector for hiring young workers and low-skilled workers in routine manual and service occupations.

³ As often argued, due to downward wage rigidity labour market adjustments in the crisis happened through employment cuts. The literature suggests that the effects of EPL on temporary employment are actually stronger in countries that exhibit more downward wage rigidity (Kahn, 2007).

⁴ A part of the underlying reason is the decline of the working-age population and a change in generational composition of the workforce due to population ageing. Nevertheless, the employment rate surpassed (by a small margin) the 2008 levels only in 2018 (not covered in the empirical analysis).

employed persons, 19% in the pre-crisis and early crisis period (2007-2011), stood at only 11% in 2017 (Figure 2). This indicates that the patterns of employment have somewhat changed in the aftermath of the recession in Croatia (Figure 1).

At the same time, during most of the post-transition period Croatian labour legislation has been considered to be particularly rigid, and is often denounced as the main culprit for the bad situation on the labour market (Rutkowski, 2003; Tomić and Domadenik, 2012). Although with the amendments to the law introduced in 2003 labour legislation in Croatia was somewhat liberalised, the overall employment protection legislation (EPL) index remained above the EU and OECD average (Matković and Biondić 2003). The new labour act enacted in 2009 did not bring any substantial changes in ‘flexibilisation’ provisions, i.e., the EPL index remained unchanged (Tomić, 2013; Potočnjak, 2014).

However, EU accession in July 2013 brought to two new reforms of labour legislation in a short amount of time. Amendments to the existing Labour Act that introduced liberalisation of employment protection for temporary contracts (EPT) and employment protection against collective dismissals (EPC) were introduced in June 2013⁵, the main purpose being not only to increase labour market flexibility but actually to harmonise the Croatian labour market regulations with those of the EU (Kunovac, 2014; Potočnjak, 2014). Part of legislation regarding regular contracts (EPR) has been left unchanged in this instance⁶. However, as soon as in the following year (July 2014)⁷ the passage of a new Labour Act was enforced by the need to further harmonise the national legislation with that in the EU (Potočnjak, 2014). This act introduced liberalisation of employment protection for regular contracts (EPR)⁸ and further liberalisation of employment protection against collective dismissals (EPC). Employment protection index for temporary contracts (EPT) has been left unchanged on this occasion, despite some changes regarding liberalisation in the area of temporary employment agencies⁹.

Table 1 sums up the recent employment protection legislation changes using the OECD’s indicators for employment protection for regular contracts, collective dismissals and temporary contracts¹⁰. Although some of the new provisions did

⁵ *Act on Amendments to the Labour Act* (OG 73/2013) was passed on 18 June 2013 (in force after 8 days).

⁶ The main changes of the law in 2013 were that it introduced the possibility that the first fixed-term contract lasts longer than three years (concluding more successive employment contracts remains limited to a maximum of three years), while the provisions on collective surpluses of workers have been simplified and the whole process was shortened.

⁷ *Labour Act* (OG 93/2014) was passed on 30 July 2014 (in force after 8 days).

⁸ The main changes in this regard have been the simplification of procedures when firing workers on permanent contracts (the abolition of the provisions regarding the obligatory retraining or displacement to another job before the dismissal), changes in the organisation of work with respect to working hours, plus potential lowering of the firing costs as the compensation for termination of employment contract in court has been reduced from a maximum of 18 to a maximum of 8 average wages.

⁹ The possibility of working via a temporary agency has been increased from one to three years. However, fewer than 1% of workers are employed through temporary agency, without significant changes in recent years.

¹⁰ More details on EPL reforms in Croatia in 2013 and 2014 can be found in Kunovac (2014), CNB (2104), Potočnjak (2014) and Brkić (2015), and additional information on previous reforms can be found in Matković and Biondić (2003), Vukorepa (2010), Tomić and Domadenik (2012) and Tomić (2013).

induce changes in the relevant indices, the general impression has been that the scope of the reforms implemented is rather limited, thus the need for labour market reform has remained (CNB, 2014; Potočnjak, 2014).

TABLE 1

EPL reforms in Croatia

	2008	2013	2014
EP for regular contracts (EPR)	2.55	2.55	2.28
EP against collective dismissals (EPC)	3.75	3.00	2.25
EP for temporary contracts (EPT)	2.21	1.96	1.96
EP for regular open-ended contracts including collective dismissals (EPRC)	2.89	2.68	2.27
<i>Ratio of EPT and EPR</i>	0.87	0.77	0.86
<i>Ratio of EPT and EPRC</i>	0.76	0.73	0.86

Notes: Values represent EPL indices based on OECD methodology.

Source: Kunovac (2014) and CNB (2014).

Therefore, labour legislation liberalisation, though advocated by the business community and many experts in the field for quite some time, happened in parallel with (a ‘push’ from) the EU accession, but also at the end of the six-year long recession and some other policy reforms that might have influenced the employment patterns; for example, vocational training without commencing employment for youth population¹¹ or seasonal employment in agriculture via vouchers¹². In addition, as of 2015 there is the possibility for an employer who hires a young person up to the age of 30 on a permanent (open-ended) contract to be exempted from paying employer’s contributions for up to five years¹³. In the following sections I will try to determine if and how employment protection legislation changes actually affected labour market outcomes in Croatia.

4 METHODOLOGY AND DATA

4.1 METHODS

Since the main research question of this paper examines the effect of employment protection reform(s) on the incidence of temporary employment and overall level of employment, the natural approach would be to use some of the standard policy evaluation methods, such as differences-in-differences or some of the matching methods. However, as the policy reforms are all-encompassing in this case, i.e., changes in labour legislation provisions have a potential effect not only for the employed population but for the entire population that might get employment; the

¹¹ See Tomić and Žilić (2018) for more details about this. For example, they report that the number of participants in the programme increased from below 500 in 2010 to 33,366 in 2016.

¹² Both vocational training without commencing employment (up to a year) and seasonal work in agriculture via vouchers (up to 90 days over the year) have been introduced by the *Law on the Promotion of Employment* (OG 57/2012, 120/2012, 16/2017).

¹³ According to the *Law on Social Security Contributions* (OG 84/2008, 152/2008, 94/2009, 18/2011, 22/2012, 144/2012, 148/2013, 41/2014, 143/2014, 115/2016, 106/2018). The Croatian Pension Insurance Institute reports that the number of people using this possibility for employment increased from slightly more than 10,000 in March 2015 to more than 83,000 at the end of 2017 (more than 108,000 at the end of 2018).

identification of the credible treatment group is somewhat difficult. Similarly, if one would like to apply some other impact evaluation method such as regression discontinuity design (RDD) it would need to have the treatment or running variable, which in this case is time; yet again, this is not unique for a person but instead applies to all potential participants on the labour market. Still, the effects of the employment protection reform(s) on the incidence of temporary employment might be viewed as an intention-to-treat (ITT) case, as the reform represents a treatment offer even if it doesn't lead to temporary contracts in all cases.

In order to avoid the aforementioned issues, this paper relies on a somewhat different approach in analysing the effects of labour legislation reforms on employment outcomes in Croatia. That is, I adapt models used in the works by Kahn (2007; 2010), which apply different probability models in the investigation of the effects of EPL reforms on employment in a multi-country environment. In essence, the following models are being estimated:

$$TEMP_{it} = \alpha + \beta * EPL_reform + \delta'X_{it} + \omega_t + \varepsilon_{it} \quad (1.1)$$

$$EMP_{it} = \alpha + \beta * EPL_reform + \delta'X_{it} + \omega_t + \varepsilon_{it} \quad (1.2)$$

where $TEMP_{it}$ is a dummy variable indicating that a person i is employed on a temporary contract in month t and EMP_{it} is a dummy variable if a person i is employed (an employee) in month t . EPL_reform indicates a reform variable, which is added to the basic set of covariates (X_{it}) to take into account the EPL reforms from 2013 and 2014, while ω_{it} represents time effect.

Essentially, the determinants of being employed (an employee) and temporarily employed (eq. 1 and 2) are estimated in a set of probit (a maximum likelihood estimator) regressions, i.e.,

$$\begin{aligned} P_r(Y_{it} = 1) &= P_r(\alpha + \beta * EPL_reform + \delta'X_{it} + \omega_t + \varepsilon_{it} \geq 0) \\ &= \Phi(\alpha + \beta * EPL_reform + \delta'X_{it} + \omega_t) \end{aligned} \quad (2)$$

where Y_i is an outcome equal to 1 if a person is a temporary employee, X_i presents a set of individual, household, area and job characteristics¹⁴, Φ is a standard normal cumulative distribution function which translates discrete values of Y_i^* (individual's underlying probability for employment/temporary employment status, which is an unobserved (latent) variable) to a probability (P_r) for observing the event $Y_i=1$ given covariates, and β is the main parameter of interest¹⁵.

¹⁴ See the next subsection and Table A1 in the Appendix for more details.

¹⁵ I also test for non-random selection of individuals into (temporary) employment by applying the so-called Heckman correction for selection, i.e., I estimate the model in two stages where in the first stage the probability of a person being employed (or economically active) is estimated, which is then used as an adjustment parameter in the second-stage equation.

Besides the set of individual, household and area characteristics I add reform variables in the model for both temporary and permanent contracts. One way to account for labour legislation reforms is to include the value of the OECD's employment protection legislation indices (Table 1) in different time-periods (as in Kahn, 2007), while the other possibility is to simply include dummy variables for the period when reforms were in place (as in Kahn, 2010). Given that the literature suggests that what affects the incidence of temporary employment is the rigidity of the protection of permanent employment relative to that of temporary and not the temporary (or permanent) protection legislation itself (Blanchard and Landier, 2002; Kahn, 2010; Bentolila, Dolado and Jimeno, 2019), I estimate the models having both temporary and permanent reform variables in the same specification. However, models including only one of the reform (dummy) variables are also estimated, having in mind that the second reform (EPR from July 2014) happened on top of the first one (EPT from June 2013). I additionally account for the possible endogeneity of the EPL reforms by adding time trend, regional dummies and quarterly GDP growth rates in the model. This should also control for the state of the economy¹⁶.

In order to establish a flat pre-reform trend, i.e., constant probability of temporary employment before the reform(s), I apply the event study in this paper. Although this method is more commonly used in financial econometrics, i.e., in estimating the impact of an event on the value of a firm, it has also been used recently in applied microeconometrics analysing different aspects of (policy) reform on labour market and welfare outcomes (e.g., Simon, 2016; Fuest, Peichl and Siegloch, 2018; Perez-Truglia, 2019), but not, to the best of my knowledge, in any estimation of the effects of labour legislation reform on labour market outcomes. In principle, event time dummies replace the treatment variable in the regression model. This would mean that I estimate the equation (1.1) or (1.2) where instead of the reform variable (*EPL_reform*) I have a set of dummy variables indicating number of periods away (before and after) from a labour legislation reform (an event), or:

$$TEMP_{it} = \alpha + \beta \sum_{j=-J}^J D_j + \delta'X_{it} + \omega_t + \varepsilon_{it} \quad (3.1)$$

$$EMP_{it} = \alpha + \beta \sum_{j=-J}^J D_j + \delta'X_{it} + \omega_t + \varepsilon_{it} \quad (3.2)$$

where $\sum_{j=-J}^J D_j$ is a vector of dichotomous indicators each of which is equal to one when an observation is j periods away from some discrete policy event (Simon, 2016), that is, from EPL policy reform (June 2013 or July 2014) in this case. If the incidence of temporary employment changed sharply around the time of the event (EPL reform) β parameters for the periods prior to the event should be equal (around) zero while β parameters for the periods after the event should be

¹⁶ Linear trends should also help account for differences in pre-trends in the incidence of temporary employment, i.e., they would help absorb a spuriously significant coefficient (Simon, 2016).

larger than zero. Accordingly, one would expect that the same parameters are equal to (around) zero for all j -periods (before and after) away from the reform in the case of some other outcome variable not affected by the EPL reform. I use the time (month and year) of the contract for each person in the sample in order to link the event to a specific person outcome and trace it back to 24 months (8 quarters) before the reform and 24 months (8 quarters) after the reform¹⁷.

4.2 DATA

Key information in this paper is taken from the Croatian Labour Force Survey (LFS) microdata in the period 2007-2017. Although set up as a “rotating panel” survey, the available data comprise essentially a repeated cross-section as no tracing of individuals over time is possible; however, the same questions are posed to a different sample of individuals each time, which means the samples can be compared over time. Besides detailed data on individuals’ labour market status, the LFS provides a rich set of information about different socio-demographic characteristics of both individuals and their respective households, as well as data on job and firm characteristics for those having a job. While the dataset is acquired on a yearly level it also provides the exact time (year, month, week) the survey is conducted and the exact timing (year, month) of the starting of the current job, thus enabling us to determine the incidence of (temporary) employment pre- and post-EPL reforms. Henceforth, information on a monthly basis extracted from a yearly dataset is used in my estimations, applying the appropriate population weights.

The dependent variable(s) follow standard ILO and Eurostat definitions of labour market status (Figure 1). This means that the focus is on employees as “individuals who work for a public or private employer and who in return receive compensation in the form of wages, salaries, fees, gratuities, payment by results or payment in kind”, and further to a subgroup of employees “whose main job will terminate either after a period fixed in advance, or after a period not known in advance, but nevertheless defined by objective criteria, such as the completion of an assignment or the period of absence of an employee temporarily replaced”. I exclude self-employed persons and family workers in the main part of the analysis, as is standard in the literature, given that their status is most likely driven by completely different factors than those of typical employees.

The above definition of temporary employment might seem too broad as it includes, apart from fixed-term contracts, different forms of seasonal and occasional work. The literature does not have a unanimous ruling on this. For example, Tejada (2017) analyses the wider definition of temporary employment in his work on Chilean data, which, besides fixed-term contracts, also includes other types of contingent jobs such as per task, per-service, and temporal (seasonal) jobs. He explains that this is important in the Chilean and other Latin American countries

¹⁷ One could argue that the date of the contract is endogenous as a person is employed based on his/her observable and unobservable characteristics; however, I control for other characteristics in the model as well.

context due to the high importance of seasonal jobs. Kahn in both his 2007 and his 2010 paper discusses different definitions of temporary employment in the data he uses, i.e., International Adult Literacy Survey (IALS) (Kahn, 2007) and European Community Household Panel (ECHP) (Kahn, 2010), and the one provided by the OECD. In general, the OECD definition is closer to the one stated above¹⁸, whereas Kahn (2007; 2010) conducted his analyses focusing on a narrower definition that covers only fixed-term contracts. However, he shows that results are qualitatively similar when using a broader definition of temporary employment (Kahn, 2010). Consequently, following the definition by the ILO and Eurostat, but also taking into account the (seasonal) character of the Croatian labour market¹⁹ and the impact of globalisation and technology (digitalisation, platform economy), the analysis is focused on a broader definition of temporary employment.

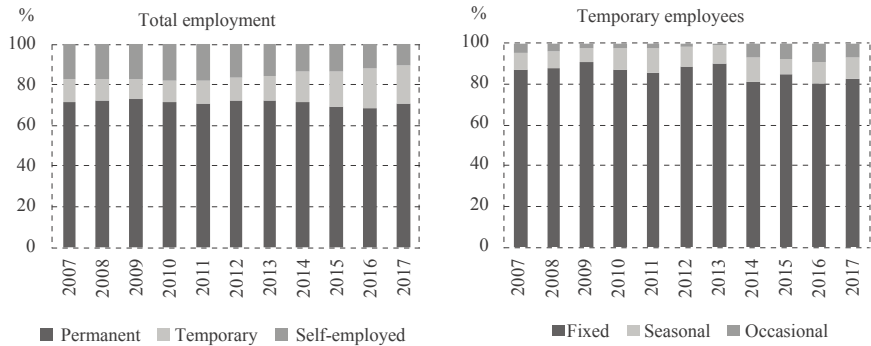
An additional caveat regarding temporary employment based on (Croatian) LFS data is worth noting here. Namely, there has been a slight change in the definition of temporary employment in 2014 in a way that a portion of workers – working on service, author's or student contract – was reclassified from self-employment to temporary (occasional) employment (Figure 2). Nonetheless, between 2013 and 2014 the share of workers in occasional jobs increased by 0.9 percentage points (from 0.5% to 1.4%) among the total number of employees, following a decrease of the trend during the crisis (with an average share of 1.1% in the period 2007-2017). It is evident, however, that this cannot be the sole reason for an increase of temporary employment by 2.4 percentage points in the same period (Figure 1) as occasional contracts constitute less than 4.5% on average of all temporary contracts in the period 2007-2017 (yet 7.5% after 2014). In addition, other data sources (CES and CBS) also point to a rise of temporary employment after 2013. All the same, I will also test the findings obtained on a narrower definition, i.e., fixed-term contracts only, but also on a broader definition of employment, i.e., overall employment that includes the self-employed.

¹⁸ Apart from fixed-term contracts, the OECD definition of temporary employment covers temporary agency workers, daily workers, trainees, people in job creation schemes, workers on contracts for a specific task, those on replacement contracts, and on-call workers (OECD, 2002).

¹⁹ It has been mentioned earlier that the Government introduced the law in 2012 with the possibility of seasonal work in agriculture via vouchers up to 90 days throughout the year. However, the share of seasonal workers among temporary employees actually decreased in 2012 and 2013 before it rose again in 2014-2017 (excluding 2015, Figure 2), but mainly due to seasonal work in the tourism sector. Other factors, such as different forms of youth employment via Government incentives, might have influenced the incidence of temporary employment; however, the two incentives (vocational training without commencing employment (temporary employment by definition) and employment of youths on permanent contract without the payment of employers' contributions) actually work in the opposite directions regarding temporary employment.

FIGURE 2

Composition of employment on the Croatian labour market (population aged 15-64)



Source: Croatian LFS.

In estimating the effects of labour legislation reforms on employment outcomes, I rely on the rich set of LFS microdata using the core individual characteristics such as age (10 5-year age dummies), gender and nationality (if born outside of Croatia), but also marriage status and the level of education as covariates (X_{it}). Although Kahn (2010) says that changes in education levels are endogenous with respect to employment status and thus does not include the level of education in estimating employment probabilities, I believe that education is an important determinant of both employment and temporary vs. permanent employment status and thus test the model with education variables as well. Additional control variables that are included in the estimations are regional residence and the level of urbanisation.

Although firm-level variables, such as industry or occupational structure, might be endogenous, i.e., can be affected by employment protection legislation (Kahn, 2007; 2010), I also estimate the models including firm characteristics such as the size of the firm, public vs. private sector and industry and occupational dummies. Namely, as stated elsewhere in the literature, inclusion of industry and occupation variables can help control for other factors affecting the incidence of temporary employment such as the reduction of adjustment costs (Boeri and Garibaldi, 2007). Basic descriptive statistics are presented in Table A1 in the Appendix. Even though it would be valuable to have some other covariates included in vector X (such as past (un)employment histories or individual fixed effects to control for individual ability), the list of controls is in line of the variables usually found in the literature.

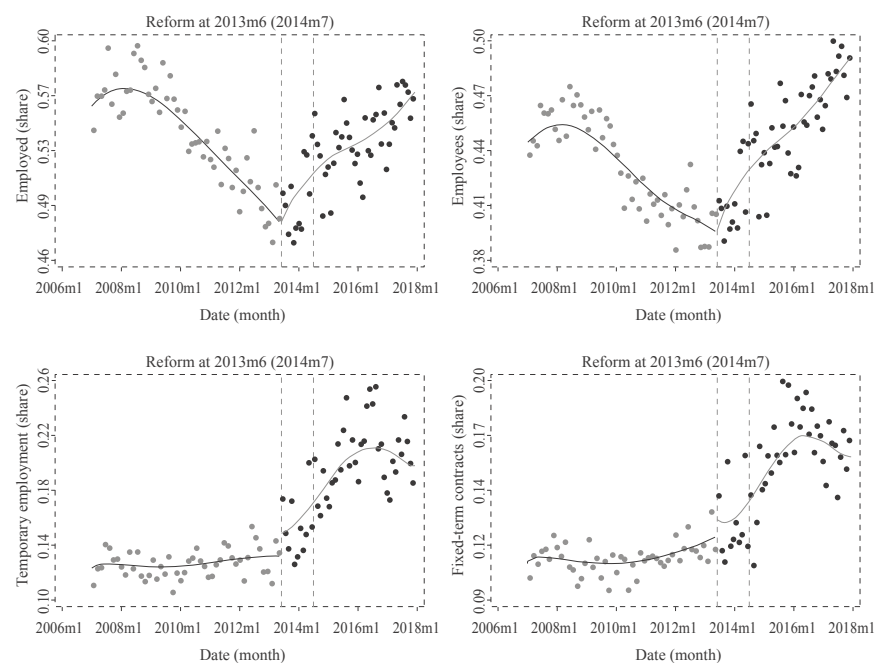
5 RESULTS

Figure 3 shows the incidence of employment – as a share of total employment and employees in the total working-age (15-64) population – and temporary employment – as a share of total temporary employees and only those on fixed-term contract in the total number of employees aged 15-64 – on a monthly level in the period 2007-2017, with indications of the months in which EPL reforms occurred. In essence, this figure represents a more detailed view of the indicators already

presented in Figure 1. Although only descriptive, Figure 3 suggests there is a cut-off in the incidence of temporary employment at the time of labour legislation reform, more so in the case of June 2013 (liberalisation of temporary employment) than in the case of July 2014 (liberalisation of regular contracts). Disruption in the case of overall employment is not so obvious; there is a rise in employment after 2013 but no evident discontinuity. Furthermore, it seems that prior to EPL reforms the trend in the incidence of temporary employment was flat (although starting to increase before the first reform when focusing on fixed-term contracts only), while the trend in the employment rate was downward sloping (as expected in a recession). Although it is hard to make any strong conclusions without further analysis, this descriptive inspection would imply that liberalisation of the (temporary) employment protection in Croatia did not produce evident jump in overall employment; however, it did induce a rise in the number of temporary employment contracts suggesting that the new legislation possibly enabled the replacement of regular employment contracts by those of a temporary nature.

FIGURE 3

Monthly shares of employment and temporary employment for the population aged 15-64



Notes: Monthly data are extracted from yearly datasets. No weights are included. Circles represent share of employed/employees in the total working-age (15-64) population and/or share of temporary employees/fixed-term contracts among all employees aged 15-64, while lines represent local linear smoothing plot.

Source: Author's calculation based on Croatian LFS.

5.1 EVENT STUDY

In order to further examine descriptive findings, I start with the graphical representation of the event study (eq. 3.1 and 3.2) in an attempt to test the assumption of there being no differential trends pre-reform, but also to show that there is a discrete impact of the EPL reform on the incidence of temporary employment on the Croatian labour market (Figure 4). As already mentioned, the date of the employment contract is used as time variable (to construct event dummies) and a window of eight quarters prior to the reform and eight quarters after the reform, evaluating separately reforms of employment protection for temporary contracts (June 2013 or q2 2013) and for regular contracts (July 2014 or q3 2014). Following Simon (2016), I apply a linear probability model, testing different sets of covariates in the model along with event dummies on both temporary employment and employee status.

As evidenced in the upper left part of Figure 4, almost all pre-treatment coefficients are close to zero and statistically insignificant while post-treatment coefficients are all larger than zero and statistically significant. This would suggest that the employment protection reform that liberalised temporary contracts (q2 2013) had a significant impact on the probability of temporary employment in Croatia. The liberalisation of employment protection of regular contracts (reform from the q3 2014), shown in the upper right panel, displays somewhat different results. There is a visible positive (and significant) post-reform trend; however, although close to zero, pre-reform coefficients are also statistically significant. As a result, one cannot say that this event (labour legislation reform in July 2014) had a significant discrete effect on the probability of temporary employment, at least not given the event study model results²⁰. However, this is not unexpected given the results for the 2013 reform as the positive post-reform effect of that event should be visible in the pre-reform period of the 2014 event (4 overlapping quarters), i.e. the reform in 2014 should be viewed as a cumulative effect on top of the previous (2013) reform.

In the lower part of Figure 4 the event study results for employment are shown: both in the 2013 and in the 2014 reform case the coefficients are close to zero and mostly non-significant indicating that labour legislation reforms did not affect the overall employment probability for new contracts. This is somewhat surprising as the actual goal of the reform was to increase overall employment; however, this result goes hand-in-hand with what was already established descriptively (Figure 3).

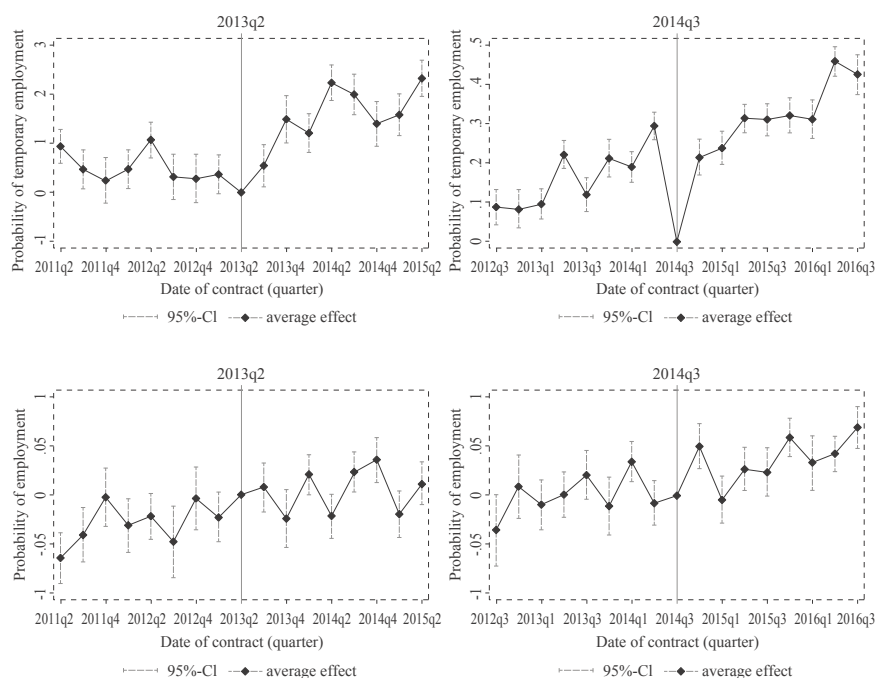
Although the presented exercise is here to establish no differential trends in the pre-reform period and potential discrete effect of the reform(s), it is worth mentioning its several potential shortcomings. First, when analysing the probability of

²⁰ I show the results on a quarterly instead on a monthly level given that “using more aggregated event dummies reduces noise and makes the pattern of the coefficients smoother” (Simon, 2016: 139). The same results estimated on a monthly level are available in the Appendix (Figure A1) where it is obvious that since the estimation contains “thrice as many coefficients with the same number of observations, each individual coefficient is less precisely estimated” (Perez-Truglia, 2019: i).

employment, i.e., the probability of becoming an employee, the alternative in this case are only those employed (self-employed and family workers) given that only they have the information on the ‘start of the contract’. So, the variation in this case is limited. Another potential shortcoming is the potential bias of omitting the jobs that have expired in the meantime as this approach identifies only those contracts that last long enough to be recorded in some subsequent LFS survey. The more time has passed, the greater the bias. However, when estimating the same (event study) models with limitation on the tenure, very similar results are obtained: the size of the coefficients is somewhat smaller, but the trends and statistical significance are the same²¹. In the next section I present more detailed results on the determinants of both temporary and overall employment, including EPL reforms.

FIGURE 4

Event study results – temporary employment (upper part) and employment (lower part)



Note: Results are from linear probability model with robust standard errors. Employment share includes only employees (15-64) and not self-employed persons and family workers. Quarterly data are extracted from yearly datasets. Regressions control for a basic set of individual characteristics, i.e., age dummies, gender, marriage status and nativity plus time trend and quarterly GDP growth rate. Other model specifications – such as those additionally including education, region and level of urbanisation – are also tested and the results are more or less the same (available upon request).

Source: Author's calculation based on Croatian LFS.

²¹ Available upon request.

5.2 DETERMINANTS OF TEMPORARY EMPLOYMENT AND EMPLOYMENT

The results of the probit regressions (eq. 2) for both temporary employment and overall employment (Table 2) are presented next²². Namely – as already mentioned – graphical representation of the event study primarily helps in establishing flat pre-trends, while probit regressions should work for showing the average effect of the EPL reforms on labour market outcomes. Given the non-linearity of estimating models in this paper, the results in the form of marginal effects are reported, i.e., the average change in the probability of temporary employment or employment as the covariate changes (increases) by one unit. I present the results of estimations having both reform variables in one model, as well as having them separately, bearing in mind that “individual” reform variables represent the cumulative effect of both reforms²³.

The main results suggest that the reform of employment protection for temporary contracts (from June 2013) – included in the model together with the EPR liberalisation dummy variable (August 2014 - December 2017) – had a positive effect on the incidence of temporary employment while the effect on the overall employment is negative (although insignificant). This result is in congruence with the interpretations from the event study (Figure 4) in the case of the effect of June 2013 reform on total employment (no effect). It is worth mentioning that the effect of EPT reform only (dummy for July 2013 – July 2014) is actually positive and significant in all the model specifications regarding the probability of temporary employment, whereas it remains negative or statistically insignificant in all model specifications for total employment (total number of employees)²⁴. Given the relatively short time span (July 2013 – July 2014) and the general economic conditions (recession) it is no surprise that the effect on the probability of overall employment remains negative in this period (after controlling for other variables). However, positive effect of the reform on the incidence of temporary employment suggest the occurrence of two-tier or dual labour market.

Turning to the effect of the EPR reform (dummy for August 2014 – December 2017), it has a positive effect on the probability of both temporary and overall employment, either in the model specification by itself or in combination with the EPT reform (Table 2). As already mentioned, this effect cannot be viewed only as an EPR reform since it came after the EPT liberalisation had already happened only a year before. In effect, this variable shows the influence of both reforms on the probability of employment (temporary employment), with the effect being stronger in the case of overall employment. Interestingly, the EPR reform variable

²² Table 2 presents the preferred model specification, while other model specifications are available in Appendix and/or upon request.

²³ For example, the second reform dummy variable (August 2014-December 2017) also includes the ‘cumulative effect’ as the reform came in on top of the first (from June 2013) reform. In addition, the results of the reform variables modelled as dummies are presented here; however, using EPL indices (Table 1) instead of dummy variables gives qualitatively the same results (available upon request). Additionally, I have estimated all the models using linear probability regressions and the obtained results are much the same as those presented here (available upon request).

²⁴ Available in tables in the Appendix and/or upon request.

exhibits a stronger influence (the size of the coefficient is larger) on the probability of temporary employment in the model that includes EPT reform variable as well, further suggesting that this variable is probably picking up the reform that happened a year before and liberalised temporary contracts. In the case of overall employment, the effect of the EPR reform variable is slightly stronger in the model including only this variable (after July 2014).

Finally, combining both reforms into one dummy variable (July 2013 – December 2017), one can see a positive effect of the EPL reforms on both temporary and overall employment, with the effect being somewhat stronger for temporary employment in this case (Table 2). Somewhat surprisingly, the effect of the permanent contract reform variable (August 2014 – December 2017) seems to be stronger than the effect of both temporary and permanent contract reform variables combined (July 2013 – December 2017) in the case of both temporary and overall employment (Table 2). In any case, it is plausible that the liberalisation of permanent contracts seems to have induced the rise in overall employment; however, the indication that liberalisation of temporary employment might have a negative or no effect on overall employment demands further attention.

TABLE 2

Marginal effects after probits – temporary employment among employees and employment (employees) for population aged 15-64

Marginal effects	Temporary employment (within employees)			Total employees (within active)		
	Both reform variables	Cumula- tive effect	Only EPR reform	Both reform variables	Cumula- tive effect	Only EPR reform
EPT liberalisation (2013m7-2014m7)	0.015*** (0.005)			-0.002 (0.006)		
EPR liberalisation (2014m8-2017m12)	0.042*** (0.005)		0.032*** (0.004)	0.068*** (0.006)		0.069*** (0.005)
Both reforms (2013m7-2017m12)		0.025*** (0.005)			0.024*** (0.005)	

*Notes: Besides the reform variables presented, these model specifications include a basic set of individual characteristics, i.e., age dummies, gender, marriage status, nativity and education level, plus urbanisation and region dummies as well as time trend and quarterly GDP growth rate. Employment share includes only employees (15-64) and not self-employed persons and family workers. More detailed information on probit regressions, including other model specifications, is available in the Appendix and upon request. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.*

Source: Author's calculation based on Croatian LFS.

In addition, the obtained results suggest that females, youths, foreigners, the low-skilled and singles from rural areas are more likely to end up on temporary contracts, which is in congruence with other findings in the literature (e.g., Kahn, 2007 or Matković, 2013). Adding regional dummies, linear time trend and GDP growth rate somewhat loosens the effect of the reform variables, while adding

firm-level variables (size, ownership, occupation and industry dummies) further loosens the effect of reform variables on temporary employment; however, the main conclusions remain the same (Table A2 in Appendix).

Although the theoretical predictions from the literature (Bentolila, Dolado and Jimeno, 2019) would imply that the stricter the temporary employment provisions relative to permanent ones the lower the incidence of temporary employment²⁵, the results presented tend to suggest the opposite. However, there are studies (e.g., Booth, Dolado and Franck, 2002b, Kahn, 2007; Cahuc, Charlot and Malherbet, 2016) which suggest that employment protection legislation regarding temporary employment actually does not affect the incidence of temporary jobs on the labour market, but instead that regulation of permanent contracts is the one that matters²⁶. In essence, the findings obtained suggest that it is not only easing of temporary employment that has played a determining role in the strong increase of temporary employment in Croatia: permanent employment protection reform too has affected the rise in temporary work.

It is worth recalling that the reforms of temporary and permanent contracts in Croatia appeared consequently one after another (during one year) which means that perhaps the effect of the changes regarding temporary contracts (from June 2013) needed more time to come into full effect and thus the result of that reform is actually visible in the permanent contract reform (July 2014) as well. In addition, perhaps the overall flexibilisation of the legislation contributed to a more widespread use of temporary contracts. The Blanchard and Landier (2002) model, for example, predicts that with EPT liberalisation firms will be more likely to hire new workers on temporary contracts to learn about their productivity; however, they will also be less likely to keep them in regular jobs. There is also the possibility that due to the long-lasting recession employers have been (and are) still reluctant to employ workers on permanent contracts and thus there is an increase of temporary employment in the aftermath of the recession despite the liberalised permanent employment protection. Finally, I rely on OECD indices of employment protection legislation to indicate whether the reform actually happened; however, there are suggestions that the reform of permanent contracts happened only ‘on paper’ while in reality the provisions regulating regular employment stayed more-or-less the same (CNB, 2014; Potočnjak, 2014).

It was mentioned in the previous section that there is a possibility that individuals are selected in a non-random manner into (activity) employment. Applying

²⁵ The same model predicts that in the case when restrictions for permanent and temporary contracts are similar (the same), the easing of the former will lead to more permanent contracts as well as to more fixed-term contracts. All the same, this theory predicts that liberalisation of the permanent contracts would lead to a reduction of the share of temporary employment on the labour market in the end (Bentolila, Dolado and Jimeno, 2019), which is not what the obtained results here show.

²⁶ For example, Cahuc, Charlot and Malherbet (2016) in their theoretical model show that the protection of permanent jobs does not have an important effect on total employment; however, it does induce the substitution of temporary jobs for permanent jobs.

Heckman correction for selection and using the share of dependent persons (<15 and >64 years of age) in the household as an ‘instrument’ in the selection equation (1st stage) suggests that the selection into (activity) employment is significant, with *rho* coefficient (the correlation between the regression equation and the selection equation) being negative proposing that those people who are less likely to be in employment (labour market) are more likely to have a temporary contract²⁷. However, controlling for selection does not change the main findings from above (Table 2); the coefficients for the reform variables are slightly higher in the case of temporary employment and slightly lower in the case of total employment after controlling for selection but the main conclusions remain.

In order to further test whether individuals were perhaps sorted into different labour market outcomes after reform(s) I estimated models for the pre- and post-reform period (for both 2013 and 2014 reform), naturally excluding reform variables²⁸. Perhaps EU accession did not only induce the change of the labour legislation; it might have also transformed the Croatian labour market in other ways. Free movement of labour is the one thing that became a dominant force for Croatian workers as migration outflows to EU countries increased considerably after July 2013. This could have affected the results in this paper as it possibly changed the composition of the domestic labour market since those who emigrated and those who have stayed probably do not have the same characteristics. However, the obtained results suggest that there are no important differences in the coefficients obtained pre and post reform(s): females, youths, foreigners, the low-skilled and singles from rural areas are more likely to end up on temporary contracts both pre and post reform(s) (similar as in Matković, 2013), with notable exceptions of the significance of urbanisation variable only in the post-reform period.

To sum up, although the event study model implied that employment protection legislation reforms from 2013 and 2014 induced a rise in temporary but not in overall employment (Figure 4) with the effect of the 2013 reform being stronger, probability regressions including reform effects in the form of dummy variables for pre and post-reform suggest that these affected the overall employment figures as well²⁹. Namely, it seems that employment protection legislation reforms aimed at liberalising labour legislation provisions for both temporary and permanent contracts induced not only a rise in temporary employment but consequently also an increase in overall employment on the Croatian labour market (Table 2). Contrary to theoretical predictions, liberalisation of permanent contracts increased the incidence of temporary employment as well. The explanation for this probably lies in the fact that due to the overall liberalisation of labour legislation – but also due to “recession scars” – employers were more willing to offer temporary

²⁷ Detailed results available upon request.

²⁸ Detailed results available upon request.

²⁹ It is important to remember that in the event study models I have used specific dummies referring to *j* periods away from the reform but related to the individuals’ employment contract date, whereas in the probit regressions reform variables are just dummies indicating 1 after the reform occurred and 0 before that (not specifically related to the time of the contract).

contracts, even after permanent contracts had become more flexible as well. As expected, the liberalisation of permanent contracts increased overall employment; however, it seems that liberalisation of temporary employment might have had no or even a negative effect on overall employment. Hence, as permanent contract flexibilisation led to an increase in overall employment, only the partial labour market reform, concentrated on temporary contracts, can be seen as harmful since it increased the share of temporary contracts without increasing the overall employment level.

5.3 ALTERNATIVE SPECIFICATIONS

It has been mentioned previously that both the changes in the LFS methodology as well as additional legislative changes could have affected the occurrence of the increased share of temporary employment on the Croatian labour market as of 2013 (Figures 1, 2 and 3). Hence, in this section I test several alternative model specifications (dependent variable definitions) in order to check whether things other than EPL reforms could have influenced the main findings.

First, legislative changes that could have affected the incidence of youth (temporary) employment are the *Law on the Promotion of Employment* that introduced the use of the ALMP measure inducing temporary (up to a year) employment of youth population as of 2012, and the *Law on Social Security Contributions* that encouraged the hiring of youths on permanent contracts as of 2015. Although these two legislative changes work in the opposite direction regarding the incidence of (youth) temporary employment, in order to take into account possible effects that these changes could have on the main results, following Tomić and Žilić (2018) I have estimated models from Table 2 by restricting the sample to the population older than 30 (Table 3).

As evidenced in Table 3, estimation of the models on the population aged 30-64 does not change the main results available in Table 2. The size of the coefficients is a bit smaller, while the signs and the significance remain the same³⁰. In addition, event study results on the restricted sample (Figure 5) reveal a pattern similar to that of the original estimation (Figure 4), with somewhat greater oscillations between the size of the coefficients, but with a general conclusion remaining the same. This suggests that the main results (Table 2) are not influenced by youth employment in the observed period, or by the legislative changes regarding their employment.

Second, it has been mentioned that the definition of temporary employment used in the previous models might be too broad when discussing the employment protection legislation reform(s). Therefore, I have also conducted an analysis restricted to fixed-term contracts as part of temporary employment. A graphical representation of the event study focusing on the incidence of fixed-term contracts is presented in Figure 6, while main regression results are available in Table 4.

³⁰ Detailed results available upon request.

TABLE 3

Marginal effects after probits – temporary employment among employees and employment (employees) for population aged 30–64

Marginal effects	Temporary employment (within employees)			Total employees (within active)		
	Both reform variables	Cumulative effect	Only EPR reform	Both reform variables	Cumulative effect	Only EPR reform
EPT liberalisation (2013m7-2014m7)	0.015*** (0.005)			-0.004 (0.00598)		
EPR liberalisation (2014m8-2017m12)	0.037*** (0.005)		0.027*** (0.004)	0.044*** (0.006)		0.047*** (0.005)
Both reforms (2013m7-2017m12)		0.023*** (0.004)			0.014** (0.006)	

Notes: Besides the reform variables presented, these model specifications include a basic set of individual characteristics, i.e., age dummies, gender, marriage status, nativity and education level, plus urbanisation and region dummies as well as time trend and quarterly GDP growth rate. Employment share includes only employees (30–64) and not self-employed persons or family workers. More detailed information on probit regressions is available upon request. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Author's calculation based on Croatian LFS.

TABLE 4

Marginal effects after probits – fixed-term contracts, temporary employment among total employment and total employment for population aged 15–64

Marginal effects	Fixed-term contracts (against permanent)			Temporary employment (within employment)			Total employment (within active)		
	Both reform variables	Cumulative effect	Only EPR reform	Both reform variables	Cumulative effect	Only EPR reform	Both reform variables	Cumulative effect	Only EPR reform
EPT liberalisation (2013m7-2014m7)	0.010** (0.005)			0.015*** (0.004)			-0.011*** (0.004)		
EPR liberalisation (2014m8-2017m12)	0.029*** (0.005)		0.023*** (0.004)	0.040*** (0.004)		0.030*** (0.004)	0.044*** (0.004)		0.051*** (0.003)
Both reforms (2013m7-2017m12)		0.017*** (0.004)			0.024*** (0.004)			0.008** (0.004)	

Notes: Besides the reform variables presented, these model specifications include a basic set of individual characteristics, i.e., age dummies, gender, marriage status, nativity and education level, plus urbanisation and region dummies as well as time trend and quarterly GDP growth rate. More detailed information on probit regressions is available upon request. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

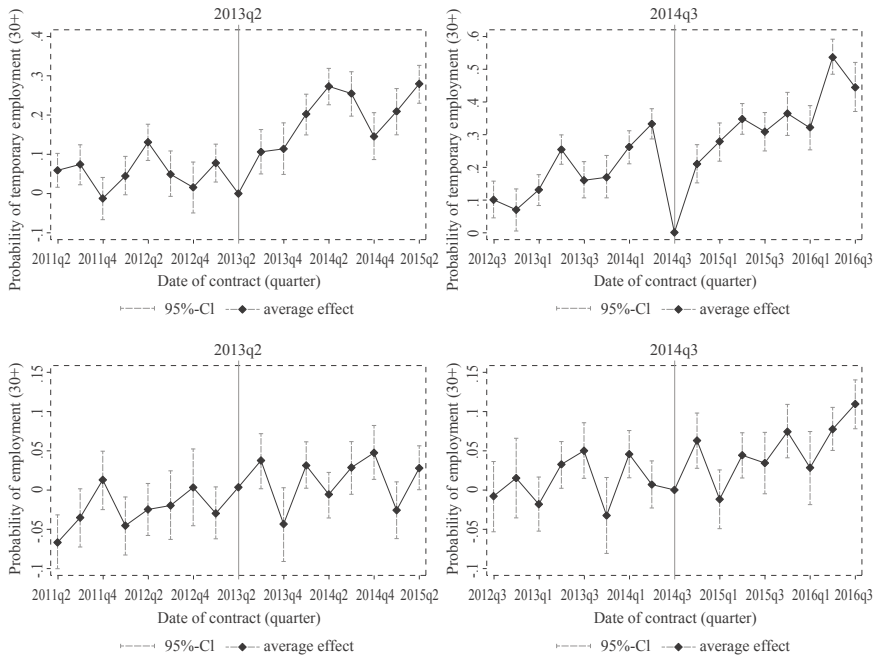
Source: Author's calculation based on Croatian LFS.

Figure 6 resembles the upper part of Figure 4; however, even in the case of the June 2013 reform (temporary contracts liberalisation) some of the pre-reform parameters are statistically significant (although close to zero). The results from Table 4 are very similar to those in Table 2 that encompass total temporary employment (fixed-term contracts, seasonal and occasional work), with the estimated coefficients being slightly smaller in size in the case of fixed-term contracts only. These results suggest that the enacted labour legislation reforms have had an impact on the incidence on temporary employment, but somewhat more pronounced when covering all forms of temporary employment than when just concentrating on fixed-term contracts.

In order to further test the issues with the definition of temporary employment and the change in the methodology in 2014 (switch of some occasional contracts between self-employment and temporary employment), Table 4 presents two additional estimations in which dependent variables are somewhat differently defined. The overall temporary employment is defined as a share among the total employment (instead of among the total number of employees) while total employment among the active population is taken as the relevant parameter instead of the total number of employees. In this way, the developments among the self-employed portion of total employment are also taken into account. Comparing these results with those in Table 2, one can see that the main conclusions remain the same (the only notable exception being the gain of the statistical significance for the EPT reform dummy in the case of its negative effect on the probability of total employment). Although the coefficients are slightly smaller in size, one can conclude that both temporary and permanent contracts liberalisation have had a positive impact on the incidence of temporary employment, whereas the effect of temporary contracts liberalisation on the incidence of overall employment is not entirely clear. All things considered, the definition of dependent variables (temporary employment and employment) does not drive the main findings, as the alternative specifications bring to the same conclusions.

FIGURE 5

Event study results – temporary employment (upper part) and employment (lower part) for population aged 30-64

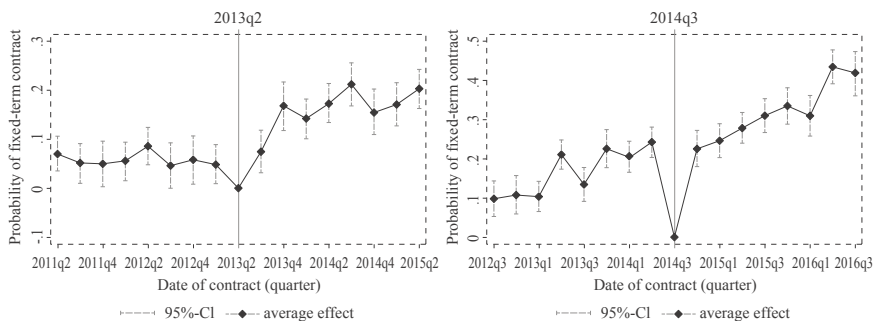


Note: Results are from linear probability model with robust standard errors. Employment share includes only employees (30-64) and not self-employed persons and family workers. Quarterly data are extracted from yearly datasets. Regressions control for a basic set of individual characteristics, i.e., age dummies, gender, marriage status and nativity plus time trend and quarterly GDP growth rate. Other model specifications – such as those additionally including education, region and level of urbanisation – are also tested and the results are more or less the same (available upon request).

Source: Author's calculation based on Croatian LFS.

FIGURE 6

Event study results for fixed contracts only



Note: Results are from linear probability model with robust standard errors. Quarterly data are extracted from yearly datasets. Regressions control for basic set of individual characteristics, i.e., age dummies, gender, marriage status and nativity plus time trend and quarterly GDP growth rate. Other model specifications – such as those additionally including education, region and level of urbanisation – are also tested and the results are more-or-less the same (available upon request).

Source: Author's calculation based on Croatian LFS.

6 CONCLUSIONS

This paper examines the effects of employment protection legislation reforms from 2013 and 2014 on employment outcomes in Croatia, testing the theoretical predictions of two-tier labour market reforms on labour market outcomes from the literature. With a push from the EU accession and the need to harmonize legislation, the reforms liberalized EP provisions for both temporary (2013) and permanent (2014) contracts thus presenting a particularly interesting case for policy evaluation. Using the LFS data in the period 2007-2017 and applying the event study method in combination with probit regressions, the main results suggest that employment protection legislation reforms from 2013 and 2014 induced a rise in temporary employment, while the effects on the overall employment are clearly visible only in the case of the second (permanent contracts) reform. Thus, it seems that the liberalisation of permanent contracts has led to an increase in overall employment, while only partial EPL reform concentrated on temporary contracts was actually detrimental, as it induced an increase of the share of temporary contracts without increasing the overall employment level. In addition, probit regression estimations suggest that specific groups of the population – females, youths, foreigners, the low-skilled and singles from rural areas – have a higher probability of ending up with temporary contracts. These results are further tested applying different model specifications, but also focusing on different definitions of temporary employment; however, they largely confirm the basic set of results.

Nevertheless, there are some caveats that need to be taken into account here. For example, I have concentrated on the OECD indices of employment protection legislation to indicate whether the reform actually happened; however, these indices might not be entirely representative of how the things actually work in practice. This is especially true for the flexibilisation of permanent contracts (2014 reform). Moreover, labour legislation includes provisions other than the Labour Act that could have affected some of the changes on the Croatian labour market in recent years. However, alternative model specifications that have tried to take into account possible effects of other legislative changes did not change the main findings. Finally, the recession – with the accompanying processes of globalisation and digitalisation – and the consequent accommodation of both employers and workers could have changed the importance of temporary vs permanent work on the Croatian labour market.

Still, one must not disregard the effects that the labour legislation reform had on the incidence of temporary employment and on the overall trends on the Croatian labour market. This is not only the case for different forms of employment, but it can have larger effects on the formation of human capital, increasing inequalities, and even further encouraging outward migration. Sound policy evaluation, both ex-ante and ex-post, is notably absent in Croatia, while at the same time legislation is constantly changing. As the labour legislation reforms from 2013 and 2014 were mainly induced from the outside, that is, by the need to harmonise Croatian

regulations with those of the EU, the lessons learned in the case of Croatia might be valuable for candidate and future accession countries.

Further steps in the analysis of the impact of labour legislation on labour market outcomes in Croatia should also focus on other outcomes on the labour market, such as labour market participation or wages, as well as on individual outcomes that could have been affected by the increased incidence of temporary employment, including the formation of marriage, having children, homeownership and/or living with one's parents. As the analysis in this paper showed that specific groups of workers, such as youths or females, are more likely to end up on temporary employment contracts more focus should be put on those specific groups as well. Perhaps it is the decisions on the supply side and not on the demand side that drive the overall results. In addition, although rich in the number of individual and labour market related variables, the LFS dataset might not be the best source of data for examining the effects of labour legislation reforms on labour market outcomes. Another possibility is the use of administrative data with detailed specifications of different types of contract and their duration, while another approach could be the use of firm-level data to check if legislation provisions induced changes in the type of employment contracts among different sectors, firm sizes and similar matters. In any case, this is too important to be disregarded in academic discourse.

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TABLE A1
Descriptive statistics

Variables	Total		Employed		Employees		Temporary employees	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
<i>Labour market status</i>								
Active	0.65	0.48						
Employees	0.47	0.50	0.83	0.38				
Self-employed	0.15	0.36	0.15	0.36				
Temporary employees	0.16	0.36	0.16	0.36	0.16	0.36		
Fixed-term contracts only	0.13	0.34	0.13	0.34	0.13	0.34	0.85	0.35
Precarious employment	0.05	0.22	0.05	0.22	0.05	0.22	0.33	0.47
<i>Age</i>								
15-19 (ref.)	0.09	0.28	0.01	0.10	0.01	0.10	0.04	0.20
20-24	0.09	0.29	0.06	0.24	0.07	0.25	0.19	0.40
25-29	0.10	0.30	0.12	0.32	0.13	0.34	0.24	0.43
30-34	0.10	0.30	0.14	0.35	0.15	0.35	0.16	0.37
35-39	0.10	0.30	0.14	0.35	0.14	0.35	0.11	0.31
40-44	0.10	0.30	0.14	0.34	0.14	0.34	0.08	0.28
45-49	0.11	0.31	0.13	0.34	0.13	0.34	0.07	0.26
50-54	0.11	0.31	0.13	0.33	0.12	0.33	0.06	0.23
55-59	0.11	0.31	0.09	0.29	0.08	0.28	0.03	0.18
60-64	0.09	0.29	0.04	0.20	0.03	0.18	0.01	0.10
<i>Individual/household characteristics</i>								
Female	0.50	0.50	0.45	0.50	0.47	0.50	0.48	0.50
Married	0.59	0.49	0.68	0.47	0.66	0.47	0.43	0.50
Foreign	0.11	0.31	0.10	0.30	0.10	0.30	0.10	0.31
Share of dependent persons in the household	0.14	0.18	0.15	0.18	0.15	0.18	0.13	0.17
<i>Education</i>								
Low skilled (ref.)	0.23	0.42	0.13	0.33	0.09	0.29	0.11	0.31
Medium skilled	0.60	0.49	0.64	0.48	0.65	0.48	0.68	0.46
High skilled	0.17	0.37	0.24	0.42	0.25	0.43	0.21	0.41
<i>Area variables</i>								
Urban	0.61	0.49	0.62	0.49	0.65	0.48	0.60	0.49
Central Croatia (w/o Zagreb) (ref.)	0.23	0.42	0.24	0.43	0.23	0.42	0.22	0.41
East Croatia	0.19	0.39	0.16	0.37	0.15	0.36	0.20	0.40
Zagreb region	0.25	0.43	0.27	0.45	0.29	0.45	0.22	0.42
North Adriatic	0.13	0.33	0.14	0.35	0.14	0.35	0.13	0.34
South Adriatic	0.20	0.40	0.18	0.39	0.19	0.39	0.23	0.42

Area Variables	Total		Employed		Employees		Temporary employees	
	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.	Mean	Std. Dv.
County unemployment rate	0.19	0.08	0.18	0.08	0.18	0.08	0.19	0.08
State of the economy								
GDP growth rate (qoq)	0.05	1.21	0.05	1.23	0.06	1.22	0.17	1.12
GDP growth rate (yoy)	0.34	3.46	0.36	3.51	0.41	3.48	0.82	3.27
Firm characteristics								
Public sector	0.36	0.48	0.36	0.48	0.36	0.48	0.21	0.41
Small firm (ref.)	0.57	0.50	0.57	0.50	0.56	0.50	0.68	0.47
Medium firm	0.20	0.40	0.20	0.40	0.21	0.40	0.16	0.37
Large firm	0.23	0.42	0.23	0.42	0.23	0.42	0.16	0.37
Occupation (Managers – ref.)								
Professionals	0.14	0.35	0.14	0.35	0.16	0.36	0.12	0.32
Technicians	0.15	0.35	0.15	0.35	0.17	0.37	0.12	0.32
Clerks	0.11	0.31	0.11	0.31	0.13	0.33	0.10	0.31
Service & sales	0.18	0.38	0.18	0.38	0.19	0.39	0.26	0.44
Agriculture	0.08	0.27	0.08	0.27	0.01	0.08	0.01	0.09
Craftsmen	0.13	0.33	0.13	0.33	0.13	0.34	0.13	0.33
Plant/machine operators	0.10	0.31	0.10	0.31	0.12	0.32	0.11	0.32
Elementary occupations	0.07	0.26	0.07	0.26	0.08	0.27	0.15	0.35
Industry (Agriculture, forestry and fishing – ref.)								
Industry (except manufacturing & construction)	0.03	0.17	0.03	0.17	0.04	0.19	0.02	0.13
Manufacturing	0.18	0.38	0.18	0.38	0.20	0.40	0.18	0.39
Construction	0.08	0.27	0.08	0.27	0.08	0.27	0.09	0.28
Wholesale and retail trade, transport, accommodation and food service activities + communication	0.30	0.46	0.30	0.46	0.31	0.46	0.39	0.49
Financial, insurance and real estate activities	0.03	0.18	0.03	0.18	0.04	0.19	0.02	0.15
Public administration, defence, education, human health and social work activities	0.19	0.39	0.19	0.39	0.23	0.42	0.15	0.36
Other services	0.09	0.29	0.09	0.29	0.09	0.28	0.11	0.31
Observations	275,034		148,022		120,705		18,362	

Source: Author's calculation based on Croatian LFS.

TABLE A2

Marginal effects after probits for temporary employment

Marginal effects	Both reform variables				Cumulative effect				Only EPR reform			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
EPT liberalisation (2013m7-2014m7)	0.0402*** (0.00399)	0.0149*** (0.00501)	0.0154*** (0.00500)	0.0118** (0.00481)								
EPR liberalisation (2014m8-2017m12)	0.0836*** (0.00242)	0.0421*** (0.00547)	0.0420*** (0.00546)	0.0321*** (0.00525)					0.0776*** (0.00235)	0.0320*** (0.00430)	0.0315*** (0.00430)	0.0241*** (0.00415)
Both reforms (2013m7-2017m12)					0.0742*** (0.00228)	0.0246*** (0.00461)	0.0249*** (0.00460)	0.0192*** (0.00443)				
Age: 15-19 (ref.)												
20-24	-0.243*** (0.0166)	-0.245*** (0.0165)	-0.247*** (0.0167)	-0.242*** (0.0178)	-0.243*** (0.0166)	-0.246*** (0.0166)	-0.248*** (0.0168)	-0.243*** (0.0178)	-0.244*** (0.0165)	-0.245*** (0.0165)	-0.248*** (0.0167)	-0.243*** (0.0178)
25-29	-0.380*** (0.0161)	-0.383*** (0.0161)	-0.381*** (0.0163)	-0.359*** (0.0174)	-0.380*** (0.0162)	-0.384*** (0.0161)	-0.382*** (0.0164)	-0.361*** (0.0174)	-0.379*** (0.0160)	-0.383*** (0.0161)	-0.381*** (0.0163)	-0.360*** (0.0174)
30-34	-0.487*** (0.0161)	-0.491*** (0.0161)	-0.488*** (0.0164)	-0.453*** (0.0175)	-0.487*** (0.0162)	-0.492*** (0.0161)	-0.489*** (0.0164)	-0.454*** (0.0175)	-0.486*** (0.0160)	-0.492*** (0.0161)	-0.489*** (0.0163)	-0.454*** (0.0175)
35-39	-0.537*** (0.0161)	-0.542*** (0.0161)	-0.537*** (0.0163)	-0.495*** (0.0175)	-0.537*** (0.0162)	-0.543*** (0.0161)	-0.538*** (0.0164)	-0.496*** (0.0175)	-0.536*** (0.0160)	-0.542*** (0.0161)	-0.538*** (0.0163)	-0.496*** (0.0175)
40-44	-0.558*** (0.0161)	-0.563*** (0.0160)	-0.558*** (0.0163)	-0.514*** (0.0175)	-0.558*** (0.0162)	-0.564*** (0.0161)	-0.560*** (0.0163)	-0.515*** (0.0175)	-0.557*** (0.0160)	-0.563*** (0.0160)	-0.559*** (0.0163)	-0.514*** (0.0175)
45-49	-0.570*** (0.0160)	-0.575*** (0.0160)	-0.571*** (0.0163)	-0.527*** (0.0175)	-0.571*** (0.0161)	-0.576*** (0.0160)	-0.573*** (0.0163)	-0.528*** (0.0175)	-0.569*** (0.0160)	-0.576*** (0.0160)	-0.572*** (0.0162)	-0.528*** (0.0174)
50-54	-0.585*** (0.0160)	-0.590*** (0.0160)	-0.586*** (0.0162)	-0.540*** (0.0174)	-0.586*** (0.0161)	-0.591*** (0.0160)	-0.587*** (0.0163)	-0.541*** (0.0175)	-0.584*** (0.0159)	-0.590*** (0.0160)	-0.587*** (0.0162)	-0.541*** (0.0174)
55-59	-0.595*** (0.0160)	-0.600*** (0.0160)	-0.597*** (0.0162)	-0.550*** (0.0175)	-0.596*** (0.0161)	-0.602*** (0.0160)	-0.598*** (0.0163)	-0.551*** (0.0175)	-0.594*** (0.0159)	-0.601*** (0.0160)	-0.598*** (0.0162)	-0.551*** (0.0174)
60-64	-0.605*** (0.0162)	-0.610*** (0.0162)	-0.607*** (0.0164)	-0.566*** (0.0176)	-0.605*** (0.0163)	-0.612*** (0.0162)	-0.609*** (0.0164)	-0.567*** (0.0176)	-0.604*** (0.0161)	-0.611*** (0.0162)	-0.608*** (0.0164)	-0.567*** (0.0176)

Marginal effects	Both reform variables				Cumulative effect				Only EPR reform			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Females	0.0176*** (0.00229)	0.0175*** (0.00229)	0.0190*** (0.00228)	0.0135*** (0.00246)	0.0176*** (0.00229)	0.0175*** (0.00229)	0.0190*** (0.00228)	0.0136*** (0.00246)	0.0176*** (0.00229)	0.0174*** (0.00229)	0.0190*** (0.00229)	0.0136*** (0.00246)
Married or cohabiting	-0.0444*** (0.00262)	-0.0436*** (0.00261)	-0.0452*** (0.00261)	-0.0389*** (0.00252)	-0.0448*** (0.00262)	-0.0436*** (0.00261)	-0.0452*** (0.00261)	-0.0389*** (0.00252)	-0.0443*** (0.00262)	-0.0434*** (0.00261)	-0.0450*** (0.00261)	-0.0388*** (0.00252)
Foreign-born	0.0326*** (0.00373)	0.0330*** (0.00373)	0.0357*** (0.00376)	0.0242*** (0.00362)	0.0330*** (0.00373)	0.0333*** (0.00373)	0.0360*** (0.00376)	0.0243*** (0.00362)	0.0324*** (0.00373)	0.0331*** (0.00373)	0.0357*** (0.00376)	0.0242*** (0.00362)
Low skilled (ref.)	-0.0884*** (0.00485)	-0.0897*** (0.00487)	-0.0874*** (0.00491)	-0.0341*** (0.00427)	-0.0880*** (0.00485)	-0.0890*** (0.00487)	-0.0875*** (0.00491)	-0.0342*** (0.00427)	-0.0871*** (0.00484)	-0.0897*** (0.00487)	-0.0875*** (0.00492)	-0.0342*** (0.00427)
Medium skilled	-0.110*** (0.00508)	-0.112*** (0.00509)	-0.105*** (0.00523)	0.00294 (0.00628)	-0.110*** (0.00507)	-0.112*** (0.00509)	-0.105*** (0.00523)	0.00276 (0.00628)	-0.108*** (0.00507)	-0.112*** (0.00509)	-0.105*** (0.00523)	0.00300 (0.00629)
High skilled	no	no	-0.00796*** (0.00243)	-0.00525** (0.00236)	no	no	-0.00852*** (0.00242)	-0.00567** (0.00236)	no	no	-0.00777*** (0.00242)	-0.00511** (0.00236)
Urbanisation dummy	no	no	yes	yes	no	yes	yes	yes	no	yes	yes	yes
Time trend	no	yes	yes	yes	no	yes	yes	yes	no	yes	yes	yes
GDP growth rate (gdp)	no	yes	yes	yes	no	yes	yes	yes	no	yes	yes	yes
Regional dummies	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Firm-level variables	no	no	no	yes	no	no	no	yes	no	no	no	yes
Observations	120,666	120,662	120,662	118,433	120,666	120,662	120,662	118,433	120,666	120,662	120,662	118,433
Log likelihood	-5.533e ⁰⁶	-5.527e ⁰⁶	-5.479e ⁰⁶	-5.130e ⁰⁶	-5.542e ⁰⁶	-5.530e ⁰⁶	-5.482e ⁰⁶	-5.132e ⁰⁶	-5.541e ⁰⁶	-5.528e ⁰⁶	-5.480e ⁰⁶	-5.13e ⁰⁶
chi2	10142	10211	10578	11657	10025	10161	10536	11629	10114	10218	10584	11658
p	0	0	0	0	0	0	0	0	0	0	0	0
r2_p	0.129	0.130	0.138	0.157	0.127	0.129	0.137	0.157	0.128	0.130	0.137	0.157

Notes: More detailed information on probit regressions, including other model specifications, is available upon request. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Author's calculation based on Croatian LFS.

TABLE A3

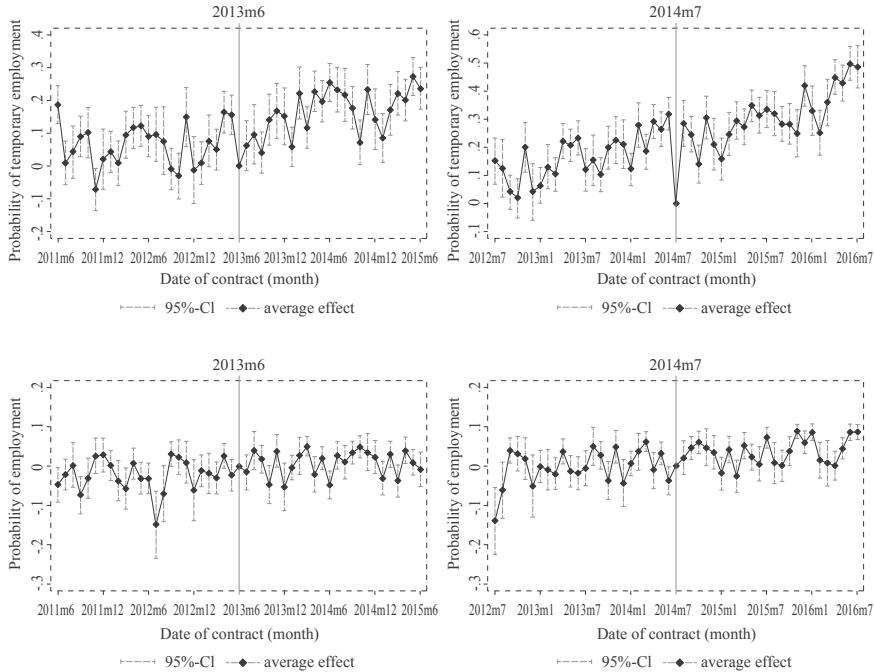
Marginal effects after probits for employment

Marginal effects	Both reform variables			Cumulative effect			Only EPR reform		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
EPT liberalisation (2013m6-2014m6)	-0.0278*** (0.00430)	0.000621 (0.00533)	-0.00152 (0.00536)				0.0230*** (0.00273)	0.0656*** (0.00468)	0.0686*** (0.00472)
EPR liberalisation (2014m7-2017m12)	0.0189*** (0.00279)	0.0660*** (0.00582)	0.0676*** (0.00586)	0.00702*** (0.00255)	0.0248*** (0.00504)	0.0240*** (0.00508)			
Both reforms (2013m6-2017m12)									
Age: 15-19 (ref.)									
20-24	0.247*** (0.0110)	0.248*** (0.0109)	0.241*** (0.0110)	0.247*** (0.0110)	0.247*** (0.0110)	0.241*** (0.0110)	0.247*** (0.0110)	0.248*** (0.0109)	0.241*** (0.0110)
25-29	0.322*** (0.0107)	0.323*** (0.0107)	0.306*** (0.0107)	0.321*** (0.0107)	0.322*** (0.0107)	0.305*** (0.0108)	0.322*** (0.0107)	0.323*** (0.0107)	0.306*** (0.0107)
30-34	0.338*** (0.0108)	0.339*** (0.0108)	0.317*** (0.0109)	0.337*** (0.0108)	0.338*** (0.0108)	0.315*** (0.0109)	0.338*** (0.0108)	0.339*** (0.0108)	0.317*** (0.0109)
35-39	0.334*** (0.0108)	0.336*** (0.0108)	0.310*** (0.0109)	0.334*** (0.0108)	0.335*** (0.0108)	0.309*** (0.0110)	0.334*** (0.0108)	0.336*** (0.0108)	0.310*** (0.0109)
40-44	0.338*** (0.0108)	0.340*** (0.0108)	0.315*** (0.0109)	0.338*** (0.0108)	0.339*** (0.0108)	0.314*** (0.0109)	0.338*** (0.0108)	0.339*** (0.0108)	0.315*** (0.0109)
45-49	0.328*** (0.0108)	0.329*** (0.0108)	0.305*** (0.0109)	0.327*** (0.0108)	0.328*** (0.0108)	0.304*** (0.0109)	0.328*** (0.0108)	0.329*** (0.0108)	0.305*** (0.0109)
50-54	0.316*** (0.0108)	0.318*** (0.0108)	0.291*** (0.0110)	0.316*** (0.0108)	0.317*** (0.0108)	0.290*** (0.0110)	0.316*** (0.0108)	0.318*** (0.0108)	0.291*** (0.0110)
55-59	0.274*** (0.0111)	0.277*** (0.0111)	0.250*** (0.0112)	0.274*** (0.0111)	0.275*** (0.0111)	0.249*** (0.0112)	0.274*** (0.0111)	0.277*** (0.0111)	0.250*** (0.0112)
60-64	0.185*** (0.0120)	0.188*** (0.0120)	0.161*** (0.0121)	0.186*** (0.0120)	0.187*** (0.0120)	0.160*** (0.0121)	0.185*** (0.0120)	0.188*** (0.0120)	0.161*** (0.0121)

Marginal effects	Both reform variables			Cumulative effect			Only EPR reform		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Females	0.0157*** (0.00251)	0.0158*** (0.00251)	0.0131*** (0.00252)	0.0157*** (0.00251)	0.0158*** (0.00251)	0.0131*** (0.00252)	0.0157*** (0.00251)	0.0158*** (0.00251)	0.0131*** (0.00252)
Married or cohabiting	0.0229*** (0.00305)	0.0220*** (0.00305)	0.0280*** (0.00306)	0.0226*** (0.00305)	0.0222*** (0.00305)	0.0282*** (0.00307)	0.0229*** (0.00305)	0.0220*** (0.00305)	0.0280*** (0.00306)
Foreign-born	-0.0195*** (0.00414)	-0.0198*** (0.00414)	-0.0269*** (0.00419)	-0.0192*** (0.00414)	-0.0192*** (0.00414)	-0.0262*** (0.00419)	-0.0195*** (0.00414)	-0.0198*** (0.00414)	-0.0269*** (0.00419)
Low skilled (ref.)									
Medium skilled	0.223*** (0.00398)	0.224*** (0.00399)	0.197*** (0.00407)	0.223*** (0.00398)	0.224*** (0.00398)	0.197*** (0.00407)	0.223*** (0.00398)	0.224*** (0.00399)	0.197*** (0.00407)
High skilled	0.301*** (0.00435)	0.303*** (0.00436)	0.260*** (0.00461)	0.302*** (0.00435)	0.302*** (0.00435)	0.260*** (0.00461)	0.299*** (0.00435)	0.303*** (0.00436)	0.260*** (0.00461)
Urbanisation dummy	no	no	0.0529*** (0.00266)	no	no	0.0511*** (0.00265)	no	no	0.0529*** (0.00266)
Time trend	no	yes	yes	no	yes	yes	no	yes	yes
GDP growth rate (qoq)	no	yes	yes	no	yes	yes	no	yes	yes
Regional dummies	no	no	yes	no	no	yes	no	no	yes
Firm-level variables	no	no	no	no	no	no	no	no	yes
Observations	171,113	171,108	171,108	171,113	171,108	171,108	171,113	171,108	171,108
Log likelihood	-1.150e07	-1.150e07	-1.140e07	-1.150e07	-1.150e07	-1.140e07	-1.150e07	-1.150e07	-1.140e07
chi2	7661	7777	9164	7568	7602	8938	7618	7776	9163
p	0	0	0	0	0	0	0	0	0
r2_p	0.0469	0.0475	0.0578	0.0462	0.0464	0.0566	0.0466	0.0475	0.0578

Notes: Employment share includes only employees (15-64) and not self-employed persons and family workers. More detailed information on probit regressions, including other model specifications, is available upon request. Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Author's calculation based on Croatian LFS.

FIGURE A1*Event study results on a monthly level*

Notes: Results are from linear probability model with robust standard errors. Employment share includes only employees (15-64) and not self-employed persons and family workers. Monthly data are extracted from yearly datasets. Regressions control for basic set of individual characteristics, i.e., age dummies, gender, marriage status and nativity plus time trend and quarterly GDP growth rate. Other model specifications – such as those additionally including education, region and level of urbanisation – are also tested and the results are more-or-less the same (available upon request).

Source: Author's calculation based on Croatian LFS.



A stochastic forecast for the Croatian pension system

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Article**

JEL: J11, J13, J14, H55, H68

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Abstract

This paper analyses the financial sustainability of the Croatian pension system after the reform that was adopted on January 1, 2019. The Croatian pension system as we know it today was started in 1999 with a reform that created the three pillars of the pension system. Over the next twenty years, Croatian economic and social conditions shifted in an unexpected way and a new reform was needed to ensure financial stability is maintained. In this paper I will analyse population trends in Croatia and forecast movements up to 2060. Afterwards, I will analyse the net government cash flow generated from the pension system, by using the forecast population numbers. The beginning year of the forecast horizon is 2018, as some data were not yet available for this year. I use stochastic methods to perform my analysis.

Keywords: Demographic, Labour Economics, Government, Leslie matrix, Stochastics forecast, Pension system, Croatia

1 HISTORY OF THE CROATIAN PENSION SYSTEM

The pension system of a country is a necessity for the security of the elderly. It is important for a country to establish and develop a sustainable pension system because it affects all citizens. Such a system can be mandatory or voluntary. Mandatory pension systems are currently widespread, and it is important for citizens to understand how they function and what their individual rights are, since they will be spending their entire lives in the system of their country. We differentiate two types of mandatory pension systems: (1) Defined-Benefit plan and (2) Defined-Contribution plan. A Defined-Benefit (DB) plan promises the individual that they will receive a specific pension amount that depends on the tenure of service and the salary earned. In the DB plan, individuals pay monthly instalments into the pension system. In the Defined-Contribution (DC) plan, individuals are required to put a predetermined amount or percentage of their salary into the “pool” of savings (pension funds). The capital is then invested in different assets and financial instruments, the accumulated capital being afterwards distributed to the individuals once they fulfil the requirements for disbursements. Some countries use the DB plan, others use the DC plan, and some countries use a mixture of both (Puljiz, 2007).

According to the Croatian Pension Insurance Institute (Mirovinsko.hr, 1999), the Croatian pension system as we know it today was started by the 1999 reform. This was the biggest reform in the pension system since Croatia gained independence. In 1999, three pillars of the pension system were established. The first pillar is mandatory, and it amounts to 15% of the gross salary. This money, which is taken from the employed, is used to provide already existing pensioners with pensions. It is also known as the “pay-as-you-go” pension system (PAYG). The second pillar amounts to 5% of the gross salary, and it can be interpreted as a DC plan, in which the individual’s money is invested in a pension fund in order to gain capital accumulation. As part of the second pillar, individuals may examine the state of

their savings at any time. According to the Croatian Financial Services Supervisory Agency (HANFA, 2019), the second pillar is slightly more flexible than the first pillar. Furthermore, individuals can decide to save their money in three different fund categories: A, B and C. If individuals, however, do not personally decide which pension category they want, the authorized institutions will place them in Category B six months after starting their first employment. Each category involves a different amount of risk, and therefore differs depending on the individuals' rights to invest in different categories of assets and financial instruments. Funds from the Category A are the riskiest ones; Category B is less risky but still riskier than Category C. Category C is known as the safest investment according to the amount of risk. Since the investments in which the money has been placed may decrease in value over time, the country regulates by law the guaranteed amount that will be paid out to each individual once they are eligible for their pension. The third pillar is voluntary, every individual deciding for themselves if they want to save some extra money for old age.

According to the Croatian Pension Insurance Institute (Mirovinsko.hr, 1999), when the 1999 pension reform was introduced, the second and third pillar of the pension system were new. Before the 1999 reform, a certain percentage of individuals' salary was deducted just in order to pay for the pensions of existing pensioners (PAYG). But after the 1999 reform, 25% of total charges for the pension system were invested in the second pillar – which amounts to 5% of the total salary. The reform started the creation of the second and third pillars on January 1, 2002. Everyone that was aged 39 or less on January 1, 2002, had to accept the two mandatory pillars and 15% (75% of the total contribution amount) of their salary was deducted for the first pillar, and 5% (25% of the total contribution amount) of their salary was deducted for the second pillar. Those that were aged 40 or over on January 1, 2002 were able to decide if they wanted to contribute 20% of their salary to the first pillar or if they wanted to be in the combined pension system. Those individuals that had worked long enough predominantly decided to stay in the first pillar, since the money invested in the second pillar would not be enough in order to offset pensions generated in the first pillar. This was also the case for some people under the age of 40 on January 1, 2002, but they were not given a choice. However, over the next twenty years, many things changed. Croatian demography started shifting in an unexpected way. According to MRMS (2019), depending on which pension scheme an individual was using, it was possible for the two individuals, doing the same job and receiving the same salary, to have different amounts of pension just because of the pension scheme they were using. This led to the conclusion that the second pillar was not showing enough strength to offset the pensions that would have been generated if individuals had contributed just to the first pillar. The Croatian government has had increasing cash outflows every year in order to sustain the pension system. Croatia is thus implementing a big new reform of the pension system that started January 1, 2019. The new reform is changing the dynamics of the minimum age to be eligible to receive a pension. Since 2011, the retirement age for the old-age pension, and early retirement, for a

woman has been gradually increasing, rising from 60 to 65 by 2030 for the old-age pension and from 55 to 60 for early retirement by 2030 (increasing yearly by 3 months). Starting with 2019, the age limit will be raised by 4 months each year for women, so that by 2027, women and men will retire at the same age. After that, the age limit will be raised by 4 months each year for both sexes until 2033, when individuals will be eligible for retirement at the age of 67 and with 15 years of work experience. The reform includes changes to the early retirement pension, which is also being shifted by four months each year, so that by the year 2033 individuals will be eligible for early retirement at 62 years of age and with 35 years of work experience. Before the 2019 reform, females were eligible for early retirement at 57 years of age and with 32 years of work experience and men at 60 years of age and with 35 years of work experience. The system has been made more flexible; since the 2019 reform, every individual is able to decide upon retirement whether they want to invest their money invested in the second pillar in the first pillar. If they decide to do so, the individual will be considered to have been charged 20% just for the first pillar their entire career. Therefore, everyone can opt for the option that suits them best. According to Mirovinsko.hr (2019), the way that the pension is calculated for every individual in Croatia is complex, but an average equation can be worked out. If the individual decides to receive a pension just from the first pillar, the capital accumulated in the second pillar will be sent to the state, and the individual's pension will be calculated according to equation (1), and an extra 27% will be added to the total (not to all, but only to those with a very low amount of pension). But if the person decides to stay in a combined pension scheme, the pension accumulated by the year 2002 will be calculated by equation (1), and pension accumulated after 2002 will be calculated by the equation (1) and multiplied approximately by 0.75 – since three quarters of the whole pension belongs to the first pillar – and then an extra 20.25% will be added to the calculated result. The rest of the pension will be disbursed from the pension fund, which can be calculated implementing financial mathematics methods. The 20.25% extra, which has been contributed from a combined pension scheme, can be interpreted as a penalty for not investing money in the first pillar. This amount is generated from the second pillar since those who decide to receive their pension just from the first pillar receive an extra 27% of the amount (again, not to all, but only to those with a very low amount of pension).

$$\text{Pension amount} = \text{Personal points} * \text{Pension factor} * \text{Actual pension value} \quad (1)$$

Personal points depend on work experience and wage value through career. The pension factor defines what ratio of personal points will be used in the pension calculation. The value of the pension factor lies between 0 and 1. If the individual fulfils all legal requirements for a pension, his pension factor will be 1. If, however, the individual does not fulfil all legal requirements for going into retirement, they can still retire but the pension factor will be less than 1. The actual pension value is defined by the government – it changes over time in order to reflect the economic state of the country.

In this paper, I will analyse how the pension system might develop in the future by implementing stochastic methods. The idea of implementing stochastic methods in my analysis came from the paper published by Tian and Zhao (2016). My whole research includes Walter Enders' *Applied Econometric Time Series* (2014) as a reference for implementing and analysing time series. First, I will start with an analysis of the population trends. Once future population movements are estimated, the given result will be used in further analysis of government net expenditures for the pension system.

2 OVERVIEW OF CROATIAN POPULATION TRENDS

The first step in analysing the sustainability of the pension system in Croatia is analysing the country's demography. A good demographic forecast would solve the problem alone. Therefore, considerable effort will be put into analysing Croatian demography. Firstly, we start with the overall population to get a picture of where are we today. Figure 1 shows the Croatian population trends over the last 18 years.

FIGURE 1

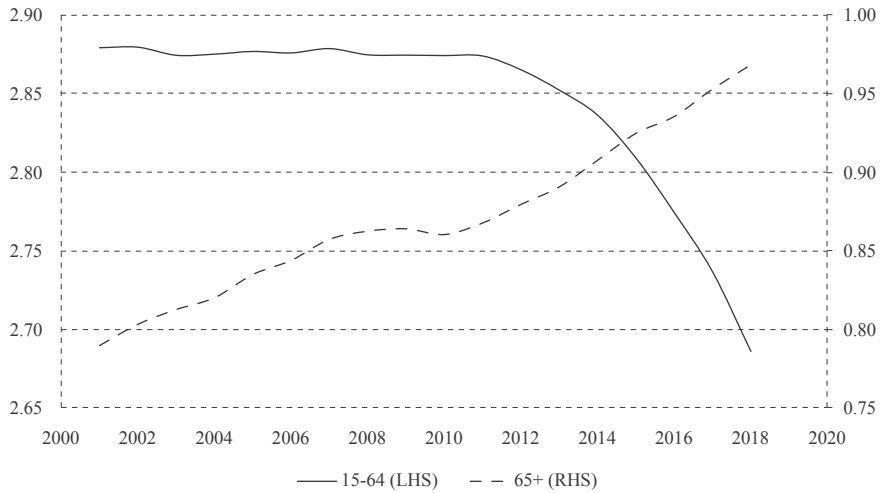
Total population in Croatia (in millions)



Source: Eurostat.

A decreasing pattern can clearly be noticed. Over the last 8 years, Croatia's population has decreased by approximately 200,000. Figure 2 shows Croatian population divided into two age groups, 15-65 and 65+ respectively.

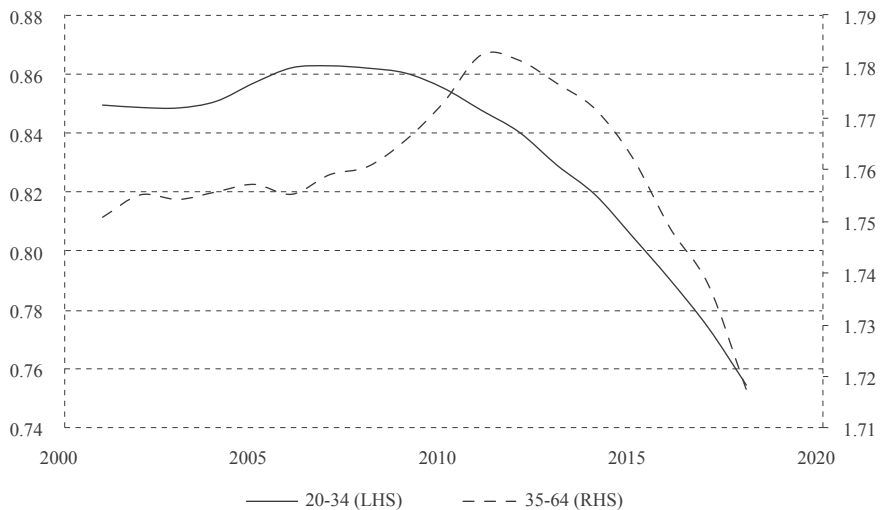
FIGURE 2
Total population in Croatia in two different age groups (in millions)



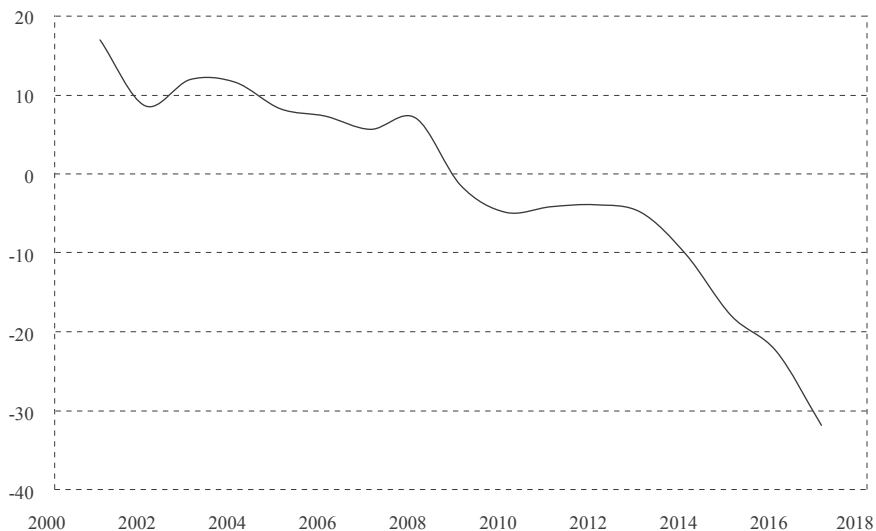
Source: Eurostat.

Here we can see cause for growing concern. While the population of retired citizens is steadily increasing, the population of the working force is swiftly decreasing. After 2011, the population of the working force decreased by approximately 170,000, while the population of people aged 64+ increased by approximately 75,000. This has negatively affected the basic pension system in Croatia. Neither the increasing trend of the population aged 65+ nor the decreasing trend of the population aged 15-64 is showing any signs of stopping. Migration is one of the main drivers of the decreasing trend of working age population. Figure 3 and Figure 4 will try to break down the population movement further.

FIGURE 3
Total population in Croatia in two different age groups (in millions)



Source: Eurostat.

FIGURE 4*Net migration in Croatia (in thousands)**Source: Eurostat.*

The population of people aged 20-34 has decreased by approximately 100,000 (110,000 from its peak point), while the population of people aged 35-64 has decreased by approximately 30,000 (70,000 from its peak point). Croatia showed positive net migration up to 2009. Figure 3 shows that this immigration has mostly impacted the numbers of the older age group. From the beginning of 2010, Croatia has had a negative net migration, which is mostly shown in the younger part of the working age population. Therefore, the younger population has had a more significant influence on the decrease in the total working age population. The main reason may be that the young are not satisfied with the economic, social, educational or many other opportunities offered in Croatia, so they try to find better opportunities in other countries. Since July 2013 Croatia has been a member of the EU. Upon the country's entry, a sharply decreasing trend in net migration occurred. The question is whether the current trend will continue to develop in a similar way. In my opinion, the short-term answer is yes, but the long-term no. In order to answer this question, the Croatian population can be separated into three groups: (1) Those that want to leave Croatia, (2) Those that do not want to leave Croatia, and (3) The undecided. Group (3) can be excluded because its members will eventually migrate to groups (1) or (2). Group (1) consists of a certain amount of the total population which is constant. Once all its members leave the country, the immigration wave will stop. Group (1) is also not leaving the country in the blink of an eye – this trend is dynamic, dependent on time, as well as other variables. Therefore, it will take time until this trend is finished.

3 INTRODUCTION TO THE LESLIE MODEL

The model used in forecasting in this analysis is the Leslie model. The Leslie model is set as follows (Cull, Flahive and Robson, 2005):

$$\begin{bmatrix} p_{1,t+1} \\ p_{2,t+1} \\ p_{3,t+1} \\ \cdot \\ \cdot \\ \cdot \\ p_{k,t+1} \end{bmatrix} = \begin{bmatrix} f_{1,t} & f_{2,t} & f_{3,t} & \dots & f_{k,t} \\ s_{1,t} & 0 & 0 & 0 & 0 \\ 0 & s_{2,t} & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1,t} & s_{k,t} \end{bmatrix} * \begin{bmatrix} p_{1,t} \\ p_{2,t} \\ p_{3,t} \\ \cdot \\ \cdot \\ \cdot \\ p_{k,t} \end{bmatrix} \tag{2}$$

where $L = \begin{bmatrix} f_{1,t} & f_{2,t} & f_{3,t} & \dots & f_{k,t} \\ s_{1,t} & 0 & 0 & 0 & 0 \\ 0 & s_{2,t} & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1,t} & s_{k,t} \end{bmatrix}$ is called the Leslie matrix

- $p_{i,t}$ ~ number of individuals in i^{TH} age group at time t
- $f_{i,t}$ ~ number of births per individual in i^{TH} age group at time t
- $s_{i,t}$ ~ survival rate in i^{TH} age group at time t

Variable $p_{i,t}$ is the population in i^{TH} age range. Let us call them cohorts throughout the analysis. There is a total of 18 cohorts in this analysis. The first one is new-borns in a given year, the second one is the population aged 1-4, the third one is the population aged 5-9 and so on. The last cohort is the population aged 80+.

It is important to note that parameters $f_{i,t}$ and $s_{i,t}$ are changing over time. If the parameters do not vary over time, the upper equation turns into a matrix difference equation that can be solved as follows:

$$\begin{bmatrix} p_{1,1+n} \\ p_{2,1+n} \\ p_{3,1+n} \\ \cdot \\ \cdot \\ \cdot \\ p_{k,1+n} \end{bmatrix} = \begin{bmatrix} f_1 & f_2 & f_3 & \dots & f_k \\ s_1 & 0 & 0 & 0 & 0 \\ 0 & s_2 & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1} & s_k \end{bmatrix}^n * \begin{bmatrix} p_{1,1} \\ p_{2,1} \\ p_{3,1} \\ \cdot \\ \cdot \\ \cdot \\ p_{k,1} \end{bmatrix}, \text{ where } P_t = \begin{bmatrix} p_{1,1} \\ p_{2,1} \\ p_{3,1} \\ \cdot \\ \cdot \\ \cdot \\ p_{k,1} \end{bmatrix} \text{ is initial population}$$

Since the given parameters vary over time, the solution for our equation is as follows:

$$\begin{bmatrix} P_{1,t+1} \\ P_{2,t+1} \\ P_{3,t+1} \\ \vdots \\ P_{k,t+1} \end{bmatrix} = \underbrace{\begin{bmatrix} f_{1,t} & f_{2,t} & f_{3,t} & \cdots & f_{k,t} \\ s_{1,t} & 0 & 0 & 0 & 0 \\ 0 & s_{2,t} & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1,t} & s_{k,t} \end{bmatrix}}_{t \text{ times}} * \dots * \begin{bmatrix} f_{1,1} & f_{2,1} & f_{3,1} & \cdots & f_{k,1} \\ s_{1,1} & 0 & 0 & 0 & 0 \\ 0 & s_{2,1} & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1,1} & s_{k,1} \end{bmatrix} \begin{bmatrix} P_{1,1} \\ P_{2,1} \\ P_{3,1} \\ \vdots \\ P_{k,1} \end{bmatrix} \quad (3)$$

Vector P_t is the given population at time t , which in our case is 2017. The parameters f_i and s_i are not constant and time series analysis will be implemented in order to estimate the dynamics of the parameters $f_{i,t}$ and $s_{i,t}$. By estimating those parameters, we can estimate the population after n years. In this paper, I will analyse the dynamics of the variables according to the 17 observable data points through time, and then I will implement a stochastic forecast by carrying out 500 Monte Carlo simulations. This method will give us a wider picture of where the population as a system is converging. The changes will be implemented in the Leslie model, which will be described in detail later in the paper.

3.1 NEWBORNS PER PERSON

According to the work of Smith, Tayman and Swanson (2013), fertility rates are one of the main variables that affect population growth. Therefore, we will start with analysing fertility rates. We start by analysing the number of births per individual in a i^{TH} age group. This number can be derived from the country's fertility rates. The fertility rate is the number of children per woman in different age groups. Since we need the data to be the number of newborns per individual, we will transform the data with the following equation:

$$f_{i,t} = \frac{F_{i,t} * P_{i,f,t}}{P_{i,t}} \quad (4)$$

$F_{i,t} \sim$ fertility rate in i^{TH} age group at time t

$P_{i,f,t} \sim$ female population in i^{TH} age group at time t

The value of $f_{i,t}$ now represents the number of newborns per individual. It would be much better if there were data available on newborns per mother's age, but these data are rather restricted (just 11 observations are available), so we are forced to use $f_{i,t}$ as calculated by the above formula. The formula itself is a very good proxy compared to the real data of newborns available (the standard deviation on average is approximated to 0.63%).

The first step was forecasting through a time series analysis for each cohort, but I ran into problems of rejecting the random walk hypothesis in the Dickey-Fuller test for some parts of the series. Table 1 shows the results of the Dickey-Fuller test:

TABLE 1

Dickey-Fuller test statistics results for random walk and random walk with a drift

Age	Test Statistics	Test Statistics	
	$\Delta y_t = \alpha_1 y_{t-1} + \varepsilon_t$	$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t$	
15-19	$\tau = -1.9585$	$\tau = -3.9106$	$\phi = 5.6557$
20-24	$\tau = -1.6152$	$\tau = -4.2537$	$\phi = 9.0580$
25-29	$\tau = -2.1451$	$\tau = -2.4060$	$\phi = 2.8946$
30-34	$\tau = -1.3703$	$\tau = -2.1818$	$\phi = 2.3866$
35-39	$\tau = -0.7783$	$\tau = -3.5498$	$\phi = 6.6255$
40-44	$\tau = -0.9005$	$\tau = -3.0782$	$\phi = 5.1171$
45-49	$\tau = -3.5818$	$\tau = -4.1482$	$\phi = 8.6203$

Source: Author's calculations.

TABLE 2

Dickey-Fuller statistics and confidence intervals for the data of 16 observations

Model	Hypothesis	Test Statistics	Confidence intervals	
			95%	99%
$\Delta y_t = \alpha_1 y_{t-1} + \varepsilon_t$	$\alpha_1 = 0$	τ	-1.95	-2.66
$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t$	$\alpha_1 = 0$	τ	-3.00	-3.75
	$\alpha_0 = \alpha_1 = 0$	ϕ	5.18	7.88

Source: Author's calculations.

We can now compare the results with 95% confidence intervals given in Table 2. The first model is random walk, and the second model is random walk with drift. To reject the hypothesis that the model is following a random walk process – or random walk with drift – with 95% confidence intervals, the test value must be higher than the absolute value of the Dickey-Fuller test. It can be noticed that this is not the case for all of the series. Therefore, the second approach was used and it yielded much better estimates and results.

3.1.1 LEE-CARTER MODEL FOR NEWBORNS PER PERSON

According to Khan, Afrin and Masud (2016), the Lee-Carter model is one way to approach the problem of forecasting mortality rates. Here, this method will be used to forecast newborns per person. The model is set as follows:

$$\log(f_{i,t}) = a_i + b_i * k_t + \varepsilon_t \quad (5)$$

where $a_i = \frac{1}{T} * \sum_{t=1}^T f_{i,t}$, $\sum_{i=1}^n b_i^2 = 1$, $\sum_{t=1}^T k_t = 0$

Each parameter a_i represents the mean value of newborns per individual rates in each i^{th} age group. The parameter k_t is a time varying trend index that can be estimated and forecasted by applying time series analysis. Each coefficient b_i shows changes in newborns per individual rates in a i^{th} age group when the newborns per person index changes. The assumptions are that b_i is constant in each age group

and that k_t is not dependent on age group, but rather on time. To solve this system of equations, we will use the singular value decomposition (SVD) method, as recommended by the Lee-Carter model. We first start with solving a_i . Afterwards, we create a new matrix:

$$z_{i,t} = \log(f_{i,t}) - a_i, \text{ where } a_i \text{ are fitted values.}$$

Then we apply singular value decomposition to obtain the product of the three matrices: $SVD(Z_{i,t}) = U * \Lambda * V^T = \Lambda_1 U_{i,1} V_{t,1} + \dots + \Lambda_n U_{i,n} V_{t,n}$. We derive b_i from the first row of the age-group component matrix i.e. $b_i = U_{i,1}$, and k_t is derived from multiplication of the time component matrix and the first eigenvalue i.e. $k_t = \Lambda_1 * V_{t,1}$. Estimated values of a_i and b_i are shown in Table 3.

TABLE 3
Parameters in the Lee-Carter model

Age	Parameter	
	a_i	b_i
15-19	-5.11	-0.33
20-24	-3.55	-0.35
25-29	-3.03	-0.09
30-34	-3.21	0.20
35-39	-4.09	0.38
40-44	-5.78	0.42
45-49	-8.85	0.64

Source: Author's calculations.

Parameters b_i reveal a lot about the trend that is present. Parameter b_i directly affects newborns per person rates each time when the index k_t is changed. It can be seen that the parameter b_i has negative values for age groups 15-29 and positive for age groups 30-49. These values show that the number of young people aged 15-29 who are having children is decreasing. Instead, people start having children at the ages of 30-49. This trend is present worldwide, not just in Croatia.

Now we have all the necessary parameters. We now need to forecast the future values of k_t . First, we start by checking stationarity. Table 4 shows Dickey-Fuller test statistics:

TABLE 4
Dickey-Fuller statistics for newborns per person index

Test Statistics	Test Statistics
$\Delta k_t = \alpha_1 k_{t-1} + \varepsilon_t$	$\Delta k_t = \alpha_0 + \alpha_1 k_{t-1} + \varepsilon_t$
$\tau = -2.4176$	$\tau = -5,0459$ $\phi = 12.8369$

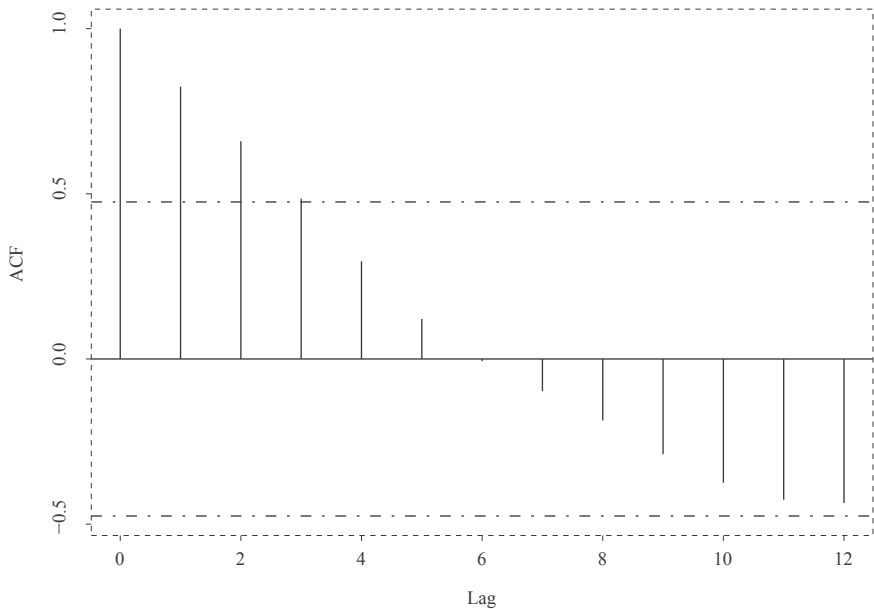
Source: Author's calculations.

Data from Table 2 can be used for comparison since the number of observations and the value of the confidence intervals is the same. The parameter α_1 in the first equation (random walk without drift) is statistically different from zero with 95% confidence, so we reject the hypothesis that this process is random walk with a 95% confidence level. When it comes to the second equation, the confidence level is even higher. We can thus reject the hypothesis that α_1 is equal to zero with a 99% confidence level, and that the constant parameter together with α_1 is statistically different from zero with a 99% confidence level.

The following two figures, Figure 5 and Figure 6, show the autocorrelation function (ACF) and partial autocorrelation function (PACF) of the newborns per person index. They are used in order to decide which process describes movements in the newborns per person index the best.

FIGURE 5

Autocorrelation function (ACF) for newborns per person index

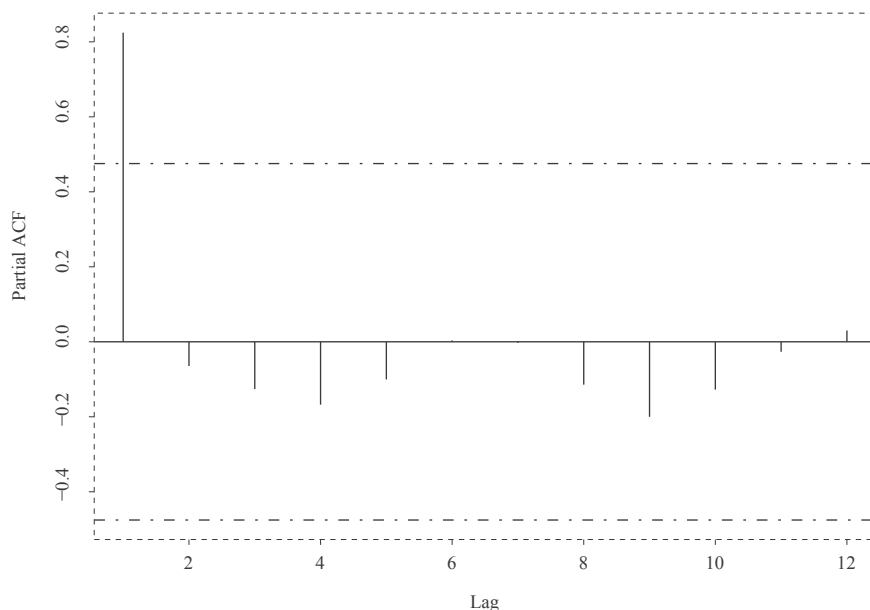


Note: The dotted line is used as a boundary for statistical significance. Everything that is above the dotted line is statistically significant.

Source: Author's calculations.

FIGURE 6

Partial autocorrelation function (PACF) for newborns per person index



Source: Author's calculations.

The autocorrelation function shows that the current k_t on average correlates with the previous three observations, but the partial autocorrelation function indicates that the movements in k_t are best explained by just one lagged dependent variable. Our conclusion is that the autoregressive model of order 1 (AR (1)) that includes the intercept term will be applied in order to forecast future changes in the newborns per person index. Estimating with ordinary least square approximation, we obtain the results shown in Table 5:

TABLE 5

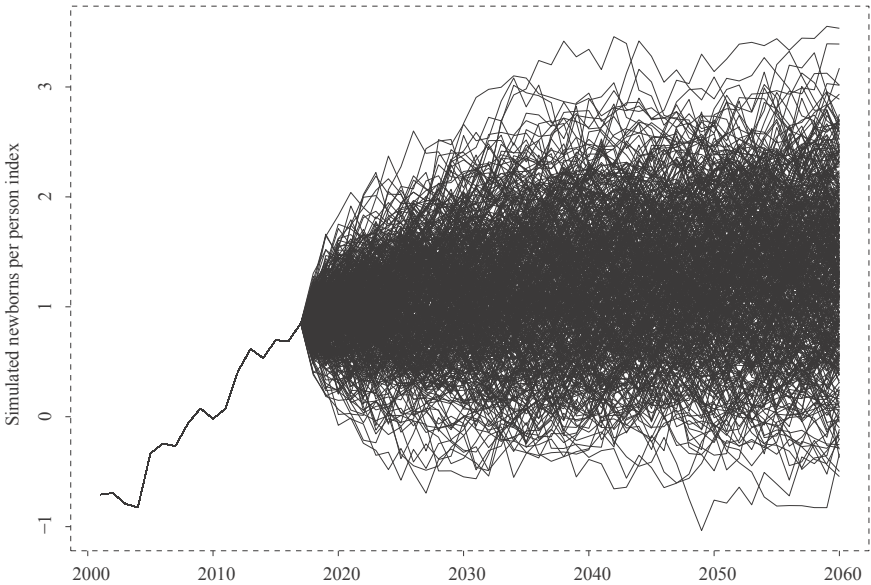
AR (1) process of newborns per person index

Estimated equation	R^2	σ	$E(k_t)$
$k_t = 0.0528 + 0.9639 * k_{t-1} + \varepsilon_t$	0.8635	0.1975	1.4598

Source: Author's calculations.

The standard error of the lag dependent term is 0.0458, which makes it statistically different from zero with a confidence level of 99%. The standard error of the intercept term is 0.61, which means that it is not statistically different from zero. However, we will include it in the model since the Dickey-Fuller test has demonstrated that that model is better with an intercept term. Now I create 500 simulations by setting equation $k_t = 0.0528 + 0.9639 * k_{t-1} + 0,1975 + \varepsilon_t$, where $\varepsilon_t \sim Normal(0,1)$. The results of the simulations are shown in Figure 7.

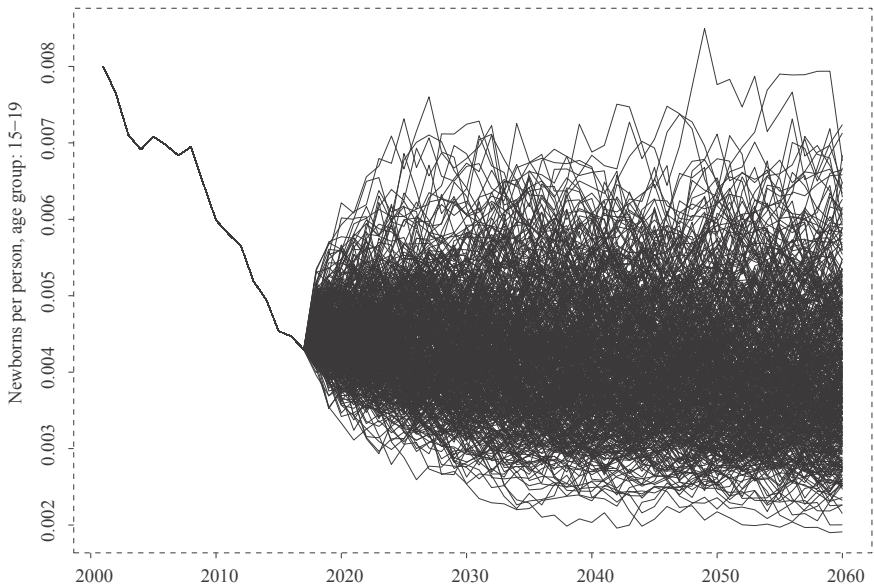
FIGURE 7
Stochastic simulation results for newborns per person index



Source: Author's calculations.

Now we have all the necessary data for simulating future values of newborns per person rates for each age group. The following two figures, Figure 8 and Figure 9, are given as final process of stochastic simulations of newborns per person rates for different age groups. We will later use this results in our Leslie matrix.

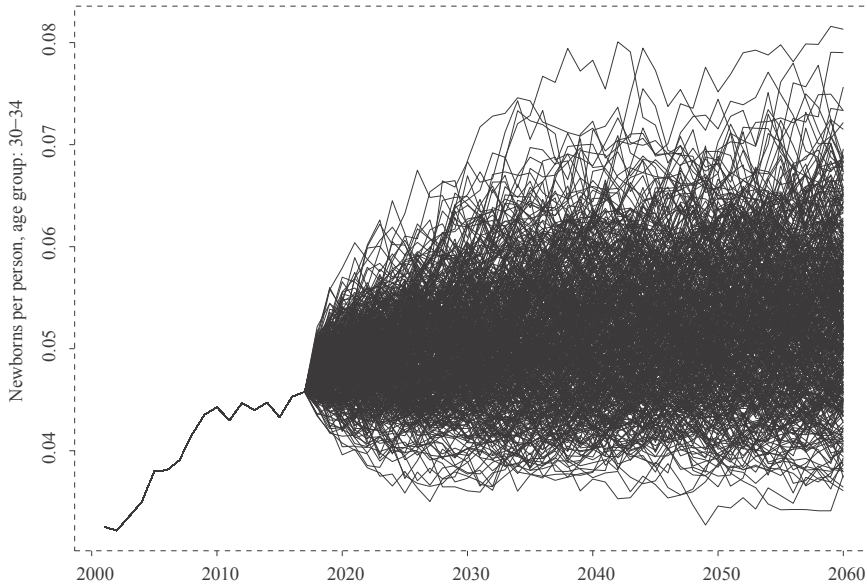
FIGURE 8
Stochastic simulation results for newborns per person rates, age group: 15-19



Source: Author's calculations.

FIGURE 9

Stochastic simulation results for newborns per person rates, age group: 30-34

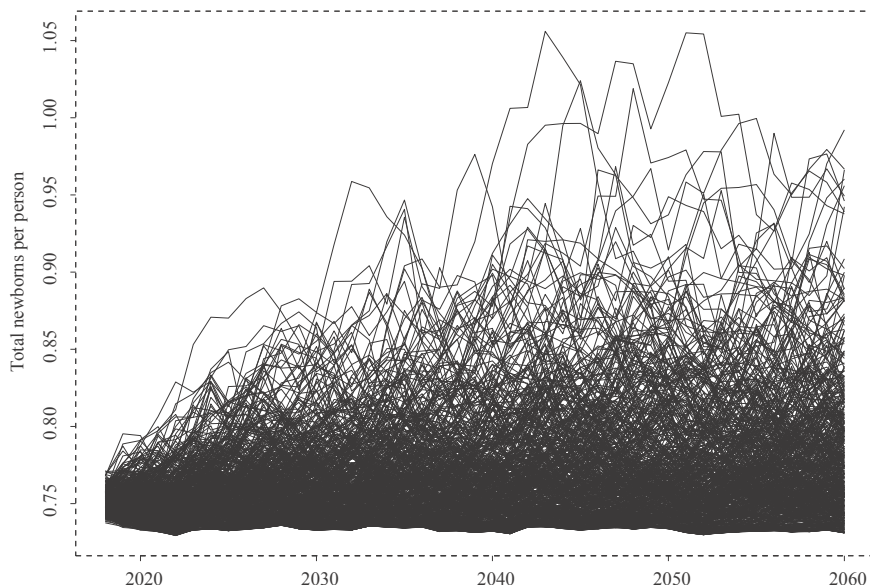


Source: Author's calculations.

All those stochastic simulations enable us to generate simulations of total newborns per person rates. We all are much more familiar with the term total fertility rates, meaning the average number of births per mother. Since we are transforming the data to newborns per person rates (not per mother), and the numbers of men and women in Croatia are approximately equal (male population amounted to 49.9% of the total population in 2018), we can therefore by rule of thumb multiply the total newborns per person rates by two in order to get fertility rates. Figure 10 shows total newborns per person rates generated from a stochastic simulation.

FIGURE 10

Stochastic simulation of total newborns per person rates, time horizon: 2017-2060



Source: Author's calculations.

In 2017 the total newborns per person rate was 0.7. By multiplying this number by two we receive an approximate fertility rate of 1.40. This is a good approximation if we compare it to the official Eurostat calculation of 1.42. Figure 10 shows forecasted values from 2017 to 2060. It can be seen that most of the data lie at values above 0.7, meaning that this model expects a higher total newborns per person rates in the future. It can be concluded that higher fertility rates are to be expected in the future¹.

3.2 SURVIVAL RATES

According to Smith, Tayman and Swanson (2013), the next important factor that needs to be estimated for our Leslie matrix is the survival rate s_i . The survival rate represents the probability that an individual will survive the given age group. To estimate this parameter, we will use the number of deaths in a given age group. The following formula will be used to transform the data:

$$s_{i,t} = 1 - \frac{M_{i,t}}{P_{i,t}} \quad (6)$$

where $m_{i,t} = \frac{M_{i,t}}{P_{i,t}}$

$M_{i,t}$ ~ number of deaths in i^{th} age group at time t

¹ This paper concludes that fertility rates would improve based on AR(1) process. AR(1) is not greatest approach one can use in estimating fertility rates because there are too many other factors which AR(1) process does not pick and future work could improve its forecasting.

The transformed data now represents the survival rate in each age group at time t . We will again use the Lee-Carter model (Khan, Afrin and Masud, 2016) to simulate future values of number of deaths in each age group.

We set our model as follows:

$$\log(m_{i,t}) = a_i + b_i * k_t + \varepsilon_t \quad (7)$$

where $a_i = \frac{1}{T} * \sum_{t=1}^T m_{i,t}$, $\sum_{i=1}^n b_i^2 = 1$, $\sum_{t=1}^T k_t = 0$

The a_i parameter in this equation represents the average age-specific mortality in different age groups. Vector k_t is the mortality index that is independent of each age group and varies with time. Each b_i parameter shows how change in the mortality index affects mortality rates in different age groups. The same procedure is used as with newborns per person to get correct forecasts of mortality rates. Estimates for a_i and b_i are given in Table 6.

TABLE 6

Parameters for mortality index in the Lee-Carter model

Age	Parameter	
	a_i	b_i
0-1	-5.29	-0.28
1-4	-8.44	-0.28
5-9	-8.99	-0.19
10-14	-8.94	-0.20
15-19	-7.83	-0.38
20-24	-7.43	-0.37
25-29	-7.40	-0.29
30-34	-7.20	-0.26
35-39	-6.80	-0.21
40-44	-6.32	-0.27
45-49	-5.73	-0.24
50-54	-5.19	-0.20
55-59	-4.75	-0.13
60-64	-4.33	-0.09
65-69	-3.91	-0.14
70-74	-3.43	-0.20
75-79	-2.89	-0.17
80+	-2.01	-0.08

Source: Author's calculations.

When it comes to parameter k_t , a time series analysis will be used first. Checking stationarity, we run into a problem. Table 7 shows Dickey-Fuller test results for the mortality index.

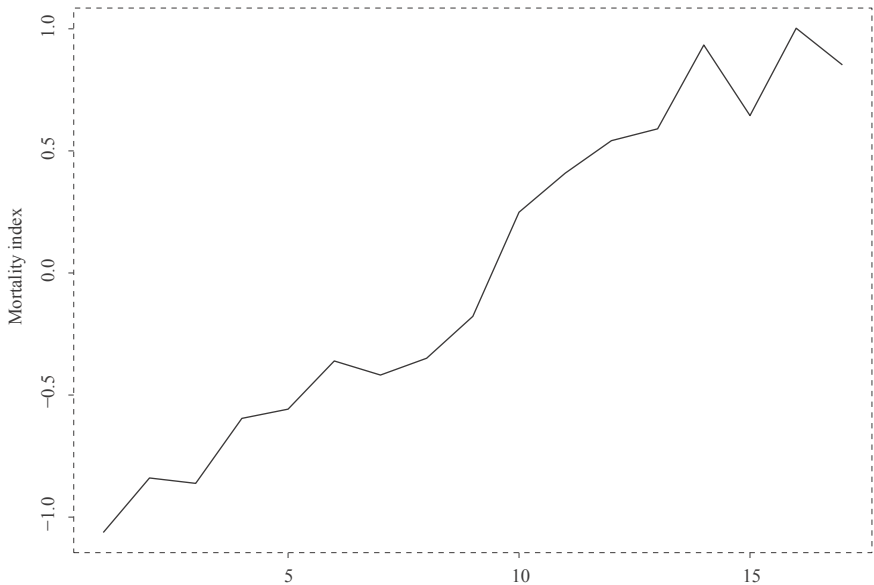
TABLE 7
Dickey-Fuller statistics for mortality index

Test Statistics	Test Statistics	
$\Delta k_t = \alpha_1 k_{t-1} + \varepsilon_t$	$\Delta k_t = \alpha_0 + \alpha_1 k_{t-1} + \varepsilon_t$	
$\tau = -1.1768$	$\tau = -2.3118$	$\phi = 2.6724$

Source: Author's calculations.

If these results are compared with those in Table 2, the data do not show enough confidence to reject the hypothesis that this process is random walk or random walk with drift with 95% confidence. We can set the model to be pure random walk without drift, and simulate future values, but that is not what I will do. The parameters b_i show how the change in k_i affects change in mortality rates in a i^{th} age group. By observing all the negative b_i parameters, we expect the value of k_i to increase over time. Generally, life expectancy has increased by a large margin over the last 100 years. Many factors affect this, and it is a trend that I expect will continue. The following Figure 11 shows observed values of the mortality index.

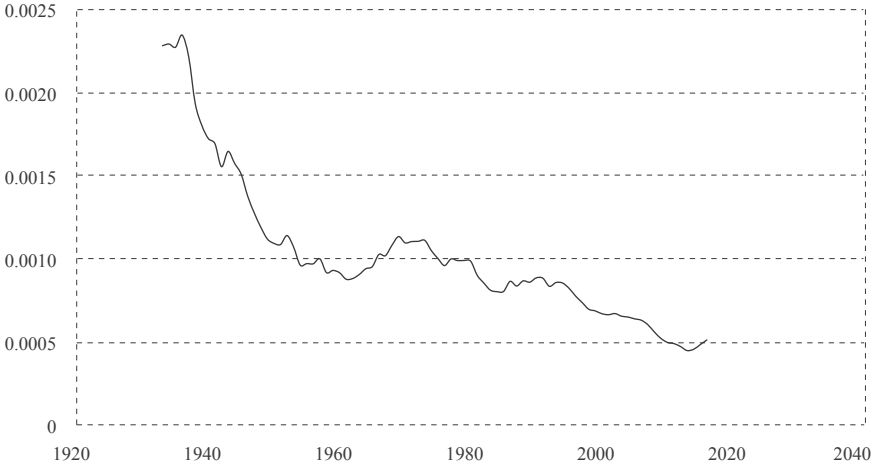
FIGURE 11
Mortality index over time



Source: Author's calculations.

We can notice from Figure 11 that the index shows a trend. I will assume here that this trend is linear. The reason for this assumption is that I do not expect the trend of decreasing patterns of mortality rates to stop. If we set our process to be pure random walk, then the expected future value is also the last observable value, and we lose the trend in the mortality index. An example of the mortality rates in the United States of America (USA) for the age group 15-19 is given in Figure 12.

FIGURE 12
Mortality rates in the USA for the period of 1930-2017



Source: *Mortality.org* (2019).

The example of the United States of America is used in Figure 12 because a large database can be drawn upon. Figure 12 illustrates that the data show a clearly declining trend. The trend shows characteristics of exponential decay. Since our mortality rate values are displayed as logarithms, by displaying the mortality index as a linear trend, we are creating exponential decay for mortality rates. From this assumption follows our new model for mortality index:

$$k_t = \beta_0 + \beta_1 * t + \varepsilon_t, \text{ where } \varepsilon_t \sim \text{random disturbance.}$$

Once we estimate β_1 with the ordinary least square estimator, we check the stationarity of the process $K_t = k_t - \beta_0 - \beta_1 * t$. Table 8 shows the Dickey-Fuller test results.

TABLE 8
Dickey-Fuller statistics for mortality index set as a model with linear trend

Test Statistics	Test Statistics	
$\Delta K_t = \alpha_1 K_{t-1} + \varepsilon_t$	$\Delta K_t = \alpha_0 + \alpha_1 K_{t-1} + \varepsilon_t$	
$\tau = -2.4707$	$\tau = -2.3118$	$\phi = 2.6724$

Source: *Author's calculations.*

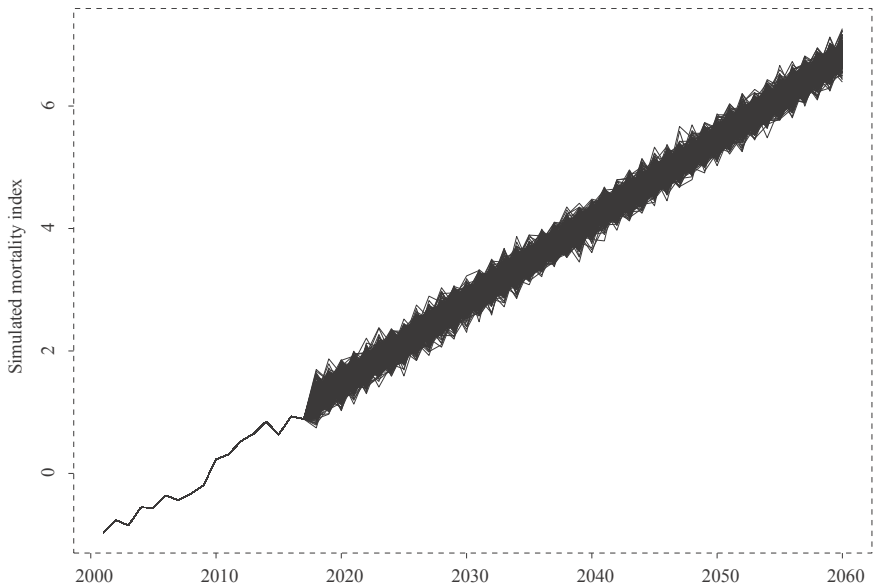
The data is stationary, so we can work with it further. The estimated parameters are shown in Table 9.

TABLE 9*Estimated parameters for mortality index*

Coefficients	Estimate	Standard error	t-value	Pr(> t)
β_0	-1.2012	0.0746	-16.11	~0
β_1	0.1335	0.0073	18.34	~0

Source: Author's calculations.

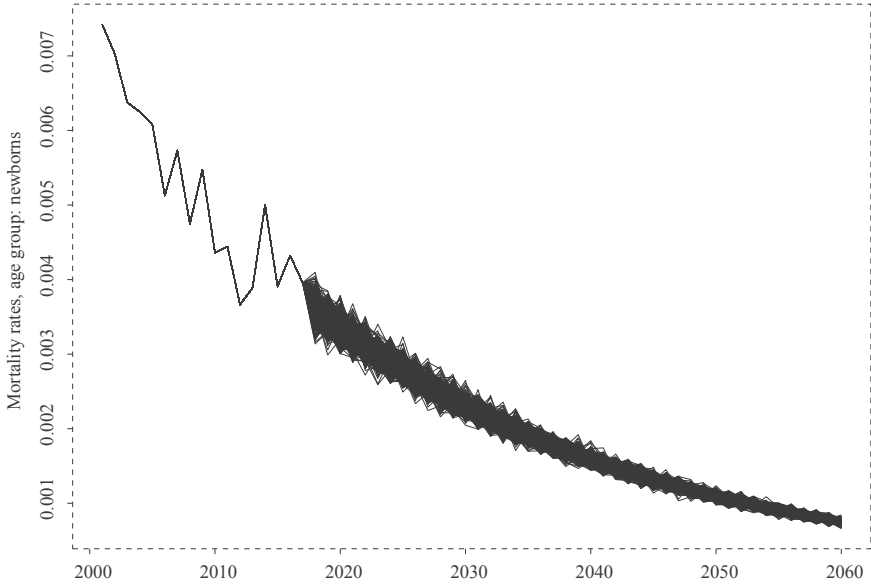
The adjusted R^2 is 0.95 and the standard deviation of whole model is 0.147. Now we estimate the stochastic model $k_t = -1.201168 + 0.133463 * t + 0.147 * \varepsilon_t$, where $\varepsilon_t \sim Normal(0,1)$ by doing 500 simulations. Figure 13 shows the results of these mortality index simulations.

FIGURE 13*Mortality index simulations**Source: Author's calculations.*

Now we have all the needed data to simulate mortality rates per cohort. We are now dealing with 18 data sets rather than 7 (as is the case with fertility rates). Figures 14 and 15 are given as examples of simulation results for two different cohorts. We can clearly observe an exponentially decreasing mortality rate trend.

FIGURE 14

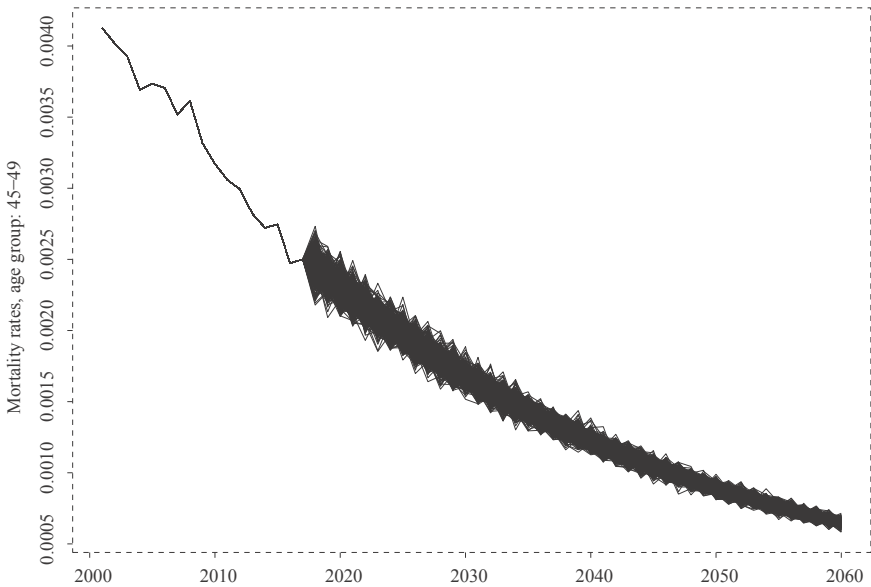
Simulated results for mortality rates for the first cohort: newborns



Source: Author's calculations.

FIGURE 15

Simulated results for the mortality index for group aged 45-49



Source: Author's calculations.

3.3 TOTAL POPULATION

Now we have all the parameters needed for creating our Leslie model. The original Leslie model is set as follows:

$$\begin{bmatrix} p_{1,t+1} \\ p_{2,t+1} \\ p_{3,t+1} \\ \vdots \\ p_{k,t+1} \end{bmatrix} = \begin{bmatrix} f_{1,t} & f_{2,t} & f_{3,t} & \dots & f_{k,t} \\ s_{1,t} & 0 & 0 & 0 & 0 \\ 0 & s_{2,t} & 0 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & s_{k-1,t} & s_{k,t} \end{bmatrix} * \begin{bmatrix} p_{1,t} \\ p_{2,t} \\ p_{3,t} \\ \vdots \\ p_{k,t} \end{bmatrix}$$

But as I have already mentioned, I will implement some changes in order to produce more precise forecasts. If we use the model as set above, the resulting forecasts will be biased. We need to look at and understand the fundamentals of the model. The output of the model is the population in each cohort. The way that the first cohort is created is a product of matrix multiplication: $f_{1,t} * p_{1,t} * \dots * f_{k,t} * p_{k,t}$. The value of fertility rates forecast for a given year is multiplied with that year's population in order to generate the number of newborns. Then for the next year, the number of new newborns is multiplied with the survival rate of the newborns' age group, and the value of those who survive is shifted into the next cohort, age group 1-4. For the year after that, the second cohort is multiplied with the second cohort's survival rate, and the value of those who survive is then shifted into the third cohort, age group 5-9. This is not what actually happens. The population that is aged 1, 2 or 3 remains in the second cohort. The model will be biased if we shift them all into the next cohort. By setting our model in this way, we are shifting the population in each period for five years, and thus generating forecasts for 5 years in each step. But because our fertility and survival rates are set per year, we are in a way dealing with apples and pears. We need to set the model in a such way that it shifts only the oldest members of a given population in a cohort. The way I decided to deal with this problem is:

$$\begin{bmatrix} p_{1,t+1} \\ p_{2,t+1} \\ p_{3,t+1} \\ \vdots \\ p_{k,t+1} \end{bmatrix} = \begin{bmatrix} f_{1,t} & f_{2,t} & f_{3,t} & \dots & f_{k,t} \\ s_{1,t} & (1-c_1) * s_{2,t} & 0 & 0 & 0 \\ 0 & c_1 * s_{2,t} & (1-c_2) * s_{3,t} & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & c_{k-2} * s_{k-1,t} & s_{k,t} \end{bmatrix} * \begin{bmatrix} p_{1,t} \\ p_{2,t} \\ p_{3,t} \\ \vdots \\ p_{k,t} \end{bmatrix} \quad (8)$$

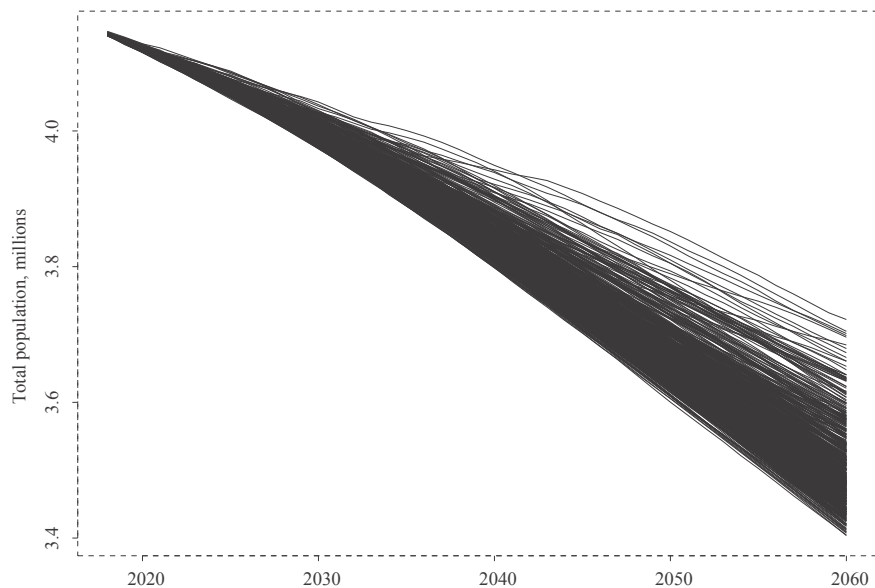
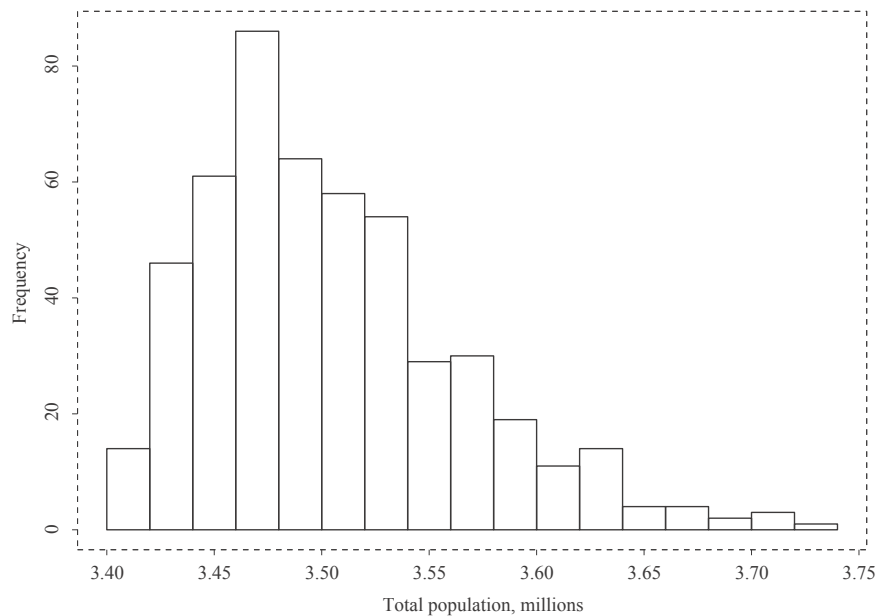
where c_i ~ Historical average ratio of last cohort age divided by population of i^{th} cohort.

Each c_i represents the proportion of the largest age value in a given cohort. For example, if the given cohort has 100 individuals aged 10-14, where just 20 members are aged 14, then the value of c_i in that cohort is 0.2. Let us say that the survival rate for the same cohort is 99% (mortality rate is 1%). This means that the next year we will see 99 individuals from this cohort. All of them are now one year older, meaning that those that were aged 14 are now aged 15 and should be put into the next cohort. In this new model, the population that is sent in next cohort is $c_i * s_{i+1,t}$ (c_i does not exist for the first cohort – newborns). It starts from the second cohort, which is why we multiply its value by $i^{TH} + 1$ (survival rate). The result is 0.198 ($0.2 * 0.99$), which equals 19.8 individuals. The population that stays in the same cohort equals $(1 - c_i) * s_{i+1,t}$ which in our case equals 0.792 ($0.8 * 0.99$) or 79.2 individuals. The total amounts to exactly 99 individuals ($19.8 + 79.2$). By setting the model in this way, we are setting survival rates to be uniformly distributed in each cohort, which is the assumption behind this model.

Now that we understand the changes in the model, we need to estimate parameters c_i . I estimated them with the equation $c_{i,t} = \frac{\text{oldest age population in } P_{i,t} \text{ cohort}}{P_{i,t}}$.

We have 17 points in time, so we estimate 17 values of $c_{i,t}$ for 17 different cohorts. All $c_{i,t}$ parameters are stationary through time, and the standard deviation value is less than 1% for almost all of them. There are just three observations of $c_{i,t}$ whose standard deviation is higher than 1%, around 1.5%. This is why I have decided to base the value of c_i on the historical average for each cohort.

Now we can generate a stochastic forecast for the Croatian population over the next 43 years (starting from 2017). Figure 16 is the final result of 500 stochastic simulations based on the Leslie model.

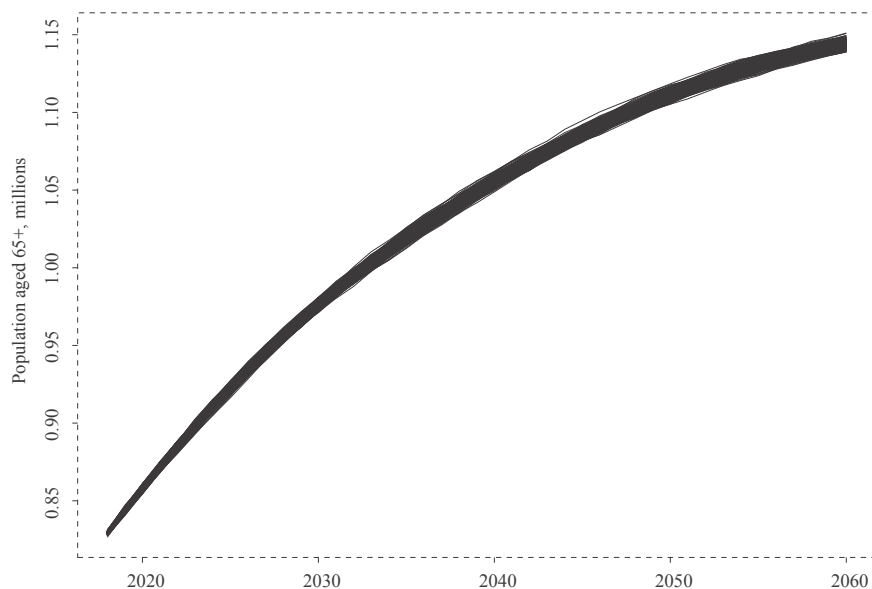
FIGURE 16*Stochastic forecast of the Croatian population from 2018 to 2060**Note: Generated by the Leslie stochastic matrix.**Source: Author's calculations.***FIGURE 17***Histogram of the Croatian population in 2060 forecast by using the stochastic method on the Leslie model**Source: Author's calculations.*

The expected population in 2060 is 3.5 million and the population's median lies around 3.49 million. The standard deviation of the total population in 2060 is 60,300, meaning 1.72% of the mean. The mean is not uncertain, as can be seen in Figure 17. Therefore, we can say with 95% confidence that the interval lies between 3.41 million and 3.65 million, and with 99% confidence that the interval lies between 3.4 million and 3.7 million. We are also interested in the changes in population for two different population groups: those aged 65+ and those aged 15-65. Figures 18 and 19 show the results of this forecast. The observable results are giving rise to growing concerns.

In the next paragraph, we are going to analyse the sustainability of the Croatian pension system through time based on the forecast population numbers. The results estimated in this paragraph will be taken in order to analyse the sustainability of the pension system.

FIGURE 18

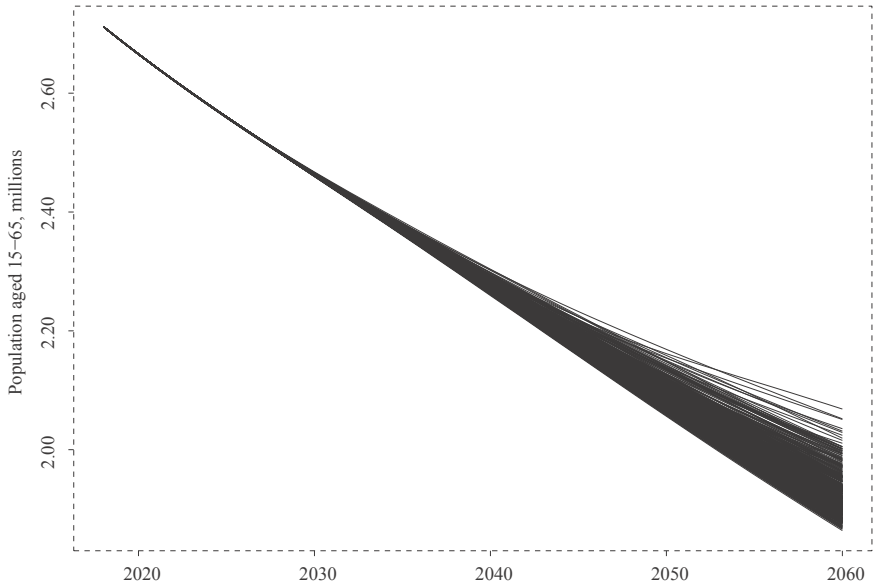
Stochastic forecast of the population aged 65+ from 2018 to 2060



Source: Author's calculations.

FIGURE 19

Stochastic forecast of the population aged 15-65 from 2018 to 2060



Source: Author's calculations.

4 POPULATION OF PENSIONERS

Now that we have estimated the population projections for each cohort, we are able to use those estimations to analyse the population of pensioners and of the employed population. The given numbers can help us estimate how much cash inflow will be generated from the employed population and see whether there will be enough cash accumulated to finance the pensioners. This section will deal with calculating the population of pensioners in Croatia.

The pensioner dynamics behaviour can be explained through the values of already existing pensioners and new pensioners. A model can be set in the following way (Tian and Zhao, 2016):

$$P_{p,t} = \theta_t * P_{p,t-1} + \alpha_1 * P_{i,t} * X_1 + \alpha_2 * P_{i,t} * X_2 \quad (9)$$

$$P_{p,t} = \theta_t * P_{p,t-1} + \alpha * P_{i,t} * X \quad (10)$$

$P_{p,t}$ ~ Population of pensioners at time t

θ ~ Survival rate of pensioners

α, X ~ Scaling factor

$P_{i,t}$ ~ Population of i^{TH} cohort at time t

This model calculates the number of the next year's pensioners by adding the number of pensioners that survive this year and newly added pensioners together. As

mentioned above, until 2027 women and men can retire at different ages. We therefore have two different equations necessary for catching up to the dynamics of the system. Equation (9) is used before 2027 and Equation (10) is used after 2027. At the present moment, women can start receiving pension benefits at the age of 62. In order to estimate the number of newly retired women, we first need to know what population of women is aged 62 and is eligible for a pension. We need to take into consideration the fact that not all women with these characteristics are necessarily going to retire, which is why we multiply the whole thing with X in order to get the number of women that will be new pensioners. The same procedure is used for men, and after 2027 for the total population. This model does not account for people in early retirement, so I will put them in the category with other pensioners. Now I will briefly explain and estimate the parameters, one by one.

The parameter θ_t represents the survival rate of pensioners. Since we already have estimated survival rates for each cohort, I estimated θ_t as a weighted average of survival rates in different cohorts. The survival rates of the cohorts 65+ are used because the assumption is that individuals older than 65 are pensioners. Although women may currently legally receive pension at the age of 62, θ_t represents the approximation of survival rates. Although after 2033 individuals will need to be 67 years old to receive pension benefits, I decided not to complicate the model further, so that θ_t represents the weighted average survival rates of the cohorts 65-69, 70-74, 75-79 and 80+. θ_t is set in the following way:

$$\theta_t = \frac{P_{15,t}}{\sum_{i=15}^{18} P_{i,t}} * s_{15} + \frac{P_{16,t}}{\sum_{i=15}^{18} P_{i,t}} * s_{16} + \frac{P_{17,t}}{\sum_{i=15}^{18} P_{i,t}} * s_{17} + \frac{P_{18,t}}{\sum_{i=15}^{18} P_{i,t}} * s_{18} \quad (11)$$

After the survival rates we need to analyse the scaling factor α . Term $P_{i,t}$ must be multiplied by 0.5 for the years leading up to 2027 because we assume that the population consists of a 50:50 ratio of men and women. By multiplying with 0.5, we scale the population of a cohort to represent just the population of women (or men). Since only women aged 62 can start receiving pension benefits, we need to multiply the calculated value with the percentage of the population aged 62 in a given cohort in order to scale the population to just the number of women aged 62. Since we need to estimate in what way postponing the age limit for retirement affects the pension system, we need to create a method that will cover postponing the retirement age inside each cohort. There are data available for each year's population on Eurostat, so I decided to calculate the historical average ratio of each age group for the given cohort. Table 10 shows the results for the relevant ages.

TABLE 10*Proportion of specific age population in cohorts 60-64 and 65-69*

Age	Weights in cohort
62	0.1996
63	0.1961
64	0.1925
65	0.2086
66	0.2039
67	0.2002

Source: Eurostat; Author's calculations.

We can observe just what we expected – a decreasing pattern of the population for every age in the cohort. Now we have everything necessary for calculating the α parameters. When we are dealing with population of men and women separately, we multiply the numbers in Table 10 with 0.5 according to Formula (9), otherwise we keep the original numbers from Table 10 and we use Formula (10).

Up until now we calculated the number of women aged 62 (and men aged 65). Now we need to find out how many women aged 62 will start their retirement plan. Fortunately, the Croatian Pension Insurance Institute (HZMO) has been publishing the numbers of new pensioners, both female and male, since 2006. Since we have the data for women aged 62 from Eurostat, we can calculate the ratio of new female pensioners to female population aged 62 (and the ratio of new male pensioners to male population aged 65). The results for both men and women can be found in Table 11.

TABLE II
Analysis of new pensioners

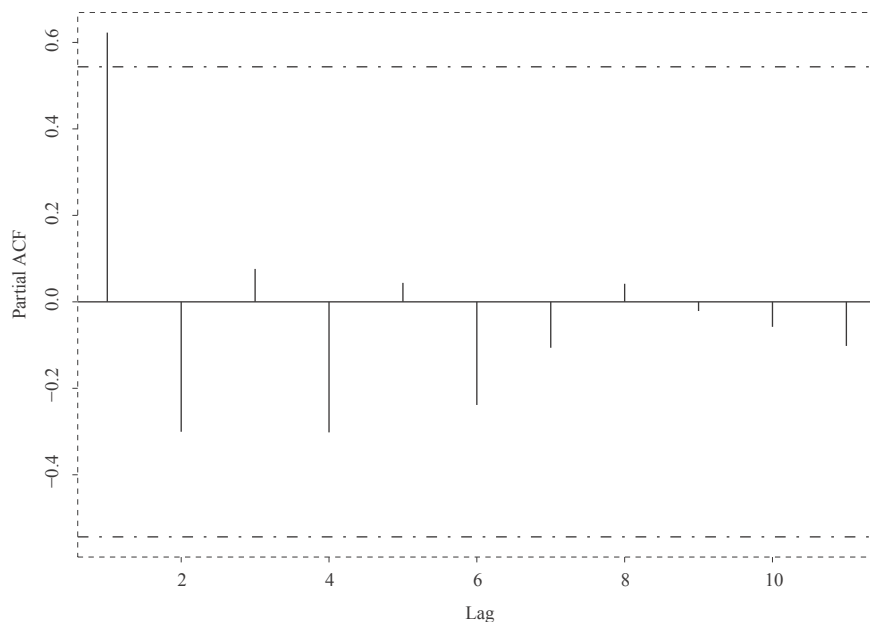
Ratio of new male pensioners to men aged 65	Ratio of new female pensioners to women aged 62	Women aged 62	Men aged 65	New female pensioners	New male pensioners	New pensioners	Year
0.92	0.85	31,654	26,229	26,930	24,145	51,075	2018
0.93	0.84	30,862	24,572	25,874	22,760	48,634	2017
0.95	0.84	30,644	25,518	25,868	24,127	49,995	2016
0.92	0.88	30,352	24,754	26,582	22,674	49,256	2015
1.06	0.97	28,119	23,014	27,223	24,303	51,526	2014
0.96	0.90	29,867	22,642	26,963	21,798	48,761	2013
1.00	0.88	30,076	21,014	26,513	20,946	47,459	2012
1.40	0.99	28,196	16,052	27,948	22,507	50,455	2011
1.41	1.28	27,957	17,636	35,835	24,834	60,669	2010
1.25	1.25	26,032	19,540	32,591	24,379	56,970	2009
1.12	1.48	20,084	22,004	29,798	24,588	54,386	2008
1.10	1.30	22,160	20,769	28,801	22,744	51,545	2007
1.02	1.14	24,809	22,387	28,255	22,901	51,156	2006

Source: Eurostat; HZMO; Author's calculations.

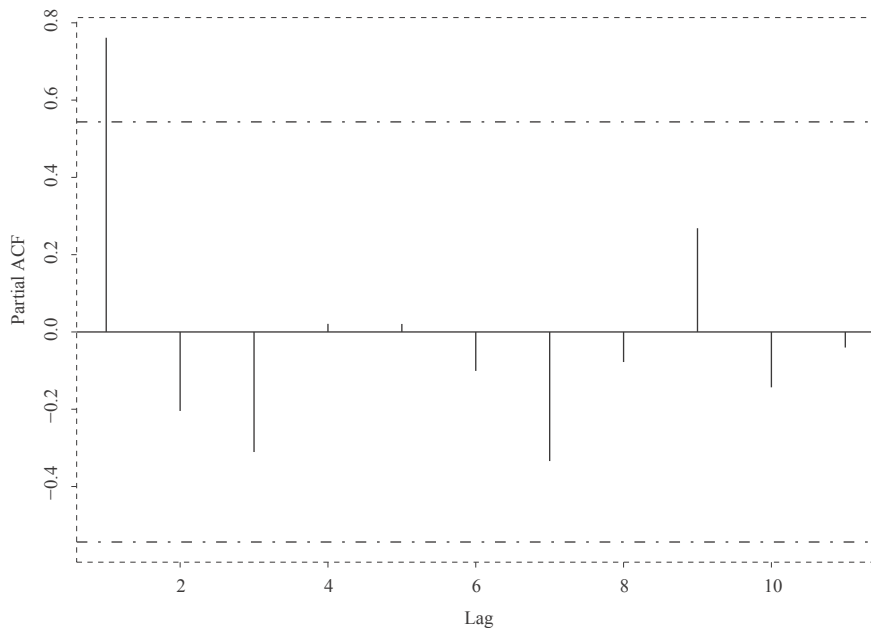
The result of some observations is higher than one because the category *new pensioners* does not include only women aged 62 and men aged 65, but also people that have retired early or late. However, this ratio can be a good benchmark for forecasting the numbers of future new pensioners. I will furthermore assume that this ratio does not change with the cohort, but rather that it just changes over time. This assumption allows me to create a stochastic process of the ratio and use it for different cohorts. In Figures 20 and 21 we can see the PACF for the process created from those two ratios. I decided to use the AR (1) process to explain the future behaviour of the ratio. Table 12 shows the estimated equations.

FIGURE 20

PACF for the ratio of new male pensioners to male population aged 65



Source: Author's calculations.

FIGURE 21*PACF for new female pensioners to female population aged 62*

Source: Author's calculations.

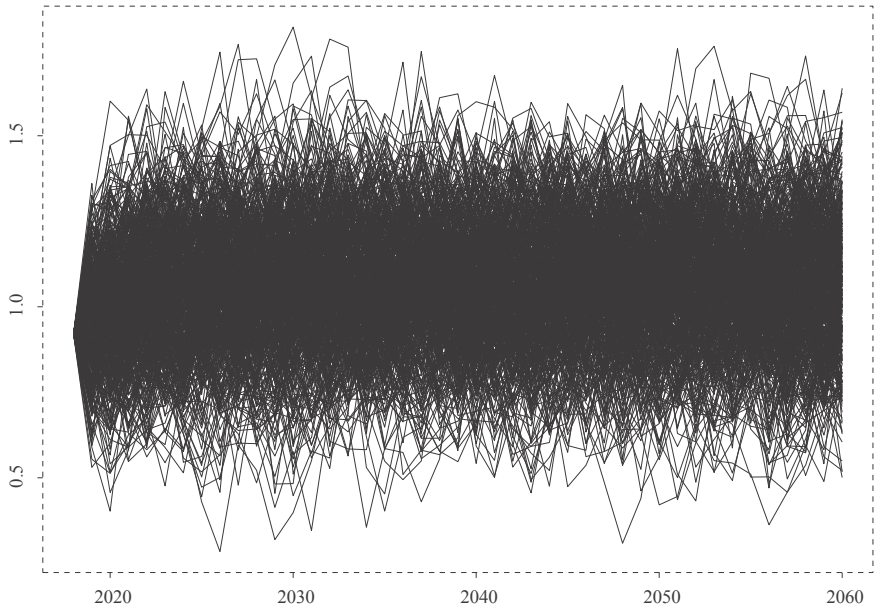
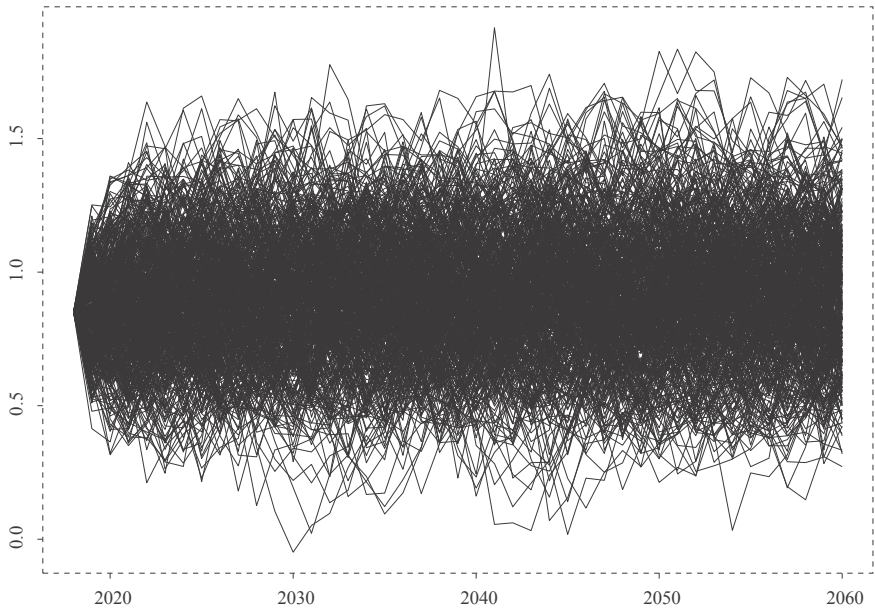
TABLE 12

AR (1) process for ratio of new female/male pensioners to female/male population aged 62/65

Gender	Estimated equation	R^2	σ	$E(y)$
Female	$y_t = 0.1629 + 0.8242 * y_{t-1} + \varepsilon_t$	0.64	0.1421	0.93
Male	$y_t = 0.350618 + 0.67092 * y_{t-1} + \varepsilon_t$	0.42	0.1437	1.07

Source: Author's calculations.

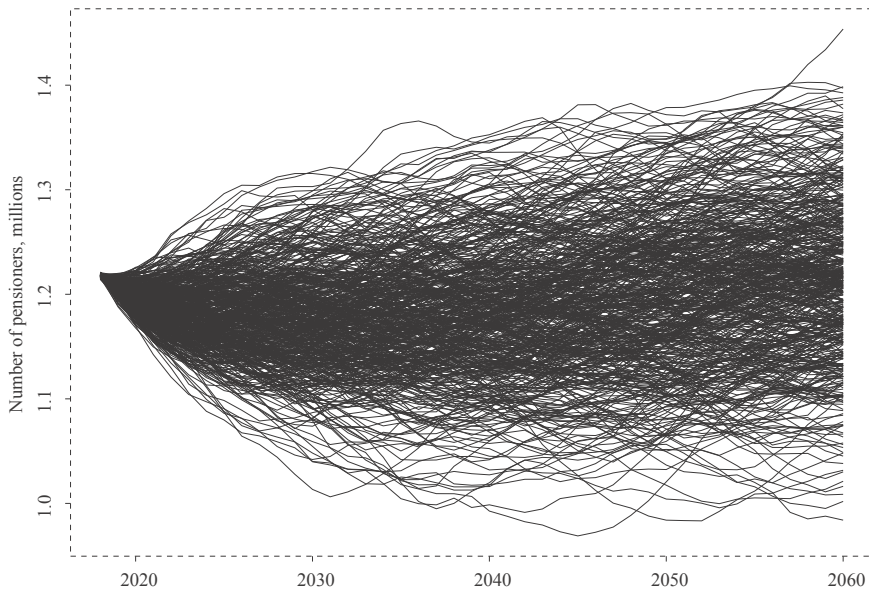
Now I set the two processes as $y_t = 0.16289 + 0.824202 * y_{t-1} + 0.1421 * \varepsilon_t$ and $y_t = 0.350618 + 0.67092 * y_{t-1} + 0.1437 * \varepsilon_t$, where $\varepsilon_t \sim Normal(0,1)$. In Figures 22 and 23 we can see the result after 500 simulations.

FIGURE 22*Stochastic forecast of new male pensioners ratio from 2018 to 2060**Source: Author's calculations.***FIGURE 23***Stochastic forecast of new female pensioners ratio from 2018 to 2060**Source: Author's calculations.*

The processes deviate significantly from their expected value. However, this should not pose a problem because it is our end goal to get a wider picture of the whole system. We have now estimated all the necessary parameters for forecasting the number of pensioners. Figure 24 shows the estimated results. The simulation is programmed in such a way as to incorporate the dynamics of shifting the minimum retirement age. The expected number of pensioners in 2060 is 1,211,136. We can say with 95% confidence that the interval lies between 1,073,076 and 1,349,965. These numbers will be used for further analysis. The number of pensioners at the end of 2017 was 1,236,258, which is to say that this model estimates a lower number of pensioners by 2060. The overall distribution of pensioners in 2060 can be observed in Figure 25.

FIGURE 24

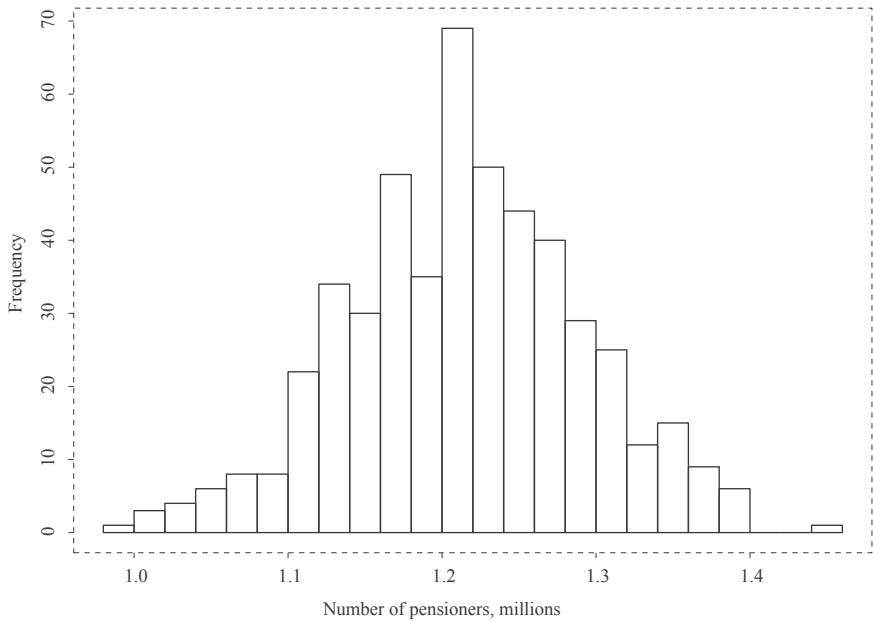
Stochastic forecast of the number of pensioners from 2018 to 2060



Source: Author's calculations.

FIGURE 25

Distribution histogram for the number of pensioners in 2060



Source: Author's calculations.

5 EMPLOYED POPULATION

We now need to estimate the employed population. The model of the employed population is set as follows (Tian and Zhao, 2016):

$$P_{E,t} = P_{w,t} * l_t * (1 - u_t) \quad (12)$$

$P_{E,t} \sim$ Employed population at time t

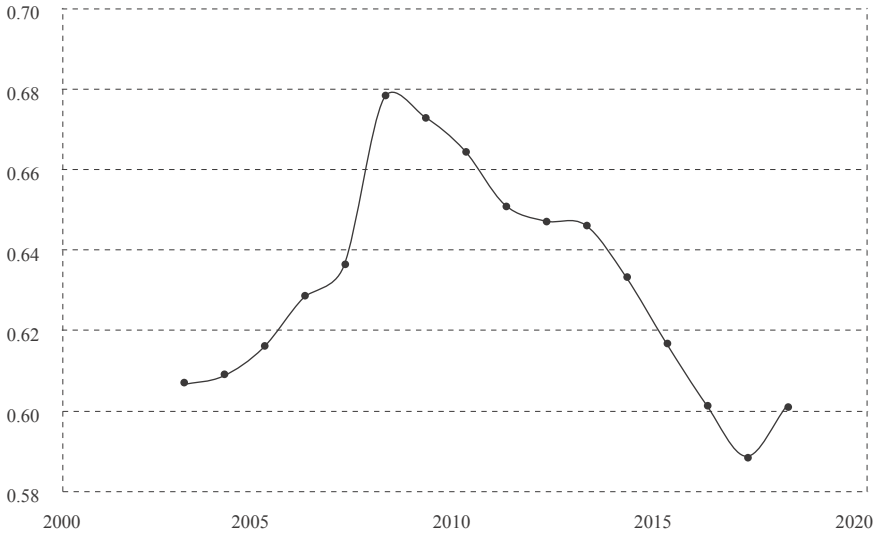
$P_{w,t} \sim$ Total working age population at time t

$l_t \sim$ Labor force to working age population ratio at time t

$u_t \sim$ Unemployment rate at time t

This model is very straightforward. The total working age population multiplied by the ratio of the labour force to total working age population and employment rate gives us the number of employed individuals.

The parameter l_t represents labour force ratio at time t . The Croatian Bureau for Statistics has been publishing monthly data on the size of the labour force since 2003. Since data for 2018 is available, we will use it. By calculating the average of the monthly labour force numbers in a year, I can estimate the labour force for the year. By dividing the result with the working age population for the chosen year, we obtain the ratio of the labour force to working age population. I calculated the working age population as male population aged 15 to 65 and female population aged 15 to 62. Figure 26 shows the results.

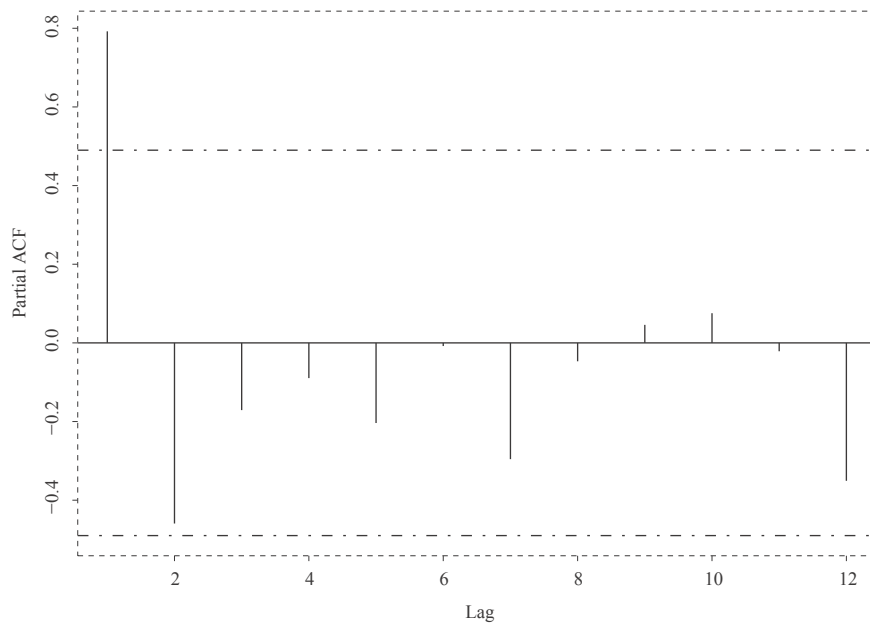
FIGURE 26*Labour force to working age population*

Source: CBS (2019); Eurostat; Author's calculations.

Since the ratio changes over time, we need to forecast its future values for the next 43 years. It is very hard to know what is going to happen in the Croatian economy over the next 5 years, let alone the next 43 years. Two other problems are that, first, the size of the working age population will fluctuate every year. Secondly, from 2033 onwards the new working age population will approximately be people aged 15 to 67. I will assume that the ratio is not dependent on the cohorts used to calculate working age population, but rather just on time. For the sake of simplicity, I will exclude the random walk hypothesis here. Figure 27 shows the PACF for the ratio of labour force to working age population. We conclude that an AR (1) process is the best fit for explaining the behaviour of the ratio². Table 13 shows the estimated values of the process. Afterwards I calculated the stochastic process for $y_t = 0.109315 + 0.827804 * y_{t-1} + 0.0152 * \varepsilon_t$, where $\varepsilon_t \sim Normal(0,1)$, 500 simulations of which are displayed in Figure 28.

² Using AR(1) process to project labor force to working age population ratio inertially projects past trends to future activity levels and probably undershoots the future (elderly) employment levels and contribution revenues that would result from pension policy and longer activity. The reader should be advised of this and possible upgrades of the model in the future.

FIGURE 27
PACF of labour force to working age population ratio

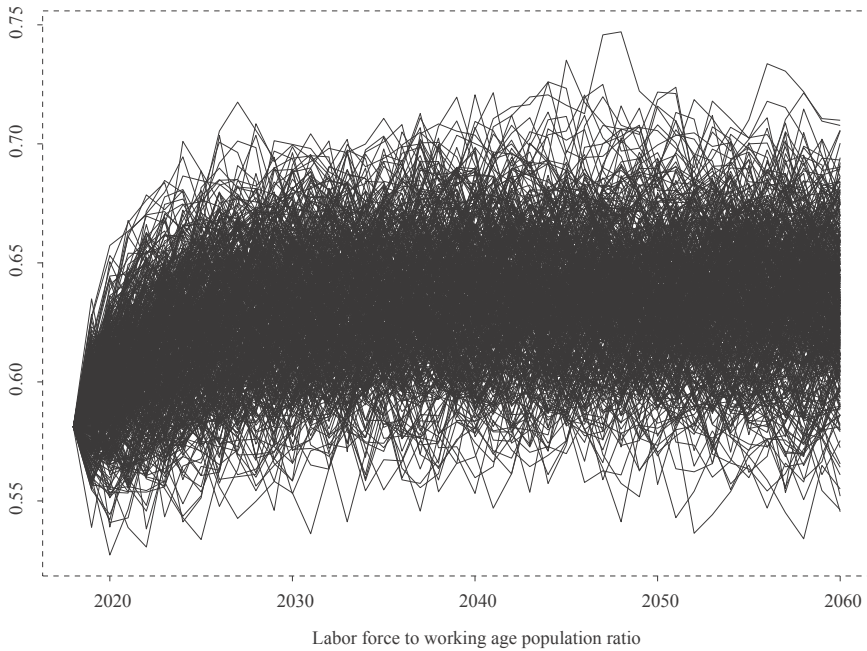


Source: Author's calculations.

TABLE 13
AR (1) process of labour force to working age population ratio

Estimated equation	R^2	σ	$E(y)$
$y_t = 0.1093 + 0.8278 * y_{t-1} + \varepsilon_t$	0.71	0.0152	0.63

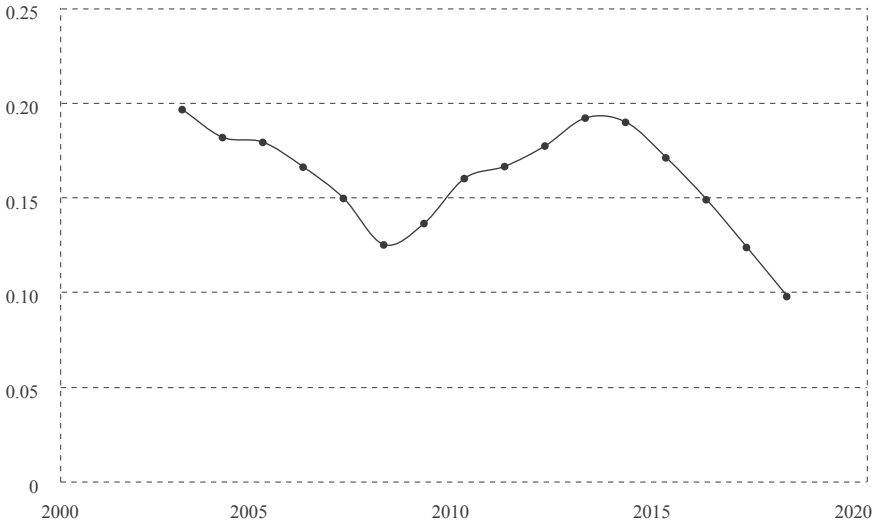
Source: Author's calculations.

FIGURE 28*Stochastic forecast of labour force ratio from 2018 to 2060*

Source: Author's calculations.

As it is already problematic to estimate the numbers of the future labour force, it is even more problematic to estimate the future unemployment rate over the next 43 years. It is very hard to predict what the movement of the future unemployment rate in the next 43 years will be, so we need to use forward-looking techniques to estimate it. Historical unemployment rates can be seen in Figure 29. Again, we have available data for 2018, which I will use. Historically, the rates fluctuate between 10% and 20%. The year 2018 saw the lowest unemployment rate in history, estimated at 9.8%. In order to try to forecast future unemployment rates up until 2060, I will employ scenario analysis with three separate scenarios, each of which will then be used in further analysis.

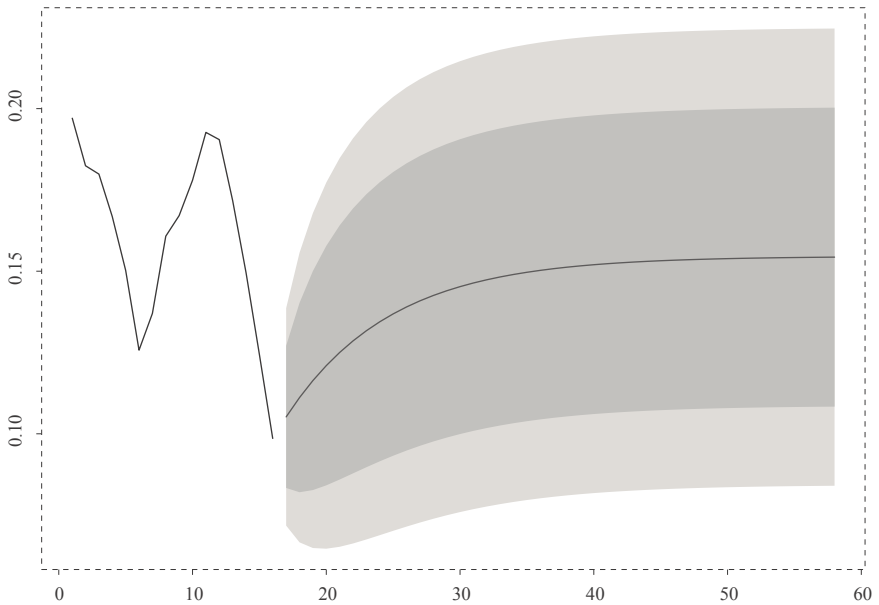
FIGURE 29
Historical unemployment rate in Croatia



Source: Croatian Bureau of Statistics.

In the first scenario the average unemployment rate will dynamically return to its historical average rate. This dynamic behaviour is shown in Figure 30. Its mean expected values will be used in further analysis.

FIGURE 30
Forecast of the future unemployment rate: Scenario 1



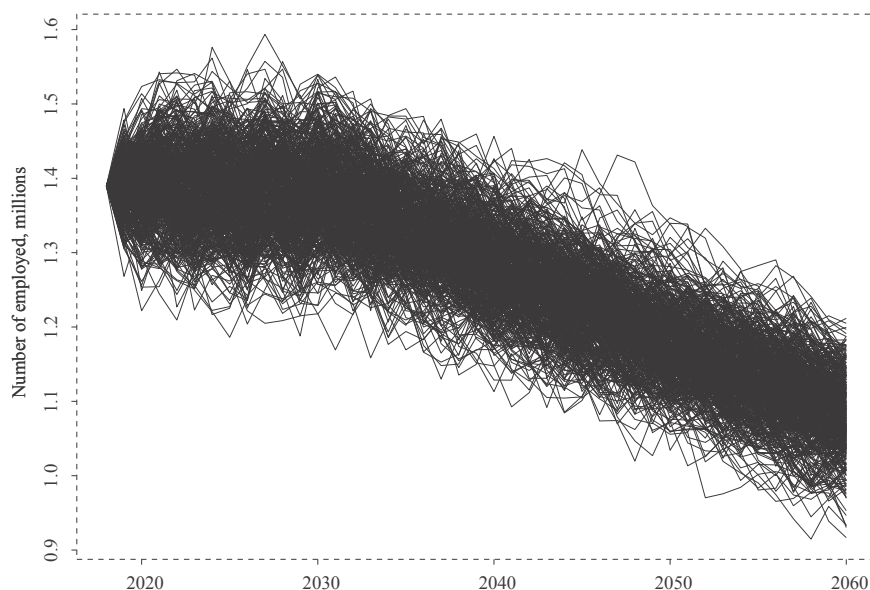
Source: Author's calculations.

In the second scenario, I will assume that the unemployment rate will on average stay at its current levels – at 9.84%. For the third scenario, I will assume that the unemployment level will dynamically converge to 5%, by dropping by 0.5% each year. After 10 years it will stay at 5% up until 2060. Those three scenarios allow us to cover three possible movements that could occur in the Croatian economy, which will help us see the wider picture of the pension system.

After creating a program that dynamically includes the postponement of the retirement age and simulating results according to Scenario 1, the results for the employed population over time can be seen in Figure 31. The expected size of the employed population in 2060 is 1,082,232. The employed population is thus smaller than the population of pensioners. This indicates the possibility that there will be high pressure on government expenses for the pension system in 2060.

FIGURE 31

Stochastic forecast of the employed population: Scenario 1

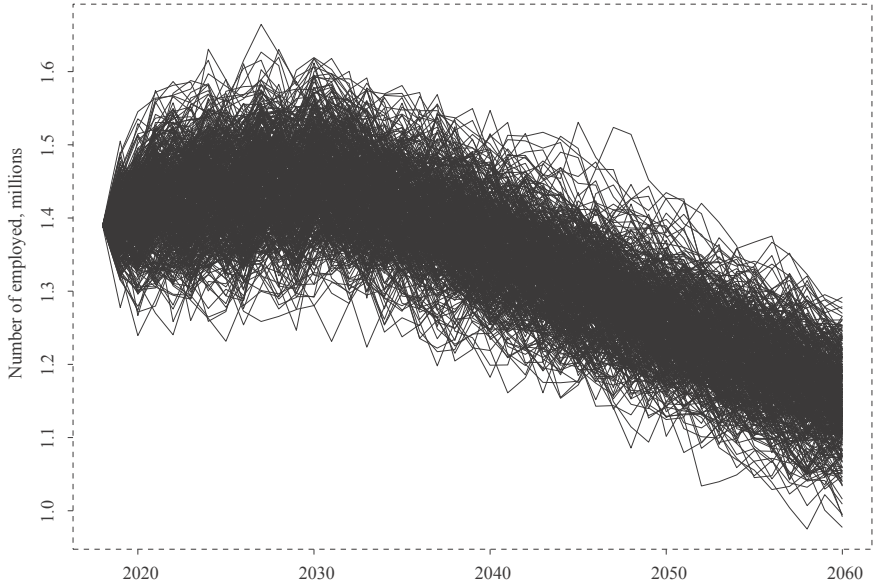


Source: Author's calculations.

Figure 32 shows the dynamics of the employed population generated according to Scenario 2. The expected employed population in 2060 is 1,153,739, which is 71,500 people more than in the last scenario. Furthermore, this number is still lower than the expected number of pensioners.

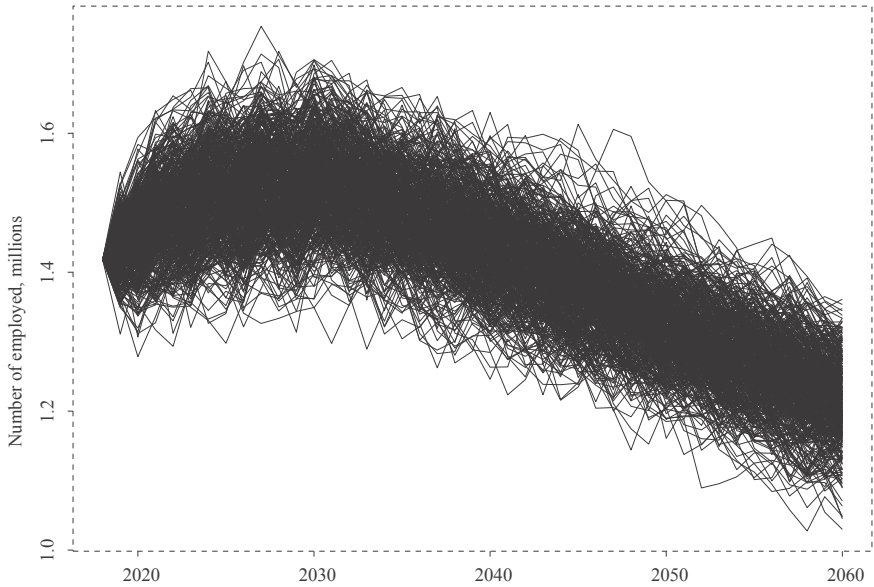
Figure 33 shows the expected employed population over time according to Scenario 3. The expected employed population in 2060 is 1,215,739, which is higher than the expected pensioner population in 2060. Since the expected number of pensioners in 2060 is 1,211,136, the best possible scenario is to end up with a 1:1 ratio of worker to pensioner by 2060.

FIGURE 32
Stochastic forecast of the employed population: Scenario 2



Source: Author's calculations.

FIGURE 33
Stochastic forecast of the employed population: Scenario 3



Source: Author's calculations.

6 ANALYSIS OF SUSTAINABILITY

Before answering the question of sustainability, we need to set the benchmark for what a sustainable system is. Let us first consider how the system functions. A certain number of people work and earn a salary for their work. A percentage of that gross salary is paid towards the pension system. This money is then used in two ways – it provides current pensioners with a pension and it is invested for capital accumulation. Therefore, a certain percentage of this money goes directly to the government for already existing pensioners. The government is obliged to provide retired individuals with pensions. So, our question is: can the government generate enough cash flow from the employed population in order to pay out pensions? If the cost of paying the pensioners is higher than the revenue earned, the government needs to pay for the rest with its own money or borrow money, so this could be understood as an investment. As opposed to companies, when the debt or cash outflow of a government is increased, every citizen is affected one way or another. Therefore, it is of the utmost importance to analyse the investment in the pension system. If the overall expenses are not too high, it will remain in the government's interest to pay for the pension system since it positively affects social conditions. However, only up to a certain point. Just as with companies, there are levels of debt where the government is better off not investing. In order to find out at what cost level the government is at break-even point requires a rather complex analysis, since many factors play vital roles. In 2017, the Croatian government gained 21.09 billion Kuna (HRK) revenue from the pension system and incurred HRK 37.67 billion expenses for the pension system (Mirovinsko.hr, 2018). The net amount was HRK -16.58 billion, whereupon the new reform was started. For this reason, I will use HRK 16.58 billion as the benchmark where the government is better off not investing. If the present value of future net expenses is higher than HRK 16.58 billion, it will be interpreted as unsustainable. It must be mentioned that this interpretation of unsustainability comes along with the assumption that the economic conditions in the country are not going to change in the next 43 years. This is not to be expected, but since I cannot know whether the economy will expand or weaken unexpectedly in the future, I decided to use this number for further analysis. I will compare the calculated present value of future expenses with 16.58 billion.

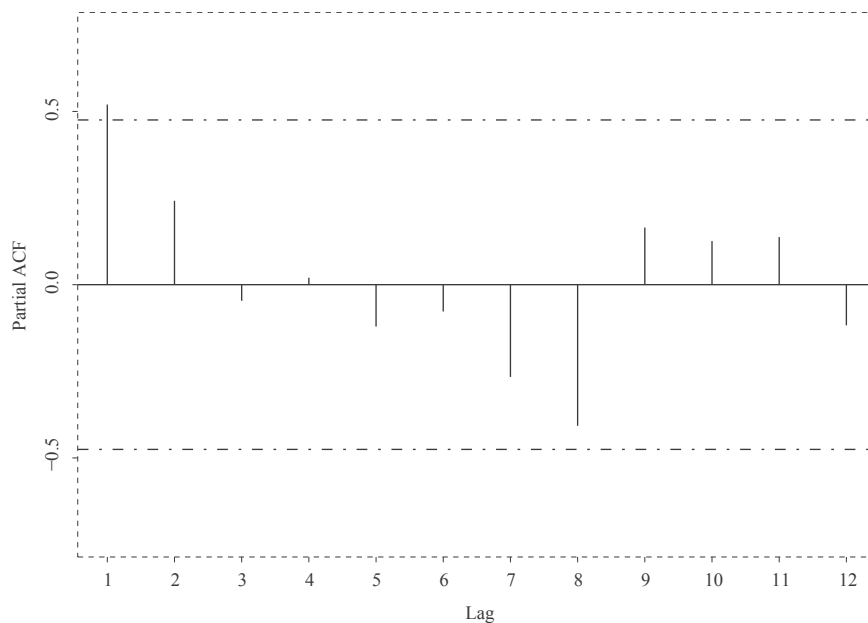
In order to forecast future government revenues and expenses from the pension system, we need to forecast wages in the country (Tian and Zhao, 2016). Table 14 shows the average gross salary and growth rates for each year. In later analysis, I shall exclude the values from 2018, but they are displayed in this table.

TABLE 14
Average gross salary and growth rates

Year	Average gross salary (in HRK)	Growth rates (in %)
2001	5,061	3.9
2002	5,366	6.0
2003	5,623	4.8
2004	5,985	6.4
2005	6,248	4.4
2006	6,634	6.2
2007	7,047	6.2
2008	7,544	7.1
2009	7,711	2.2
2010	7,679	-0.4
2011	7,796	1.5
2012	7,875	1.0
2013	7,939	0.8
2014	7,951	0.2
2015	8,055	1.3
2016	7,752	-3.8
2017	8,055	3.9
2018	8,448	4.9

Source: *Narodne novine*; Author's calculations.

FIGURE 34
PACF of growth rates in wages



Source: Author's calculations.

The average growth rate of the gross salary is 3.1%. From Figure 34 we conclude that the autocorrelation function of the first order should be used in order to predict future growth rate values. By knowing the future growth rate values, we can easily calculate future salary values. It is hard to predict future salary growth rates over the next 43 years. Growth rates can be explained through the economy of the country, as well as through politics and law. Most of those variables are hardly observable in the economy. I will use the AR (1) model to estimate the parameters. Since we are forecasting 43 years ahead, as long as we use the correct average and take various possible events and extrema into consideration, we should get a very good dynamical convergence of the salaries. Table 15 shows AR (1) parameters estimates. Now I created the following process: $y_t = 0.0143 + 0.52176 * y_{t-1} + 0.0264 * \varepsilon_t$, where $\varepsilon_t \sim Normal(0,1)$. Figure 35 shows the result of 500 simulations of the process.

TABLE 15

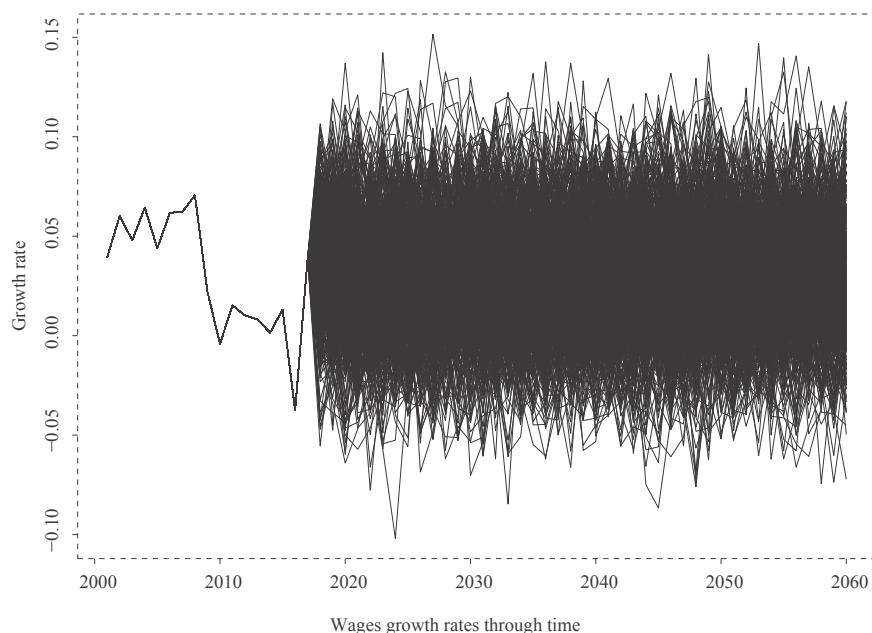
AR (1) process for growth rates in wages

Estimated equation	R^2	σ	$E(y)$
$y_t = 0.0143 + 0.5218 * y_{t-1} + \varepsilon_t$	0.28	0.0264	0.0299

Source: Author's calculations.

FIGURE 35

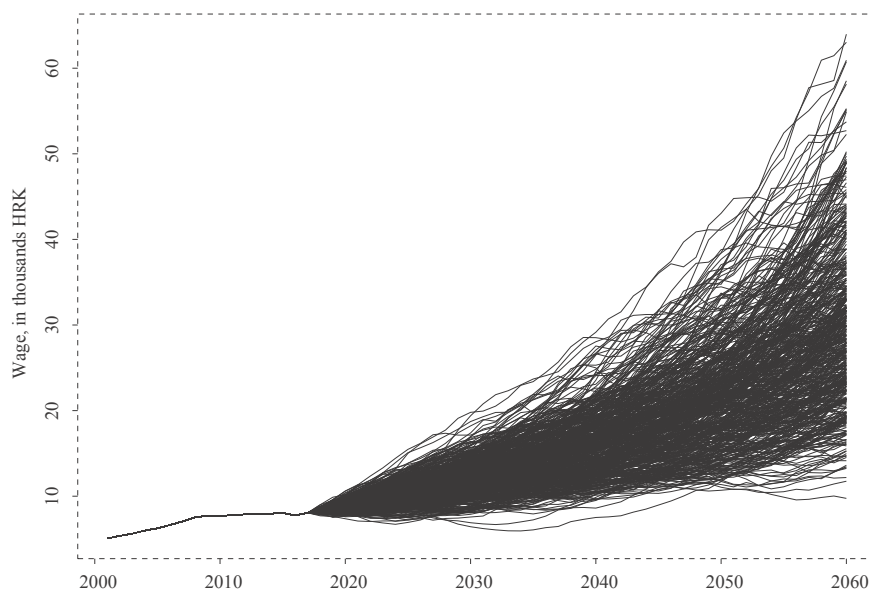
Stochastic forecast for growth rates in wages



Source: Author's calculations.

The process estimates growth rates between -10% and 15%. I believe that the 500 simulations generated above can explain the dynamics of future growth rates in wages for the next 43 years. Figure 36 shows the realized values of future wages. The expected gross wage in 2060 is HRK 29,735 and the median value is HRK 28,343. Estimated wage distribution in 2060 can be seen in Figure 37. We can estimate with 95% confidence that the interval lies between HRK 15,106 and HRK 51.307.

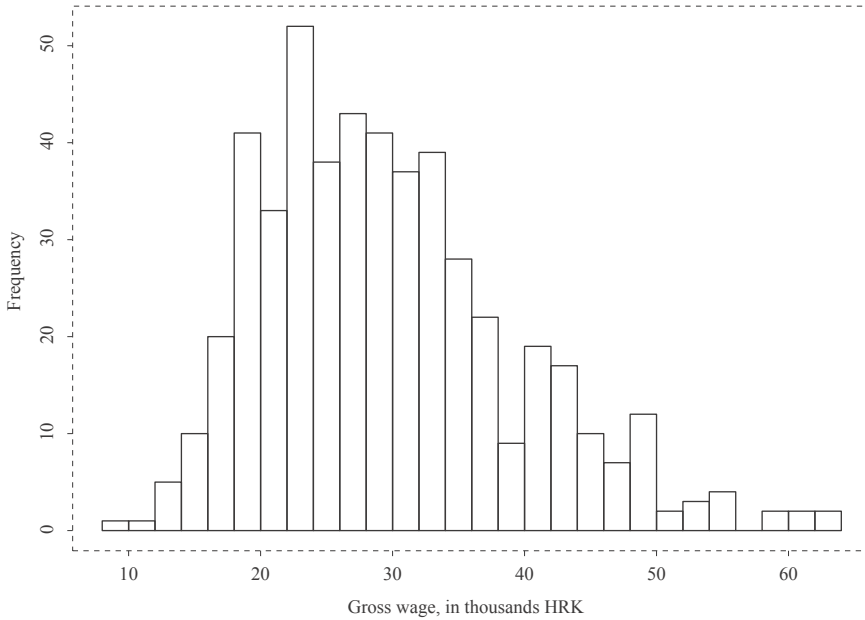
FIGURE 36
Stochastic forecast of future wages



Source: Author's calculations.

Now we can start estimating the revenues generated from the pension system over the next 43 years. We know that before 2019, 15% (contribution rate) of an individual's gross salary was paid to the first pillar³. That money was then used to finance pensioners. After the new reform, every pensioner may decide whether they want to receive a combined pension (financed from both pillars) or a first-pillar pension only. We can conclude that the combined pension scheme was not sustainable, since the government implemented its reform in 2019. If an individual wants to receive pension just from the first pillar, all the capital accumulated in the second pillar will be transferred to the state.

³ Author's note: This is not true for everyone, but we want to simplify the calculation process.

FIGURE 37*Histogram of wage distribution in 2060*

Source: Author's calculations.

Now we need to estimate the amount of capital accumulated in the second pillar and that may be a difficult problem. Firstly, recall from the first paragraph that individuals can decide which investment scheme they want to have in the second pillar. Each investment scheme leads to different capital accumulated. Forecasting the future expected returns and standard deviations is a problem that requires deeper stochastic analysis which I will not implement here. Secondly, each year, a different number of individuals will decide to send their capital from the second pillar to the state, and we can view the number of individuals in each year as a random variable through time i.e. stochastic process which I will not model here. Putting everything together, future expected returns of the second pillar and the number of individuals that decide to receive pensions just from first pillar can be modelled as a stochastic process, but I will not involve stochastic calculus here; it is left for future research.

We do know that the market-implied pension contribution rate lies between 15% and 20% from the fact that some individuals will receive a combined pension and others will receive pension just from the first pillar. Therefore, I will estimate future revenues by setting my equation in such a way that the contribution rate equals to 20%, meaning that 20% of the gross salary is paid towards the government after January 1, 2019. If every individual decided to receive their pension just from the first pillar, estimating the contribution rate at 20% is a very good approximation of government cash flow through time. The equation for calculat-

ing revenues is set in the following way (the revenues are scaled to a yearly basis) (Tian and Zhao, 2016):

$$Revenues_t = Average\ gross\ wage_t * Employed\ population_t * 0.2 * 12 \quad (13)$$

When it comes to expenses, we need to know what percentage of the gross wage the pension should amount to. Table 16 shows the average pension rates for December of each year, as reported by HZMO, as well as the percentage of the average gross salary in that year.

TABLE 16
Average pension by year and percentage in gross salary

Year	Average pension (in HRK)	Percentage in gross salary (in %)
2001	1,672	33
2002	1,720	32
2003	1,801	32
2004	1,848	31
2005	1,904	30
2006	2,000	30
2007	1,999	28
2008	2,169	29
2009	2,164	28
2010	2,151	28
2011	2,184	28
2012	2,502	32
2013	2,417	30
2014	2,423	30
2015	2,437	30
2016	2,525	33
2017	2,439	30

Source: HZMO; Author's calculations.

As we can see, the percentage of the pension amount in gross salary oscillates between 28% and 33%. The average is 30%, so I will use that value as the expected pension per pensioner in further analysis. This wage indexation is assumed for reasons of simplicity in further analysis. The expenses equation is set in the following way (Tian and Zhao, 2016):

$$Expenses_t = Average\ gross\ wage_t * Pensioners_t * 0.3 * 12 \quad (14)$$

This equation is also scaled to yearly values. By subtracting costs from revenues, we obtain the net cash flow generated from the pension system. We again have three different scenarios, which will be analysed separately.

If we use the contribution rate of 15% in Equation (13), we estimate that the expected net cash flow in 2018 is HRK -16.1 billion. We already know that in

2017 the net cash flow was HRK -16.58 billion. As already mentioned, since the start of 2019, every individual has been able to decide whether they want their pension to be funded from the first pillar or be combined, which will directly influence the contribution rate. If we assume that no one will use the combined pension system, we can exclude its existence from our calculations – to simplify the estimation process – and say that 20% of the salary amount will be contributed just for the first pillar.

In all three following scenarios, analysed in paragraphs 6.1, 6.2 and 6.3, I expect that the second pillar will not gain enough competitiveness in comparison with the first pillar. This is just an assumption in order to see what the outcome of this scenario is, and readers should be aware of it. Later, the outcome of the scenario when the second pillar gains in competitiveness will be shown.

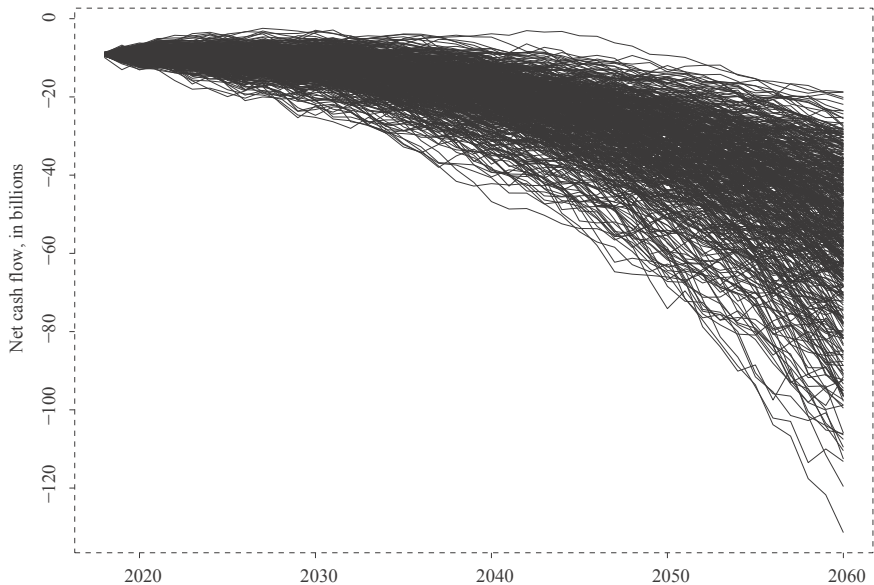
6.1 FUTURE DYNAMICS OF THE PENSION SYSTEM WITHOUT THE SECOND PILLAR: UNEMPLOYMENT RATE SCENARIO 1

As described above, in the first scenario the unemployment rate is expected to return dynamically to its historical average. We have already concluded that this is the worst-case scenario when it comes to the ratio of pensioners to workers. We can thus expect that this scenario will also be the worst in net cash flow generated by the government from the pension system. The result calculated by estimating revenues and subtracting estimated expenses can be seen in Figure 38. The expected net cash flow in 2060 is HRK -53.91 billion. Discounted until today with discount factor of 2.99%⁴ – since the expected wage growth is 2.99% per year (as shown in Table 15) – we obtain the value of HRK -15.19 billion. This number is very close to the value of HRK -16.58 billion, meaning that it is showing signs of possible unsustainability. The future value of HRK 16.58 billion in 2060 is HRK 58.9 billion (calculated with an interest rate factor of 2.99%). The percentage that corresponds to the value of HRK -58.9 billion is around 34%. We can interpret this by saying it is 34% probable that the pension system will be unsustainable by 2060 if the unemployment rate converges to its historical average.

⁴ Discounting with wages was used instead of GDP for reasons of simplicity i.e. GDP is assumed to grow at the same rate.

FIGURE 38

Stochastic forecast of government net cash flow from the pension system: Scenario 1



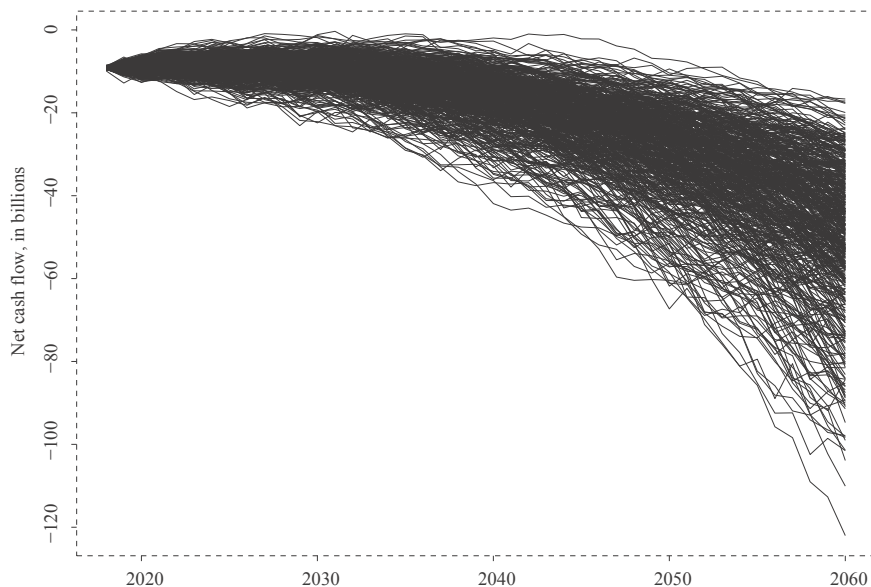
Source: Author's calculations.

6.2 FUTURE DYNAMICS OF THE PENSION SYSTEM WITHOUT THE SECOND PILLAR: UNEMPLOYMENT RATE SCENARIO 2

In the second scenario, the unemployment rate is expected to oscillate around 9.84%, which equals to the value of the average unemployment rate in 2018. We already know that in this case the net cash flow generated from the pension system should be positively affected. Figure 39 shows the net cash flow generated from the pension system. The expected net cash flow in 2060 is HRK -48.81 billion. The present value of HRK -48.81 billion is HRK -13.75 billion. The percentage that corresponds to the value of HRK -58.9 billion is around 23%. So we can say that it is 23% probable that the pension system will be unsustainable by 2060 if the future unemployment rate oscillates around 9.84% on average. Considering that the historical unemployment rate was never this low, if it stayed at this level for the next 43 years, 23% of the simulated results (out of 500) leads to government debt that we consider unsustainable. This is not a good outlook for the Croatian pension system. The truth is that the historical unemployment rate has nothing to do with the future unemployment rate, so it is feasible to assume that the unemployment rate could actually be at this level, if not at an even lower one.

FIGURE 39

Stochastic forecast of government net cash flow from the pension system: Scenario 2

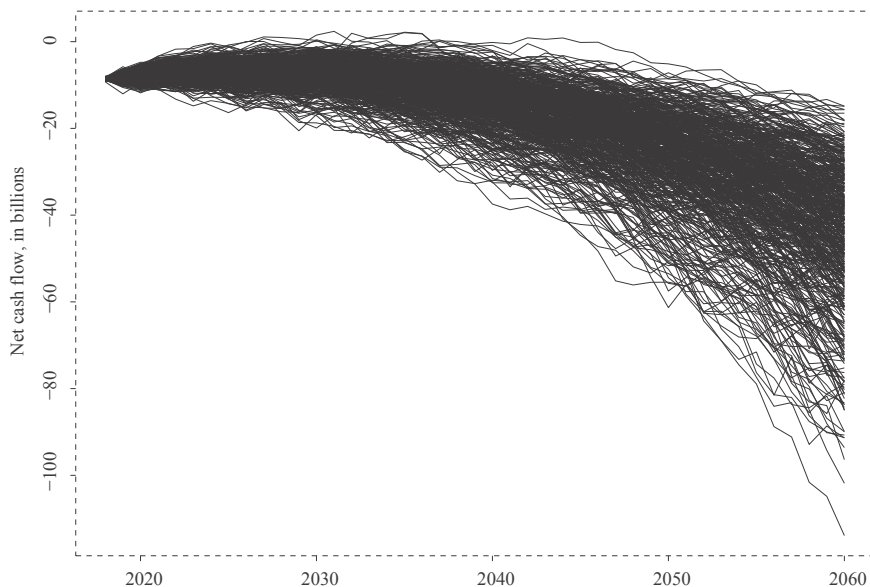


Source: Author's calculations.

6.3 FUTURE DYNAMICS OF THE PENSION SYSTEM WITHOUT THE SECOND PILLAR: UNEMPLOYMENT RATE SCENARIO 3

In the third scenario, the future unemployment rate is expected to oscillate around 5% on average. We already know that this is the best scenario out of the three that are created. Figure 40 shows net cash flow generated by the government if scenario 3 occurs. The expected net cash flow generated in 2060 is HRK -44.38 billion which equals HRK -12.50 billion at present value. The percentage that corresponds to the value of HRK -58.9 billion is around 17%. Figure 40 shows that the expected net cash flow may not change that much over the next 15 to 20 years. But after 2040 the expected net cash flow starts to decrease rapidly.

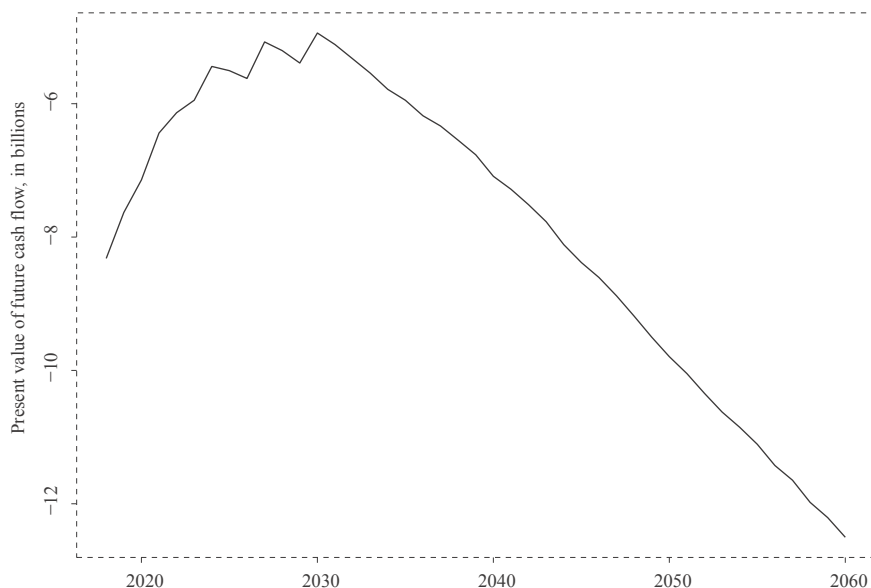
FIGURE 40

Stochastic forecast of government net cash flow from the pension system: Scenario 3*Source: Author's calculations.*

We are interested in the present value of future expenses. An interesting phenomenon can be observed from Figure 41. The figure shows the expected present value of future expenses over the years. With the unemployment rate from Scenario 3, we can notice that the present value of future cash flow keeps increasing over the first 12 to 15 years. It then starts decreasing without signs of stopping. This expected present value of future cash flow is estimated if the contribution rate equals to 20%, meaning that every individual decides to receive pensions just from the first pillar. Figure 41 predicts that this reform will not solve financial sustainability problems; it will only postpone them for a couple of decades.

FIGURE 41

Expected present value of government future cash flow generated from the pension system: Scenario 3



Source: Author's calculations.

These three analysed scenarios were created on the assumption that the second pillar of the pension system will never be as competitive as the first pillar. Next, we will analyse what would happen if the second pillar gains in competitiveness. It should be mentioned again that this interpretation of unsustainability is made with the assumption that the economy will not change a lot from its present state. If a huge positive shift in the real gross domestic product (GDP) happened, then the government could handle higher debt for the pension system. This interpretation of unsustainability should be understood by its being kept in mind that I can hardly predict future changes in the economy.

6.4 STRENGTHENING THE SECOND PILLAR

In this chapter there will be an assumption of the fungibility of the first and second pillar in order to estimate the fiscal space that could be opened to raise the replacement rates. The second assumption is that the second pillar will not be immediately strengthened in 2019. I will assume that the strengthening of the second pillar will occur in 2030. This assumption may be questionable but thinking of the dynamics of the system we can conclude that the new reform will not immediately affect the financial sustainability of the pension system in 2019, but rather it will take some time until the dynamics adjust. Therefore, I created scenarios in which the second pillar is starting to gain strength in 2030. If the assumption is made that second pillar is starting to gain strength in 2025 or 2035 the overall solution deviates less than 1% from what will be illustrated in this paper, which indicates that

as long as the second pillar gains strength in the forecast period the convergence in the solution is inevitable. Therefore, in 2030 pensioners will decide to receive their pension from a combined pension scheme and the new contribution rate will be 15%. For this case I will create two different scenarios. In the first scenario, the government will pay 75% of the total pension amount, since the contribution rate of 15% equals 75% of the total pension amount. The other 25% will be financed from the second pillar. In the second scenario I expect even better strengthening of the second pillar, where the same conditions regarding this year apply as in the first scenario, but I will also assume that every two years the government will decrease expenses by 5% over the next ten years. Government expenses for the total pension system would remain fixed at 50% after 2040. The other 50% will be financed from the second pillar (note that the assumption of the fungibility of the first and second pillar is used).

For the first scenario, revenues and expenses are set in the following way:

$$Revenues_t = Average\ gross\ wage_t * Employed\ population_t * 0.15 * 12 \quad (15)$$

$$Expenses_t = Average\ gross\ wage_t * Pensioners_t * 0.3 * 12 * 0.75 \quad (16)$$

These equations are applied for the years after 2030.

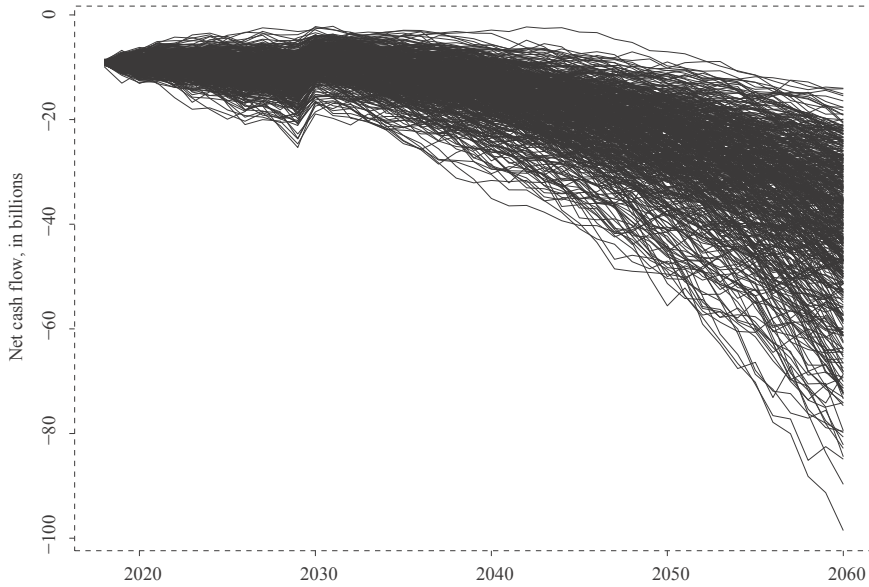
In this scenario, the government is earning less revenue, but it is also incurring fewer expenses. Figure 42 shows the estimated result of a stochastic forecast of the government net cash flow, where the unemployment rate is expected to increase over the years (scenario 1 for the unemployment rate). In 2060, the expected net cash flow is HRK -40.43 billion, which stands for HRK 11.39 billion present value. This is already a better result than the one analysed in paragraph 6.3. The percentage that corresponds to the amount of HRK -58.9 billion 2060 is around 12%.

Figure 43 shows the estimated result of net government cash flow generated with Equations (15) and (16), where the unemployment rate is expected to decrease over the next 43 years and remain around 5%. The expected net cash flow in 2060 is HRK -33.28 billion, which stands for HRK -9.38 billion present value. The percentage that corresponds to the value of HRK -58.9 billion in 2060 is around 5%. We can conclude that if the second pillar gains in competitiveness, we can expect stronger financial sustainability of the Croatian pension system.

This analysis shows that possible strengthening of the second pillar would exert much more influence on the whole pension system than changes in the unemployment rate. According to this scenario, we can say that there it is 5% to 12% probable that the Croatian pension system is unsustainable by 2060 if the second pillar shows enough strength to cover 25% of the total expenses created by the pension system. This interpretation of unsustainability comes along with the assumptions we set in this analysis.

FIGURE 42

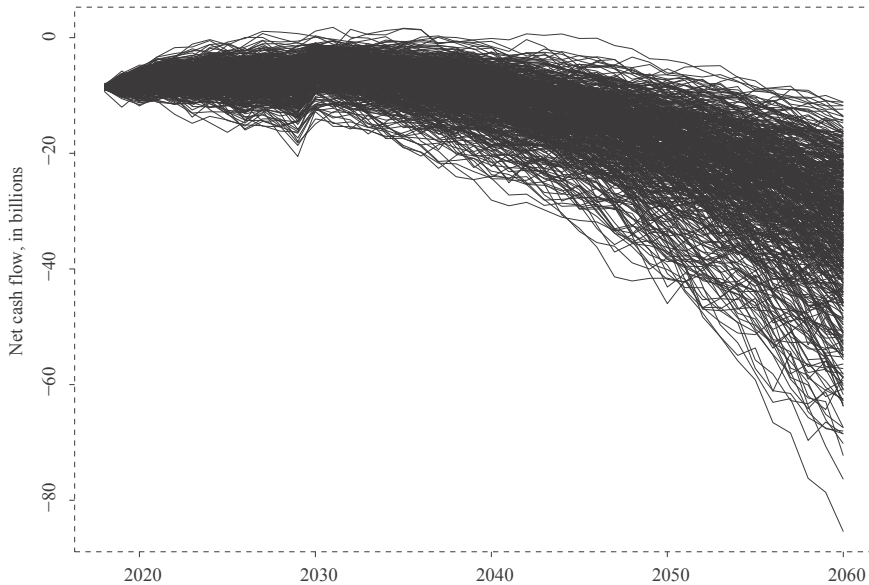
Stochastic forecast of government net cash flow with the assumption that pensioners decide to use a combined pension scheme after 2030. Unemployment rate from scenario 1 is used



Source: Author's calculations.

FIGURE 43

Stochastic forecast of government net cash flow with the assumption that pensioners decide to use a combined pension scheme after 2030. Unemployment rate from scenario 3 is used



Source: Author's calculations.

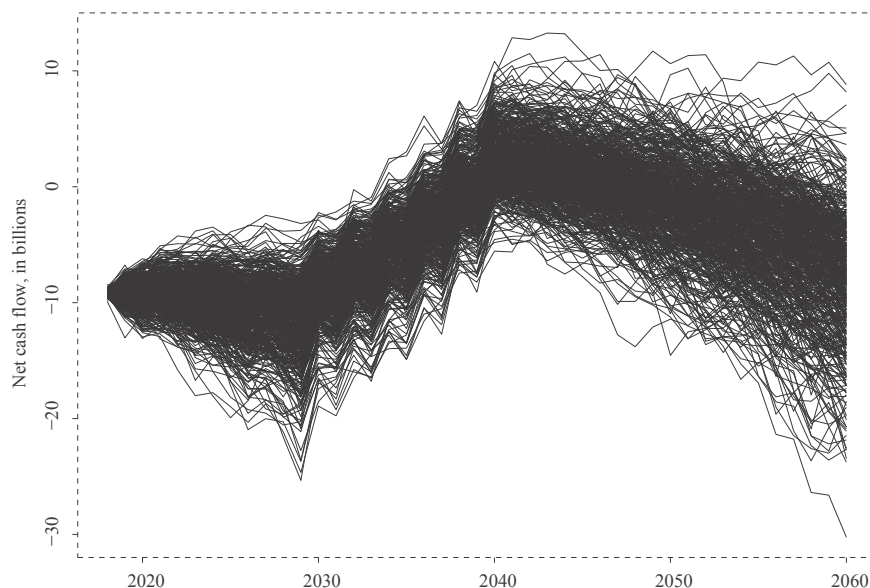
For the second scenario of strengthening in the second pillar, the used expenses equation changes dynamically through time, starting as Equation (16). Every 2 years the expenses drop by 5%, so that the equation for the years after 2040 is set in the following way:

$$\text{Expenses}_t = \text{Average gross wage}_t * \text{Pensioners}_t * 0.3 * 12 * 0.5 \quad (17)$$

Figure 44 shows the estimated net government cash flow generated by this scenario. This figure shows financial sustainability of 100%. The expected government net cash flow in 2060 is HRK -7.64 billion. This is so far the best possible scenario that can occur. Also, around the year 2040, the expected government net cash flow for the pension system has positive values. If the second pillar gained enough strength to replicate this scenario, there would not be a single observation that yields financial unsustainability.

FIGURE 44

Stochastic forecast of government net cash flow with the assumption that the second pillar gains enough competitiveness to cover 50% of expenses after 2040. Scenario 1 unemployment rate is used



Source: Author's calculations.

6.4.1 CAN PENSION INCREASE IF SECOND PILLAR GAIN ITS COMPETITIVENESS?

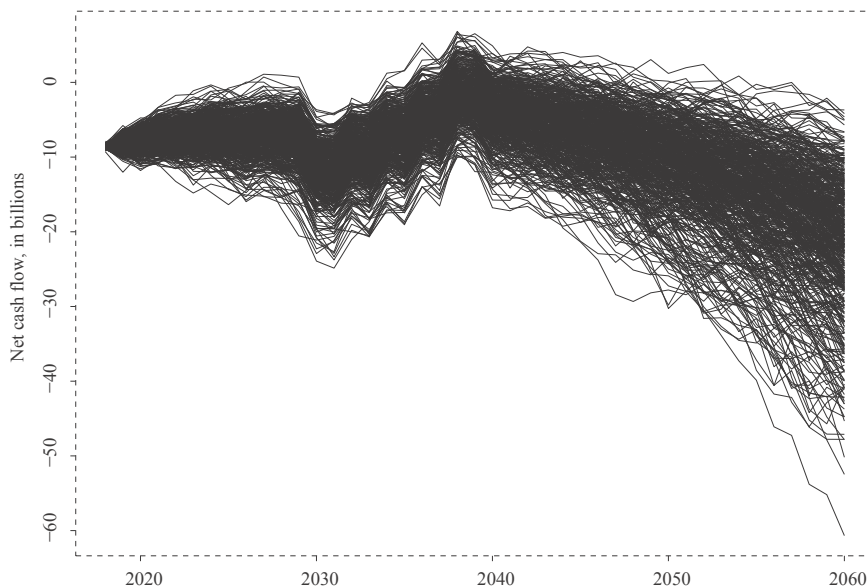
We saw that if we expect the unemployment rate to increase on average in the forecast horizon, and if the second pillar gains enough competitiveness to cover 50% of the expenses of the pension system, then the pension system would surely be financially stable in the forecast horizon. If the average unemployment rate stays at the same value as in 2018 (9.84%) or if it decreases in the forecast horizon, the result will be even better. In this scenario we expected pensions to amount to 30% of the gross salary. We saw that the pension system is definitely sustainable in this scenario, no matter what the unemployment rate is.

Together with assumption of the fungibility of the first and second pillar, I assume that pensions will amount to 35% of the gross salary after 2030 with the unemployment rate from scenario 1 (where the unemployment rate increases over time), and financial sustainability is 100% probable. The worst observation generated by this scenario is HRK -51.28 billion in 2060, which is still lower than the future values of HRK -16.58 billion. We can conclude that if the second pillar generates enough competitiveness to cover 50% of the expenses after 2040, then the government will be able to increase the pensions to 35% of the gross salary, and the system will still be financially sustainable with 100% probability.

Figure 45 shows the stochastic forecast for net cash outflow if we add another extra condition to the previous scenario: that pensions amount to 40% of the gross salary after 2040. The expected government net cash flow in 2060 is then HRK -28.55 billion. The percentile that corresponds to the value of HRK -58.9 billion is around 1%. This was calculated with the worst unemployment rate scenario. According to this analysis, the government would be able to increase pensions to amount to 35% of the gross salary between 2030 and 2040. They would also be able to increase them once more in 2040 to amount to 40% of the gross salary with a maximum of 1% probability of being financially unsustainable. If the second unemployment rate scenario occurred, the expected probability for the system to be unsustainable is less than 1%. If the third unemployment rate scenario occurred, the expected probability for the system to be unsustainable would be around 0.1%. The results of this analysis are based on the assumption that the second pillar gains enough competitiveness to cover 50% of the expenses of the pension system.

FIGURE 45

Stochastic forecast of government net cash flow with the assumption that the second pillar gain enough competitiveness to cover 50% of expenses and extra assumption that pension amounts to 35% of gross salary between 2030 and 2040 and 40% of gross salary after 2040. Scenario 1 of unemployment rate is used



Source: Author's calculations.

7 CONCLUSION

In this paper I used stochastic methods to analyse the sustainability of the Croatian pension system. I also created three possible scenarios for future unemployment rates: A scenario in which the unemployment rate will on average increase for the next 43 years, a scenario where the unemployment rate will on average stay the same as it was in 2018, and a scenario where the unemployment rate will on average decrease.

The benchmark of unsustainability is the net cash flow in 2017, HRK -16.58 billion, since it was after that year that the government started working on the new reform. If the present value of future net cash flow is lower than HRK -16.58 billion, the pension system is said to be unsustainable. This is made with the assumption that Croatia will not experience significant unexpected positive or negative shifts in the economy in the forecast period.

Furthermore, I created three scenarios to forecast future movements in the pension system. In the first scenario, the second pillar never gains enough competitiveness to compensate pensions generated from the first pillar, meaning that every individual would receive pensions just from the first pillar. The analysis demonstrated

that there is a between 17% and 34% chance that the pension system will be unsustainable by 2060 if this scenario occurs.

In the second scenario, the second pillar gains enough competitiveness after 2030 to compensate for the same value of pensions as the first pillar. So that the expected cost of pension system is financed 75% by the first pillar and 25% by the second pillar. This scenario demonstrated that there is 5% to 12% probability of the pension system being financially unsustainable.

The third scenario is set in such a way that the cost of the pension system in 2030 is financed 75% by the first pillar and 25% by the second pillar. After 2030, I assumed the fungibility of the first and second pillar in such a way that more than 25% of the individual pension is financed from the second pillar. This indirectly estimates the fiscal space that could be opened to raise the replacement rates. The amount paid for the pension system by the first pillar is reduced by 5% every two years until 2040. In 2040, the costs of the pension system are split evenly between the first and second pillar. It was demonstrated that in this scenario there is a 100% probability that the pension system will be financially sustainable by 2060.

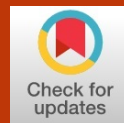
It was also demonstrated that if the second pillar gained enough competitiveness to cover 50% of the expenses after 2040, the expected pension rates (replacement rate) could be increased to 35% of the gross salary after 2030 with 100% probability of being financially sustainable. Furthermore, it was shown that an extra increase in the pension rate – where it would amount to 40% of the gross salary after the year 2040 – is possible in this scenario, with a 1% probability of being financially unsustainable, all while taking into account the worst unemployment rate scenario.

Disclosure statement

No potential conflict of interest was reported by the author.

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How is health associated with employment during later working life in Croatia?

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Article**

JEL: I12, J14, J21

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Abstract

This paper investigates how self-rated health (SRH), as a measure of general health, is associated with employment during later working life in Croatia. Using data from Wave 6 of the Survey of Health, Ageing and Retirement in Europe (SHARE), we estimate logistic regression models and study whether and to what extent the effects of SRH change with the inclusion of objective health measures. Worse SRH significantly decreases the probability of employment, but this effect becomes insignificant after account is taken of the objective health-related variables. This suggests that in Croatia, SRH and (a combination of) objective health indicators behave as substitutes, and either SRH or objective health measures can be adopted for the study of labour market participation. As worse health lowers the probability of employment during later working life in Croatia, in order to improve the working capacity of older adults, policymakers should strive for more efficient health promotion strategies and public health initiatives.

Keywords: (non-)employment, health, later working life, SHARE, Croatia

1 INTRODUCTION

Trends in population ageing can arguably be attributed to increases in life expectancy and low fertility. As in many other central and eastern European countries, population ageing in Croatia is further exacerbated by high rates of emigration. According to Eurostat (2019a), Croatia is likely to lose more than 15% of its population by the middle of the century. The ageing of the population, compounding the decline in total population, is shrinking the available workforce and manifesting in the form of major labour shortages in Croatia (European Commission, 2019). Therefore, older workers' labour market transitions, and (early) retirement decisions especially (see Bađun and Smolić, 2018), have become an important, if not a central matter of public debate.

To mitigate the effects of population ageing, and to ensure sufficient resources are available for retirement, policymakers are actively seeking ways to extend people's working lives. This, however, raises the issue of whether older individuals are able to supply labour given their health and social conditions. On the other hand, (early) retirees who left the labour market earlier than desired, at least with respect to their health and socio-demographics, might represent an "unused work capacity" (Brugiavini, Croda and Mariuzzo, 2005).

In 2018, the employment rate of older workers (ages 55 to 64) in Croatia was 42.5%, the lowest within the EU (Eurostat, 2019b), and did not meet the Stockholm target of 50% (European Commission, 2011). The employment rate of people aged 50 to 64 in Croatia was, at 51.6% in 2018, the second lowest in the EU, with only Greece behind (Eurostat, 2019b). During the last decade, employment rates of people in their later working lives, at ages 50 to 64 and ages 55 to 64, have fluctuated around 50% and 40% respectively (Eurostat, 2019b). This indicates that a significant fraction of the workforce in Croatia exits the labour market

before reaching the statutory retirement age. Research has explored several possible reasons, including the economic transition (Tomić, 2014), low working-life quality among older employees (Galić, Parmač Kovačić and Vehovec, 2019), and an institutional setting favouring early retirement (Baloković, 2011; Bejaković, 2016). However, research relating health to older workers' employment in Croatia remains limited, with existing studies on the health-employment relationship (Bubaš, Miloš and Delić-Brkljačić, 2008; Ecimović Nemarnik and Macan, 2018) mainly focusing on the effects of occupational diseases, while the issue of older workers in general attracts little attention among policymakers in Croatia (Goić, 2017). A major knowledge gap in this field thus relates to how general health affects older people's (non-)employment in Croatia.

This paper uses data from the Survey of Health, Ageing and Retirement in Europe (SHARE) to address this knowledge gap. Our main goal is to investigate how self-rated health (SRH), as a measure of general health, is associated with employment during later working life (ages 50 to 64) in Croatia. Prior research has included SRH as a single health-related predictor of labour market participation among older adults in Croatia (Ostrovidov Jakšić and Jakšić, 2019), but one problem with such an approach is that SRH may be endogenous with respect to labour market participation. For example, people may use poor health conditions to validate their non-participation (Bound, 1991). To circumvent this problem, some authors (Dwyer and Mitchell, 1999; Cai and Kalb, 2006; Blundell et al., 2017) have used objective health measures to instrument SRH. Other authors (Kalwij and Vermeulen, 2008), however, argue that SRH is endogenous due to omitted objective-health indicators, and suggest including them as controls, assuming that SRH offers additional health information that might not be captured by the objective health indicators. If this is the case, then both SRH and more objective measures of health will have an impact on labour market participation (Kalwij and Vermeulen, 2008). SHARE builds a comprehensive and multidisciplinary database including a wide range of health indicators, allowing one to consider several dimensions of health simultaneously, and to treat the endogeneity of SRH as an omitted variables issue. In this study, we assess the relative importance of the effects of different health indicators on labour supply decisions during later working life in Croatia, and we focus on the effects of SRH in an effort to understand how they change when one takes account of the more objective health measures. We examine whether SRH keeps its independent effect on later-life employment after the inclusion of other health-related variables, or whether SRH loses its significance when controlling for objective health indicators.

Our paper beyond this point is organized as follows. We proceed to review pertinent literature on the relationship between health and labour market outcomes. We next describe our data and methods, and report the results. The final section concludes, with a policy-oriented discussion of our findings.

2 A LITERATURE REVIEW

We approach health as a component of human capital, and we relate it to individuals' labour market positions within this framework. Enhancements to physical and emotional health can be thought of as investments in human capital (Becker, 1962). In his well-known paper, Grossman (1972) uses the theory of human capital to explain the commodity-like demand for "good health" and health care. His model assumes that every individual is endowed with an initial health capital stock that depreciates with age although individuals can augment their human capital stock through investments, for example, by purchasing extra health services, adding more years of formal schooling, and on-the-job training (Grossman, 2000; 2008).

Country-specific (e.g. Cai and Kalb, 2006; Leung and Wong, 2002) as well as cross-national comparative (e.g. Brugiavini, Croda and Mariuzzo, 2005; Alavinia and Burdorf, 2008; Kalwij and Vermeulen, 2008; Bambra and Eikemo, 2008; Trevisan and Zantomino, 2016; Reeuwijk et al., 2017) studies show that subjective and objective health indicators are both important determinants of labour market decisions. SRH is considered a subjective health indicator. It is a very informative measure of health in general (Idler and Benyamini, 1997), and it successfully predicts morbidity, disability and mortality among the elderly (Jylhä, 2009). While SRH is widely used in studies on determinants of labour force participation, there are several issues associated with this variable. For example, Bound (1991) argues that people who are outside of the workforce may use their health-related limitations or report poor health to justify their non-participation. Moreover, as health is a form of human capital, and because people can invest in their own health, health production should be jointly determined by labour supply and consumption, and it may depend upon unobserved individual characteristics like preference parameters (Cai and Kalb, 2006). Objective health indicators, on the other hand, provide information on, for example, biomarkers, like grip strength or body mass index (BMI), whether or not a person has ever been diagnosed with a certain disease, or whether or not a person shows symptoms of either physical or mental health conditions (e.g. Cai and Kalb, 2006:246; Kalwij and Vermeulen, 2008:627). Some authors use objective health measures as an instrument for SRH (Blundell et al., 2017). Others (Kalwij and Vermeulen, 2008), however, argue that objective health indicators should be used in tandem with SRH because different health indicators may reflect different dimensions of health. A systematic review of literature on health measurements and biases is provided extensively in Barnay (2016).

In a study of Australian workers (aged 15 to 49 and 50 to 64), Cai and Kalb (2006) find that better health increases the probability of labour market participation. Their measure of health comprises SRH, five chronic health conditions, and a self-constructed measure of major injury. A study using the Household, Income and Labour Dynamics in Australia (HILDA) panel data confirms this finding, but stresses education as another important determinant of labour market participation (Laplagne, Glover and Shomos, 2007). This is in line with findings

suggesting that highly educated people are more efficient producers of health (Lleras-Muney, 2005), and that schooling displays a productive efficiency effect (Grossman, 2008). Health is also found to be a significant determinant of employment, but not vice versa, in a large cross-sectional study on the Hong Kong population (Leung and Wong, 2002). Maurer, Klein and Vella (2011) find that ill health and poor functioning increase the odds of deciding to exit the labour market among older men in the US.

Many studies have employed cross-sectional or panel datasets provided by SHARE to explore the relationship between health and labour market outcomes (e.g. Alavinia and Burdorf, 2008, Kalwij and Vermeulen, 2008, Trevisan and Zantomino, 2016, Reeuwijk et al., 2017). One of them (Alavinia and Burdorf, 2008:42) concludes that "...poor SRH (of Europeans aged 50 to 64) is associated with non-participation in the labour force due to early retirement, [with] being unemployed or being a homemaker". The same study relates these labour market outcomes to several chronic health conditions, like stroke, diabetes, and musculoskeletal disease. But even though disability and economic inactivity appear to be associated closely in many European countries, with disability benefits exceeding unemployment benefits (Haveman, 2000), one SHARE-based study reports a rather high frequency of retirees with no health limitations (Brugiavini, Croda and Mariuzzo, 2005).

While poor health is a strong push factor out of the labour force, welfare regimes differ greatly with respect to the absolute risk of early retirement or economic inactivity. In a study of sixteen European countries, Trevisan and Zantomino (2016) report a twofold increase in the odds of leaving the labour market if older workers have experienced acute health shocks. Reeuwijk et al. (2017) report that poor SRH among older workers in Europe increases the risk of labour market exit, but the effect varies across welfare state regimes. Kalwij and Vermeulen (2008) also make use of multiple health indicators available within the SHARE database. The authors investigate how health is associated with labour market participation of older adults in 11 European countries, and treat the endogeneity of SRH as an omitted variables issue. Severe and mild chronic health conditions, functional limitations, grip strength, BMI, and a measure of mental health enter their analysis as objective health variables. Their findings indicate that SRH is a fairly reliable measure of health in some countries, while in other countries, both subjective (SRH) and objective health measures have their own impacts on labour market participation at older ages. This paper examines the case of Croatia: how does SRH relate to labour market participation in Croatia – does it retain its independent effect after the inclusion of objective health measures or do objective health measures fully account for the relationship between SRH and employment during later working life?

3 METHODS

Our research draws Wave 6 data from the SHARE database (Börsch-Supan, 2019). SHARE is a cross-national, multidisciplinary panel study designed to collect detailed information on the health, socio-economics, and the family and social networks of older Europeans. The SHARE dataset includes respondents aged 50 or over, and their partners of any age. SHARE is based on probability samples, and it is representative of community-dwelling older adults. The data are collected by means of computer-assisted face-to-face interviews. Croatia first joined SHARE for Wave 6, with the fieldwork running from June to November 2015 (for more details see Malter and Börsch-Supan, 2017). The current analysis is restricted to Croatian SHARE Wave 6 respondents aged 50 to 64 at the time of the interview. The resultant sample numbers 1287 observations (around 51.6% of the total Croatian SHARE Wave 6 sample).

We use STATA 15 (StataCorp, 2017) for data processing and statistical analysis. All STATA logs (i.e. annotated STATA outputs) are available from the authors upon request.

3.1 VARIABLES

We derive the dependent variable from the question on respondents' current job situation. The original answer scale comprises six categories: retired, employed (or self-employed, including working for family business), unemployed, permanently sick or disabled, homemaker, and other. We dichotomize these values, distinguishing between employment and all other categories. According to some authors (e.g. Kalwij and Vermeulen, 2008), non-employment within the 50 to 64 age range can be equated to some sort of pre-retirement. Our outcome is thus binary, denoting whether the respondents work or do not work.

To take into account the multi-dimensional nature of health (Kalwij and Vermeulen, 2008), we introduce several health-related explanatory variables. We measure subjective (self-rated) health with a scale variable ranging from 1 (excellent SRH) to 5 (poor SRH). We centre this variable around 3 (good SRH) for ease of interpretation.¹ We supplement SRH with a range of more objective health indicators. We consider the following:

- a) Number of chronic conditions. SHARE offers a list of more than twenty chronic conditions to all respondents. Respondents use this list to choose chronic conditions they themselves were ever diagnosed with. Their answers are summed into a single variable, which is readily available within the SHARE database.

¹ Different studies operationalize SRH in different ways. Many authors opt for a dichotomized scale (e.g. Desesquelles, Egidi and Salvatore, 2009; Giatti, Barreto and César, 2010; Zajacova and Dowd, 2011). Our conclusions do not change substantially if using a binary SRH variable (we re-ran our analyses using both very good or excellent SRH versus good or worse SRH, and poor or fair SRH versus good or better SRH; results not shown, but available from the authors upon request).

- b) Number of limitations with (instrumental) activities of daily living, (I) ADLs. SHARE asks whether, “because of physical, mental, emotional or memory problems”, respondents had “any difficulty” (yes or no) with ADLs – activities of daily living (such as dressing, walking across a room or eating), or with IADLs – instrumental activities of daily living (such as preparing a hot meal, shopping for groceries or taking medications). We combine the counts of ADL and IADL limitations into a single scale ranging from 0 to 15 (number of items with reported difficulty). A combined measure of ADL and IADL disability is suggested by research (e.g. Spector and Fleishman, 1998; LaPlante, 2010).
- c) Number of depression symptoms. This variable indicates respondents’ scores on a EURO-Depression scale. This scale was developed to assess late-life depression in Europe (Castro-Costa et al., 2007) and it ranges from 0 to 12 self-reported symptoms (such as feelings of guilt, loss of appetite or tearfulness).
- d) Grip strength. Grip strength is recognized as an important factor to measure as people age: it is a strong predictor of disability, morbidity, frailty and mortality (e.g. Andersen-Ranberg et al., 2009). SHARE includes a variable on maximum grip strength from two dynamometer measurements on each hand. To account for male-female differences, we create a variable with gender-specific grip-strength quantiles. We choose to do so instead of using a (group-centred) continuous grip strength variable so that we can retain respondents with missing values (more than 7% of our age-restricted sample) under “unknown” (a separate category).
- e) Body mass index (BMI). Centred around 25, a threshold for becoming overweight (WHO, 2000; Nuttall, 2015).

We also considered two variables on health-related behavioural risks: drinking and smoking. The drinking variable measured units of alcoholic beverage during the last seven days, while the smoking variable referred to the average amount of cigarettes the respondent smokes per day. Both variables ranged from 0 to 60 in our age-restricted sample. In our univariate analyses, we found no significant effect of smoking, and a positive effect of drinking on employment. Such a “reverse causality” effect is not uncommon in epidemiological research (Rothman and Greenland, 2005; Sieminska et al., 2008; Balsa et al., 2008), as people with poor health may be more likely to refrain from substance abuse. For this reason, we decide to leave these variables out of our models.

The analysis controls for age (and age squared), gender, the age-gender interaction, living arrangements (living with partner, living alone or living with others with no partner in a household), the number of children² and education (low,

² Note that each SHARE household designates only one of its members as a family respondent. The family respondent (alone) answers questions about children. To provide scope for an individual-level analysis, we copied the data provided by the family respondent to the partner within the same household.

medium, high, based on the ISCED 2011 classification of country-specific educational categories collected by SHARE).

3.2 MODELS

Since our dependent variable is binary, we use logistic regression models to assess the health-employment nexus among older adults in Croatia. Before fitting the models, we exclude 39 respondents with a missing value on employment status or one of the explanatory variables (with the exception of grip strength, see previous section). We build the models in a stepwise manner to understand better how the effect of SRH changes with the inclusion of other health-related variables. We first estimate the baseline, SRH-only model (Model 1), and then add a series of more objective health indicators (Model 2). Our regression models are not weighted, but we account for clustering at the household level. It is important to recognize that our observations are not independent because research shows that partners tend to coordinate their work/retirement decisions (Gustman and Steinmeier, 2001; Ozawa and Lum, 2005; Bađun and Smolić, 2018).

We use two statistics to interpret our results. We first present odds ratios, the exponentiations of logit coefficients. A positive logit coefficient corresponds to an odds ratio greater than 1, while a negative logit coefficient corresponds to an odds ratio lower than 1. In our case, the odds ratios show how the odds of employment, compared with non-employment, change with a one-unit increase in the explanatory variable (holding all other explanatory variables constant). We supplement odds ratios with estimates of expected differences in employment probabilities (i.e. average marginal effects) associated with each health-related explanatory variable in our two models.

4 EMPIRICAL FINDINGS

We first present descriptive statistics. Table 1 shows means or percent shares, as appropriate, by employment status, for all variables in our analysis. Overall, 35% of the respondents in our sample are employed and 65% are not employed. Our respondents are, on average, 57.87 years old, and there are more women than there are men in our sample. Most of the respondents live with their partners, in two-person households, and report an average of 1.90 children. Note large differences in educational attainment by employment status. As for health, the average SRH score in our sample is 3.05, with employed respondents scoring lower (i.e. reporting better health) than not employed respondents. As compared to their not employed counterparts, employed respondents in our sample also report fewer chronic conditions, (I)ADLs, and depression symptoms, their average grip strength is higher and their BMI is lower.

TABLE 1
Descriptive statistics

Variable	Non-missing N ^a		Mean (standard deviation) or percent share ^a		
	Employed	Not employed	Employed	Not employed	All respondents
Age	451	831	56.28 (3.50)	58.74 (3.81)	57.87 (3.88)
Gender	451	831			
Female (%)			48.56	61.37	56.86
Male (%)			51.44	38.63	43.14
Living arrangements	451	831			
Lives with partner (%)			86.92	81.47	83.39
Lives alone (%)			8.87	10.35	9.83
Lives with others (%)			4.21	8.18	6.79
Children	450	831	1.77 (0.88)	1.97 (1.02)	1.90 (0.98)
Education	451	830			
Low (%)			9.76	33.37	25.06
Medium (%)			62.97	57.47	59.41
High (%)			27.27	9.16	15.53
SRH	451	831	2.60 (1.06)	3.30 (1.18)	3.05 (1.18)
Chronic conditions (I)ADLs	451	831	0.86 (1.03)	1.71 (1.53)	1.41 (1.44)
Depression symptoms	451	831	0.05 (0.29)	0.42 (1.72)	0.29 (1.40)
Depression symptoms	446	821	1.69 (1.90)	2.64 (2.38)	2.30 (2.27)
Grip strength	421	773	40.04 (12.29)	35.90 (11.77)	37.36 (12.11)
BMI	444	819	26.64 (4.04)	27.65 (4.71)	27.29 (4.51)

^a Unweighted figures.

Source: Authors' calculations based on SHARE Wave 6 data.

Odds ratio estimates from a series of logistic regression models appear in Table 2. The first column reports univariate odds ratios (results from single-predictor models, estimated one by one). The key takeaway from this exercise is that all variables relate to the odds of employment; each health-related variable is found to be highly significant (with p-values less than 0.001) except for grip strength ($p < 0.10$).

Let us next look at Model 1. This model includes the full set of controls and SRH as a single measure of health. We allow for non-linear age effects (we include age squared) and include an interaction with gender to control for the gender-specific labour supply behaviour of older adults. The odds ratio associated with SRH ($p < 0.001$) indicates that the odds of employment decrease by 31.6% for a unit increase in SRH. This means that the likelihood of employment drops as subjective health worsens (i.e. as the SRH score increases). In addition to the odds ratio,

we interpret this finding in terms of the average marginal effect. The first column in Table 3 shows the estimated change in the probability of employment associated with a one-step change in SRH: a unit drop in SRH reduces the probability of employment by 6.5 percentage points.

In Model 2, we introduce more objective health indicators in addition to SRH. We find no direct evidence of the endogeneity of SRH due to omitted objective health indicators: SRH loses its significance once additional, more objective health measures are controlled for. The initially highly significant and substantial effect of SRH becomes insignificant in Model 2. As shown in Table 3, the estimated drop in the probability of employment associated with a unit worsening in health fell from 6.5 percentage points ($p < 0.001$) in Model 1 to 1.6 percentage points ($p = 0.195$) in Model 2.

TABLE 2
Odds ratio estimates from logistic regression models

Variables (ref. denotes base levels for factors)	Univariate ORs	Model 1	Model 2
Age ^a	0.837 ***	1.215	1.205
Age squared		0.977 ***	0.977 ***
Gender			
Male	ref.	ref.	ref.
Female	0.585 ***	1.973	1.842
Age-gender interaction			
Age * female		0.734 *	0.740 *
Age squared * female		1.015	1.016
Living arrangements			
Lives with partner	ref.	ref.	ref.
Lives alone	0.817	0.735	0.707
Lives with others	0.501 **	0.467 **	0.536 **
Children	0.811 ***	0.810 ***	0.825 **
Education			
Low	0.267 ***	0.401 ***	0.412 ***
Medium	ref.	ref.	ref.
High	2.641 ***	3.259 ***	3.527 ***
SRH ^c	0.590 ***	0.684 ***	0.905
Chronic conditions	0.582 ***		0.719 ***
(I)ADLs	0.552 ***		0.814 **
Depression symptoms	0.812 ***		0.934 *
Grip strength (quintile)			
First	0.702 *		1.106

Variables (ref. denotes base levels for factors)	Univariate ORs	Model 1	Model 2
Second	0.852		0.982
Third	ref.		ref.
Fourth	1.236		1.036
Fifth	1.467 *		1.175
BMI ^d	0.946 ***		0.968 *
Constant		1.291	2.262
N	1248	1248	1248
Clusters in sample	868	868	868
Wald Chi squared		225.03 ***	252.34 ***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ^a Values are centred around age 50. ^b Observations with missing data on grip strength are included as a separate category; however, we do not report the associated odds ratio (it is insignificant). ^c Values are centred around 3 (good SRH). ^d Values are centred around BMI of 25 (cut-off for overweight).

Source: Authors' calculations based on SHARE Wave 6 data.

In Model 2, only objective health indicators show a significant relationship with labour market participation of older adults in Croatia. For example, with each additional chronic condition, the odds of employment decrease by 28.1% (see Table 2). This translates to a 5.4 percentage-point decrease in the probability of employment for each additional chronic condition (see Table 3).

TABLE 3

Average marginal effects associated with health-related variables

Variables	Model 1	Model 2
SRH	-0.065 ***	-0.016
Chronic conditions		-0.054 ***
(I)ADLs		-0.034 **
Depression symptoms		-0.011 *
Grip strength (quintile) ^a		
First		0.017
Second		-0.003
Third		ref.
Fourth		0.006
Fifth		0.027
BMI		-0.005 *

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ^a Average marginal effect for factor levels is the discrete change from the base level (ref.).

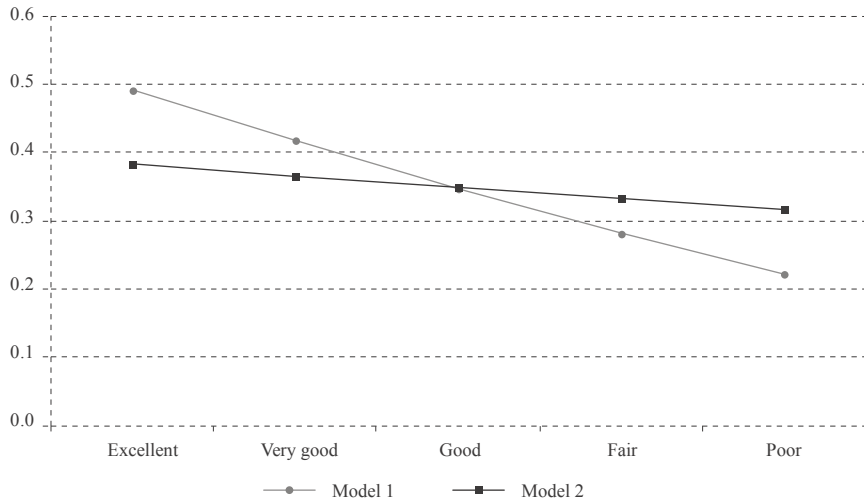
Source: Authors' calculations based on SHARE Wave 6 data.

These findings suggest that in Croatia, SRH strongly correlates with objective health indicators. Our additional analyses reveal that this is indeed the case (results available upon request); SRH seems to be associated with all of the considered objective health indicators (p-values are below 0.001 for chronic conditions, (I) ADLs and depression symptoms, and $p < 0.10$ for grip strength and BMI).

In Figure 1, we compare the estimated probabilities of employment by SRH values for the two model specifications. Note that in Model 2, however, objective health indicators take on the role of SRH, which is only significant in Model 1.

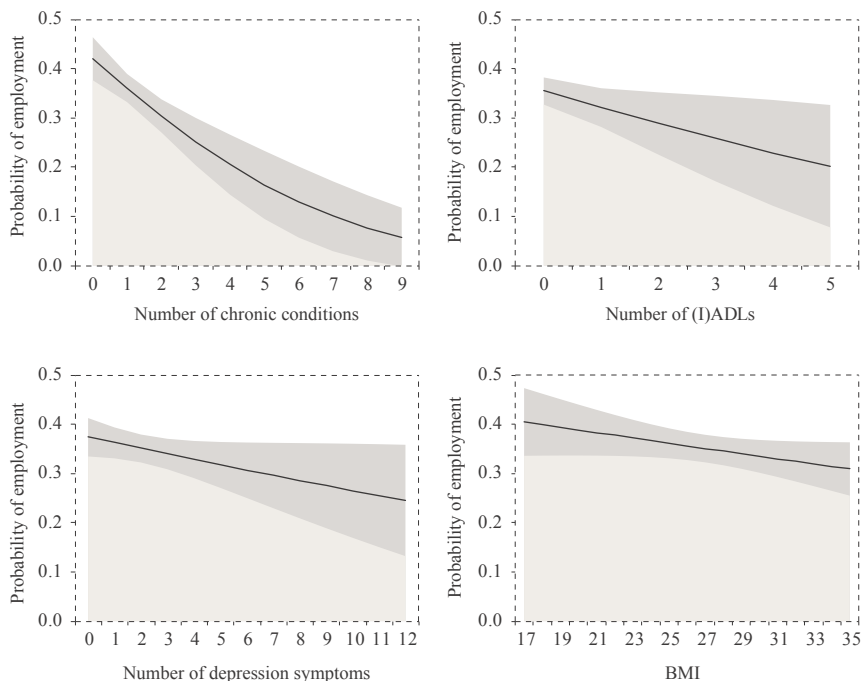
FIGURE 1

Estimated probabilities of employment by SRH



Source: Authors.

The four graphs in Figure 2 show how probabilities of employment are estimated to change with objective health indicators that are found to be (at least marginally) significant in Model 2. The y-axes are set to be equidistant for ease of comparison.

FIGURE 2*Estimated probabilities of employment by objective health indicators**Source: Authors.***5 CONCLUSION**

In this paper, we aimed to identify how general health associates with employment during later working life in Croatia. Using a novel dataset from the SHARE study, we refined the existing evidence on the relationship between health and labour market outcomes among older adults in Croatia. The SHARE data allowed us to consider SRH along with a set of objective health variables, and to test whether both have independent effects on later-life employment in Croatia, or whether they can function as substitutes. We first estimated an SRH-only model, and then added objective health indicators in a second specification. We found that SRH loses its significance after controlling for additional (more objective) health measures. As objective health indicators took over the role of SRH in the latter specification, we can conclude that in Croatia, SRH can successfully act as a single health measure in labour market participation equations, or one can choose to use a combination of objective health indicators instead (Kalwij and Vermeulen, 2008). Ill health, either in terms of subjective (SRH) or objective indicators, is found to reduce the probability of employment during later working life in Croatia.

The labour market in Croatia is signalling serious workforce shortages in many sectors, with population ageing as a major contributor. While employment rates at ages below 50 come close to the EU average, employment rates of older adults in Croatia are considerably below the EU average. Therefore, unless Croatia

permits unrestricted immigration, one possible option in the medium run is to push for an increase in the number of older people in employment. But older adults' health might turn up as an obstacle to this policy option, and our findings support this assumption.

We expressed our findings in terms of average marginal effects to provide tangible ground for policy action, because encouraging active work in older age is crucial for countries experiencing population decline. As Brugiavini, Croda and Mariuzzo (2005) point out, the generosity of the pension system can push healthy-enough individuals out of the labour force. However, the relationship between health and labour market participation of older adults should not be overlooked when planning for pension, labour market, or healthcare system reforms. The scope of policy intervention could very much hinge on our understanding of how health affects older workers' ability to supply labour. With pension and health systems under great pressure, policymakers need to find adequate means of making people economically productive for longer. Deteriorating health gives rise to early exits from the workforce. We thus must find appropriate health intervention mechanisms to improve the working capacity of current and future cohorts of workers. These interventions should strive to more efficiently avert and treat long-term illnesses.

One limitation of our study is its cross-sectional design. Longitudinal SHARE data for Croatia will only become available in the following years, and we need such data to trace the effects of changes in health on corresponding changes in labour market status. Further research with additional panel waves will allow us to address questions of causal inference (and ordering) between health and older adults' labour market behaviour in Croatia.

Disclosure statement

No potential conflict of interest was reported by the authors.

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History matters: development and institutional persistence of the Habsburg Military Frontier in Croatia

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Article**

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Abstract

In this paper we explore the effect of the long-gone Habsburg Military Frontier on modern institutions in Croatia. We use the Life in Transition Survey and geographic regression discontinuity design to identify the causal mechanism between historical institutions and attitudes towards trust and corruption. We find that the areas of the former Military Frontier are underdeveloped and poorer with worse economic performance indicators. Our results suggest that respondents living in the former Military Frontier territory have lower levels of interpersonal trust, a higher level of trust in public authorities, but also tend to bribe those institutions more often when they interact with them. We claim that the war in Yugoslavia in the 1990s is not just a confounding factor in the analysis but also a potential channel and find evidence that attitudes towards bribery can survive even harsh wars, while trust in public institutions collapses during extreme events of violence.

Keywords: development, geographic regression discontinuity, institutions, macroeconomics

1 INTRODUCTION

The notion that history, previous developments and path dependency are relevant for today's socioeconomic context has recently attracted a lot of academic interest in economics. Indeed, since the pioneer work by North and Thomas (1973) and North (1981; 1990) in institutional economics, and Greif (1994; 2006) on the impact of persistence on culture and institutions in development, a series of scholars have recently further explored this research agenda, in terms both of research avenues and the employment of new empirical methods and identification strategies. Using the latest econometric techniques, Acemoglu, Johnson and Robinson (2001) show how the institutions of early European settlers shape economic performance today, Glaeser et al. (2004) find that growth and human capital accumulation improve political institutions, Nunn (2008) shows a negative causal effect from Africa's slave trades on current economic performance, while Glaeser and Shleifer (2002) argue that the historical initial level of coercion risk explains the different legal origins and legal systems that shape modern socioeconomic outcomes. This type of research has, rightfully, elevated economics as a discipline into a multidisciplinary, multidimensional high impact field, and the natural experiments they use have become a state-of-the-art tool applied to explain what causes growth.

In this paper we use a (quasi) natural experiment – the geographic position of the Habsburg Military Frontier in Croatia – to identify the causal relationship between historical institutions and the attitudes towards trust and corruption of households in modern-day Croatia. We show that history matters, that institutions are persistent and that these deeper institutional relationships are important, both for policy-making and for reform design. We argue that civic capital, i.e. trust, could be one of the causal mechanisms that is usually absent from standard macroeconomic literature. While these types of research designs are common in applied microeconomics, they are less frequent in macroeconomic research, especially in Croatia.

Therefore, by using a natural experiment approach that yields intriguing results, we believe that we provide substantial insights into the functioning and development of the modern Croatian economy and significantly contribute to the advancement of methodological approaches in macroeconomic research.

Becker et al. (2016) claim that trust in institutions and corruption are the channels through which long-gone Habsburg political and institutional legacy affects modern day Europe. Building on their work we underline the fact that the former Habsburg-Ottoman border, along most of its length, was actually only the border between the Ottoman Empire and the Habsburg military cordon known as the Military Frontier. The Frontier, which existed for more than 350 years, and which was disbanded almost 150 years ago, was a militaristic establishment ruled from Vienna the purpose of which was to stop the Ottomans from making further inroads into Europe. This historic episode split the population into two parts, which lived under very different economic and political systems for a long period of time. It can be argued that the separation was exogenous to different factors that can explain existing differences in a number of observable modern-day outcomes. In that case, the assignment of households to the treatment can be taken as random, as in an experiment. The former border cut through parts of present-day Croatia, Serbia, Romania and Hungary. This exogenous variation defined around the border enables us to use regression discontinuity design (RDD) to study within-country variation and look at effects of the Military Frontier on modern beliefs and attitudes.

Although the two parts of Croatia are comparable in most demographic outcomes, we find significant differences in activity rates and economic status. The indicators are worse for the former Military Frontier and reveal that these areas are underdeveloped, poorer, and have higher unemployment rates and worse economic performance indicators. In order to explain the observed differences in development, we use three waves of the Life in Transition Survey (LiTS), fixed effects and geographic RDD to estimate ordered logit models since the responses we measure are categorical variables. Our results suggest that respondents living in the former Military Frontier territory have a higher level of trust in public authorities, but also tend to bribe those institutions more often when they interact with them. We also find that affiliation with the Military Frontier has a statistically significant negative effect on interpersonal trust. It seems that an extreme institution-building case study, such as the Military Frontier, did not only instill trust in its public institutions, but that it negatively affected trust among people.

In the following section we explain natural experiments, review the literature on natural experiments in macroeconomics, and argue the challenges and advantages of detecting causality in macroeconomics. We explain the regression discontinuity design and our overall empirical approach together with the data in section IV, after an overview of the history of the Military Frontier. Section V presents our empirical results, as well as a number of robustness checks and falsification tests.

In Section VI we tackle the most obvious confounding element and a potential channel in our analysis, that of the War for Croatian Independence and the establishment of the Republic of Serbian Krajina in the 1990s, which partially overlapped with the territory of the former Military Frontier. Finally, section VII concludes with a discussion of the implications of our findings for modern east-to-west migrations and with its associated European policies.

2 NATURAL EXPERIMENTS IN MACROECONOMICS

Detecting causality in macroeconomics is a highly debated topic in empirical research, as the direction of causality is often unclear and the exact channels are indistinguishable, leading to lack of credible identification and poor policy advice (Fuchs-Schündeln and Hassan, 2016). Due to the difficulty of the task at hand, most of the work done in empirical macroeconomics relies on matching conditional correlations and finding highly-sophisticated ways to improve the fit of econometric models. Unlike natural and some social scientists, macroeconomists traditionally do not use experiments to detect causality, as neither field nor laboratory experiments are available to them. For obvious reasons it would be impossible to control a huge and complex system such as an economy of a country in a laboratory, while field experiments would be overly expensive and due to their inevitably vast socioeconomic impacts it is highly unlikely there would be consensus to carry them out. However, there is an alternative in the literature referred to as – natural experiments.

As Fuchs-Schündeln and Hassan (2016: 4) stated, natural experiments are “... episodes that provide observable, quasi-random variation in treatment subject to a plausible identifying assumption”. An episode can be an introduction of a new policy measure, a historical episode or a naturally-occurring event such as a flood or climate change. As opposed to a laboratory experiment, macroeconomists have to argue convincingly that the intervention or treatment they are using is comparable to an experiment; i.e. that it is randomly assigned. In order to argue randomness they have to compare the treated and the control group and show that their observable characteristics differ only in the fact that one group was treated while the other was not.

The main goal of natural experiments in macroeconomics is to identify causal mechanisms (which one cannot find in conventional macroeconomic models) in order to explain the fundamental causes of growth. Although standard macroeconomic models seemingly provide those answers, their maximum reach is to give only approximate causes of growth that typically involve capital accumulation, technology, and investment. And while they are good at pinning down the mechanisms of growth, they stop short of answering the why type of questions. The fundamental causes of growth on the other hand, would identify institutions, social structure, and civic capital as the main background players.

This paper uses a natural experiment to provide evidence of historical institutions having long-term effects on institutions, civic capital and economic outcomes. Natural experiments are fairly unexplored in Croatian economics and macroeconomics. But in another context, they show that history matters, and that historical institutions have long-lasting effects, which, if ignored, will undermine most efforts at reform. Although civic capital is a slow-moving variable, it significantly determines societies' capacity for growth leaving some with high, and others with low levels of civic capital. The Habsburg Empire is well known for its reputation of "good" institutions and it is documented that the former Habsburg territory enjoys higher levels of civic capital than that of its Ottoman neighbors. However, not all Habsburg institutions were driven to build civic capital, some were established to defend the south-east borders of the Empire. Political history and the type of military colonialism that the Habsburgs preserved in Croatia for 350 years still largely influence economic performance in Croatia, especially within the country. We find that the areas that were formerly part of the Military Frontier are poorer, have higher levels of trust in institutions, a higher tendency to bribe them, and show less trust in other people (possibly related to the ethnic population mix in the area). These results are consistent with the colonial policies of the Habsburgs who exerted highly centralized authority through its military institutions, while at the same time failing to provide adequate resources to alleviate poverty, leaving the people to resort to corruption.

The literature on natural experiments in macroeconomics so far actually detected four fundamental causes of growth, adding luck and multiple equilibria to the institutions, social structure, and civic capital referred to above (Fuchs-Schündeln and Hassan, 2016). The effect of institutions on growth is extensively studied in Acemoglu, Johnson and Robinson (2001; 2002) who use an instrumental variable approach, and in Michalopoulos and Papaioannou (2013) who rely on regression discontinuity design. This type of literature uses rather simple econometric methods, but their challenge lies in correctly and convincingly identifying that the treatment is indeed random and that the natural episode resembles an experiment. Acemoglu et al. (2003) study the effect of institutions on business cycles and find that bad macroeconomic policies are no longer correlated with macroeconomic volatility once the effect of institutions is controlled for. They claim that macroeconomic policies are just tools easily replaced by other bad tools and that they are rather symptoms of deeper institutional distortions that stand in the way of higher growth. Another strand of this literature tries to detect whether replacing bad institutions would lead to preferable outcomes. These studies look at the persistent effects of historical institutions such as colonialism (Banerjee and Iyer, 2005; Iyer, 2010), forced labor systems (Dell, 2010), and communism (Alesina and Fuchs-Schündeln, 2007).

Social structure also plays a role; for example, Acemoglu, Johnson and Robinson (2005) show that those Western European countries that had a stronger merchant class also developed property rights that lead to economic growth, a concept

known as Law Merchant (Milgrom, North and Weingast, 1990). On a similar note, in Russian regions in which the Holocaust significantly reduced the size of the middle class, political and economic outcomes were worse even decades later (Acemoglu, Hassan and Robinson, 2011). Moving away from social structure, differences in civic capital – encompassing trust, beliefs, norms, and traditions – lead a society to different outcomes. Guiso, Sapienza and Gonzales (2011:3) define civic capital as “...those persistent and shared beliefs and values that help a group overcome the free rider problem in the pursuit of socially valuable activities”. Since civic capital is intertwined with institutions, the challenge in this type of research is to separate the effects in order to claim causality. Tabellini (2010) for example finds variation in civic capital within countries that dates even centuries back in history and causes modern day differences in the level of economic development. Guiso, Sapienza and Gonzales (2016) study cities in Italy and whether they had free city status in medieval times. It turns out that a longer history of self-rule is correlated with both higher civic capital and higher levels of economic development.

Trust is probably one of the best examples of civic capital as it is a prerequisite for sales, financial and investment transactions, and contracts, particularly employment contracts. The importance of trust rises with the level of complexity in the economic system, and even if differences in trust were not so detrimental decades or centuries ago, they have certainly become so more. Algan and Cahuc (2010) isolate the effect of trust and find that higher trust among people leads to higher GDP per capita. Effects of trust go beyond growth, Guiso, Sapienza and Gonzales (2004) detect the exact mechanism that translates civic capital to economic growth. In their case they find that trust – represented by financial development and the level of sophistication of the financial system – plays a role in economic growth. The other potential channel could be that of regulation (Aghion et al., 2010), where trust and government regulation are negatively correlated, implying that lower trust increases the incidence of higher government regulation.

These papers are just one piece of the puzzle as they provide evidence of civic capital having an impact on growth. The other part is detecting factors behind differing levels of civic capital. Literature provides three possible factors: historical institutions, experiences of violence and conflict, and climate (as surveyed in Fuchs-Schündeln and Hassan, 2016). Besides Tabellini (2010) and Guiso, Sapienza and Gonzales (2016), one of the most influential papers that uses historical institutions to explain different levels of trust and attitudes towards corruption is Becker et al. (2016). Using geographic RDD they show that areas once part of the Habsburg Empire have higher levels of trust in institutions and lower levels of corruption than in nearby areas that were under the Ottoman rule. Regarding the effect of the history of violence on modern-day outcomes, Nunn and Wantchekon (2011) find that levels of trust are reduced in areas of Africa that were historically affected by the slave trade while controlling for a number of observable factors. Jancec (2014) studies conflict in South East Europe and finds that trust is lower in

countries that were exposed to more frequent authority changes in the historical time span of 500 years.

3 HISTORICAL BACKGROUND ON THE MILITARY FRONTIER

Rothenberg (1960) writes that the Military Frontier existed for over 350 years, since the longest lasting Frontier on the south of Croatia was established in 1522 and disbanded in 1881. In the 18th and 19th centuries the Frontier was divided into nine districts: the longest-living Croatian and Slavonian Military Frontier districts situated in modern-day Croatia (1522–1881), and eight provisional districts in other countries: the Danube, Tisa, Mureş and Sava Frontiers (1702–1751), the Banat Military Frontier (1751–1873), the Transylvanian Military Frontier (1762–1851), and the Šajkaš Battalion (1763–1873). According to s.n. (1829) the population of the Military Frontier in 1828 was 1,073,680, while Roksandić (1988) reports every 15th inhabitant was a soldier. Ethnically, the settlers were divided almost equally into indigenous Croats, dominantly Catholic, and refugees, primarily Orthodox Serbs who were granted royal privileges to populate the Habsburg Military Frontier and serve in the war against the Ottomans.

Inside the Austro-Hungarian Empire, the settlers of the Military Frontier, the so-called *Grenzer* (German) or *Graničari* (Croatian) enjoyed privileges in the form of land allotments and were free of serfdom in exchange for permanent military service and loyalty to the Austrian Habsburg crown, instead of the Hungarian-Croatian one that ruled the rest of Croatia. The Frontier was established to defend aristocratic possessions of Inner-Austria and eventually to halt Ottoman armies intruding further into the Habsburg Empire. Rothenberg (1964) argues that the institution of the Military Frontier was a military establishment and an agricultural economy with barely any crafts or trade. He continues to explain the longevity of the Frontier not only by persistent Ottoman threats but also because the military status of the *Grenzer* was preferred to the manorial obligations in the civil part of the Empire. Eventually, the decline of the Ottoman Empire together with rising nationalistic aspirations and the abolition of serfdom in the 19th century eroded the leverage of imperial policy in the Frontier area and led to the final dissolution in 1881.

The life in the Military Frontier is explained in Roksandić (1988) who describes the society as being founded on a system of cooperative (or communal) families that provided soldiers from the pool of grown men, while women engaged in agriculture, child and senior care as well as all remaining communal duties. Due to the elongation of the territory that spanned from the Adriatic sea all the way to the Carpathian mountains and a 1,800 km long border with the Habsburg Empire (see Figure 1), the Frontier never developed into a coherent social and economic area. Moreover, the borders to the Habsburgs were not natural geographic areas, nor did they come from historical borders, making most important social and geographic characteristics very similar on both sides of the border (Roksandić, 1988). On the other side, the Frontier bordered with the Ottoman Empire, and in most cases social and geographical characteristics significantly differed on both sides of that border.

According to Amstadt (1969), the Frontier was super-institutionalized and super-bureaucratized, and under constant pressures for reforms, the need for which partially stemmed from the bureaucracy itself. Becker et al. (2016) showed that the Habsburg institutions established in the long-gone Habsburg Empire – even in areas very far from Vienna – survived both World Wars, the socialist system, transition, and persist to this day. Although the Military Frontier established institutions, civic capital (culture), and identity different from the rest of the Empire, the demonstrated efficacy of the Habsburg administration does not give reason to doubt its effectiveness in establishing military colonialism. As Habsburg civic institutions (Becker et al., 2016), religion (Boeckh, 2013), and nationalism (Sanford, 1992), survived the twentieth century, it is plausible to assume that the heritage of military colonialism, i.e. the Military Frontier survived as well.

FIGURE 1
Military Frontier in 1800



Source: *The World of the Habsburgs (1800)*.

4 DATA, IDENTIFICATION, AND METHODOLOGY

4.1 DATA

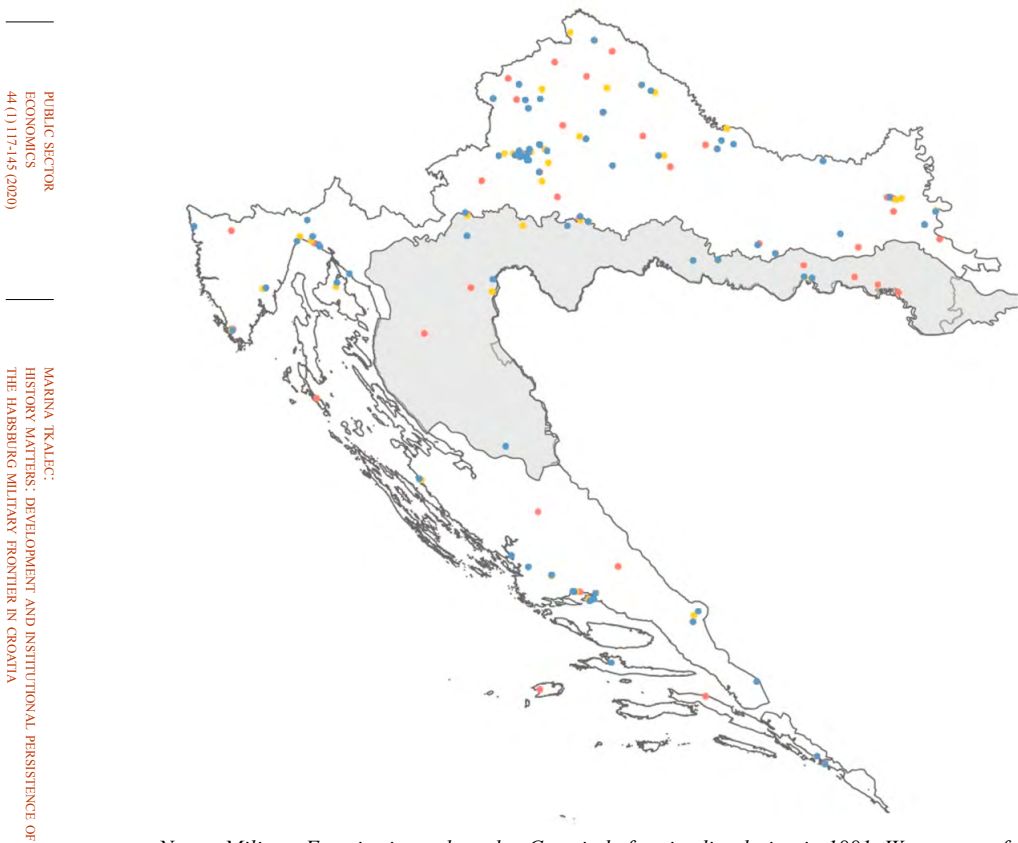
In order to analyze the long-run persistence of the Military Frontier in modern-day institutions, we use all three waves of the LiTS collected by the European Bank for Reconstruction and Development (EBRD) in 2006, 2010, and in 2016. LiTS records attitudes, opinions and values in post-transition countries. In particular, the first wave (2006) assessed public attitudes, well-being and the impact of economic and political change; the second wave (2010) dealt mostly with the effects of the financial crisis; while the last wave from 2016 explored life satisfaction, corruption, and gender gaps in the labor market and business. The covariates in LiTS are observed at the individual level and they include information on the respondents' age, gender, education, religion, labor market status, household size, number of children under age 14, and – most importantly – location of residence. Figure 2 displays the location of respondents in the three LiTS waves differentiating them by colors. The shaded area represents the former Military Frontier. We

restrict the analysis to modern-day Croatia because the Croatian and Slavonian districts represent the longest-lasting Military Frontier, persisting for 359 years. The part of the Slavonian district in the far east (Eastern Symium) is left out from the analysis because the area came under the territory of the Socialist Republic of Serbia in 1945. For each location in our dataset, we provide corresponding geographic longitudes and latitudes together with information on affiliation with the Military Frontier using Regan and Kaniški (2003). A geographic information system (GIS) is used to geocode location data in order to compute distances between locations and distances to the Military Frontier border, enabling us to take different subsamples of respondents around a specified distance from the border.

As in Becker et al. (2016) we use corruption and trust in public institutions as our main outcomes of interest. In all three LiTS waves, the question on trust in public institutions in the survey is unchanged and reads: 'To what extent do you trust the following institutions?' with courts and police among the offered institutions. The answer categories span from 'complete distrust' to 'complete trust', with 'some distrust', 'neither trust nor distrust', and 'some trust' in between. We exclude a small number of observations that provide no answer, or where the answer is 'difficult to say'. Regarding corruption, the question of interest is 'In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?' where both courts and traffic police are included as possible situations. The answers proposed are: 'never', 'seldom', 'sometimes', 'usually', and 'always'. For our falsification test we use a proxy for social capital, constructed as a dummy variable for political party membership and voluntary organization or club membership.

FIGURE 2

Military Frontier 1868–1881 and the LiTS locations



Notes: Military Frontier in modern-day Croatia before its dissolution in 1881. We are grateful to Tomislav Kaniški from Leksikografski zavod Miroslav Krleža who provided us with Military Frontier 1868–1881 shapefiles from Regan and Kaniški (2003). LiTS wave 2006 is presented by the red color, the 2010 wave with yellow, and the 2016 wave with the blue color.

Columns (1)–(4) in Table 1 report descriptive statistics of our individual-level covariates. There are 13.9% respondents that live in the territory of the former Military Frontier. The average age of all respondents is slightly above 50 years, there are 59% men, most of the respondents have secondary education, and are Christian. They live in small households (mean household size is 1.8) with the mean number of children under 14 equal to 1.4. Somewhat above 70% of the households in which they live own a car, a bank account, and has a debit or a credit card, while 86% own a mobile phone. Slightly above half of households own a computer and have access to internet at home.

4.2 IDENTIFICATION AND METHODOLOGY

Columns (5)–(8) in Table 1 report descriptive statistics for Military Frontier and non-Military Frontier separately. In terms of age, gender, education, religion, household size and number of children under 14 there are hardly any differences

between the two subsamples. However, there are significant differences in terms of respondents working for income during the last 12 months, and all six household-level variables that reflect economic status. Presumably, the indicators are worse for the former Military Frontier, so we include them as controls in our analysis. These simple descriptive statistics show that the areas of the former Military Frontier are poorer and have higher unemployment rates and worse other economic performance indicators.

Our basic model estimates the effect of an individual living in a location that was once under the Habsburg Military Frontier on his/her measures of trust and corruption. We estimate the following equation:

$$outcome_{i1w} = \alpha + \beta military\ frontier_{i1w} + X'_{i1w}\gamma + \varphi_w + \epsilon_{i1w}$$

where i is an individual living in location l in a specific LiTS wave w , *military frontier* _{$i1w$} is an indicator that takes the value 1 if a location was a part of the Military Frontier and 0 otherwise, X'_{i1w} is a set of individual and household-level control variables, and φ_w are LiTS wave fixed effects. We first estimate the model using all observations from the three waves in Croatia (Table 2), and then continue with border specifications – sample restricted to respondents living within 200 kilometers from the former Military Frontier border (Tables 3 to 7). In our robustness analysis we further restrict the samples, down to 25 kilometers around the border. In Table 7 we test the validity of our model by using different outcomes – such as trust in other people, and in private entities, and also social capital presented by membership in political parties – where we find that our falsification tests hold. We estimate ordered logit models since the responses are categorical variables, assuming a constant odds ratio.

We also propose the use of a geographic RDD approach. Following Dell (2010), we view institutions implemented in the Military Frontier as a deterministic and discontinuous function of geographic position, i.e. longitude and latitude. In other words, using the historical borders of the Frontier we are able to estimate the effect using the geographic RDD approach. While RDDs are a widely popular identification strategy in economics (Thistlethwaite and Campbell, 1960; Lee and Lemieux, 2010), geographic RDD differs from the simple setup as the forcing variable is two-dimensional since location is uniquely determined by both longitude and latitude. Therefore, the identification assumptions are identical – all other covariates must be constant across the Military Frontier border – but the estimation is slightly altered. In particular, we estimate:

$$outcome_{i1w} = \alpha + \beta military\ frontier_{i1w} + X'_{i1w}\gamma + f(\text{geographic location}_l) + \varphi_w + \epsilon_{i1w}$$

where $outcome_{i1w}$ is a realization of the outcome variable for an individual i in location l for a LiTS wave w , and *military frontier* _{$i1w$} is an indicator that takes the value 1 if a location was a part of the Military Frontier and 0 otherwise. X'_{i1w}

TABLE 1
Descriptive statistics

	Both sides				Military Frontier		Non-Military Frontier	
	Mean (1)	SD (2)	Min (3)	Max (4)	Mean (5)	SD (6)	Mean (7)	SD (8)
Part of Military Frontier	0.139	0.346	0	1	1.000	0.000	0.000	0.000
<i>Individual-level variables</i>								
Age of respondent	50.299	17.613	18	95	52.420	17.534	49.957	17.605
Male respondent	0.587	0.492	0	1	0.619	0.486	0.582	0.493
Worked for income during last 12 months	0.479	0.500	0	1	0.360	0.481	0.498	0.500
Education (omitted category: no degree)								
Compulsory schooling education	0.147	0.355	0	1	0.195	0.396	0.140	0.347
Secondary education	0.456	0.498	0	1	0.410	0.492	0.464	0.499
Professional, vocational school or training	0.170	0.375	0	1	0.159	0.366	0.171	0.377
Higher professional degree (university, college)	0.136	0.343	0	1	0.083	0.276	0.145	0.352
Post-graduate degree	0.026	0.159	0	1	0.021	0.143	0.027	0.161
Religion (omitted category: atheist)								
Buddhist	0.001	0.024	0	1	0.000	0.000	0.001	0.026
Jewish	0.001	0.024	0	1	0.000	0.000	0.001	0.026
Christian	0.900	0.300	0	1	0.928	0.260	0.895	0.306
Muslim	0.012	0.109	0	1	0.031	0.174	0.009	0.095
Other	0.007	0.085	0	1	0.004	0.064	0.008	0.087
<i>Household-level variables</i>								
Household has a car	0.713	0.452	0	1	0.609	0.489	0.730	0.444
Household has a bank account	0.713	0.452	0	1	0.654	0.476	0.723	0.448
Household has a credit/debit card	0.750	0.433	0	1	0.587	0.493	0.782	0.413
Household has a mobile phone	0.856	0.351	0	1	0.739	0.440	0.875	0.330
Household has a computer	0.584	0.493	0	1	0.437	0.497	0.608	0.488
Household has access to internet at home	0.558	0.497	0	1	0.420	0.494	0.581	0.494
Household size (equivalent scale)	1.755	0.624	1.000	4.500	1.774	0.656	1.752	0.619
Household number of children under 14	1.353	0.757	1	7	1.416	0.809	1.343	0.748

Source: *Life in Transition Survey (LiTS) 2006, 2010 and 2016*; see main text for details.

denotes individual and household-level covariates, φ_w is a set of LiTS wave fixed effects, while $outcome_{i,w}$ denotes a flexible (polynomial) function of geographic location – either longitude and latitude or distance to border. In order to pinpoint our effect, we propose varying distances to border, bandwidths, starting with 200 kilometers from both sides of the border and narrowing down to 25 kilometers.

5 RESULTS

In the first part of our analysis we estimate the model on the whole sample of households in Croatia. Table 2 uses 3,361 observations from 164 different primary sampling units (PSU) or places of residence collected from the three LiTS waves. The four models presented control for respondents' age, gender, and religious affiliation.¹ Our results show that living in a location that was once part of the Military Frontier is positively associated with higher trust in courts and police. Interestingly, when we control for the fact that the respondent actually interacted with the court or with the traffic police in the last 12 months, we find a statistically significant, strong, and positive relationship between living on former Military Frontier territory and unofficial payments/gifts – bribes – made to courts and to the traffic police. In other words, respondents seem to have a higher level of trust in public authorities, but also tend to bribe those institutions more often when they interact with them. Similarly, Becker et al. (2016) found that living in ex-Habsburg territory increases trust in courts and police, but they found an opposite effect for bribery, that it decreases the intensity of bribery. The Military Frontier is therefore somewhere in between the institution-friendly Habsburg Empire and the bribery-friendly manifestation of persistent economic under-development east of the civil part of Croatia, in this case possibly even confounded by the presence of Ottomans (for details on the relationship between corruption, socialism, and the Ottomans see Uberti, 2018).

5.1 BORDER SPECIFICATION

In order to make our treatment and control groups more comparable, we continue by restricting our sample to the border specification of respondents living within 200 kilometers from the border. This slightly shrinks the total number of observations, while the number of locations by which we cluster falls from 164 to 159, preserving most of the statistical power. According to Table 3 the effects found persist, and remain robust. In three cases the point estimate is slightly lower suggesting that there still might be unobserved location differences present. Regarding the size of the estimated effects, marginal effects presented in Table A1 of the Appendix suggest that when holding other variables at their means, living on the former Military Frontier territory increases the probability of moving to a higher

¹ Although minority status is an important determinant, the question from the first LiTS 'Do you consider yourself as a member of an ethnic minority in this country?', is not repeated in the two subsequent waves. Based on a question from the third wave 'What is your ethnicity?' we were able to construct a minority dummy and repeat our analysis for the first and third LiTS waves only. These results are available on request and they suggest that the results on all three LiTS waves are robust. The minority dummy is significant in a small number of cases and the sign and size of all other coefficients remains unchanged. The only change is in the statistical significance of our Military Frontier variable that goes down in some cases with trust as the outcome variable. We believe this is due to small sample size that reduces statistical power.

category of trust in courts by 3.8 percentage points, on average across the five categories. For the remaining measures, the average marginal effects are equal to 2.8 percentage points for the trust in police, 6.8 percentage points for bribes to courts, and 4.2 percentage points for bribes to the traffic police. As there are five answer categories, their average share amounts up to 20% suggesting that the Military Frontier moves the public institutions categories by 14–34% on average. The marginal effects for Military Frontier affiliation are large in comparison to respondents' age and gender, although they are somewhat smaller than some religion types.

TABLE 2
Trust and corruption in courts and police

	Trust in		Bribes to	
	courts (1)	police (2)	courts (3)	traffic police (4)
Part of Military Frontier	0.392** (0.189)	0.273** (0.137)	0.835*** (0.259)	0.469* (0.258)
Age of respondent	-0.001 (0.002)	0.010*** (0.002)	-0.008** (0.003)	-0.018*** (0.003)
Male respondent	-0.120* (0.064)	0.075 (0.061)	0.090 (0.099)	0.131 (0.094)
Used service in last 12 months			0.547*** (0.165)	0.644*** (0.123)
Controls for religious affiliation (6 categories)	Yes	Yes	Yes	Yes
Controls for LiTS wave	Yes	Yes	Yes	Yes
No. of observations	3,361	3,411	3,272	3,302
No. of locations	164	164	164	164
Pseudo-R ²	0.016	0.019	0.029	0.046

*Notes: Coefficients and standard errors from ordered logit estimation. Dependent variable in columns (1) and (2) is answer to the question "To what extent do you trust the following institutions?" Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don't know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question "In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?" Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don't know/Refusal set to missing in regressions. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.*

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.

Table A2 provides details on the marginal effects by specific answer categories. Living in former Military Frontier territory increases the probability of reporting some trust in courts by 5.1 percentage points, and decreases the probability of reporting complete distrust in courts by 7.2 percentage points. Regarding bribes to courts, Military Frontier is associated with a 16.9 percentage points lower probability of reporting the category of never having to bribe, a 7.3 percentage points higher probability of having to bribe sometimes, and a 3.6 percentage points higher probability of usually having to bribe the courts.

5.2 GEOGRAPHIC REGRESSION DISCONTINUITY DESIGN

The results of our geographic RDD are presented in Table 4 with the two-dimensional RDD in latitude and longitude in the upper panel, and the one-dimensional RDD with distance to border in the bottom panel. For the two-dimensional case we present four different specifications with either the linear, quadratic, cubic or quartic polynomial function of geographic location. The reference, linear, specification is shown in the first row and it clearly resembles the results from the border specification (Table 3). At higher orders of polynomials, a lot of statistical significance is lost – but as Gelman and Imbens (2018) suggest that controlling for polynomials of orders above two leads to noisy estimates and poor coverage of confidence intervals – we prefer the linear estimate. The one-dimensional case remains robust only for the outcomes related to bribes. The effect persists for the linear and the quadratic case, but also when we add an interaction term (distance to border multiplied with the Military Frontier dummy) to the linear case.

TABLE 3

Trust and corruption in courts and police: border specification

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
Part of Military Frontier	0.383** (0.188)	0.285** (0.139)	0.813*** (0.261)	0.448* (0.260)
Age of respondent	-0.001 (0.002)	0.010*** (0.002)	-0.007** (0.003)	-0.018*** (0.003)
Male respondent	-0.119* (0.066)	0.068 (0.063)	0.084 (0.010)	0.118 (0.094)
Used service in last 12 months			0.599*** (0.167)	0.652*** (0.124)
Controls for religious affiliation (6 categories)	Yes	Yes	Yes	Yes
Controls for LiTS wave	Yes	Yes	Yes	Yes
No. of observations	3,272	3,319	3,183	3,213
No. of locations	159	159	159	159
Pseudo-R ²	0.016	0.018	0.029	0.047

*Notes: Coefficients and standard errors from ordered logit estimation. Border sample: respondents living within 200 km from the former Military Frontier border. Dependent variable in columns (1) and (2) is answer to the question “To what extent do you trust the following institutions?” Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don’t know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question “In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?” Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don’t know/Refusal set to missing in regressions. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.*

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.

TABLE 4
Geographic regression discontinuity design

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
<i>Polynomials in latitude and longitude</i>				
Linear polynomial (reference specification)	0.329* (0.192)	0.267* (0.147)	0.869*** (0.270)	0.450* (0.253)
Quadratic polynomial in latitude and longitude	0.225 (0.232)	-0.076 (0.191)	0.902** (0.445)	0.402 (0.341)
Cubic polynomial in latitude and longitude	0.214 (0.243)	-0.077 (0.199)	0.825* (0.485)	0.287 (0.332)
Quartic polynomial in latitude and longitude	0.275 (0.311)	-0.210 (0.249)	0.697 (0.715)	0.356 (0.469)
<i>Polynomials in distance to border</i>				
Linear polynomial in distance to border	0.352 (0.244)	0.055 (0.184)	0.781** (0.371)	0.460* (0.301)
Quadratic polynomial in distance to border	-0.006 (0.052)	-0.196** (0.083)	0.773** (0.372)	0.458*** (0.146)
Interacted linear polynomial in distance to border	0.241 (0.285)	-0.021 (0.206)	0.929** (0.395)	0.711** (0.295)
No. of observations	3,272	3,319	3,183	3,213

*Notes: All reported estimates are coefficients of the variable “Part of Military Frontier” in a model specification that includes all control variables shown in Table 3. Coefficients and standard errors from ordered logit estimation. Border sample: respondents living within 200 km from the former Military Frontier border, based on GIS-computed distance from border. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.*

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.

5.3 ROBUSTNESS CHECKS

Although we do find statistically significant results, we subject our analysis to the bias-variance tradeoff and vary the distance to border that decides on the sample size and how close to the discontinuity – border – we run our analysis. We therefore narrow the bandwidth from the initial 200 kilometers to 150, 100, 50, and finally to 25 kilometers. We perform this exercise with the approaches taken in Tables 3 and 4 (the two-dimensional linear RDD), results of which are presented in the first rows of Table 5, i.e. for the 200 kilometer case. The point estimates appear to be rather stable when we decrease the bandwidth, and we can safely claim that the results are robust down to 50 kilometers around the border. At the narrowest band though (25 kilometers), only the result for bribes to courts holds, although the coefficients for the traffic police are statistically significant at the 10.9% and 10.3% levels.

As mentioned earlier, there are significant differences in some individual and household-level variables between the treatment and the control group. These are

presumably endogenous to the Military Frontier as they mostly reflect the economic status. In Table 6 we show the results when we include these additional control variables: working for income status, household size, number of children under 14, urbanization, and controls for household property such as owning a car, a bank account, a mobile phone, and/or a computer. Our results indicate that the results are arguably very stable; the variance does increase a bit, and the point estimates are somewhat smaller for the trust outcomes, and larger for the bribes outcomes. It is therefore safe to assume that none of the controls included could be a convincing alternative channel of the military colonialism effect.

5.4 MILITARY COLONIALISM, INTERPERSONAL TRUST AND SOCIAL CAPITAL

Finally, we run the analysis on interpersonal trust and trust in private entities, instead of trust in public services, to corroborate that the effect is coming from the public institutions and not from some pre-existing social life of the region. The Military Frontier in its approach did not interfere with the existing way of living, but channeled its power through newly-built institutions. We find that the affiliation with the Military Frontier has a statistically significant negative effect on interpersonal trust (column (1) of Table 7), while the point estimate for the trust in trade unions is also negative. Becker et al. (2016) for example did not find a statistically significant effect for interpersonal trust, so it leads us to believe that the Military Frontier, as an extreme institution-building case study, did not only instill trust in its own public institutions, but that it negatively affected trust between people. The results in this paper reflect on historical intuition and on Greif (1994) that the population of the Military Frontier had good reason to trust Vienna as it protected them from local governments, feudal lords from the civil part of Croatia, and most importantly, from paying taxes. Meanwhile, the people that migrated to the Military Frontier from the East brought with them the culture of the East and Ottomans as well. And since the Ottoman Empire, unlike the Habsburg Empire, was not ruled by law (Uberti, 2018), it is not that surprising that bribery persisted. Also, the ethnic population mix laid the ground for higher trust in extended families and lower trust across different ethnic groups.

TABLE 5
Different bandwidths around Military Frontier border

	Trust in		Bribes to		No. of	
	courts	police	courts	traffic police	observations	clusters
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Border specification (as in Table 3) (distance from border in km)</i>						
<200	0.383** (0.188)	0.285** (0.139)	0.813*** (0.261)	0.448* (0.260)	3,272	159
<150	0.403** (0.188)	0.289** (0.139)	0.830*** (0.263)	0.469* (0.261)	3,232	157
<100	0.367* (0.188)	0.268* (0.141)	0.825*** (0.264)	0.449* (0.265)	3,054	148
<50	0.401** (0.195)	0.213 (0.150)	0.850*** (0.279)	0.451* (0.268)	2,178	105
<25	0.131 (0.243)	0.117 (0.183)	0.735* (0.394)	0.527 (0.329)	967	51
<i>RDD specification with linear polynomial in latitude and longitude (as in Table 4) (distance from border in km)</i>						
<200	0.329* (0.192)	0.267* (0.146)	0.869*** (0.270)	0.450* (0.253)	3,272	159
<150	0.356* (0.192)	0.282* (0.147)	0.895*** (0.271)	0.484* (0.253)	3,232	157
<100	0.300 (0.192)	0.257* (0.150)	0.853*** (0.276)	0.447* (0.258)	3,054	148
<50	0.227 (0.196)	0.264 (0.175)	0.813*** (0.309)	0.482* (0.261)	2,178	105
<25	0.004 (0.232)	0.015 (0.185)	0.839* (0.456)	0.605 (0.371)	967	51

*Notes: All reported estimates are coefficients of the variable "Part of Military Frontier" in a model specification that includes all control variables shown in Table 3. The number of observations and clusters reported in columns (5) and (6) refer to the average number of observations/clusters in all four model specifications. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.*

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.

TABLE 6
Additional control variables

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
<i>Border specification</i>				
Part of Military Frontier	0.324*	0.229*	0.825***	0.476*
	(0.185)	(0.137)	(0.265)	(0.260)
Age of respondent	-0.004	0.006**	-0.004	-0.014***
	(0.002)	(0.003)	(0.004)	(0.125)
Male respondent	-0.094	0.045	0.024	0.046
	(0.064)	(0.065)	(0.104)	(0.094)
Used service in last 12 months			0.589***	0.587***
			(0.171)	(0.125)
Worked for income during last 12 months	-0.048	-0.179**	0.198*	0.216*
	(0.077)	(0.085)	(0.101)	(0.095)
Urban area	0.089	-0.043	0.110	-0.004
	(0.121)	(0.112)	(0.225)	(0.194)
Household size (equivalent scale)	0.036	0.173**	0.195*	0.094
	(0.079)	(0.077)	(0.114)	(0.101)
Household number of children under 14	0.116**	0.059	-0.097	-0.038
	(0.055)	(0.052)	(0.074)	(0.073)
Controls for religious affiliation (6 categories)	Yes	Yes	Yes	Yes
Controls for LiTS wave	Yes	Yes	Yes	Yes
Controls for household property (4 variables)	Yes	Yes	Yes	Yes
Controls for education level (6 categories)	Yes	Yes	Yes	Yes
No. of observations	3,272	3,319	3,183	3,213
No. of locations	159	159	159	159
Pseudo-R ²	0.020	0.022	0.033	0.051
<i>RDD specification with linear polynomial in latitude and longitude</i>				
Part of Military Frontier	0.280	0.220	0.880***	0.474*
	(0.188)	(0.143)	(0.274)	(0.254)
Controls (as above)	Yes	Yes	Yes	Yes

Notes: Coefficients and standard errors from ordered logit estimation. Sample: respondents living within 200 km from the former Military Frontier border, based on GIS-computed distance from border. Dependent variable in columns (1) and (2) is answer to the question "To what extent do you trust the following institutions?" Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don't know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question "In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?" Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don't know/Refusal set to missing in regressions. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.

TABLE 7

Interpersonal trust and membership in organizations

	Trust in		Membership in	
	other people (1)	trade unions (2)	political parties (3)	civic organizations (4)
<i>Border specification</i>				
Part of Military Frontier	-0.329* (0.185)	-0.141 (0.195)	0.016 (0.105)	0.103** (0.149)
Controls (as in Table 6)	Yes	Yes	Yes	Yes
No. of observations	3,243	3,196	3,370	3,370
No. of locations	158	159	159	159
Pseudo-R ²	0.013	0.008	0.052	0.116
<i>RDD specification with linear polynomial in latitude and longitude</i>				
Part of Military Frontier	-0.299 (0.190)	-0.126 (0.198)	0.010 (0.105)	0.105** (0.152)
Controls (as in Table 6)	Yes	Yes	Yes	Yes
No. of observations	3,243	3,196	3,370	3,370
No. of locations	158	159	159	159
Pseudo-R ²	0.015	0.009	0.059	0.118

Notes: Columns (1) and (2): Coefficients and standard errors from ordered logit estimation. Columns (3) and (4): marginal effects and standard errors from probit estimations. Sample: respondents living within 200 km from the former Military Frontier border, based on GIS-computed distance from border. Dependent variable in columns (1) and (2) is answer to the question "To what extent do you trust the following [...]?" Column (1): Other people. Column (2): Trade unions. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don't know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) is answer to the question "Are you a member of a political party?". Dependent variable in columns (4) is answer to the question "Are you a member of (other) civic/voluntary organizations?". Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.

Source: *Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.*

Banerjee and Iyer (2005) and Iyer (2010) for example found that British colonialism in India had long-term adverse impacts on the social structure of affected areas, in the sense that they are now less able to exert their influence on policy makers to obtain an appropriate amount of expenditure on public goods. Spanish forced labor systems in Peru have a persistent negative effect on modern household consumption, most probably also due to lower access to education, health and public goods (Dell, 2010). It seems that the Habsburg Military Frontier due to its authoritarian centralized system was efficient in installing institutions, but due to its militaristic nature, not particularly interested or successful in caring for the social and economic fabric of the *Grenzer* society.

As a different falsification test, we also use proxies for social capital as our outcomes. Regarding membership in political parties (column (3) of Table 7), we find no statistically significant effect, but there is a small positive effect on membership

in civic organizations. The latter could possibly be explained by the typical life in communities that persisted in the Military Frontier territory much longer than in the rest of Croatia, but further research is needed to confirm this hypothesis.

6 WAR IN YUGOSLAVIA

In this section we recognize that there is possibly a confounding element and a potential channel in our analysis and explore if our results hold if we take into account this endogenous shock. Due to the massive east-to-west migrations induced by the Ottoman conquests, the ethnic composition on the border with the Ottomans permanently changed. As a response to migration, but also due to the defense strategies of Austrian noblemen, Vienna organized a military cordon on the eastern and south eastern borders of Croatia. It used the influx of mostly Serbian refugees to create a migration policy that consisted of the following. The area was to be populated by refugees that would be granted certain rights together with institutionalized ethnic and religion tolerance in the area of the Military Frontier in exchange for military obligations. The settlers were given land and they were freed from manorial obligations – serfdom – as opposed to the civil part of the Empire. The special status persisted until the dissolution of the Frontier in 1881 when its territory (and population) was unified with Croatia. A hundred years later, one could still observe that the ethnic composition from the 19th century was geographically preserved with relatively more Serbs living in the former Military Frontier area. With the collapse of socialist systems around Europe, Croatia opted for independence from Yugoslavia in 1991, spurring the proclamation of the so-called Republic of Serbian Krajina, which covered much of the area of the former Military Frontier. During the 1990s, the area was thus under fire, military occupation, and it endured extreme human and infrastructure losses. Taking this rather recent historical episode into consideration, one has to argue that it is possibly the war in Yugoslavia that is driving our results, and not the former Military Frontier, although the Frontier was a channel that led to the violent conflict in the 1990s in the first place.

TABLE 8

Trust and corruption in courts and police

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
Part of Military Frontier	0.325 (0.230)	0.153 (0.139)	0.804** (0.344)	0.567 (0.348)
Age of respondent	-0.002 (0.002)	0.010*** (0.002)	-0.009*** (0.003)	-0.019*** (0.003)
Male respondent	-0.127* (0.068)	0.064 (0.067)	0.051 (0.106)	0.123 (0.100)
Used service in last 12 months			0.509*** (0.178)	0.637*** (0.130)
Controls for religious affiliation (6 categories)	Yes	Yes	Yes	Yes
Controls for LiTS wave	Yes	Yes	Yes	Yes
No. of observations	3,036	3,080	2,957	2,994
No. of locations	147	147	147	147
Pseudo-R ²	0.016	0.020	0.023	0.043

*Notes: Coefficients and standard errors from ordered logit estimation. Sample: areas behind the frontline at arrival of UN forces in 1992 are excluded. Dependent variable in columns (1) and (2) is answer to the question "To what extent do you trust the following institutions?" Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don't know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question "In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?" Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don't know/Refusal set to missing in regressions. Standard errors clustered at the level of PSU or place of residence are in parentheses. *significance at 10, **5, ***1 percent.*

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016 and Šterc and Pokos (1993); see main text for details.

We therefore put our investigation under further scrutiny, and create two geographical subsamples. According to Šterc and Pokos (1993) we were able to identify LiTS household locations that were behind the frontline on the arrival of UN forces in 1992. The first subsample therefore excludes the areas behind the frontline on the arrival of UN forces in 1992 (Table 8); this way we completely exclude any occupied areas. The results are robust, although statistically significant only for the bribes to courts outcome. The bribes to traffic police issue is significant at the 10.3% level, and that of trust in courts at the 15.7% level. When we exclude only the area that was behind the frontline in 1992 and that used to be part of the former Military Frontier (Table 9), the results are even more convincing as both bribe outcomes become statistically significant and strongly positive. What one might conclude is that the attitudes towards bribery are more persistent as they survive even harsh wars, while trust in public institutions collapses during extreme events.

TABLE 9

Trust and corruption in courts and police

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
Part of Military Frontier	0.288 (0.231)	0.141 (0.142)	0.821** (0.340)	0.577* (0.343)
Age of respondent	-0.001 (0.002)	0.009*** (0.002)	-0.009*** (0.003)	-0.018*** (0.003)
Male respondent	-0.129* (0.067)	0.067 (0.064)	0.045 (0.103)	0.124 (0.095)
Used service in last 12 months			0.513*** (0.173)	0.615*** (0.126)
Controls for religious affiliation (6 categories)	Yes	Yes	Yes	Yes
Controls for LiTS wave	Yes	Yes	Yes	Yes
No. of observations	3,184	3,230	3,106	3,143
No. of locations	155	155	155	155
Pseudo-R ²	0.015	0.018	0.026	0.044

Notes: Coefficients and standard errors from ordered logit estimation. Sample: areas behind the frontline at arrival of UN forces in 1992 on the territory of former Military Frontier are excluded. Dependent variable in columns (1) and (2) is answer to the question “To what extent do you trust the following institutions?” Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don’t know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question “In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?” Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don’t know/Refusal set to missing in regressions. Standard errors clustered at the level of PSU or place of residence are in parentheses: *significance at 10, **5, ***1 percent.

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016 and Šterc and Pokos (1993); see main text for details.

7 CONCLUSIONS

The goal of this research was to use a natural experiment in macroeconomics to identify a causal mechanism of a specific political system on modern-day civic capital in order to reveal some of the fundamental causes of growth. This is the first such research done for Croatia, as it goes beyond simple mechanics of growth and provides evidence that history matters and that institutions are persistent and have far-reaching impacts. The standard to achieve this goal in modern macroeconomics is to use natural experiments and pair them with methods borrowed from microeconometrics. The literature so far has offered that growth is causally related with institutions, social structure, and civic capital, both between and within countries.

Our identifying assumption is that the Military Frontier randomly split the country for a period of more than 350 years and established different economic and political systems on the two sides of the border. We obtain robust evidence that the

former Military Frontier area is poorer than the rest of the country, and that this finding can be attributed to lower interpersonal trust, but higher trust in public institutions and higher incidence of bribery. These effects are not only statistically significant, but also quantitatively reasonable as the Military Frontier moves the trust in public institutions categories by 14–34% on average. The limitation to our study is that it builds on past events, and therefore cannot be generalized or used for speculating about the future. However, parallels can be drawn. For example, one can argue that the role of Vienna (as the center of the Habsburg Empire) has now just been replaced by other political centers, and that modern day decisions on east-to-west migrations are once again in hands of politicians. As history teaches us, these decisions have far-reaching effects lasting for decades and centuries.

This study provides substantial insight into the functioning of the economy and explains factors that cause persistent differences in economic outcomes within Croatia. History matters, be it in the form of a military cordon, episodes of violence and war, or migration. Any reform or economic policy tool utilized without taking into account institutions, social structure and culture, will be ineffective and repeatedly replaced by another ineffective tool, because in order to change the trajectory, one must look into the underlying causes. Institutions and societies are persistent, but they also change, sometimes driven internally, and sometimes by exogenous events. Existing research teaches us that both persistence and change are equilibrium outcomes (Acemoglu, 1995), and that small steps and gradual reforms are usually not enough to move a country out of a 'bad' equilibrium. Since both policy makers and institutions are inherently endogenous, providing recommendations is naturally a complex task, one that asks for an empirically realistic theory of comparative growth based on institutions. Empirical research that explores the causal links between those endogenous elements is one step closer to building a more realistic theoretical framework for policy advice.

Disclosure statement

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TABLE A1

Average absolute marginal effects

	Trust in		Bribes to	
	courts	police	courts	traffic police
	(1)	(2)	(3)	(4)
Part of Military Frontier	0.038	0.028	0.068	0.042
Age of respondent	0.000	0.001	0.000	0.002
Male respondent	0.012	0.007	0.006	0.010
Atheist	0.046	0.031	0.004	0.010
Buddhist	0.092	0.190	0.008	0.054
Jewish	0.137	0.101	0.097	0.137
Muslim	0.019	0.061	0.059	0.063
Other religion	0.001	0.034	0.048	0.013
LiTS wave 2010	0.020	0.068	0.069	0.089
LiTS wave 2016	0.074	0.081	0.043	0.067
Used service in last 12 months			0.050	0.061

Notes: Average absolute marginal effects of each independent variable for model specifications presented in Table 3, holding the other variables at their mean. Dependent variable in columns (1) and (2) is answer to the question “To what extent do you trust the following institutions?” Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don’t know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question “In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?” Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don’t know/Refusal set to missing in regressions.

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details

TABLE A2
Marginal effects of Military Frontier by category

	Trust in	
	courts	police
	(1)	(2)
Complete distrust	0.072	0.025
Some distrust	0.024	0.022
Neither trust nor distrust	0.038	0.023
Some trust	0.051	0.044
Complete trust	0.006	0.027
Average absolute marginal effect	0.038	0.028

	Bribes to	
	courts	traffic police
	(3)	(4)
Never	0.169	0.105
Seldom	0.053	0.024
Sometimes	0.073	0.056
Usually	0.036	0.019
Always	0.007	0.005
Average absolute marginal effect	0.068	0.042

Notes: Average absolute marginal effects of each independent variable for model specifications presented in Table 3, holding the other variables at their mean. The last row presents average absolute marginal effect across categories and is the same number as presented in Table A1. Dependent variable in columns (1) and (2) is answer to the question "To what extent do you trust the following institutions?" Column (1): The courts. Column (2): The police. Answer categories are: 1 = Complete distrust; 2 = Some distrust; 3 = Neither trust nor distrust; 4 = Some trust; 5 = Complete trust. Category 6 = Difficult to say/Don't know/Not applicable/Not stated are set to missing in regressions. Dependent variable in columns (3) and (4) is answer to the question "In your opinion, how often is it necessary for people like you to have to make unofficial payments/gifts in these situations?" Column (3): Interact with the courts. Column (4): Interact with the traffic police. Answer categories are: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Usually; 5 = Always. Category 6 = Difficult to say/Don't know/Refusal set to missing in regressions.

Source: Life in Transition Survey (LiTS) 2006, 2010 and 2016; see main text for details.



Capitalism without capital: the rise of the intangible economy

JONATHAN HASKEL and STIAN WESTLAKE,
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Book review by DUBRAVKO MIHALJEK*
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This book by and large meets the high expectations raised by its catchy title: it provides important insights on the evolution of capitalism in the global economy during the first two decades of the 21st century. The concept of intangible capital – computerised information, innovative property and economic competencies – helps explain developments as diverse as the long-term decline in business fixed investment, low measured productivity growth, the rise of giant technology firms, the shift in financial intermediation from banks to markets, and the growth of inequality. The book is broad in coverage yet is focussed on the core theme; it is well-articulated and informative for economists as well as other social scientists and non-specialists. And importantly, it provides sound and insightful policy advice.

Unlike the technological breakthroughs of the past century – for instance in transportation and telecommunications, electricity generation and use, new materials, agriculture, medicine – digital technologies are largely disembodied. Computer software, databases, product and service designs, organisational skills and business processes take no physical form. This “intangible” character of much of today’s capital, in contrast to machines, factory buildings, power plants, laboratories, scientific equipment and so on, is important because, as Haskel and Westlake argue, it changes the way that the market economy works.

To get to that big picture, Jonathan Haskel and Stian Westlake begin by discussing what intangible capital is and what its special properties are.¹ The first studies on the contribution of different types of knowledge to economic output date back to the early 1960s. At the time, economists such as Fritz Machlup and Zvi Griliches began to measure expenditure on R&D and started to question the then established view that research and development (R&D), product design, training, branding and the like were an intermediate input.

The next step in understanding the role of intangible capital was to account for the contribution of computer hardware and software in investment statistics. The first task faced an immediate challenge: the price of hardware has to be properly adjusted for quality improvements. Otherwise, the tendency for computer prices to fall over time results in an erroneous conclusion that spending on computer hardware accounts for a declining proportion of total investment. It took almost 20 years, starting in the early 1980s, for this adjustment to be properly implemented by statistical agencies, first in western Europe and then in the United States.

That was followed by accounting for software. Many companies and institutions write their own computer codes, which represent a long-lasting form of knowledge that has no tangible form. Citibank, for instance, once employed more programmers than Microsoft (p. 40). While both economists and statisticians

¹ Jonathan Haskel is professor of economics at Imperial College Business School in London, and since September 2018 an external member of the Bank of England’s Monetary Policy Committee, a body that sets policy interest rates in the United Kingdom. Stian Westlake is Executive Director of Policy and Research at Nesta, a UK research foundation focusing on innovation.

concluded that software ought to be treated like an investment, the problem was that there was no place for software on various investment surveys that statistical agencies asked firms to fill out. Again, it took several years to implement this change. The US Bureau of Economic Analysis started counting expenditure on software as part of investment spending in 1999, followed by the UK statistical authorities in 2001.

In a pioneering work on the measurement of intangible capital, Corrado, Hulten and Sichel (2005) defined three broad categories of intangible investment: computerised information, innovative property, and economic competencies.² *Computerised information* includes investment such as purchasing software, writing own software, and developing and maintaining databases. *Innovative property* covers investment spending on R&D, mineral exploration, creating entertainment and artistic originals, and design and other product development costs. *Economic competencies* include other expenditure that does not directly involve innovation or computers: training of staff (i.e., investment in a company's human capital); marketing and branding (i.e., investment in understanding customer needs); and spending on organisational capital (i.e., re-engineering of business processes) that creates distinctive business models or corporate cultures. Statistical agencies around the world have gradually taken over this categorisation of intangible investment. In the United States, the first to implement it fully, capitalisation of software added about 1.1% to the 1999 GDP, while R&D added 2.5% to the 2012 GDP. Investment in intangible capital is already estimated to exceed that in tangible capital in Finland, Ireland, the United States, Sweden and the United Kingdom.

An important contribution of the book is a discussion in Chapter 4 of the distinguishing characteristics of intangible investment. Haskel and Westlake propose four such characteristics: scalability, sunkness, spillovers, and synergies. The first of the four S's, *scalability*, stems from the non-rival nature of intangible assets. For instance, once a company has developed its human resources management software, it can use it in multiple locations at the same time without any additional cost. By contrast, physical assets such as trucks can only be used in one place at one time: they are not scalable the way intangible capital is.

The second feature is that the cost of developing intangible capital is largely irrecoverable or "sunk". For instance, an airline company that developed its own software for flight reservations is unlikely to find a buyer for that system if it goes out of business. That contrasts with tangible assets such as delivery vehicles, which can be sold off to recover partly the initial investment costs.

Intangible investments by one firm also tend to have large spillovers to other firms. Unless protected by comprehensive patents, the benefits from R&D

² See Corrado, C., Hulten, C. and Sichel, D., 2005. Measuring capital and technology: an expanded framework in: C. Corrado, J. Haltiwanger and D. Sichel, eds. *Measuring capital in the new economy*. Chicago: University of Chicago Press, pp. 11-46.

investment and software development – not to mention innovations in business organisation, training and branding of products and services – also tend to benefit firms that did not pay for such investment. While this may also be the case with investments in some physical assets, e.g., in transportation infrastructure, it is easier to establish property and usage rights over tangible assets than intangibles. In fact, as Haskel and Westlake remind us, much of the legal system and institutional history is based on the establishment of property rights over capital assets.

Intangible investments also exhibit synergies with one another – e.g., hardware with software – and with tangible investments – e.g., computers and software have dramatically increased productivity and investment in warehousing and distribution of goods and services since the 1990s. As Haskel and Westlake explain, such synergies matter because they create incentives to bring together different intangibles, especially new ideas. This encourages openness and sharing rather than appropriation of knowledge. At the same time, it encourages firms to protect their intangible investments against competition – not by protecting individual assets (e.g., through patents), but by creating clusters of intangibles, for instance mobile phone operating systems, data bases, streaming services and so on.

These four distinguishing characteristics of intangible capital have some important consequences for the development of the central thesis of the book, that the growing proportion of intangible capital in total investment changes the way the market economy functions. Most of the book – Chapters 5–11 – is devoted to the analysis of some of these consequences. Only a few are noted here.

Perhaps the easiest to understand is the impact of intangible capital on market competition. Scalability enables successful companies in an intangible-rich economy to grow very fast and expand globally. With their superior technology and integrated business processes, successful tech firms can create major obstacles to the competition of incumbent and entry of new firms. This may affect the competitive structure of some industries – retail, travel agencies, and taxi services are just some of the more recent examples.

Although intangible-rich companies may on their own invest huge amounts in R&D, productivity growth in the entire economy may stagnate. The reason is that potential competitors may be discouraged from entering a market in which a few dominant firms already have a technological and competitive edge – for instance, a more powerful internet search engine. Leading firms can easily overtake their competitors by scaling up on their intangible assets, and by assimilating knowledge through acquisition of potential rivals, often start-ups. This may result in a growing gap between leading (“frontier”) and lagging firms and, in aggregate, a slower productivity growth in the economy. This explanation, developed in Chapter 5, provides an interesting angle on the debate on so-called secular stagnation, a hypothesis that we live in a period of permanently slower total factor productivity growth.

The four S's of intangible capital also imply that intangible-rich companies are not confined to a specific location. They can shift their operations globally, according, for example, to the tax treatment they receive in a given location. This may create unhealthy tax competition among cities, regions and countries vying to attract successful tech companies, not to mention any resulting revenue losses. It also means that more resources than otherwise may be wasted on unproductive lobbying and rent-seeking activities.

There are important consequences of intangibles for the rise of inequality as well. As discussed in Chapter 6, the synergies and spillovers that intangibles create make it easier for intangibles-rich companies to attract talent with the education and skills needed to work in knowledge-based industries, and to pay them higher wages. Recent research suggests that such inter-firm differences can explain a significant proportion of the rise in income inequality. In addition, the rise of intangible industries makes cities with network externalities increasingly attractive places to live and work in. Given the limited supply of land for development in most urban centres, rising demand for housing inevitably drives up property prices. And as housing is the main form of wealth for most families, house price inflation is one of the key determinants for growing wealth inequality.

No less important are the consequences of intangible capital for investment financing, elaborated in Chapter 8. Traditional ways of funding business investment – borrowing from banks and issuing bonds in corporate debt markets – are not suitable for financing intangible investments. The reason is that such capital does not have the properties of traditional collateral: it is not tangible (unless protected by copyright or patents) so creditors cannot seize and sell it to recoup losses if the borrower can't repay the loan or make payments on the bond it issued. This implies that much of intangible capital has to be financed by issuing equity, or from a firm's retained earnings. Buyers of intangible firms' equity are unlikely to be traditional ones, retail or institutional investors, but rather specialised investment and venture capital funds. This, in turn, has consequences for the way intangible-rich firms are managed as well as for their growth and life cycle.

What does all this imply for public policy? Haskel and Westlake examine five questions in Chapter 10 that they see as most challenging for policymakers in an intangible-rich economy. The first one is how to develop a "good" intellectual property rights framework for intangible capital. As noted above, it is hard to prove who owns intangibles, and even then, their benefits tend to spill over to many users. The second one is how to maximise the benefits of synergies associated with intangible capital. In particular, how to devise urban land use rules, and plan and develop physical infrastructure in cities so as to create the best possible conditions for knowledge and innovative ideas to spread easily. The third challenge is how to facilitate the financing of an intangible economy, in particular the shift from debt to equity financing. A core issue is the tax treatment of debt: tax systems around the world allow companies to claim tax relief on interest

payments but not on the cost of equity. The fourth policy challenge is how to encourage more investment in intangibles. What combination of favourable conditions for private investment on the one hand, and public investment on the other – public R&D funding, public procurement, training and education – will help knowledge-based, intangible-rich activities to spread? And finally, how is one to cope with the income and wealth inequality associated with the rise of intangible economy?

Haskel and Westlake develop a number of policy proposals to tackle these five challenges. They are not only embedded in sound economic analysis and supported by empirical findings, but also make good common sense. Particularly illuminating is the comparison of policy approaches in two fictional countries in Chapter 9. Not surprisingly, one feature that makes a big difference in how countries cope with the challenges of intangible economy is social capital. Trust and social cohesion make it easier for ideas to spread around the economy through social networks. They also make it politically more feasible to mitigate the consequences of rising inequality through government policy. Where social cohesion is weak and mistrust of institutions and other social groups is widespread, the growing importance of intangibles often leads to economic pressures. Those pressures, in turn, exacerbate the political divides driving today's populist movements.



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