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Master's thesis / Specijalistički diplomski stručni

2021

Degree Grantor / Ustanova koja je dodijelila akademski / stručni stupanj: **RIT Croatia / RIT Croatia**

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:229:036056

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Download date / Datum preuzimanja: **2021-10-24**

The impact of euro adoption on mortgage rates: What can Croatia expect?

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2 May, 2021

Abstract

The purpose of the paper was to study the effect the integration in the eurozone had on the retail interest rates before and after the adoption of the euro. While most of the studies in this field focused on the inter-bank rates, this research set out to study mortgage rates, thereby obtaining insight into what both households and the banking sector may experience. The study researched whether or not mortgage rates converged in pre-adoption and post-adoption periods in Estonia, Latvia, Lithuania, Slovenia, and Slovakia, with an intention to attempt to estimate what could happen in Croatia. The results implied that in most cases the mortgage rates of the euro-adopting countries are correlated to the average mortgage rates in the eurozone in the pre-adoption period. Nevertheless, the findings surprisingly showed that these countries experienced different degrees of convergence, and sometimes even divergence of these interest rates. Hence, without identifying a repetitive pattern of behavior of interest rates, an estimate for the Croatian case could not have been made.

Keywords: Eurozone; mortgage rates; interest rates; convergence; Croatia; Euro

The impact of euro adoption on mortgage rates: What can Croatia expect?

The Republic of Croatia currently uses the kuna as its official currency, but after joining the European Union (EU) in 2013, it became apparent that it would be only a matter of time before it adopted the euro. In advance of the adoption, a process of economic convergence would be required to take place. The Maastricht Treaty concluded in 1992 among member states of the European Communities – the predecessor of the European Union, effectively serves as the foundation treaty of the European Union and has defined four convergence criteria. While some economists debate over the adequacy of the use of the term convergence in the context of the Treaty arguing that it provides only fiscal stability and price rules, the notion of convergence usually refers to the process of structural and institutional harmonization amongst members with the intention of enabling those who underperform to catch up with members who perform well (Afxentiou, 2000). In this context, as Borowski et al. (2003) noted, a country like Croatia aspiring to join the monetary union, would need to have central bank enforcing policies that would sustainably keep inflation low, as reflected in the market by low long-term interest rates. In addition, managing debt and the budget deficit would need to be credible and the government is supposed to show firm action in these areas. The last step would be for the future member to undertake measures to ensure participation in the ERM II – the Exchange Rate Mechanism – which would imply fulfillment of the convergence criteria (Borowski et al., 2003). Seven years after Croatia became a member of the EU, Croatian Prime Minister Andrej Plenković officially announced further integration of Croatia in this union by setting January 1st of 2023 as the fixed date for the adoption of the euro as Croatia's national currency. This came a year after the Eurogroup's statement (2019) welcoming Croatia's efforts to join the Exchange Rate Mechanism (ERM II), a step in the process of joining the monetary union – the Euro Area, and a few months after the Eurogroup's decision (2020) to approve participation of the current Croatian national currency, the kuna, in this mechanism. This Eurogroup's decision confirms that Croatia has made success in keeping inflation low, maintaining stable kuna-related exchange rates, improving the balance of payments, and reducing the public debt.

The euro adoption, as expected, will be under accountability and supervision of the Croatian National bank (HNB) which, like other central banks, is in charge of executing monetary policy, which

deals with the money supply and interest rates, in order to meet the central government's macroeconomic objectives such as economic growth and inflation. While executing its monetary policy, the HNB, besides being responsible for processing checks, and supervising compliance of banks' operations and Croatian laws, such as consumer protection laws, must make sure that the amount of currency and coins within circulation are enough to meet demand (Greenlaw, 2014). In order to achieve its objectives, HNB uses a set of three instruments: open market operations, reserve requirements, and standing facilities. HNB is able to issue and sell securities in national or foreign currency, as well as buy and exchange them, thereby affecting the kuna's exchange rate (Rudelić, 2018). However, once Croatia adopts the euro, the HNB will have to adjust its operations to new circumstances. HNB's monetary policy instruments that were used prior to the adoption of the euro will be replaced by those of the Eurosystem, which has the potential to largely impact banks as reserve requirements will be lower (Croatian National Bank & Government of the Republic of Croatia, 2018). A lower reserve requirement should correspondingly contribute to an expansionary monetary policy, effort that normally entails the reduction in reserve requirements. In practice and as per the theoretical interpretations, it has been shown that the lower reserve requirement, lowering the required amount of cash banks need to hold in reserves, induces lower interest rates and effectively means more loans to clients which in turn enlarges the total supply of money circulating and expands the economy. According to the quantity theory of money (QTM) this usually comes at the cost of a higher real inflation rate, if the extent of money supply expansion is larger than that of the economic growth.

Analogous to the Croatian Central Bank operating in Croatia, the European Central Bank (ECB) is in charge of administering monetary policy in the EU, which, in other words, means that individual EU members have little to no influence over controlling the money supply; therefore, the supranational institution – ECB - is the primary body in terms of deciding on monetary policy as compared to any individual country's national central bank (Yanushevsky et al., 2018). This means that the commercial banks in the whole eurozone will be affected by the ECB's decisions and the use of its instruments. In the same way as other central banks, the ECB will manipulate the money supply in the economic area it supervises, thereby indirectly impacting the economy of each member state,

and their financial sectors in particular. The European Central Bank influences the money supply mainly through the control of three interest rates: the rate on the marginal lending facility, the rate on the deposit facility, and the main refinancing operations rate. The rate that plays a relevant role in the process of commercial banks setting their interest rates for their customers is the Euro Interbank Offer Rate - Euribor, which represents an indicative interest rate published every day that essentially shows the average of rates of selected banks for a set of maturities (Abbassi & Linzert, 2012). Wallace (2015) defines Euribor as "a benchmark [rate] compiled by some [20] of the biggest banks in the world, which submit an interest rate each day representing the cost of lending to another large bank". The direct impact on banks is not the only effect changes in Euribor may produce. Namely, many of the mortgage loans offered by banks both in Croatia and the rest of Europe, are subject to variable interest rates that vary in accordance to Euribor – there is a positive relationship between these two, implying that as Euribor rises the interest on consumers' mortgage loans will also rise and vice-versa.

When it comes to the banking sector in Croatia, the HNB prepares numerous reports that provide an insight into Croatia's financial system. In its most recent *Report on selected indicators of structure, market concentration, and operations of credit institutions* issued in September 2020, the HNB indicates that there are 23 credit institutions currently operating in Croatia, out of which 20 are commercial banks. It is interesting to note that the report states that 9 out of 23 banks are domestically owned, but the share of the assets of domestically owned credit institutions (including 3 which are not commercial banks, but housing savings banks) in the total assets of credit institutions is 9.55%, while the 14 foreign-owned credit institutions, which are solely banks, hold 90.45% of total assets. This disproportion, where 9 domestically owned credit institutions own only one-tenth of total bank assets, suggests that the banking sector is in both absolute and relative figures dominated by foreign capital and that the analysis of the performance of domestic banks solely would not allow for an accurate understanding of the financial services market in the Republic of Croatia.

Banks that operate in Croatia offer loans that may simply be categorized as follows: cash loans, housing loans, and others. Unlike most other loans, an overview of the loan offers by Croatian banks suggests that housing loans are subject to either a combination of fixed and variable interest rates (occurring respectively) or to a variable rate during the entire payment period. The variable

interest rate of housing loans offered by one foreign bank operating in Croatia - Raiffeisen (2021) is defined as "the sum of the fixed part…and of the 12-month Euribor determined on the day of 28/5/2020 in the amount of -0.08%, less 0.50% of the primary customer bonus". This is not the same for all banks in Croatia, and some loans are actually NRS-dependent, NRS being a Croatian national reference rate calculated by the HNB. However, according to the official government's document under the title of *Croatia's plan for replacement of national currency with euro* (2020) all NRS-dependent loans and banks will not be able to issue any new loans with variable interest rates linked to the NRS. The NRS will not cease to exist, but the NRS HRK, which is the NRS applicable to the selected loans with variable rates issued in kunas, will merge with NRS EUR as per specific methodology elaborated in the plan.

In the *Strategy for the adoption of the Euro as the official currency in Croatia* numerous benefits of the euro adoption have been identified including the elimination of exchange-rate risk, reduction of the cost of debt, and a lessening in the overall probability of a banking crises (Government of Croatia & Croatian National Bank, 2018). Joining the eurozone, according to the Strategy (2018), may as well bring potential challenges including inflation resulting from the conversion costs, loss of sovereignty, and additional costs of joining the euro system and providing obligatory financial support to the struggling eurozone members.

This paper studies the topic of other implications Croatia will face once the euro is adopted. Specifically, it aims to explore the possible repercussions associated with euro adoption by evaluating its impact on the interest rates on housing loans. Following what Ivanov (2017) noted in her research, it is concluded that once the long-term interest rates (on public debt) have converged, it will be reflected in commercial banks' loans in that they would not differ significantly from those in the Euro Area.

This paper attempts to research whether or not interest rates of observed euro-adopting countries followed the movements of the observed rates in the Euro Area before and after adopting the Euro. In addition, the paper investigates if convergence did occur and if it was reflected by the decrease over time in the difference of mortgage rates found in the observed euro-adopting countries and the eurozone. The purpose of this study was to gain a better understanding of how commercial

banks' interest rates on retail loans for households will react to euro adoption. Therefore, this paper may be viewed as a new line of inquiry, considering that the research on this topic has heretofore predominately focused on inter-bank markets rather than the rates experienced directly by households. The results obtained are intended to allow for drawing conclusions on what the Croatian financial service sector and households may expect from the euro-adoption process.

Methods

Purpose

A set of statistical analysis methods was applied to the secondary data collected in order to identify if euro-adopting countries have their potential interest rates getting closer to those of the eurozone, which would imply convergence. Furthermore, the paper set out to use the methods to identify a potential correlation between the movements of interest rates in selected countries and movements of interest rates calculated in the form of Euro Area (eurozone) average. The purpose was to determine if a pattern existed in interest rate behavior before and after euro adoption and to form expectations of what will happen with loans in the Croatian financial service sector.

Instruments

The data was collected in the form of interest rates. All interest rate data collected refer to mortgage loans with the initial rate fixed (IRF) for between five and ten years, which, according to the paper of Hüfner and Isabell Koske (2008), may be representative of the euro adoption process and its impact on interest rates. The time frame observed is 10 full years separated into 120 month segments, which entails a period commencing five years before the adoption and ending the month before the adoption, and the period starting on the month of the adoption and ending five years later. This time frame was supposed to allow for the analysis of how interest rates will behave differently before and after the euro adoption.

Interest rates were collected in the form of monthly averages for Slovenia, Slovakia, Lithuania, Latvia, and Estonia from the official website of each countries' central bank, along with the Euro Area average statistic which was collected from the European Central Bank's official website. The criteria used to determine which countries' interest rates to compare with the Euro Area average is two-fold.

The recency of the euro adoption should indicate that the country's interest rate analysis is more likely to be representative of what Croatia may experience as they were exposed to the same global and supranational economic events, while at the same time GDP per capita represents an indicator of comparability between economies. Thus, the four most recent Euro Area members – Slovakia, Estonia, Latvia, and Lithuania were selected, along with Slovenia which is economically comparable to Croatia.

Data was collected and organized in an excel spreadsheet. Five pieces of information were collected for each observed country: month and year column, the country's interest rate in that month, Euro Area average interest rate in that month, and the absolute difference between these two interest rates. The number of rows corresponds with the number of months observed - 120, with the clear labeling of the month when the euro was adopted by a country. It is important to note that Euro Area averages excluded the observed country's interest rate from the average in order to avoid data bias when performing correlation analysis. Differences in the interest rates between countries and Euro Area averages were expressed in absolute values, as the occurrence of convergence should be reflecting in the smaller difference regardless of which of the two variables is larger or smaller. In addition to this data, the mean of Euro Area average interest rates was calculated below each country's table, for the purpose of performing t-tests. Once the calculation of the difference of these variables had been done in Excel, statistical analyses of the data were performed in Minitab software.

Correlation analyses were run for the two sets of variables:

1) number of months (1 to 60 in the two periods: pre-adoption and post-adoption)

2) the difference between a country's interest rates and Euro Area average interest rates

These analyses were supposed to indicate if the interest rates difference got smaller or larger as the time passed by i.e. as the number of months increased – which would reveal if convergence in the economy observed occurred. Another correlation analysis run was for interest rates of a country observed and Euro Area average interest rates, which should have showed if the interest rates tracked each other and moved in the same direction. Lastly, a one-sample t-test analysis was run to examine if there is a significant difference between the mean of the set of 60 interest rates of a country and the hypothesized mean, which in this case, is the mean of Euro area average interest rates for the time

frame within which we observe the selected country's interest rates. All analyses were separately performed for the pre-adoption period data and post-adoption period data.

Procedures

All but one country had missing interest rates data for at least a couple of monthly periods, and in these situations, in order to avoid errors in statistical analyses, the corresponding month number was omitted. For instance, if the first and third months observed had interest rate data available, but the second month observed did not then the data entered in the Minitab for the statistical analysis included neither the month number (2) nor the interest rate for the month as it is unavailable.

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Results

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Pre-adoption

In an effort to see if mortgage rates in the euro-adopting countries converged with the euro-zone average, a correlation analysis between months (time) and the absolute value of the difference in the mortgage rates of individual euro-adopting countries and the Euro Area average (excluding the corresponding country) was performed for the pre-adoption and post-adoption periods separately. The results of this analysis suggest that a single conclusion cannot be drawn for all the observed countries. Namely, in the pre-adoption period, only Lithuania shows a statistically significant correlation ($r = -.708$, $p < .000$) between months and the absolute difference between Lithuanian interest rates and the Euro Area average interest rates, as shown in Figure 1 (Appendix A).

As expected, the correlation is negative, implying that as the adoption date comes closer, the difference between Lithuanian interest rates for the loans observed and the average interest rates of the Euro Area gets smaller. Such results indicate the existence of convergence, and the p-value obtained confirms that the correlation between these two sets of values did not occur by chance. Estonia (see Appendix A) does show convergent mortgage rates too, however with a statistically less significant value. Amongst other three countries (see Appendix A) which all suggest positive correlation, Latvia has the highest correlation coefficient, $r = .305$, $p = .044$, when compared to Slovakia ($r = .289$, $p = .025$) and Slovenia ($r = .155$, $p = .340$). These results come unexpected, as positive correlation arises from the occurrence of divergence, that is, the researched difference

between the mortgage rates has expanded despite the deeper integration in the monetary union. However, it is worth noting that all three correlation coefficients which reflect divergence are not statistically significant. In line with the lack of significant values of correlation coefficients, one of the countries with the identified divergence, Slovenia - showed high p-values thereby failing to reject the null hypothesis that may be interpreted as the assumption that time has no effect on the degree of convergence. In the case of Slovakia and Latvia despite the null hypothesis being rejected, the divergence here is not substantial because the correlation cannot be described as statistically significant due to a very low positive correlation coefficient.

Furthermore, one-sample t-tests were conducted between euro-adopting countries and the EU average in order to see if the euro-adopting countries' mortgage rates were or were not significantly different from the euro-zone average. This analysis, too, was supposed to show whether or not the convergence of the mortgage rates occurred. It was found in all cases that euro-adopting countries' mortgage rates were significantly different at $p = .000$, which implies that the interest rates of these countries did not come close to being equal to those of the Euro Area, thus leading to a conclusion that convergence failed to occur. Please see Table 2 in Appendix B for complete results. As shown in the table, Lithuania reported the lowest t-value, $t(1) = 6.12$, $p = .000$, Slovakia marked the highest one, $t(1) = 31.71$, $p = .000$.

The analysis of the correlation between the interest rates of individual countries and the interest rates on the level of the eurozone show statistically significant results for the majority of countries in the pre-adoption period. Apart from the Latvian case ($r = .094$, $p = .545$), as shown in Table 1 (Appendix A), interest rates of other countries were strongly positively correlated with the Euro Area average interest rates in the pre-adoption period. Analogous to the analysis of the correlation between the time and interest rates difference between the Euro Area and the individual countries, Lithuania marks the highest degree of correlation. This means that the interest rates of Lithuania, similarly to other observed countries excluding Latvia, fluctuate most strongly of the observed countries in the same direction as those of the eurozone.

Post-adoption

When correlating months (time) with the difference in mortgage rates in euro-adopting countries and the eurozone average, it seemed that the correlation coefficients for the post-adoption period did not show a statistically significant correlation in the case of the majority (60%) of countries, specifically Slovakia, Slovenia, and Estonia. On the other hand, two countries – Latvia (r = .528, p = .000) and Lithuania (r = .917, p = .000) did display a strong and positive correlation between the time and the difference in their and Euro Area's mortgage rates, given the high correlation coefficients and p values. This suggests divergence, hence no country had mortgage rates convergence with a high level of statistical significance. Figure 2 (Appendix B) shows the difference in the correlation coefficients between the Lithuanian and Estonian cases, which are two extreme results, that is, the highest and significant correlation coefficient, with p = .000, and the lowest and statistically insignificant correlation with p = .788. Appendix B encompasses correlation analysis results for the other three countries.

Surprisingly, one-sample t-tests used to calculate the difference between the mean of Euro Area average mortgage rates and the mean of individual countries' mortgage rates in the period after the adoption of the euro indicate larger differences when compared to the pre-adoption period t-tests, as shown by Table 2 (Appendix B).

In addition, the correlation analysis assumed to indicate if mortgage rates of the countries that joined the eurozone track this monetary union's average mortgage rates shows that only Slovenia (r = .709. p = .000) has had mortgage rates positively correlated with the eurozone mortgage rates. On the other hand, Latvia (r = -.773, p = .000) and Lithuania (r = -.887, p = .000) are negatively correlated in this context, while the interest rates of Slovakia (r = .106, p = .415) and Estonia (r = .263, p = .071) are not statistically significant correlated to those of Euro Area's average. Please see Appendix B and Table 3 for detailed results.

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Discussion

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Main findings and the related literature

The results of the research differ from the expectations denoted by the beforementioned research questions. In terms of the second research question assuming that the interest rates of joining

members should be getting closer to the Euro Area average interest rates, the results undoubtedly rejected it. In the pre-adoption period, out of five countries, only Lithuania (r = -.708; p=.000) confirms the assumption, while other countries, besides showing statistically insignificant correlation coefficients, indicate positive correlation meaning that the difference increases as time goes by. Therefore, contrary to the expected, convergence in this context in the pre-adoption period has not been identified for the dominant part (80%) of the sample. It is found that in the post-adoption period, all countries had shown a positive correlation between their interest rates and those of the eurozone, with only two (40%) of these indicating a statistically significant correlation. Thus, the assumption of the second research question is undoubtedly confirmed to be false, in both time periods observed. When it comes to the correlation between the interest rates of individual countries and the interest rates of the Euro Area, we see that in the pre-adoption period there is a statistically significant positive correlation for the majority of the sample (80%). Unpredictably, interest rates of the countries in the post-adoption period were in a correlation with those of the monetary union to a smaller extent i.e. in 60% of the sample. This suggests that no clear pattern could be found and used as a prediction for the Croatian case. It is virtually impossible to conclude if the financial service sector in Croatia will actually have the interest rates on their commercial loans decrease to the level of the Euro Area until the adoption or within the five-year period after the adoption.

If we assume that the convergence of the long-term interest really occurred and that the convergence of the short-term rates, denoted by the similarity of short-term reference interest rates (in Croatia it is ZIBOR) of central banks and those of the European Central Bank's (EURIBOR) did take place, there are multiple explanations as to why interest rates on the observed loans for house purchase did not meet the level of the Euro Area interest rates. Firstly, the conclusion drawn here is that this research does not provide supporting evidence that in any of the countries examined interest rates matched those of the eurozone and that these interest rates did not converge. A research study on Slovakian adoption of the euro finds that interest rates in the retail sector, especially on loans for households may take more time to drop to the level of the eurozone interest rates, mainly due to the lack of competition and cross-border activity in the banking sector (Hüfner & Koske, 2008). The study further explains that there is a noticeable dispersion of the interest rates in this monetary union among

countries, and that standard deviation of interest rates on different loan categories actually suggest that convergence will not be present at the same time and at the same level for all loan in every member state. Hüfner and Koske (2008) additionally claimed that it took seven years for Greece to have its housing loans interest rates fully converged, concluding that the convergence must take place eventually. Ivanov (2017) argues that despite being subject to the single monetary policy, which is corroborated by the correlation analysis of the interest rates of countries and the eurozone, there are other effects that affect the cost of borrowing. Note that the interest rates of commercial banks may differ due to differences in the economic development of countries, countries' debt-to-GDP ratio (suggesting different perceptions of the state of public finance), inflation rates across countries, or other macroeconomic indicators. In addition, countries have different levels of foreign direct investments, and their banking sectors may differ significantly. All of these issues lead to circumstances wherein countries cannot have the same interest rates (Ivanov, 2017). On the other hand, Hüfner and Koske (2008) discussed this further and found that differences in factors that determine the pace of the integration in the monetary union may cause retardation of the convergence, implying that institutional factors including taxation and consumer protection may cause the degree of convergence to differ across countries.

It is possible to assume that the positive correlation of the difference between euro-adopting countries' mortgage rates and the eurozone average mortgage rates with the time in the pre-adoption period means that the divergence got underway. The divergence certainly can occur, as Ivanov (2017) explained stating that the participation in the EMR II does not imply that divergent trends will never be present. In fact, they may take place in both the pre-adoption and the post-adoption phases. In addition, Kusovac and Pavić (2018) discussed the possible causes of this phenomenon and argued that divergence may be present as a consequence of a sequence of events taking place in the financial markets and the investors' of risk associated with investing in national-level markets. Hence, it may be argued that the fulfillment of the convergence criteria and participation in the EMR II mechanism sometimes may not outweigh the effects of what happens in financial markets and this could subsequently adversely impact the degree of convergence of the long-term interest rates on

government bonds which then presumably will lead to the difference in interest rates which are subject of this research narrowing down.

The underlying assumption of the research question that refers to the correlation between the interest rates of joining members and the eurozone interest rates was corroborated by the findings, but only for the pre-adoption period. The fact that 80% of the countries in the pre-adoption period have their interest rates fluctuating in the same direction as those of the eurozone's, could be interpreted as the successful integration in the monetary union, effect of the participation in the EMR II, or exposure to the same economic events. It might be suggested that the prevalence of the symmetrical nature of the economic shocks countries were exposed to. The notion symmetrical refers to the economic shocks experienced by all the members (in this case we apply it to the joining members) at the same time to a similar degree (Rusek, 2008). Symmetrical nature is demonstrated by the fact that countries' interest rates track those of the eurozone portrayed by the correlation with a high degree of statistical significance. The results of the same correlation analysis for the post-adoption period are not consistent with the previous findings, as two out of three statistically significant correlations show a negative relationship between the interest rates in the two sets of data observed. This comes as a surprise as it is expected that the deeper integration in the monetary union should lead to exposure to the same effects.

Implications

The initial assumption was that Croatia, despite the difference in time of adoption and economic circumstances within which it happens, once it adopts the euro in 2023 will experience the same effects on the interest rates on the loans for house purchase with the IRF of more than 5 and up to 10 years, as other member states of the eurozone. This assumption was based on the prediction that all countries experience the same effect within the time period. Along the lines of the previous statements, these findings based on other countries should help us estimate if the interest rates on these loans will decrease or increase once it adopts the euro and if the convergence will actually occur. However, the findings of the correlation analysis of the interest rate differences and the number of months after the adoption do not lead to any specific conclusion, as it failed to result in a statistically significant correlation. Therefore, there is no evidence that in the first five years of being an eurozone

member, Croatia's interest rates will converge. Moreover, no specific conclusion can be drawn from the correlation analysis between the interest rates in countries observed and the interest rates of the eurozone. This means that the findings failed to indicate if the member state's interest rate actually move in the same or opposite direction after the adoption of the euro. Hence, as the research did not identify a pattern in the behavior of the interest rates in the post-adoption period in neither of the two correlation analyses, it is impossible to apply it in the Croatian case and estimate the future behavior of the retail interest rates in the Croatian financial services sector.

If the undermentioned limitations of this paper would be removed, especially in terms of the lacking sophistication of the instrument and method it is possible that results obtain in such research would be more meaningful and would enable more predictability of interest rates in Croatia. Therefore, additional research should be directed towards finding reasons for the lack of interest rate convergence in the first five years of the eurozone membership. It would be useful to address the existence of a positive and statistically significant correlation between joining members' interest rates and the Euro Area average interest rates before adopting the euro, and lack thereof in the post-adoption period. If running correlation analyses for all other 14 eurozone members would suggest that convergence is taking place in the first five years of membership, putting the five countries observed here in juxtaposition with the rest of the members could lead to a conclusion why in some countries the convergence does not occur as expected. An additional contribution to the scientific research of this field would be to compare the degrees of convergence across different loans, which would possibly suggest an answer as to why the loan type observed in this paper did not show the assumed convergence degree.

The findings of this paper did not allow for estimating firm practical implications. The conclusion appears to be that it is difficult to forecast with any degree of certainty as to what will happen to Croatian mortgage rates in the remaining pre-adoption months and the following post-adoption time period. Observed countries experienced different impacts on the mortgage rates, with no reason found to explain these differences, thus Croatia can experience either convergence or divergence in the context of the discussed mortgage rates. The paper did not succeed in providing

those affected by these rates – real estate participants or stakeholders, including existing or potential homeowners, with a special insight into the financing aspect of their industry.

Limitations

The primary limitation of this paper is the accuracy of the assumption that the specific loans being observed and researched. As the majority of papers fails to research interest rates on retail banking loans and mostly deals with the government bonds and short-term inter-bank interest rates, there is a lack of evidence to suggest that the interest rates on loans for house purchase with the initial rate fixation of more than 5 and up to 10 years are representative and that what happens with the interest rates associated with this loan type could actually be used to predict the behavior of the interest rates on other types of loans. To be more specific, it could be that the interest rates on this loan type show slower convergence when compared to other loans' interest rates. Besides, the potential lack of representativity of the loan type observed, the criteria for selecting the countries to be subjects of the research may be inadequate. The fact that the time difference between the adoption date of the countries is less significant does not necessarily imply that the impact of the euro adoption will more similar, as there are other factors such as the economic downturn related to the corona pandemic that could affect financial markets and economies, and subsequently the interest rates and the convergence thereof. In addition, five (26%) out of nineteen member states of the eurozone could have experienced different interest rates behavior than the majority (74%) of the member states that were not included in this research. In other words, the research of other countries' interest rates would perhaps allow for more significant predictions, but the question of the applicability to the Croatian case would still remain. The limitation of this research may be seen in terms of the observed period, that is, the 5-year pre-adoption period and 5-year post-adoption period. Assuming that the interest rates convergence may have occurred some years after this 5-year period, this would be missed by this research. Accordingly, it might be argued that interest rates should be analyzed over a longer period of time, such as 20 years, but that would not be possible for most of the countries researched as they still haven't been a member of the eurozone for ten years. Another position could be that the research was limited by the 5-year post-adoption period which could be too long for the interest to remain stable and follow one direction. If the 2-year post-adoption period was observed, it could be that the

results would be more statistically significant and allow for the application. Lastly, a limitation could be the quality of the instrument and research method and the sophistication of the statistical analysis utilized in this paper. The majority of the papers in this field scrutinizing convergence in the Euro Area use statistic models such as VAR or even more complex ones, which perhaps suggest that a complex phenomenon as convergence cannot be researched with some simple statistical analysis.

Final remarks

Despite the apparent limitations, the importance of this research is multi-fold. This paper may be viewed as a first step towards researching interest rates on loans that directly affect households and non-banking businesses, as opposed to focusing on financial and global markets. In addition, the lack of a firm conclusion as to what happens with regards to the interest rates observed is not meaningless, as it tells us that not every country will experience convergence as we expect it, and it incentivizes further research which would set out to find more statistically significant data. This paper contributes to the scientific economics research in the area of the interest rates convergence in the eurozone and additionally introduces Croatia in that context.

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Appendix A

Table 1

Overview of the correlation coefficients and p-values for all countries observed in their pre-adoption periods

Country	Correlation coefficient and p-value
Latvia	r = .094, p = .545
Lithuania	r = .856, p = .000
Slovakia	r = .687, p = .000
Slovenia	r = .658, p = .000
Estonia	r = .713, p = .000

Figure 1

Scatter plot displaying the correlation between the difference of Lithuanian and the average eurozone mortgage rates and months (a time variable)
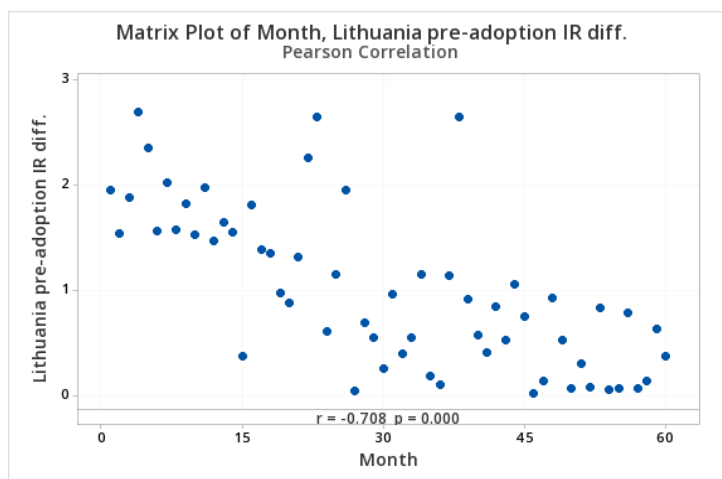
Figure 3

Scatter plot displaying the correlation between the difference of Slovakia and the average eurozone mortgage rates and months (time) in the pre-adoption period
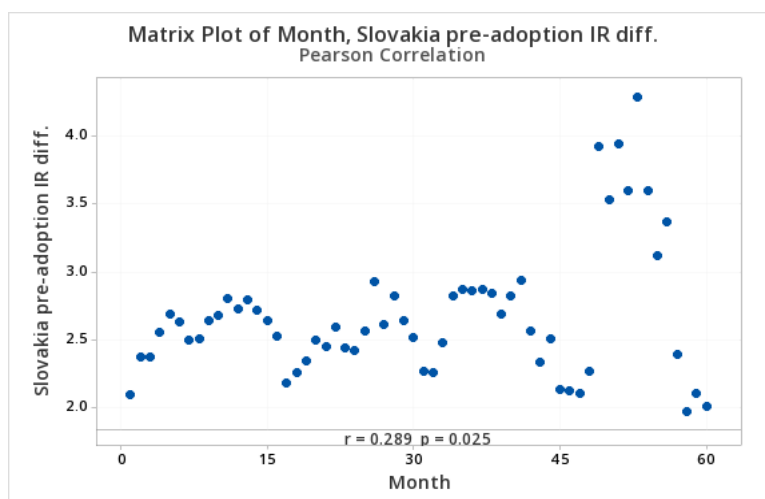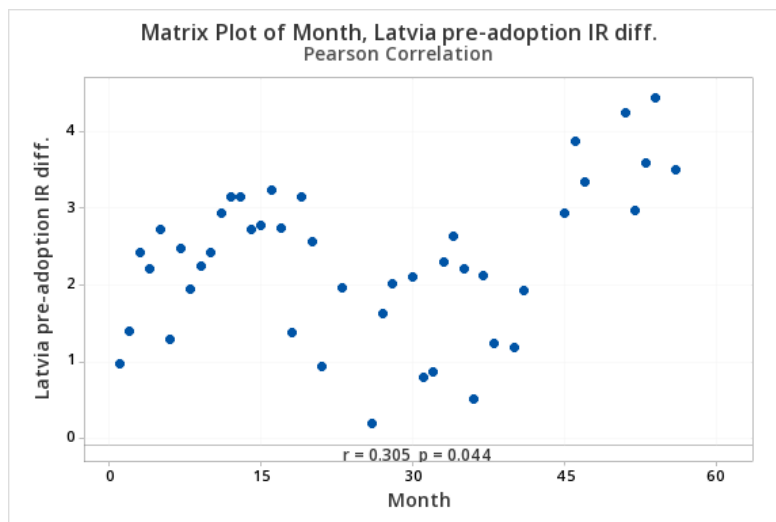
Figure 4

Scatter plot displaying the correlation between the difference of Slovenia and the average eurozone mortgage rates and months

(time) in the pre-adoption period
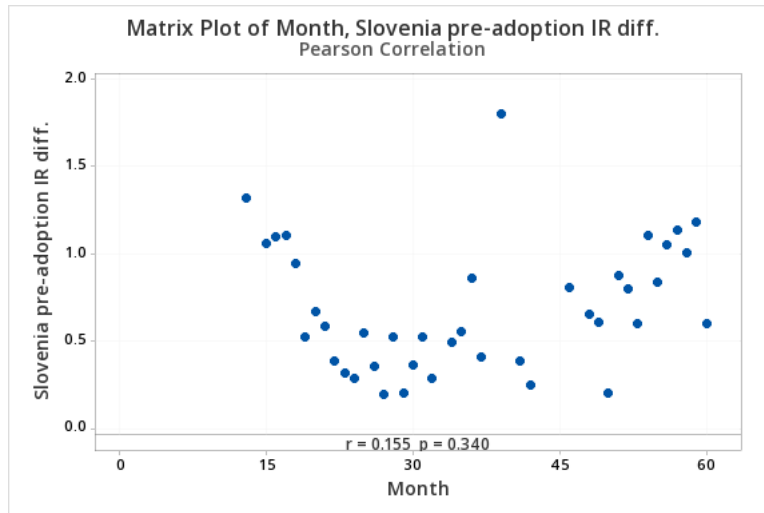
Figure 5

Scatter plot displaying the correlation between the difference of Latvia and the average eurozone mortgage rate and months

(time) in the pre-adoption period

Figure 6

Scatter plot displaying the correlation between the difference of Estonia and the average eurozone mortgage rate and months

(time) in the pre-adoption period
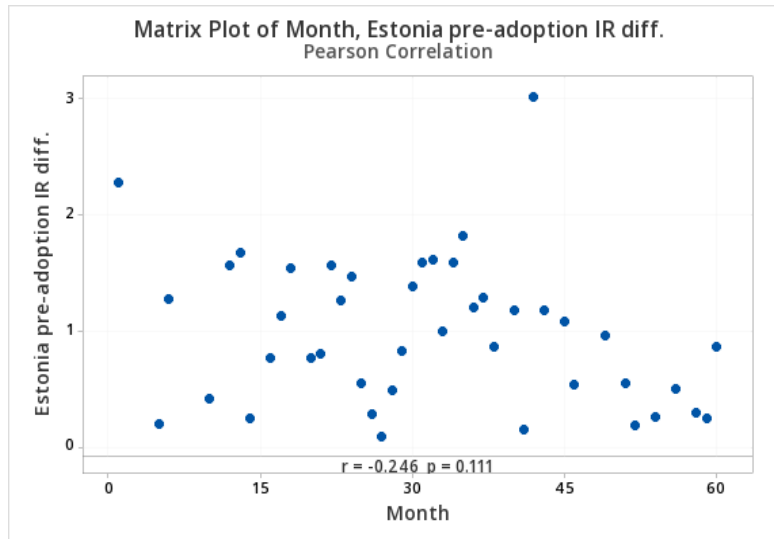
Appendix B

Table 2

Overview of the 1-sample t-test results for all observed countries in the pre-adoption and post-adoption periods

Country	T-value pre-adoption	P-value pre-adoption	T-value post-adoption	P-value post-adoption
Latvia	18.13	p = .000	20.51	p = .000
Lithuania	6.12	p = .000	10.96	p = .000
Slovakia	31.71	p = .000	25.21	p = .000
Slovenia	9.14	p = .000	19.11	p = .000
Estonia	7.79	p = .000	5.89	p = .000

Table 3

Overview of the correlation analysis of the mortgage rates of the euro-adoption countries and the eurozone average mortgage rates in the post-adoption period

Country	Correlation coefficient	p-value
Latvia	r = -.773	p = .000
Lithuania	r = -.887	p = .000
Slovakia	r = .106	p = .415
Slovenia	r = .709	p = .000
Estonia	r = .263	p = .071

Figure 2

Scatter plots showing the correlation between the difference of Estonian and Lithuanian and the average eurozone mortgage rates and months (time) in the post-adoption period
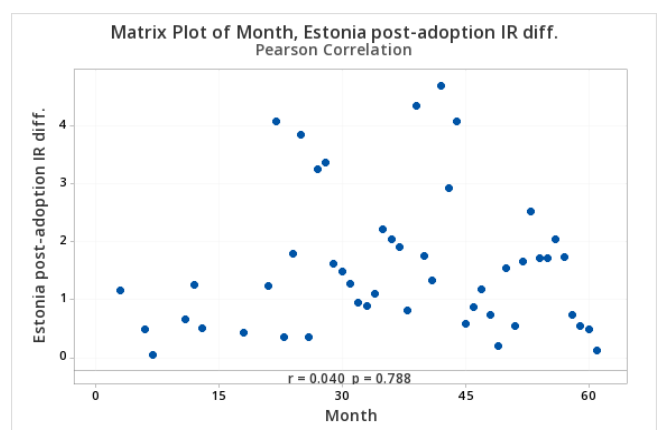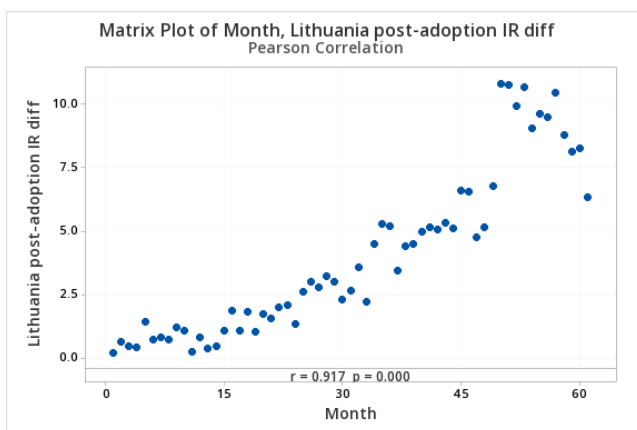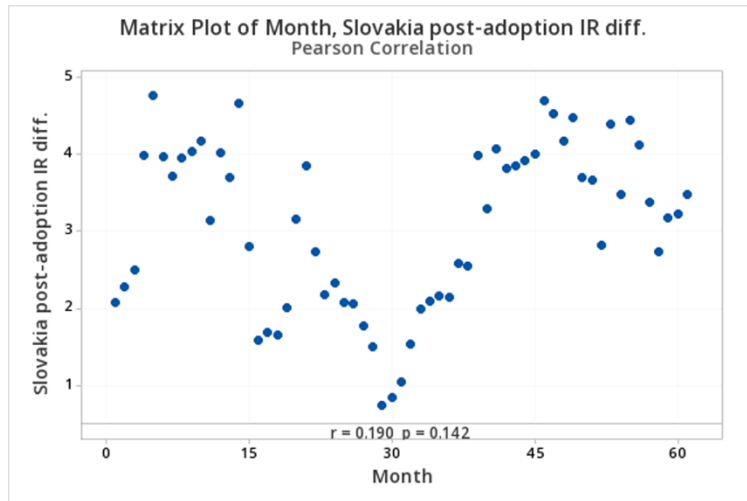
Figure 7

Scatter plot displaying the correlation between the difference of Slovakia and the average eurozone mortgage rates and months (time) in the post-adoption period

Figure 8

Scatter plot displaying the correlation between the difference of Slovenia and the average eurozone mortgage rates and months (time) in the post-adoption period
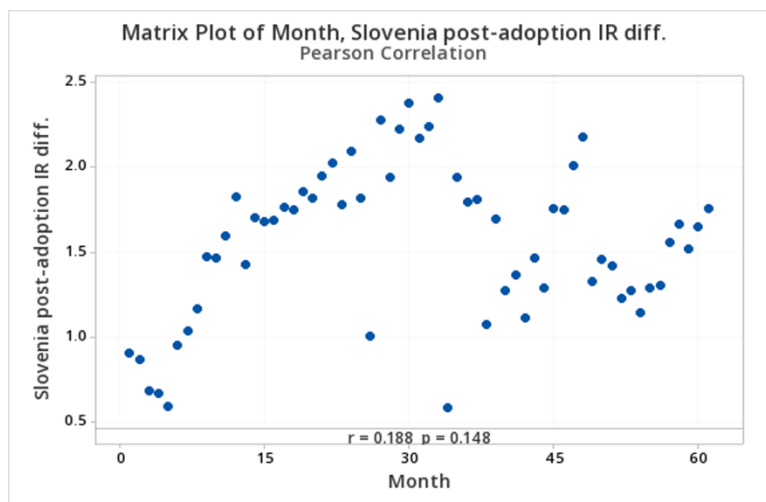
Figure 9

Scatter plot displaying the correlation between the difference of Latvia and the average eurozone mortgage rate and months

(time) in the post-adoption period