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CONTENTS

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THE IMPACT OF DEMOGRAPHIC AND SOCIO-PSYCHOLOGICAL FACTORS ON CONSUMERS ETHNOCENTRIC TENDENCIES IN CROATIA

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ABSTRACT

The purpose of this paper is to determine the impact of demographic, socio-psychological factors and the intensity of ethnocentric tendencies among Croatian consumers that will lead to the conceptualization of consumers ethnocentric profile in Croatia. The research was conducted using the questionnaire method on a sample of 1000 respondents in Croatia. The results were processed using a multivariate statistic that is used for the factor and descriptive inferential statistical analysis. Statistics showed the causes of consumer ethnocentrism to be psychological, associated with the structure of consumer's social environment which cannot develop in isolation but as part of a set of socio-psychological, economic, political and demographic influences. As a result, consumer's ethnocentrism cannot be fully identified only assumed. Consumer's ethnocentrism will depend on country, values, customs and behavioral patterns. The statistical analysis concluded regardless of gender the consumer who is expressing high ethnocentric tendencies would be older, less educated, with low income, highly religious and is dissatisfied with their life in Croatia.

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I. INTRODUCTION

Integration of markets has led to the need to understand consumer behavior that varies depending on cultural, sociological, geographical and demographic factors. The impacts of globalization consciously or unconsciously leads to negative attitudes within societies. The cause for the opposite attitudes lays in the reaction of individuals focussed on preserving their culture, customs, traditions, which are the trademark of every country and region. In such situations, ethnocentric tendencies appeared in purchase decisions, which include the beliefs that buying a foreign product is unpatriotic and immoral as this could cause loss of jobs and in general, harm the overall development of their domestic economy.

In their work Callingham and Baker (2002) indicated that the combination of demographic factors with other consumer measurements, such as consumer ethnocentrism may lead to better understanding of consumer buying behavior. Numerous studies (Bannister, Saunders, 1978; Hult, Kellior, 1994.; Good, Huddleston, 1995; Sharma et.al., 1995; Nielsen, Spence, 1997; Klein, Ettenson, 1999; Kucukemiroklu, 1997; Vida, Fairhurst, 1999; Balabanis et.al., 2001; Rachocka, 2001; Good, Stoel, 2001; Balabanis, et.al., 2002; Javagli et.al., 2005., Cutura 2006; Dmitrović, Vida, 2007; Yeong et.al., 2007; Othman et.al., 2008; Ramsaran-Foward, 2010; Kumar et.al., 2011.; Josiassen et.al., 2011; Sutikno, Cheng, 2011; Ranjbairan, et.al., 2011; Hamelin et.al., 2011) used demographic factors as control variables for the purpose of identification of the ethnocentric tendencies in consumers purchase behaviors. The results of these studies have significantly contributed to the creation of the profile of ethnocentric consumers who are mostly identified by standard demographic factors. Older consumers with low incomes, lower education, with women representing a larger proportion, are the factors that generally determine the profile of ethnocentric consumers. However, determining the consumer ethnocentric profile is a complex process and can significantly depend on the area, region or country of research.

Besides the demographic factors, it is necessary to understand and identify other underlying influences on ethnocentric tendencies, such as socio-psychological factors offering a greater ethnocentric profile of consumers of a certain country or region. Therefore, the aim of this paper is to determine the ethnocentric consumer profile in Croatia based on the demographic and socio-psychological factors.

The paper is structured as follows: in Section 2, the literature review on the impact of demographic and socio-psychological factors on consumer's ethnocentric tendencies is presented. Then the methods applied in the study are described in Section 3 and research findings are presented in Section 4. Section 5 present concluding comments.

II. LITERATURE REVIEW

The concept of consumer ethnocentrism provides the explanation why consumers choose domestic over foreign products, and it also helps to identifiy which factors have a significant impact on the intensity of consumers' ethnocentric tendencies. According to the literature review, many factors such as demographic and socio-psychological significantly influence consumer ethnocentric tendencies that can predict final consumers' purchasing choices.

Older people are generally more conservative, more patriotic and more likely to have experienced conflicts with foreign countries (Sharma et.al., 1995). The arguments supporting a positive relation between the age and consumer ethnocentric tendencies are based on increased cosmopolitan lifestyle over the recent years, as well as socio-cultural influences on behavior patterns of the younger population. Sternquist McLain (1991) Caruana, Magri (1996); Klein,

Ettenson (1999); Vida, Fairhurst (1999); Shin (2001); Ramsaran-Fowdar (2010); Josiassen et.al., (2011); Sutikno, Cheng (2011); showed stronger ethnocentric tendencies amongst older consumers than within the younger population. The research results have indicated that older consumers have the stronger ethnocentric tendency and that ethnocentric tendencies proportionally increase in line with the age variable. Nevertheless, there are also some contradictions amongst the findings. Some researchers (Balabanis et.al., 2002) showed that there is no meaningful relation between these two variables. However, Good and Huddleston (1995) found that the age was the only demographic variable that showed a constant impact when determining the ethnocentric tendencies in consumer.

The underlying logic is that women are more conservative and collectivistic about maintaining social harmony, quality of life and positive feelings amongst general society. (Yoo, Donthu, 2005). The research results (Wall et.al., 1988; Hult, Keillor, 1994; Sharma et.al., 1995; Brunning 1997; Nielsen, Spence 1997; Ruyter, Birgelen, Wetzels 1998; Klein, Ettenson 1999; Kucukemiroklu 1999; Vida, Fairhurst 1999.; Balabanis et.al., 2002, Cutura, 2006; Othman rt.al., 2008; Ramsaran-Fowdar, 2010; Josiassen et.al., 2011; Sutikno, Cheng, 2011) indicate that the degree of women's ethnocentrism is higher than men's. By the results of previous studies it can be assumed a significant influence of the gender on the tendency of consumer ethnocentrism, although some studies (Good, Huddleston, 1995; Caruana, Magri, 1996; Kucukemiroglu; 1997; Kesic et.al., 2004, Cutura, 2006) pointed a certain inconsistencies in determining the relation between these two variables.

The basic argument is that less educated consumers have a stronger sense of awareness of belonging and therefore of the preservation of the domestic economy and are more conservative and less open to other, different countries. Most studies (McLain, Sternquist, 1991; Good, Huddleston, 1995; Sharma et.al., 1995; Caruana, Magri, 1996; Klein, Ettenson, 1999.; Piron, 2000; Balabanis et.al., 2001; Orth, Firbasova, 2003, Cutura, 2006) showed negative relation between levels of education and consumer ethnocentrism. Therefore, they found that consumers with higher levels of education showed lower ethnocentric tendencies than consumers with lower levels of education.

The higher levels of income provide consumers with more opportunities to travel and thus the exposure to foreign products influences their purchasing behavior. Lifestyle of this group resulted in the broader cosmopolitan view of the other societies. Wall, Heslop and Hofstra (1988) suggested that there is a link between level of income and consumer ethnocentric tendencies, and, the higher level of income, the less likely that such consumers include domestic products in their purchase choices. Several studies have reported that consumers with higher levels of income expres lower ethnocentric tendencies than consumers with lower levels of income (Othman et.al., 2008; Kumar et.al., 2011). However, some findings (Kesic et.al., 2004; Cutura, 2006; Fowdar-Ramsaran, 2010) did not find any difference in ethnocentric tendencies amongst the consumers who had different levels of income.

Religion variable in some studies in Croatia proved as a significant predictor of ethnocentrism in some sociological studies (Sram, 2008) and showed that religious people express higher ethnocentric tendencies. Although religion does not encourage negative attitudes and judgments based on the ethnicity of the other societies and cultures, it is a historical fact that religion was often used to identify various ethnic groups and cultures. In view of the above, it is assumed that religious consumers, who evaluate the traditional customs and norms, would express higher ethnocentric tendencies in order to preserve the local economy, culture and religion. The development of religion is a result of the main function of the religion which is to

protect identity in times of crisis and transition (such as Croatia), as well as the acceptance of religion as a part of tradition and national culture (Maldini, 2006). Therefore, it is focussed on preserving local economy and general employment. Religion is represented amongst older age, rural, lower-educated, people with a strong sense of tradition and culture, providing additional profile characteristics in determination of consumer's ethnocentric profiles.

Life satisfaction is a process of individual assessment (Diener et.al., 1985, 71) and as such can be considered as the cognitive component of an individual consumer assessment. Life satisfaction is a complex variable that will influence on consumer buying behavior and at the same time is being recognized through their purchase choice between domestic and foreign products. It can be concluded that consumers who are more satisfied with life in the country where they live, have higher ethnocentric tendencies than consumers who are not satisfied with their life. Therefore, satisfaction with life in Croatia, as one of the assumptions of consumer ethnocentrism, will influence consumers ethnocentric tendencies.

Analysis of numerous literature indicated the existence of the significant differences in consumers ethnocentric tendencies according to demographic factors. Therefore, contribution of this paper is:

1. testing the reliability and validity of Cetscale, that has not been previously investigated in this research country (Croatia)

2. investigating how demographic and socio-psychological factors influence consumer ethnocentric tendencies in this research setting.

III. METHODOLOGY: RESEARCH DESING AND RESEARCH OBJECTIVES

Professional market research agency in Croatia was contracted for the data collection process. Stratified and a random sample of the 1000 Croatian consumers was used in this study. The empirical study was carried out in 2010 by the direct contact with interviewers and respondents using face to face interview. Our primary objective was to create a profile of ethnocentric consumers in Croatia based on demographic and socio-psychological factors.

For the purposes of this study a multi-item scale Cetscale was used to measure consumers' ethnocentric tendencies, developed by Sharma and Shimp, 1987. The other sections of the questionnaire form included social-psychological variables such as religion and satisfaction with life in Croatia. The third part of the questionnaire included questions regarding the demographic variables, identifying age, gender, education level and level of household incomes of respondents. The scale of measurement was ordinal with degrees from 1 to 5, where respondents express their degree of agreement or disagreement with the statement date (1 = completely disagree, 5 = strongly agree).

Collected data was statistically analysed using computer software packages for processing qualitative and quantitative data of social research-SPSS 17. (Statistical Package for the Social Sciences). In this paper, various multivariate statistical analyses were used as a Factor analysis and Analysis of variance (ANOVA).

IV. RESEARCH FINDINGS

In the first phase of data analysis, we verified the existence of outliers, univariate and multivariate normality, bivariate and multivariate multicollinearity and heteroskedasticity. Purification of data obtained in an adequate sample of 848 respondents. The basic, demographic factors of the

respondents were age, gender, education level and level of household incomes. The following table shows demographic characteristics of respondents who participated in empirical research of this paper.

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Characteristics	N	Percentage (%)
Age:		
15-24	127	15,0
25-34	162	19,1
35-44	142	16,7
45-54	120	14,2
55-65	141	16,6
65-	156	18,4
Total	848	100
Gender:		
Male	388	45,8
Female	460	54,2
Total	848	100
Education:		
Elementary school or less	191	22,6
Secondary /qualified workers	189	22,3
College /Highly qualified workers	341	40,1
University	122	14,4
Master	3	0,4
Doctor	2	0,2
Total	848	100
Household incomes:		
Without incomes or to 1000	22	2,6
1001-4000	170	20,0
4001-7000	188	22,2
7001-11000	146	17,2
11001-	67	7,9
I do not know/Refuse to answer	255	30,1
Total	848	100

Source: Research findings (N=848)

The table 2 shows the socio-psychological characteristics of the respondents.

TABLE 2. SOCIO-PSYCHOLOGICAL CHARACTERISTICS OF THE RESPONDENTS

Characteristics	*N*	*Percentage (%)*
I am not at all religious	74	8,7
2	79	9,3
3	237	27,9
4	230	27,1
I am absolutely religious	228	26,9
Total	***848***	***100***
I am not at all satisfied with life in Croatia	63	7,4
2	156	18,4
3	435	40,7
4	184	21,7
I am completely satisfied with life in Croatia	100	11,8
Total	***848***	***100***

Source: Research findings (N=848)

Preceding multivariate statistical approach it is necessary to determine the reliability of measurement scales Cetscale. The table 3. show the coefficient Cronbach's alpha.

TABLE 3. RELIABILITY OF CETSCALE

Number of variable	*Cronbach's Alpha*
17	,963

Source: Research findings (N=848)

Results showed a high Cronbach's alpha (0.963) which indicates a high reliability coefficient of Cetscale as well as the representativeness of the research results. Next step is to use the factor analysis to measure consumers' ethnocentric tendencies.

TABLE 4. KAISER-MEYER-OLKIN TEST AND BARTLETT TEST OF SPHERICITY

Kaiser-Meyer-Olkin test		,971
Bartlett test of sphericity	**Chi-Square**	12451,617
df		136
Sig.		,000

Source: Research findings (N=848)

The results of the statistical tests Kaiser-Meyer-Olkin is very high (KMO= 0.971) and Bartlett test of sphericity was statistically significant ($\alpha \leq 0.05$) and suggested that this variable was suitable for the factor analysis. Furthermore, the results of table 4 indicated that the Cetscale was an appropriate tool in measuring consumer tendencies of Croatian consumers. The following table shows the number of the extracted factor.

TABLE 5. TOTAL VARIANCE EXPLAINED

	Initial Eigenvalues			*Extratcion Sums of Squared Loadings*		
Component	***Total***	***% of Variance***	***Cumulative %***	***Total***	***% of Variance***	***Cumulative %***
1	10.754	63,257	63,257	10.754	63,257	63,257
2	1,269	7,465	70,721	1,269	7,465	70,721
3	,594	3,497	74,218			
4	,519	3,052	77,270			
5	,483	2,840	80,110			
6	,428	2,517	82,627			
7	,351	2,066	84,694			
8	,336	1,976	86,670			
9	,319	1,877	88,547			
10	,296	1,742	90,289			
11	,274	1,611	91,900			
12	,271	1,592	93,493			
13	,258	1,519	95,012			
14	,241	1,416	96,428			
15	,220	1,296	97,724			
16	,200	1,179	98,903			
17	,187	1,097	100,000			

Extraction Method: Principal Component Analysis

Source: Research findings (N=848)

The first factor can explain 63,257 % of the total variability and the second factor explain 7,465 %. Because of the simplicity of the results obtained by factor analysis for further processing, varimax rotation method has not been used. Lateral dimensions of the involvement of the sample takes almost perfect form, where all the manifest variables show significant loading on Factor 1 (> 0.7) thus indicating at the excellent properties of convergent and discriminant validity. Namely, the matrix of unrotated factor structure achieves the goal of data reduction. The result of one factor followed an explanation with 63% of the Total Variance, and one solution is considered the best choice. Because of interpretation, factor 1, is named consumer ethnocentrism.

Further analysis shows results of anova between demographic factors and tendencies of consumer ethnocentrism. Results of one-way ANOVA were computed for each demographic variable as shown in Table 6.

TABLE 6. ANALYSIS OF VARIANCE TENDENCY OF CONSUMER ETHNOCENTRISM AND DEMOGRAPHIC FACTORS

	Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Age	43,384	5	8,677	9,091	,000
Gender	0,491	1	0,491	0,491	,484
Education	46,576	10	4,658	4,870	,000
Household income	34,751	17	2,044	2,089	,006

Source: Research findings (N=848)

Analysis of variance was performed to determine whether there was a demographic difference of consumer ethnocentric tendencies. Based on research findings presented in table 6 it can be concluded that there is a demographic difference in determining the tendencies of the consumer ethnocentrism except for variable gender.

Anova results indicate that the relationship between the age and ethnocentric tendencies is significant. It showed that the younger respondents in age group 15-24 were found to be less ethnocentric then the consumer in age group 65 and more.

In this research this is the only demographic variable that did not find any significant difference between females and men, although the female respondents showed stronger ethnocentric tendencies than men. A number of studies had indicated that females tended to rate domestic products more favourably than men.

Statistical analysis shows that there is a significant relationship between education level and ethnocentric tendencies. However, the analysis reveals that the lower educated consumers showed stronger ethnocentric tendencies than consumers with a college, master or doctoral degree.

In the above table 6, anova results indicate that there is a difference in ethnocentric tendencies between different income levels and suggests that rich people are more likely to purchase foreign products. Respondents whose monthly income level was 4000 kn and less had higher ethnocentric tendencies than those whose monthly income exceeded 4000 kn. It is interesting that the respondents with higher levels of income (from 9000 and more) showed significant differences in expressing ethnocentric tendencies.

Finally, the table results indicate that consumers' ethnocentric tendencies differ according to age, education level and level of household income.

The following table shows results of one-way ANOVA computed for socio-psychological factors as shown in Table 7.

TABLE 7. ANALYSIS OF VARIANCE TENDENCY OF CONSUMER ETHNOCENTRISM AND SOCIO-PSYCHOLOGICAL FACTORS

	Sum of squares	*df*	*Mean square*	*F*	*Sig.*
Religiosity of respondents	61,351	4	15,383	16,509	,000
Satisfaction of respondents with life in Croatia	14,650	4	3,663	3,709	,005

Source: Research findings (N=848)

Significant differences in consumer ethnocentrism were observed according to variable religion ($p<0,000$, $F=16,509$). The results indicated that religious consumers show higher ethnocentric tendencies than non-religious consumers.

Consumers ethnocentric tendencies differ according to a variable satisfaction of respondents with life in Croatia ($p<0,005$, $F=3,709$). The results indicated that consumers who are more satisfied with life in Croatia showed higher ethnocentric tendencies. Specifically, the analysis of the literature showed that respondents who were satisfied with life in a country where they live, prefer domestic products.

Since the variation within groups is confirmed, we can assume that variable religion and satisfaction with life in Croatia significantly influence intensity of ethnocentric tendencies.

V. CONCLUDING COMMENTS

Knowledge of global markets and understanding of consumer preferences, desires and purchase habits is of crucial importance in recognition of various consumer profiles. Significant determinants in identifying the various profile of consumers are demographic and socio-psychological factors. In order to determine the specific characteristics of ethnocentric profile consumers with the inclusion of standardized demographic and socio-psychological factors research results showed interesting findings that create ethnocentric profile of Croatian consumers. The results of this research suggested that there is a difference in ethnocentric tendencies between demographic and socio-psychological factors except for the variable gender. In fact, this study did not only find any significant difference between male and female respondents although female respondents showed stronger ethnocentric tendencies than men. The implication is that the Croatian consumer who expresses high ethnocentric tendencies will be older, less educated and a low-income earner, highly religious and dissatisfied with a life in Croatia, regardless of the gender. This study confirms that the demographic and socio-psychological factors are considerably important factors which influence consumers' ethnocentric tendencies in Croatia and therefore predict consumer preferences in purchasing choices.

However, the contribution to this field of research in relation to the previous research, are related to examine the impact of additional assumptions on consumers ethnocentric tendencies, that have greatly contributed to the conceptualization of ethnocentric profile in this country of research, Croatia. In addition, a comprehensive review of the data analysis of this research points to the fact that the inclusion of socio-psychological factors besides standardized demographic

factors, created the foundation for better understanding of the purchase intentions between domestic and foreign products. Therefore, empirical verification has been expanded and provided a deepened insight into the design of ethnocentric profile with the variables religion and satisfaction with life as one the assumptions in determining the ethnocentric tendencies in Croatia.

The findings of this empirical study will provide valuable guidance to the marketing efforts of both domestic and foreign companies which are planning to enter the market in Croatia. Determinating the profile of ethnocentric consumers in Croatia would provide domestic company with the opportunity to adjust existing strategic acitivities, or create appropriate strategies to better promote domestically produced goods for a specific segment of consumers (older consumers, less educated and low-income, highly religious and dissatisfied with lives in Croatia). On the other hand, foreign company needs to create effective strategies to enter the Croatian market taking into consideration the characteristic of ethnocentric consumers.

Even though the results are interesting and in support of past studies, some limitations to the study remain. As we stated before, consumers' ethnocentrism cannot be fully identified only assumed. Namely, ethnocentric tendencies depend on the individual characteristics of a consumer and cannot be generalized. This could be better explained by including additional variables in any future studies in order to accurately identify consumers' ethnocentric profile and thus contribute to a more comprehensive understanding and prediction of the purchasing choices of Croatian consumers. It would be interesting to include some other possible significant factors such as the marital status, employment and the number of household members to further determine the ethnocentric tendencies amongst Croatian consumers. Additionally, future researchers on consumer ethnocentrism are called upon to search further and deeper in order to get a more complete picture about consumer purchase behavior in Croatia or other country of interest.

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UTJECAJ DEMOGRAFSKIH I SOCIO-PSIHOLOŠKIH ČIMBENIKA NA POTROŠAČKE ETNOCENTRIČNE TENDENCIJE U HRVATSKOJ

SAŽETAK

Cilj je ovoga rada utvrditi povezanost demografskih, socio-psiholoških čimbenika i etnocentričnih tendencija u hrvatskih potrošača, a koji će doprinijeti konceptualizaciji potrošačkog etnocentričnog profila u Hrvatskoj. Istraživanje je provedeno na reprezentativnom uzorku od 1000 ispitanika na području Republike Hrvatske. Podaci prikupljeni anketnim istraživanjem analizirani su multivarijatnom statističkom metodom kao što je faktorska analiza te analizom varijance (ANOVA). Rezultati istraživanja su ukazali Uzroci i djelovanja potrošačkog etnocentrizma mogu biti psihološke, osobne naravi u korelaciji definiranom strukturom socijalnog i društvenog okruženja. Međutim, navedeni uzroci ne mogu se u potpunosti identificirati, ali se, ovisno o zemlji, kulturi, vrijednostima, običajima i obrascima ponašanja potrošača mogu pretpostaviti. Stoga, etnocentrične sklonosti kod potrošača ne razvijaju u izolaciji, nego su dio skupa socio-psiholoških, gospodarskih, političkih i demografskih utjecaja. Analiza rezultata je ukazala da će potrošač koji izražava jače etnocentrične tendencije biti osoba starije životne dobi, s niskim stupnjem obrazovanja i niskim prihodima, visoko religiozan i nezadovoljan životom u Hrvatskoj, neovisno o spolu ispitanika.

Ključne riječi: Potrošač, Potrošački etnocentrizam, Demografski čimbenici, Socio-psihološki čimbenici, Cetscale, Etnocentrične tendencije, Etnocentrični profil potrošača, Hrvatska

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NATIONAL LEGISLATIVE SYSTEMS AND FOREIGN STANDARDS AND REGULATIONS: THE CASE OF INTERNATIONAL FINANCIAL REPORTING STANDARDS` ADOPTION

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ABSTRACT

This study is focused on the linkages between the legislative families as descriptors of national legislative systems and International Financial Reporting Standards (IFRSs) issued by the International Accounting Standards Board (IASB). We consider such analysis as a case study for the more general issue of explaining the preferences of national regulators in the adoption of foreign norms, rules, standards and practices. By using a dataset of 162 jurisdictions and dummy variables designed to capture the current stage of IFRSs adoption and, respectively, the taxonomy of their legislative systems, we find that a full IFRSs adoption is more likely to occur in countries which have principles-based on legislative mono-systems. In addition, we observe that a strong rule of law, with an effective mechanism of property rights reinforcement, as well as the pre-adoption existence of a pro-growth set of public policies can contribute to the encouragement of IFRSs adoption.

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I. INTRODUCTION

In the context of the existence of transnational regulatory entities and of deepening globalization processes, the national regulators face several problems in the adoption of exogenous norms, rules, standards and practices. The preferences of such bodies for accepting / rejecting or adjusting them vary according to a complex set of institutional behaviour determinants. Among them, the constitutive and functional characteristics of the domestic legislative structures and institutions have an important role. This study is focusing on the possible linkages between the adoption of the International Financial Reporting Standards (IFRSs) and the national legislative taxonomy. There are several advantages in analysing the IFRSs adoption as a case study for foreign standards assimilation mechanisms and influence factors in different autochthonous economic, politic, social and cultural systems. A list of such gnoseological advantages that can be achieved by studying the particular case of IFRSs adoption in order to provide some insights about the acceptance mechanisms for international regulations, standards and practices, far to be exhaustive, can include: the specific approach of IFRSs as principles-based standards; the fact that IFRSs are issued and promoted by transnational entities but reflect some national practices from developed economies; the heterogeneity of individual adoption situations; the eventual conflicts between these international standards and national regulations and practices; the existence of an ongoing process of international accounting harmonization driven by globalization forces etc.

Currently, there is a growing literature studying the possible interrelations between IFRSs adoption and the distinctive features of national legislative institutions and mechanisms: Hope et al. (2006) find that those countries which have weaker investor protection mechanisms are more likely to adopt IFRSs; Krivogorsky et al. (2010) provide compelling evidence that jurisdictions and national levels of bureaucratic formalities in business are factors that modify company likelihood to adopt IFRSs early; Armstrong et al. (2008) find that the reaction market reactions to IFRSs adoption is less positive for firms resident in code law countries; Ball (2000) provides some empirical evidence that code law countries links accounting income directly to current payouts; Ball (2006) identifies some problems associated with transferring accounting standards from common law to code law, especially with regard to countries that have less respect for protecting shareholders value and minority rights; Burgstahler et al. (2006) document that earning management is more pronounced in countries with weaker legal systems and enforcement; Leuz et al. (2003) concludes that weak outsider protection and private control benefits create incentives to manage earnings.

This paper seeks to provide two contributions to the existing literature. Firstly, it adopts a more detailed perspective in defining the legislative families based on Faculty of Law, University of Ottawa with the help of the Supreme Court of Canada Library data on "world's legal systems". Secondly, it checks the robustness of our findings by considering other possible explanatory variables as well for the countries' relative preferences in IFRSs adoption for listed companies.

Our arguments can be resumed as follows: 1) the relative preference for professional decisions of legal authorities based on precedent customs and practices versus detailed regulations can be seen as separation criteria between different types of legislative families adopted by individual countries and 2) a major feature of IFRSs consists in the fact that these are a set of principles-based standards, promoting professional judgment. Thus, the IFRSs will be easier adopted in countries in which the general legislative framework is more oriented toward the practices-based decisions, being guided only by a simplified set of principles, and less toward detailed written norms, rules and regulations. In order to avoid the costs of *institutional dissonances*, the decisional bodies will tend to adopt that set of standards which is more compatible with the general philosophy of the national regulatory framework. More detailed written rules are more efforts are required to

incorporate exogenous standards based on a different approach. Due to the costs of institutional adjustments, supplementary obstacles for IFRSs adoption can appear if the legislative systems are characterized by a higher degree of complexity with various regulations issued by different channels and subjects of frequent changes.

II. LEGISLATIVE FAMILIES

The IFRSs adoption is a complex process involving public authorities, professional bodies or joint structures. The preferences of these entities to adopt the standards depend on a complex set of factors, including *inter alia* the general preferences for formal codification of the legislative systems. Thus, the nature of the regulatory societal framework, being synthesized by the characteristics of the "legislative families" is expected to influence the context, amplitude and effects of IFRSs adoption.

The concept of „legislative families" was introduced within the comparative law at the beginning of the 19th century. Subsequently, different criteria have been suggested in order to perform a typology of the judicial systems, their classification being essentially an academic instrument, but also useful to any person wanting to capitalize it as a comparative argument. The estimation criteria regarding the affiliation of a jurisdiction to a legislative family or another, have varied along history, starting from those of geographical and religious type (Esmein, 1905) to those which had in view race (Sauser-Hall, 1913), historical origins (Sarfatti, 1933), the contents of the law (Arminjon et al. 1951), and the judicial style (Zweigert and Krotz, 1998). These have proven to be useful instruments leading to the identification of a number of legislative families in which the judicial systems could be integrated.

Among the criticism critically upon the old classifications, Mattei (1997), starting from the judicial theory and sociology of Max Weber, suggests a classification distinguishing between rule of professional law, rule of political law and rule of traditional law. Similarly, Vanderlinden (1995) looks emphasize five law systems: common, doctrinarian, jurisprudence, legislative law and the system of revelation.

Although the identified judicial systems are somehow similar to one another, being based on similar cultural and operational traditions within the context of certain similar social, economic and political conditions, the approached legislative families did not answer absolutely to the challenges generated by the judicial culture and mentality, within the context of a lack of cooperation with areas such as judicial sociology, history of law or anthropology (Gessner et al. 1996). Thus, a more recent evolution is the so-called "third judicial family" and the idea of mixed judicial systems. The term "mixed" must be construed restrictively, so that this category defines the case in which two or more systems apply cumulatively or interactively. For instance, Palmer (2001) underlined the idea that mixed jurisdictions represent in fact the third major judicial family alongside of common law and Roman-German law. Currently, there are some attempts of creating an approach referring to the "family trees"- Örücü (2004) - the main object being the attempt of demolishing the conventional model of the judicial systems and creating their reconstruction in which the judicial systems should be classified according to their filiations and constitutive elements. However, there are other attempts of renewing the old tradition of the judicial families as well (Reyntjens, 1991 and Heiss, 2001).

Our view is that the analysis of the various concepts met in literature allows us to conclude that each judicial system tends to acquire special characteristics in accordance with the respective jurisdictions and populations, despite the affiliation to the same judicial family.

Hence, civil law is currently the judicial system met in most of the world countries, its primary source being legislation, the normative judicial acts (especially codifications). These codes are mainly characterized by a high level of generalization which allows judges to construe and analyze the whole practical circumstances, either by applying the law or by completing the gaps through extrapolation.

What differentiates the essential judicial system of common law from other judicial systems is the explicit recognition of the decision ordered by legal courts as a primary source of law; being a system based on induction in which the judicial concepts are the result of a consequent jurisprudence which defines the application areas. Within the context of the express recognition of the judicial precedent as a legal source, the decisions ordered by the higher courts become compulsory for the inferior courts. However, in certain jurisdictions, the state reserves the right of proceeding to the annulment of the judicial decisions and the performance of a codification, taking into consideration that there are multiple conflicting or ambiguous judicial decisions.

Regarded as a complex of traditions and customs which, in time, have become law, common law can develop based on religion, ethnicity or cultural identity. It has sometimes an important significance in the matter of the personal state in a significant number of countries with mixed judicial systems which tend to apply to "common laws" under the shape of the codes. This is specific to a number of African countries but it's also the case of China or India, for instance, but in very different conditions. The Islamic judicial system is an autonomous system of religious nature, explicitly based on religious principles, predominantly on Koran. One of the distinctive characteristics of the Islamic law is the fact that the rights of the community are above those of the man, the individual rights and freedoms being restricted by moral, religious and divine imperatives. The system is used in countries with Islamic tradition where moral norms recently tend to be interpreted in a broader sense, in order to adapt them to the contemporary realities.

No doubt, the existence of the mixed judicial families allows the prominence of more law systems which can find applicability simultaneously regarding the same political entity. These include two or more legislative systems interacting in a multicultural and multi-religious society, being sometimes applied complementarily. The judicial systems from various countries in North Africa or Middle East are strongly influenced by the civil law tradition but, in certain fields - especially in those affecting the individual and family rights and the property rights - the structure of this system tends to follow the Islamic tradition. Taking into account these distinctive features of legislative families, our research hypothesis is:

H: *The preference of regulators from an individual country to adopt IFRSs will increase as the autochthonous legislative system is closer to Common Law and Civil Law mono-systems.*

III. DATA AND METHODOLOGY

In order to test our hypothesis, we have constructed two dummy variables: *IFRSs* dummy and, respectively, *legislative families* dummy for 162 jurisdictions according to current available information (see Table 1). The first dummy is designed to reflect several stages of IFRSs adoption. In our dataset, for 37% of the included countries, IFRSs are not required nor permitted for quoted companies. For 4.9%, IFRSs are permitted while for 10.5% of cases, IFRSs are required for some companies. Only in 47.6% of cases, the international standards are required for all companies.

TABLE 1. DEPENDENT AND EXPLANATORY VARIABLES

Variable	*Description*	*Source*
IFRSs dummy	Dummy taking the next values: • "0" - IFRSs are not permitted/ not mentioned by the relevant legislation and no de facto compliance can be observed; • "1" - IFRSs are permitted for listed companies (individual and consolidated financial statements) but the international standards are not compulsory; • "2" - IFRSs required for some listed companies (e.g. large companies, financial institutions and so on); • "3" - IFRSs required for all listed companies both for individual and consolidated financial statements.	Since the identification of different intermediary situations is sometimes difficult, data are compiled from various sources, mainly Deloitte (2010), PriceWaterhouseCoopers (2010), Ernst&Young (2010), Financial Standards Foundation (2010), World Bank (2010b), International Monetary Fund (2010), ISAR/ UNCTAD (2010), OHADA (2000) data
Legislative families dummy	Captures the typology of the legislative families	Coded by authors based on University of Ottawa (2010)
Rule of law	Captures perceptions to the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	World Bank (2010a)
Real GDP per capita	Real GDP per capita (log) (US dollars at constant prices and exchange rates-2000)	UNCTAD (2010)

Source: Author calculation

On the website of the Faculty of Law, University of Ottawa with the help of the Supreme Court of Canada Library on "world's legal systems", the categories of legal systems are divided into: civil law, common law, customary law, Muslim law and mixed law (University of Ottawa, 2010). We find, in these categories, countries in which two or more legal systems apply concurrently or interactively, as well as those in which systems are rather juxtaposed because they apply to more or less clearly distinct fields. According to this source, "mixed systems" appear in the following categories: Thus, our dummy variable for *legislative families* can take values from 1 to 27 (see Table 2). The number of jurisdictions that fall into the "mixed systems with civil law" category is 65 (19.12% of the world's legal systems), "mixed systems with common law" are 53 (15.59 %), "mixed systems with customary law" are 54 (15.88%) and "mixed systems with Muslim law" are 33 (9.70 %).

TABLE 2. LEGISLATIVE FAMILIES

Codification	*Description*
	Simple legal families
1	Civil Law (mono-system)
2	Common Law (mono-system)
3	Muslim Law (mono-system)
4	Customary Law (mono-system)
	Mixed legal families (Hybrids with civil law, common law, Muslim law or customary law in different combinations)
5	Hybrids with Civil Law and Muslim Law (3.14% of world population)
6	Hybrids with Civil Law and Customary Law (28.54% of world population)
7	Hybrids with Civil Law and Common Law (3.47% of world population)
8	Hybrids with Civil Law, Common Law and Customary Law (0.8% of world population)
9	Hybrids with Customary Law and Common Law
10	Hybrids with Customary Law and Civil Law
11	Hybrids with Common Law and Customary (2.94% of world population)
12	Hybrids with Common Law and Civil Law
13	Hybrids with Common Law and Muslim Law (5.25% of world population)
14	Hybrids with Muslim Law and Common Law
15	Hybrids with Muslim Law and Civil Law
16	Hybrids with Muslim Law, Civil Law and Customary Law
17	Hybrids with Muslim Law, Common Law and Customary Law
18	Hybrids with Muslim Law, Civil Law, Common Law and Customary Law
19	Hybrids with Civil Law, Muslim Law and Customary Law (3.62% of world population)
20	Hybrids with Civil Law, Customary Law and Muslim Law
21	Hybrids with Common Law, Muslim Law and Customary Law (19.17% of world population)
22	Hybrids with Civil Law, Common Law, Jewish Law and Muslim Law (0.09% of world population)
23	Hybrids with Customary Law and Muslim Law
24	Hybrids with Common Law , Civil Law and Customary Law
25	Hybrids with Muslim Law, Customary Law and Civil Law
26	Hybrids with Civil Law, Common Law and Customary Law
27	Hybrids with Civil Law, Customary Law and Common Law

Source: Author calculation

The main statistic properties of the data are listed in Table 3.

TABLE 3. SUMMARY STATISTICS OF LEGISLATIVE FAMILIES AND IFRSS ADOPTION

	Legislative families dummy	*IFRSs adoption dummy*
Mean	5.45	1.69
Median	2.00	2.00
Maximum	27	3.00
Minimum	1	0.00
Std. Dev.	5.86	1.39
Skewness	1.32	-0.26
Kurtosis	3.87	1.22
Jarque-Bera	52.31	23.43
Cross-section observations	162	162

Source: Author calculation

The values of dispersion, the non-normal distribution and the presence of the *fat tails* effects suggest that there is an important degree of data heterogeneity. Thus, it is necessary to employ an estimation method robust to such heterogeneity. We appeal to the *Generalized Linear Models* (GLM) estimation framework. This methodology allows flexible specifications of the model and "for non-normal data without clustering, generalized linear models are an appropriate alternative to linear models" (Tuerlinckx et al., 2006).

IV. RESULTS AND ROBUSTNESS CHECK

Column 1 of Table 4 reports the standalone GLM estimation. It appears that the type of legislative families exercises a significant influence of 1% to IFRSs adoption. The negative sign suggests that this influence is more in favour of boosting up the adoption as the legislative structures are closer to simple civil and common law systems.

TABLE 4. IFRSS ADOPTION AND LEGISLATIVE FRAMEWORK

	Model 1 (Generalized Linear Model- constant included)	*Model 2 (Generalized Linear Model- BHHH)*	*Model 3 (Generalized Linear Model- Quadratic)*	*Model 4 (Quantile Regression)*	*Model 5 (binary equation- dependent: binary IFRS)*
Legislative families dummy	-0.09***	-0.05***	-0.05***	-0.07***	-0.07***
	(5.27)	(4.22)	(3.68)	(4.34)	(3.68)
Rule of law		0.23***	0.23***	0.54***	0.63***
		(2.78)	(3.23)	(7.22)	(4.28)
Real GDP per capita (20 years moving average)		0.08***	0.08***	0.21***	0.09***
		(7.08)	(7.74)	(11.30)	(4.15)

Notes: ***, **, and * represent statistical significance at 1%, 5%, and 10% level. Figures in bracket represent the t- statistic; For the Generalized Linear Model estimations: a) Family: Poisson; b) Link function: Log; c) Optimization algorithm: BHHH (Model 2) and, respectively, Quadratic Hill Climbing (Model 3); For Quantile Regression estimation: a) Coefficient covariance: Bootstrap (10000 replications); b) Sparsity estimation: Siddiqui (mean fitted) - bandwidth method: Hall-Sheather (size parameter: 0.05); c) Random generator: Knuth; d) Bootstrap method: Markov Chain Marginal (as modified by Kocherginsky, He and Mu, 2005); for Binary equation: binary choice- extreme value model; Included observations: 162.

A first way to check the robustness of these results can consist in taking into account some control variables. We first consider the "rule of law" variable as this is captured in the methodology proposed by Kaufman et al. (2010) and reported by *Worldwide Governance Indicators* World Bank' project (WGI) (2010a). There are several transmission channels through which the rule of law can support the IFRSs adoption. For instance, we may argue that the investor's demand for fair value information and a company's commitment to transparency increase the likelihood of providing such information by taking into account the requirements of IFRSs. There is some recent empirical evidence to support this thesis (see Muller et al., 2008). One possible argument is that increased disclosure as a consequence of IFRSs adoption can enforce the corporate reputation (Espinosa et al., 2004), improves the market liquidity (Verrecchia, 2001), and lowers company's cost of capital (Healy and Palepu, 2001, Core, 2001) and so it can provide an *informational rent* for owners.

The pre-existence of a sound legal system, with effective mechanisms of reinforcement for property rights and investors protection, can also support higher net inflows of foreign investments (Hewko, 2002). Furthermore, the presence of foreign investors will exercise a supplementary pressure on local decisional bodies to adopt IFRSs, since such an adoption benefits them as well as foreign debtors due at least to: a) reducing the information processing cost of foreign investors and b) lowering the effect of other barriers on cross-border investments such as the geographic distance (Beneish et al. 2009). Such channel applies both for direct and equity foreign investments (Brüggemann et al., 2009; DeFond et al., 2009).

Besides the rule of law, we also consider the economic growth as a possible key determinant of IFRSs adoption. Archambault and Archambault (2009) document that less economically

developed countries are more likely to allow IFRSs. Ramanna and Sletten (2010) argue that as more jurisdictions with economic ties to a given country adopt IFRSs, benefits perceived from lowering transactions costs to foreign financial-statement users come to outweigh institutional differences.

Our main argument is that, in a pro-growth oriented policy framework, the adoption of IFRSs can appear as a "natural" solution considering its various potential benefits. Among others, the adoption: a) can improve the activity of capital markets especially in relation to small companies in insider economies (Schleicher et al., 2010; Daske et al., 2008); b) can contribute to a decrease in companies' cost of capital and an increase in equity valuations (Daske et al., 2008); c) can strength the authorities' responsiveness to risks, prudential oversight of capital, liquidity and risk management (Financial Stability Forum, 2008). All these effects can largely contribute to economic growth and, so, decisional bodies can support the IFRSs adoption as a growth engine. Thus, we are expecting that both rule of law and economic growth to have a positive impact on adoption processes.

The outputs of a covariance analysis between IFRSs and legislative families' dummies and, respectively, World Bank proxy for *rule of law* and real GDP per capita are displayed in Table 5 (*Spearman rank-order* covariance) and Table 6 (*Kendall's tau*). According with these outputs, it can be concluded that as long as the considered transmission channels between the control variables, IFRSs adoption and legislative structures can be sustained theoretically, they are also empirically valid.

TABLE 5. COVARIANCE ANALYSIS OF IFRSS ADOPTION DUMMY AND EXPLANATORY VARIABLES - SPEARMAN RANK-ORDER COVARIANCES

		Covariance	*Correlation*	*t-Statistic*	*Probability*
Legislative families dummy	IFRSs adoption dummy	-839.82	-0.43	-6.08	0.00
Rule of law	IFRSs adoption dummy	979.93	0.49	7.03	0.00
Rule of law	Legislative families dummy	-417.69	-0.20	-2.55	0.07
Real GDP per capita	IFRSs adoption dummy	849.58	0.42	5.87	0.00
Real GDP per capita	Legislative families dummy	-607.15	-0.29	-3.79	0.00
Real GDP per capita	Rule of law	1820.79	0.83	18.64	0.00

Notes: Included observations: 162; Dunn-Sidak multiple comparison adjusted probabilities; the test statistics and associated ρ-values reported are meant to test the hypothesis that a single correlation coefficient is equal to zero; degree of freedom adjusted.

TABLE 6. COVARIANCE ANALYSIS OF IFRSS ADOPTION DUMMY AND EXPLANATORY VARIABLES - KENDALL'S TAU MEASURES OF ASSOCIATION

		tau-b	*tau-a*	*Score (S)*	*Concordance*	*Discordance*	*Probability*
Legislative families dummy	IFRSs adoption dummy	-0.37	-0.26	-3357.00	1766.00	5123.00	0.00
Rule of law	IFRSs adoption dummy	0.37	0.30	3873.00	6027.00	2154.00	0.00
Rule of law	Legislative families dummy	-0.14	-0.13	-1636.00	4335.00	5971.00	0.08
Real GDP per capita	IFRSs adoption dummy	0.32	0.26	3333.00	5757.00	2424.00	0.00
Real GDP per capita	Legislative families dummy	-0.21	-0.18	-2378.00	3964.00	6342.00	0.00
Real GDP per capita	Rule of law	0.64	0.64	8355.00	10698.00	2343.00	0.00

Notes: Included observations: 162; Dunn-Sidak multiple comparison adjusted probabilities; the test statistics and associated ρ-values reported are for testing the hypothesis that a single correlation coefficient is equal to zero; degree of freedom adjusted.

Thus, column 2 of Table 4 reports our empirical evidences for the existence of a significant positive effect at 1% of better legislative framework and sustainable growth to adoption. Moreover, the robustness can be checked, for instance, by modifying the estimation procedure. The modifications might refer to: 1) changes in optimization procedure for GLM framework and 2) changes in methodology.

Thus, column 3 of Table 4 presents the results obtained when the optimization procedure shifts from *BHHH* algorithm to the so-called *Quadratic Hill Climbing* algorithm. With the exception of minor modifications in t-statistics, there are no significant changes in the relevance of considered variables with such shift. Column 4 displays the output of *quantile regression* estimation. Originally proposed by Koenker and Bassett (1978), *quantile regression* provides estimates of the linear relationship between regressors and a specified quantile of the dependent variable. One important special case of quantile regression is the *least absolute deviations* (LAD) estimator, which corresponds to fitting the conditional median of the response variable. Such method allows a more complete description of the conditional distribution than conditional mean analysis alone and, since it does not require strong distributional assumptions, it offers a distributional robust method of modelling the relationship between different percentiles of dependent and the explanatory variables. We employ a bootstrap estimation (10000 replications) based on the *Markov Chain Marginal Bootstrap* (MCMB) in the version developed by Kocherginsky et al. (2005). This version alleviates the autocorrelation problems that can appear in the standard version of MCMB by prior transforming the parameter space and after the performance of the MCMB algorithm, transferring

the results back to the original space. This methodology substantially improves the significance of the estimated parameters.

In addition, we have tested the capacity of our conceptual framework to predict the extreme cases (full adoption of current IFRSs). Such choice is justified by the fact that in our dataset only 48% of the observed cases represent the last stage of IFRSs adoption, whereas the others count for intermediary stages. Thus, it can be argued that, if our model is sound, it should be able to predict the situations of full IFRSs adoption and to discriminate between such situation and other stages of adoption. In order to perform such test, the IFRSs dummy is transformed in a binary variable according to the next rule:

$$Binary\_IFRSs_i = \begin{cases} 1, \ if \ IFRSs = 3 \\ 0, otherwise \end{cases} \quad (1)$$

The binary estimation is reported in column 5 of Table 4. All the variables are remaining significant at 1% after the transformation of the dependent variable. The binary equation also allows an estimation of the model predictor capacity through the so-called *classification table*. The fraction of observations that are correctly predicted is termed *sensitivity*, while the fraction of observations that are correctly predicted is labelled as *specificity*. The content of such classification is displayed in Table 7 with prediction results based upon expected value calculations.

TABLE 7. EXPECTATION-PREDICTION EVALUATION FOR BINARY SPECIFICATION

	Estimated Equation			***Constant Probability***		
	Binary_IFRSs dummy=0	Binary_IFRSs dummy=1	Total	Binary_IFRSs dummy=0	Binary_IFRSs dummy=1	Total
E(Binary_IFRSs = 0)	56.15	29.58	85.73	44.60	40.40	85.00
E(Binary_IFRSs = 1)	28.85	47.42	76.27	40.40	36.60	77.00
Total	85.00	77.00	162.00	85.00	77.00	162.00
Correct	56.15	47.42	103.57	44.60	36.60	81.20
% Correct	66.06	61.59	63.93	52.47	47.53	50.12
% Incorrect	33.94	38.41	36.07	47.53	52.47	49.88
Total Gain*	13.59	14.06	13.81			
Percent Gain**	28.59	26.80	27.69			

Hosmer-Lemeshov Statistic	3.05	Prob. Chi-Sq(8)	0.93
Andrews Statistic	8.04	Prob. Chi-Sq(10)	0.63

Notes: *Change in "% Correct" from default (constant probability) specification; **Percent of incorrect (default) prediction corrected by equation; For Goodness-of-Fit Evaluation tests: Grouping based upon predicted risk (randomized ties),; Success if probability is higher than 70%.

Such expected values are computed in the left-hand table. In the lower right-hand table, we can compute the expected number of *Binary_IFRSs= 0* and *Binary_IFRSs*= 1 observations for a model estimated with only a constant. For this restricted model, E (*Binary_IFRSs= 0*) is computed as *n(1-p)*, where *p* is the sample proportion of *Binary_IFRSs*= 1 observations. A classification is labelled as "correct" when the predicted probability is less than or equal to the cut-off (70% in our estimation) and the observed *Binary_IFRSs= 0*, or when the predicted probability is higher than the cut-off and the observed *Binary_IFRSs*= 1. Overall, the estimated model predicts 63.93% of the observations (66% of the observations with dependent = 0 and 61.6% of the observations with dependent = 1) correctly. It appears that the levels of *sensitivity* and, respectively, *specificity* for our model are almost the same, implying that it can discriminate both „extreme" and „regular" cases. The gain in the number of correct predictions obtained by moving from the right table to the left table provides a measure of the predictive ability of our model. Roughly, there is an improvement of 27.69% over the constant probability model with our estimation. The Goodness-of-Fit tests, *Hosmer-Lemeshow* and *Andrews*, compare the expected fitted values to the actual values by group. If these differences are "small enough", the model is fitting the data adequately. The values of these tests, also reported in Table 7, suggest that this is the case with the binary specification.

Overall, we view these results as providing some empirical support for our research hypothesis by highlighting the preference of Common Law and Civil Law countries to adopt in full the IFRSs.

V. CONCLUSIONS

We hypothesize that countries which are characterized by principles and practices-based legislative systems are more likely to adopt IFRSs. In order to test such hypothesis, we have constructed, for a dataset of 162 jurisdictions, dummy variables designed to capture the current stage of IFRSs adoption and, respectively, the taxonomy of their legislative systems. We have tested the linkages between such variables inside a GLM framework and obtained robust evidences that the full adoption of IFRSs is more likely to occur for countries with mono-systems of Common Law and Civil Law types. Thus, we conclude that a flexible, homogenous and practices oriented general legislative system can be a prerequisite for a smooth and complete IFRSs adoption. We also find that a strong rule of law, with an effective mechanism of property rights reinforcement, can contribute to a faster IFRSs adoption. Such result does not necessarily contradict other findings in literature, since the IFRSs adoption can be viewed as an expression of the overview concern of decisional bodies to support the quality of contract enforcement, the property rights and the social order and not only as a tool for the compensation of the national legislative framework' deficiencies. Similarly, it appears that the pre-adoption existence of a pro-growth set of public policies can facilitate the IFRSs adoption. Of course, the significance of our analysis depends on the relevance of the considered transmission channels which are far from being completely and consistently described on a conceptual level and perfectly robust empirically tested. However, the provided evidences can contribute to enhance a broader explanatory framework of the conditions in which there is a clear preference of regulatory bodies to adopt international standards.

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Bogdan Dima, Stefana Dima (Cristea), Nicoleta Claudia Moldovan, Marilen Gabriel Pirtea

NACIONALNI ZAKONODAVNI SUSTAV I MEĐUNARODNI STANDARDI I PROPISI: SLUČAJ USVAJANJA MEĐUNARODNIH STANDARDA FINANCIJSKOG IZVJEŠTAVANJA[1]

SAŽETAK

Ova studija je fokusirana na veze između zakonodavnih okvira kao deskriptora nacionalnih zakonodavnih sustava i Međunarodnih standarda financijskog izvješćivanja (MSFI), koje objavljuje Odbor za međunarodne računovodstvene standarde (IASB). Takve analize se razmatraju kao studije slučaja za šira pitanja u objašnjenju preferencija nacionalnih vlasti u usvajanju stranih normi, propisa, standarda i praksi. Korištenjem skupa podataka od 162 pravne i dummy varijable, osmišljene za dostizanje trenutne faze usvajanja MSFI-a, odnosno, taksonomije njihovih zakonodavnih sustava, smatra se da će se puna primjena MSFI-a vjerojatnije dogoditi u zemljama koje svoja načela temeljena zakonskim monosustavima. Osim toga, primjetno je da snažna vladavina prava,uz učinkovit mehanizam jačanja imovinskih prava, kao i prethodno donošenje skupa javnih politika rasta, može pridonijeti poticanju usvajanja MSFI-a.

Ključne riječi: usvajanje MSFI-a, zakonodavni okviri, vladavina prava, rast

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ADAPTIVE MARKETS HYPOTHESIS: EMPIRICAL EVIDENCE FROM MONTENEGRO EQUITY MARKET

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ABSTRACT

In this paper we examined adaptive markets hypothesis (AMH) using three factors we assumed that affect weak-form of market efficiency: observation period, time horizon represented by rolling window sizes and data aggregation level. We have analyzed market value weighted index MONEX20, which is proxy from Montenegro equity market, over 2004-2011 period. Rolling window analysis with fixed parameter in each window is employed to measure the persistence of deviations from a random walk hypothesis (RWH) over time. Actually, using rolling sample approach we checked whether short-range linear dependence is varying over time. This method was applied on the first order serial autocorrelation coefficients (AC1), as well as on runs test, since evidence on non-normality properties of MONEX20 suggests using non-parametric test. The evidence was found that all three factors impact degree of weak-form Montenegro equity market efficiency which has serious consequences on profit opportunities over time on this market.

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I. INTRODUCTION

The concept of market efficiency is the core paradigm of finance. This term is used to describe return generation process which has important implication on financial models based on rational expectations. Mobarek and Keasey (2000) recall that the weak-form of efficient market hypothesis (EMH) tests measure whether past series of share prices or returns can be used to successfully predict future share prices or returns. The major empirical investigation of the above tests measures the statistical dependence between price changes. If no dependence is found, meaning price changes randomly, then this provides evidence in support of the weak-form of EMH, which implies that no profitable investment trading strategy can be derived based on past prices. While, if dependence is found, which means price do not change randomly, the basis of profitable investment rule is created and the assumption of the weak-form of EMH is violated. However, profitability of a trading rule depends largely on the operating costs (such as brokerage cost, interest cost, settlement cost) and on opportunity to make transactions at the exact prices quoted in the market.

The literature on capital markets efficiency is very large, and Eugen Fama (1991) did a great effort to make review of most interesting ideas and approaches to EMH. Also, very useful overview of the different concepts of market efficiency and their anomalies was offered by Dimson and Mussavian (2000) starting with the Bacheliers doctoral dissertation submitted in 1900, when concept of market efficiency had been anticipated for the first time. The EMH theory has been extended and analyzed in many other directions (LeRoy, 1973; Lucas, 1978) and from different regional and national market perspectives (Worthington and Higgs, 2004).

Lim and Brooks classify the weak-form EMH literature based on the research framework adopted, namely 1) full sample (fixed parameter); 2) sub-samples (non-overlapping, fixed parameter); 3) full sample (time-varying parameter) and 4) rolling estimation windows (overlapping but fixed parameter in each window).

Although the idea that market prices incorporate all information rationally and instantaneously is over 40 years old, various researches notice that the emerging discipline of behavioral economics and finance has challenged this hypothesis, arguing that markets are not rational, but are driven by fear and greed instead. In his article Lo (2004) proposed a new framework that reconciles market efficiency with behavioral alternatives by applying the principles of evolutionary approach to economic interactions. The proposed reconciliation, Lo named the "Adaptive Markets Hypothesis" (AMH). As Lim and Brooks (2011) stated in their literature review the AMH implies more complex market dynamics, such as cycles, trends, bubbles, crashes, manias and other phenomena that occur in the financial markets. They also briefly described Lo's research (2004, 2005) which offers a concrete example by computing the rolling first-order autocorrelation for monthly returns of the Standard & Poor's (S&P) Composite Index from January 1871 to April 2003. Lim and Brooks emphasize that "his graphical plot reveals that the degree of efficiency, measured by the first order autocorrelation coefficient, varies through time in a cyclical fashion with the surprising result that the US market is more efficient in the 1950s than in the early 1990s."

The possibility that market efficiency does evolve over time is also described by Self and Mathur (2006): "The true underlying market structure of asset prices is still unknown. However, we do know that, for a period of time, it behaves according to the classical definition of an efficient market; then, for a period, it behaves in such a way that researchers are able to systematically find anomalies to the behavior expected of an efficient market."

In their paper Todea at al. (2009) investigated the profitability of the moving average

strategy on six Asian capital markets considering the episodic character of linear and/or non linear dependencies over 1997-2008. The main conclusion is that profitability of moving average strategies is not constant in time, but it is episodic showing when sub-periods of linear and non-linear correlation appear.

Neely et al. (2009) examined the intertemporal stability over time of the excess returns earned by several broad classes of technical trading rules in the foreign exchange market. Their findings where consistent with adaptive markets hypothesis, as they showed that both institutional and behavioral factors influence investment strategies and opportunities on foreign exchange market. Research from various authors like Brock et al. (1992) and Sullivan at al. (1997) have also found evidence that particular classes of technical trading rules enable the possibility of earning abnormal profit in the stock market.

The effect of changing market conditions on DJIA return predictability, which is consistent with adaptive markets hypothesis, was found in study by Kim et al. (2011). As they concluded, return predictability is associated with stock market volatility and economic fundamentals. Additionally, there are various studies which point out the importance of the behavioral finance and discuss that investor's behavior like overreaction and overconfidence is irrational, but still highly predictable (DeBondt and Thaler, 1985; Barber and Ordean, 2001)

Apart from the main finding of time-varying weak-form efficiency in stock markets, the rolling window approach allows previous studies to gain additional insight. Despite the qualitative nature of AMH, it offers a number of concrete implications for the practice of investment management.

Next table shows an overview of results of the main papers related to Adaptive Market Hypothesis testing.

TABLE 1. COMPARATIVE ANALYSIS OF ADAPTIVE MARKET HYPOTHESIS STUDIES

Study	*Data and methodology*	*Results*
Andrew W. Lo 2004	Monthly returns of the S&P Composite Index (1871 – 2003) analyzed over 5 year rolling window	The degree of market efficiency varies through time in cyclical fashion. Markets adapt to evolutionary selection pressures
Self, J. K. and Mathur, I 2006	Daily returns of G7 national indices (1992 - 2003) analyzed using MTAR model and E-G stationary tests	Revealed existence of asymmetric stationary periods, anomalous market behavior and the degree of market efficiency varies through time. Markets adapt to evolutionary selection pressures
Neely, C. J. et al. 2009	Stability of excess returns (1973 – 2005) to technical trading rules in foreign exchange market using ARIMA models	The degree of market efficiency varies through time in cyclical fashion. Markets adapt to evolutionary selection pressures
Todea, A. et al. 2009	Daily returns of 6 indices – All Ordinaries Index, Hang-Seng Index, BSE national Index, Kuala Lumpur Composite Index, Strait Times Index and Nikkei 225 Index (1997 – 2008) analyzed using Moving average strategy	The degree of market efficiency varies through time in cyclical fashion. Markets adapt to evolutionary selection pressures
Kim, Jae H. et al. 2011	Daily returns of the DJIA (1900 – 2009) analyzed using automatic variance ratio, automatic portmanteau tests and generalized spectral test	The degree of market efficiency varies through time in cyclical fashion. Markets adapt to evolutionary selection pressures

Source: Author calculation

It is important to notice that the Adaptive Market Hypothesis was not analyzed in too many studies. Additionally, the authors of above compared studies analyzed whether market efficiency changes during the observation period which resulted with conclusion that market efficiency changes over time. We did get to the same results which proved that market efficiency changes over time, and contributed to these types of studies examining two additional factors: time horizon and data aggregation level.

II. DATA DESCRIPTION

In this study we analyze daily data of MONEX20, market value-weighted index which is proxy for Montenegro equity market. The data is analyzed over period of eight years, starting from January 13th 2004 to December 31st 2011. This period covers all available data of MONEX20. In order to obtain time series of continuously compounded returns, we transformed daily data of MONEX20 according to the formula

$$r_t = \log\left(\frac{p_t}{p_{t-1}}\right)100 \tag{1}$$

where p_t and p_{t-1} represent the stock index value at time t and t-1, respectively. Weekly data is obtained by averaging daily returns. We examined three factors we assumed to influence degree of weak-form of market efficiency: observation period (P, P1, and P2), time horizon (rolling window sizes), and aggregation level (daily and weekly returns). The higher levels of data aggregation were not considered due to relatively short length of available MONEX20 data. Observation period P was divided in two sub-periods: P1, ranging from 2004 to 2008 and P2, from 2009 to 2011. Sub-period P1 reflects rapid development of Montenegro capital market as a consequence of mass-voucher privatization process which is characterized by euphoria, while sub-period P2 reflects stock market collapse as a consequence of global financial crisis and vulnerability of small emerging market. In order to test the structural stability of original data series of daily returns, we applied the t-test, which showed statistically significant difference between means for two sub-periods (for P1(2004-2008) mean value is 0.001701 and for P2 (2009-2011) mean value is -0.0000947), with a p-value of 0.02556.

We have employed rolling window method, in order to assess the stability of first order autocorrelation coefficient and stability of the results of runs test. First order autocorrelation coefficient is employed because it was found that this coefficient was statistically significant for daily and weekly aggregation level. Since evidence on non-normality properties of MONEX20 suggests using non-parametric test, the runs test was used. To make possible comparison between two aggregation levels we have chosen different rolling window sizes in order to cover approximately one year period for both aggregation levels.

Table 2 presents summary of descriptive statistics of daily and weekly returns for total observation period (P) and two sub-periods (P1 and P2). Sample means, standard deviations, ranges, skewness, kurtosis, Jarque-Bera statistics, Augmented Dickey-Fuller statistics and p-values have been reported. The mean of continuously compounded returns for MONEX20 ranges from -0.097(min) to 0.113(max), and -0.051(min) to 0.066(max) for daily and weekly data, respectively. Reported skewness and kurtosis indicate strong non-normal distributional properties for both aggregation levels and sub-periods. Jarque-Bera statistics and corresponding p-values justify non-normality properties of the series. Also, Augmented Dickey-Fuller (ADF) statistics and its corresponding p-values test null hypothesis of unit root (non-stationary) against the alternative of no unit root (stationary) and we accepted alternative hypothesis that MONEX20 is stationary time series for both aggregation levels and both sub-periods.

TABLE 2. DESCRIPTIVE STATISTICS OF MONEX20 RETURNS FOR DIFFERENT OBSERVATION PERIODS AND AGGREGATION LEVELS

	Daily			*Weekly*		
	P	***P1***	***P2***	***P***	***P1***	***P2***
Mean	0.001028	0.001701	-0.0000947	0.001163	0.001826	0.0000617
Median	0.0000	0.000376	-0.000563	0.000196	0.000633	-0.000716
Maximum	0.112857	0.112857	0.098454	0.065592	0.041626	0.065592
Minimum	-0.097084	-0.097084	-0.074976	-0.051181	-0.051181	-0.022454
Std. Dev.	0.018591	0.020327	0.015205	0.010682	0.011338	0.009425
Skewness	0.634349	0.479338	1.010999	0.855153	0.262036	2.413928
Kurtosis	8.270597	7.151493	11.13923	8.621936	5.871159	18.39132
Jarque-Bera	2422.126	935.6853	2171.611	585.5935	90.15099	1658.782
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADF statistics	-34.5965	-27.11818	-21.84317	-14.97606	-11.11391	-10.57167
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	1978	1237	741	407	254	153

Notes: P: 2004-2011, P1: 2004-2008, P2: 2009-2011

Source: Author's calculation

Figure 1. Returns on MONEX20 for different aggregation levels

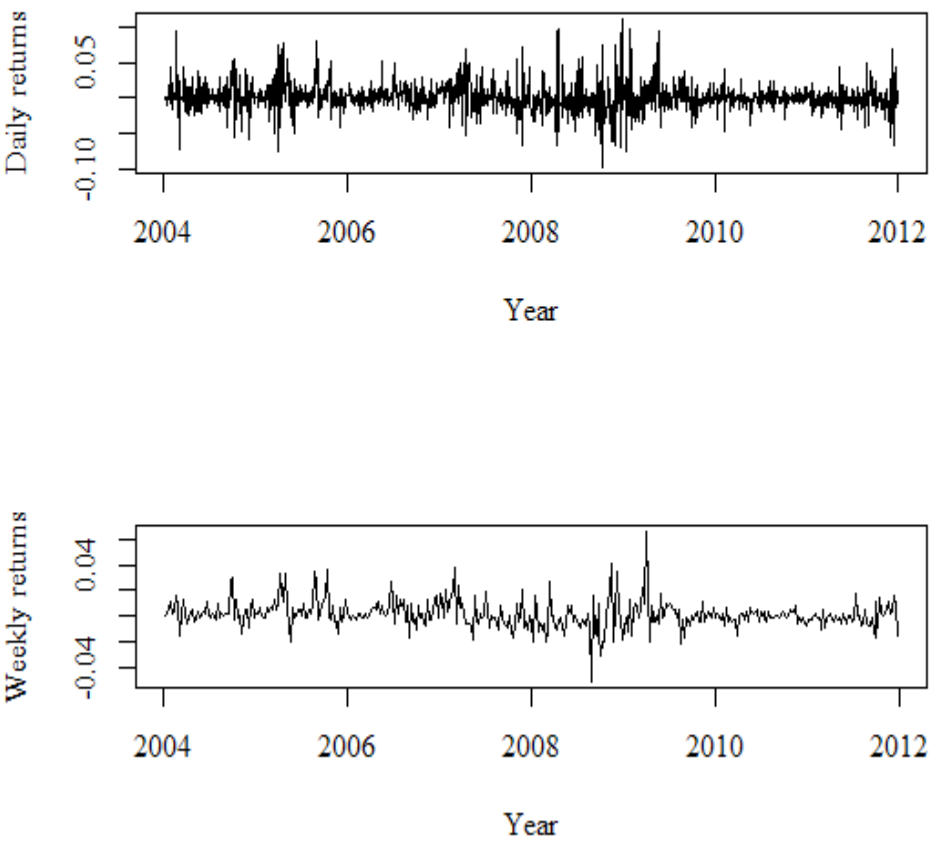


FIGURE 1 DISPLAYS MONEX20 RETURNS.

III. METHODOLOGY

Consider the following random walk process:

$$r_t = r_{t-1} + \varepsilon_t \tag{2}$$

where r_t and r_{t-1} represent the returns on MONEX20 index at time t and t-1, respectively, and ε_t is a random disturbance term satisfying $E(\varepsilon_t)=0$ and $E(\varepsilon_t, \varepsilon_{t-g})=0$, $g\neq 0$, for all *t*. If return generation process follows model (2) we conclude that market is weak-form efficient. As Worthington and Higgs noted, the best predictor of future prices is the most current price, so, "in a market which complies with random walk, it is not possible to use information on past prices to predict the future prices" (Worthington and Higgs, 2004).

In order to analyze how observation period, time horizon (represented by rolling window sizes) and data aggregation level influence weak-form market efficiency we employed rolling window method to test stability of first order autocorrelation coefficient (AC(1)), as well as to test results of runs test.

First order autocorrelation coefficient is given by:

$$AC(1) = \frac{\sum_{t=1}^{N-1}\left(r_t - \bar{r}_1\right)\left(r_{t+1} - \bar{r}_2\right)}{\left[\sum_{t=1}^{N-1}\left(r_t - \bar{r}_1\right)^2\right]^{1/2}\left[\sum_{t=2}^{N-1}\left(r_t - \bar{r}_2\right)^2\right]^{1/2}} \tag{3}$$

where N is the number of observations, $\bar{r}_1$ is the mean of the first N-1 observations and $\bar{r}_2$ is the mean of the last N-1 observations. If absolute AC(1) significantly differs from zero its calculated value should be out of limits, where limits are given by:

$$\pm z_{\alpha/2}\frac{1}{\sqrt{N}} \tag{4}$$

Runs test is non-parametric test which is traditionally used in random walk model and ignores properties of distribution. This test ignores the absolute value in time series and takes into consideration only the price changes of the same sign, which are called runs (Popović, 2000). Actual number of runs is being compared with the expected number of runs, obtained by applying the following formula

$$\mu(R) = \frac{2n_1 n_2}{n_1 + n_2} + 1 \tag{5}$$

where μ(R) is expected number of runs, and n_1, n_2 are sums of positive and negative runs, respectively.

The standard error of the expected number of runs is calculated as follows:

$$\sigma(R) = \sqrt{\frac{2n_1n_2(2n_1n_2 - n_1 - n_2)}{(n_1 + n_2)^2 (n_1 + n_2 - 1)} + 1} \tag{6}$$

Expected number of runs is compared with the actual number of runs (R), i.e. with number of sequences of the returns with the same signs (+ or -). The difference between actual number of runs and expected number of runs can be expressed by a standardized-normalized value of Z, as follows:

$$Z = \frac{R - \mu(R)}{\sigma(R)} \tag{7}$$

The null hypothesis for the runs test is that the observed returns are randomly distributed. The null hypothesis is rejected if the calculated number of runs falls outside the 95% confidence interval: $\mu(R)-1.96\ \sigma(R) \leq R \leq \mu(R) + 1.96\ \sigma(R)$, and is accepted if the value lies in between ±1.96. The Z-value is tested at 5% significance level, that is, the null hypothesis can not be rejected with 95% confidence level. In other words there is a probability of rejecting a null hypothesis when it is true 5 out 100 times.

The percentage of AC(1) which are out of limits, as well as percentage of runs test rejecting null hypothesis at 5% significance level were calculated by employing rolling analysis for different window sizes. The main idea of the rolling window approach in this research is to check whether short-range linear dependence is varying over time. This approach is of use to test whether stock market efficiency is changing over time.

IV. EMIPIRICAL RESULTS

Table 3 displays different rolling window sizes according to aggregation levels we examined. There is no standard rule by which the right size of the rolling window could be defined. When applying this analysis, the size of rolling window is related to the length of time series. Over period of eight years, starting from January 13th 2004 to December 31st 2011, which encompasses all available data on Montenegro Stock Exchange, we analyzed two aggregation levels – daily and weekly. Additionally, we had to trade-off between sufficient number of windows and windows length. In order to obtain statistically valid results, 50 days were the minimal rolling window size for each aggregation level and periods analyzed. We were guided by the same principle, when choosing applied windows sizes.

TABLE 3. ROLLING WINDOW SIZE ACCORDING TO AGGREGATION LEVEL

	Rolling window sizes (*n*)			
Daily	50	100	200	300
Weekly	10	20	40	60

Source: Author's calculation

Percentages of out of limits AC(1) for different rolling window sizes, aggregation levels and observation periods (P, P1 and P2) are shown in Table 4. Higer percentage indicates lower degree of weak-form market efficiency, while lower percentage implies higer degree of weak-form market efficiency.

TABLE 4. PERCENTAGE OF OUT OF LIMITS AC(1) FOR DIFFERENT ROLLING WINDOW SIZES AND AGGREGATION LEVELS

	Daily				*Weekly*			
	n=50	***n=100***	***n=200***	***n=300***	***n=10***	***n=20***	***n=40***	***n=60***
Out of limits P	54.17	71.63	64.59	67.42	0.98	3.02	13.00	20.17
Out of limits P1	58.62	80.05	77.86	75.55	0.78	3.19	20.33	31.17
Out of limits P2	46.65	57.16	41.03	52.45	1.32	2.74	0.00	0.00

Notes: P: 2004-2011, P1: 2004-2008, P2: 2009-2011

Source: Author's calculation

Observation period

The results indicate that sub-period P2 is the same or more efficient than P1 for both aggregation levels and for all rolling window sizes employed. By increasing rolling window size towards longer time horizon, the difference of market efficiency degree between two sub-periods P1 and P2 becomes more evident for both aggregation levels. The whole observation period is characterized by cyclical changes of market efficiency on daily level, while by increasing time horizon on weekly level, the market efficiency decreases.

Data aggregation level

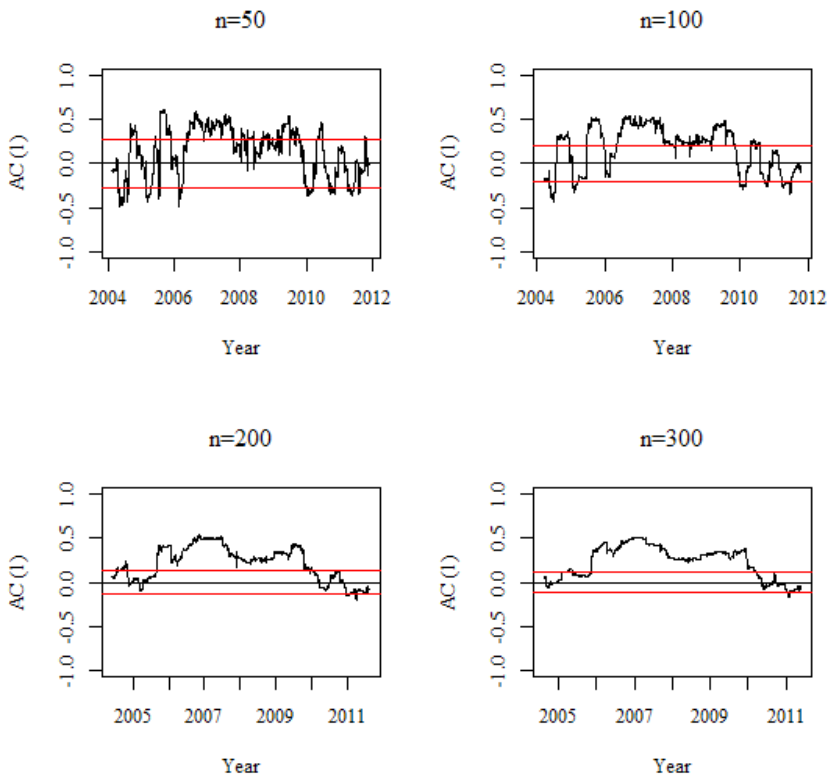
From the data aggregation perspective, the higher level of aggregation increases degree of market efficiency, no matter which period of observation and time horizon is considered.

Time horizon

If time horizon becomes broader by widening rolling window size, degree of market efficiency decreases over total observation period (P) and sub-period P1, on weekly aggregation level. Sub-period P2 has shown specific pattern of efficiency, comparing to P and P1: by increasing time horizon form n=10 to n=20, the degree of market efficiency *decreases* (from 1.32% to 2.74% out of limits), while further increase of rolling window size leads to *increase* of market efficiency (from 2.74% to 0.00% out of limits). Considering daily data, as adaptive markets hypothesis suggests, degree of market efficiency is changing in a cyclical manner, for total as well as for both sub-periods. Note that over total observation period cyclical changes result as follows: by increasing window size from 50 to 100 degree of market efficiency *decreases* (from 54.17% to 71.63% out of limits), than, by increasing from 100 to 200 degree of market efficiency *increases* (from 71.63% to 64.59 out of limits), and finally, by increasing from 200 to 300 degree of market efficiency again *decreases* (from 64.59% to 67.42% out of limits).

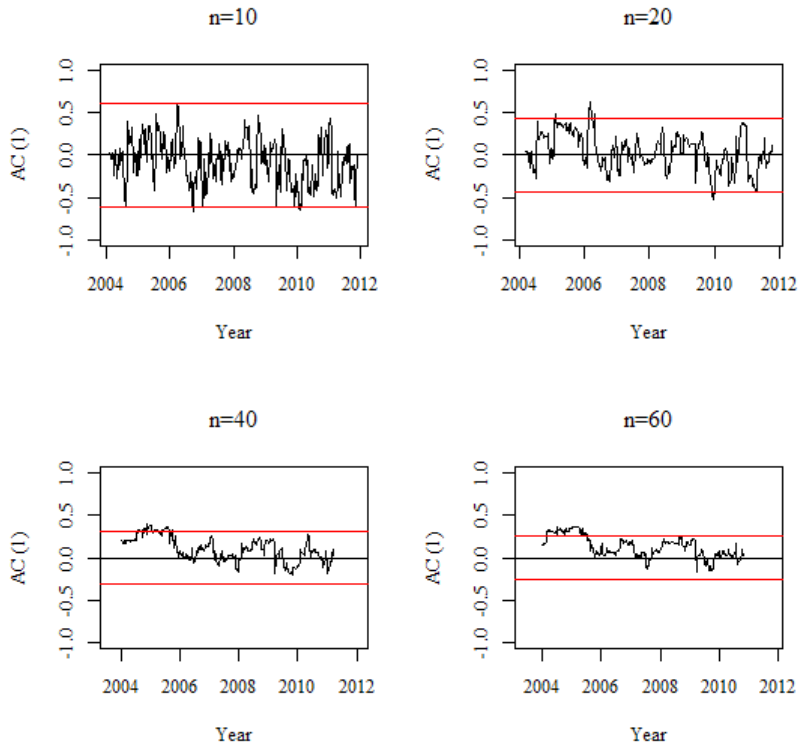
Graphic presentation of daily and weekly AC(1) for different rolling window sizes are given by Figure 2 and Figure 3, respectively.

Figure 2. Daily AC(1) for different rolling window sizes



Source: Author's calculation

Figure 3. Weekly AC(1) for different rolling window sizes



Source: Author's calculation

Table 5 shows the percentage of runs test that reject random walk hypothesis at 5% significance level for different rolling window sizes, aggregation levels and observation periods (P, P1 and P2).

TABLE 5. PERCENTAGE OF THE RUNS TEST THAT REJECT RW HYPOTHESIS FOR DIFFERENT ROLLING WINDOW SIZES AND AGGREGATION LEVELS

	Daily				*Weekly*			
	n=50	***n=100***	***n=200***	***n=300***	***n=10***	***n=20***	***n=40***	***n=60***
Out of limits P	25.78	37.51	49.43	56.72	9.34	9.07	7.69	7.00
Out of limits P1	29.73	43.85	53.50	64.69	8.98	7.97	10.79	7.79
Out of limits P2	19.10	26.64	42.23	42.08	9.93	10.96	2.21	5.56

Notes: P: 2004-2011, P1: 2004-2008, P2: 2009-2011

Source: Author's calculation

Observation period

According to the results obtained by runs test, market efficiency of sub-period P2 comparing to P1 depends on aggregation level as well as time horizon considered. On daily aggregation level, P2 is always more efficient comparing to P1, no matter which time horizon is considered. At weekly aggregation for n=10 i n=20 degree of market efficiency in P1 is higher than in P2 (compare 8.98% to 9.93% out of limits for n=10 and 7.97% to 10.96% for n=20). The conclusion is quite opposite when taking into consideration n=40 i n=60 (compare 10.79% to 2.21% out of limits for n=40 and 7.97% to 5.56% for n=60). Opposite to AC(1) test, the results of runs test have shown absence of cyclical changes in market efficiency over whole observation period on daily level. By increasing time horizon over total observation period the degree of market efficiency decreases on daily aggregation level, while increases on weekly level of aggregation.

Data aggregation level

The higher level of aggregation increases degree of market efficiency, no matter which time horizon and which period of observation is taken into consideration.

Time horizon

As we already explained, wider time horizon reflects lower degree of market efficiency on daily aggregation level over total observation period P, while on weekly aggregation level it reflects higher degree of efficiency. The same conclusion can be drown for both sub-periods on the basis of daily data, but at weekly data we found cyclical changes in both of them.

V. CONCLUDING REMARKS

This paper seeks evidence whether three factors: observation period, time horizon, and data aggregation level affects degree of efficiency of Montenegro equity market. We focused on examining degree of market efficiency over time and the main finding of this paper is that we proved adaptive markets hypothesis. General conclusion is that all three factors effects degree of efficiency of Montenegro equity market which has serious consequences on profit opportunities over time on this market. Employed tests have shown that influence of those factors is mutually dependant and interactive. In order to examine correlation between current and past returns of MONEX20, the rolling analysis was employed on AC(1) and on p-value of runs test. The results of both tests proved time-varying market efficiency.

Our findings can be summarized as follows:

- Period of euphoria (P1) and period of recession (P2) have shown different degree of Montenegro equity market efficiency. Generally, over P1 period market was less efficient comparing P2. Note that over two sub-periods there are intervals with different degree of market efficiency which proves adaptive markets hypothesis and time varying character of market efficiency.
- From data aggregation perspective we conclude that increasing data aggregation level increases degree of market efficiency. This finding is highly intuitive because averaging daily data in order to get weekly, influence of factors that cause lower efficiency decreases.
- By widening time horizon (rolling window size), degree of market efficiency generally decreases and we found evidence that decrease has a cyclical pattern.

Both tests employed proved adaptive markets hypothesis, but using AC(1) cyclical changes were found on daily aggregation level, while, using runs test these changes were found

on weekly aggregation level. The reason for this could lie in fact that we only used rolling window sizes which refers to period up to one year. That could be considered as short term, in which data is more volatile. Using such rolling window sizes was consequence of relatively short available MONEX20 time series.

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Saša Popović, Ana Mugoša, Andrija Đurović

HIPOTEZA O ADAPTIVNOSTI TRŽIŠTA: EMPIRIJSKI DOKAZ SA TRŽIŠTA AKCIJA CRNE GORE

SAŽETAK

U ovom radu je ispitivana hipoteza o adaptivnosti tržišta kroz analizu tri faktora za koje smo pretpostavili da imaju utjecaja na slabu formu efikasnosti tržišta: period promatranja, vremenski horizont predstavljen dužinom pokretnog prozora i razina agregiranosti podataka. Analiza je provedena na tržišno ponderiranom indeksu MONEX20 koji predstavlja *proxy* za crnogorsko tržište akcija u periodu od 2004-2011. godine. Metoda pokretnih prozora s fiksnim parametrima u svakom prozoru pojedinačno je primijenjena kako bi izmjerili odstupanja od hipoteze slučajnog hoda tokom vremena. Zapravo, pomoću ove analize je ispitivano variranje kratkoročne linearne ovisnosti prinosa iz prethodnog i tekućeg perioda. Metoda pokretnih prozora je primijenjena na autokorelacijski koeficijent prvog reda (AC1) i na test znakova (neparametarski test), s obzirom na to da serija podataka indeksa MONEX20 ne dolazi iz normalnog rasporeda. Analiza je dovela do zaključka da sva tri faktora utječu na razinu slabe forme efikasnosti crnogorskog tržišta akcija, što ima ozbiljne konsekvence na mogućnosti ostvarivanja profita tokom vremena na ovom tržištu.

Ključne riječi: hipoteza o adaptivnosti tržišta, slaba forma hipoteze o efikasnosti tržišta, metod pokretnih prozora, autokorelacijski koeficijent, test znakova, Crna Gora

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INTEREST RATE RISK OF BOND PRICES ON MACEDONIAN STOCK EXCHANGE - EMPIRICAL TEST OF THE DURATION, MODIFIED DURATION AND CONVEXITY AND BONDS VALUATION

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– intrinsic value,
– duration,
– convexity

ABSTRACT

This article presents a valuation of Treasury Bonds (T-Bonds) on the Macedonian Stock Exchange (MSE) and an empirical test of duration, modified duration and convexity of the T-bonds at MSE in order to determine sensitivity of bonds prices on interest rate changes. The main goal of this study is to determine how standard valuation models fit in case of T-Bonds that are traded on MSE and to verify whether they offer reliable results compared with average bonds prices on MSE. We test the sensitivity of T-Bonds on MSE on interest rate changes and determine that duration and convexity jointly are a more accurate measure as approximation of bond prices changes than duration only. Our final conclusion is that T-Bonds traded at MSE are not sensitive on interest rate changes due to institutional investors' permanent higher demand, while at the same time the market has a limited offer of risk-free instruments.

Reference to this paper should be made as follows: Ivanovski. F 2013. Interest rate risk of bond prices on Macedonian stock exchange - empirical test of the duration, modified duration and convexity and bonds valuation, *Ekonomska istraživanja – Economic Research 26(3): 47- 62*

I. INTRODUCTION

The price of any financial instrument is equal to the present value of the expected cash flow from the financial instrument (Damodaran, Applied Corporate Finance, 2010). In order to determine the intrinsic value of a bond we need to estimate the expected cash flows and the appropriate required rate of return (yield). The expected cash flows are determined from bond characteristics or bond contract. The required rate of return (yield) reflects the yield for financial instruments with comparable risk, or alternative investments (Brealey, 2006). Bond as a debt instrument requires from the issuer (debtor or borrower) to repay to the lender/investor the amount borrowed (principal) plus interest over a specified period of time. A key feature of a bond is the nature of the issuer, which is usually divided in three groups: government, municipalities and corporations (domestic and foreign).

We are analyzing Treasury Bonds (T-Bonds) that are quoted and traded on the Macedonian Stock Exchange (MSE). MSE was established in September 1995, but its real start was with the first ring of Stock-Exchange bells on 28 March 1996. First T-Bonds' quotation on MSE happened in 2000, when Ministry of Finance issued T-Bonds as a compensation for "frozen" (old) foreign-exchange deposits in Macedonian commercial banks before the Republic of Macedonia gained independence from former Yugoslavia (Code: RM01). New types of T-Bonds (Bonds for Denationalization, Code: RMDEN) were issued on MSE in 2002. Starting from 2006, MSE regularly calculates Bond Price Index (OMB).

MSE's short-history strongly affects securities valuation, due to the relatively short time series and impossibility to calculate market premium. The limited numbers of securities that are quoted and traded on MSE as well as the low liquidity of the market are additional factors that have significant influence on the process of valuation.

The Old Foreign-Exchange Saving Bonds and Bonds for Denationalization are listed and traded on MSE. Bonds for Denationalization are most liquid, permanently and in significant amounts traded on MSE. These types of bonds are the focus of our research. Pursuant to the Law on Issuance of Bonds for Denationalization, Republic of Macedonia in a period of eleven years carried out one issue of Bonds for Denationalization annually. The Government of the Republic of Macedonia every year makes a decision on the amount of the Bonds for Denationalization to be issued. First issue of Bonds for Denationalization was made in March, 2002, while the last eleventh issue of this type of bonds was launched in March 2012. The total amount of issue per year varies between EUR 10 - 30 million, and depends on amounts of effective Government decisions for denationalization made for a specific year for which bonds are given as a form of compensation. Bonds for Denationalization are registered securities, denominated in euro and unrestrictedly negotiable. The face value of the bond is EUR 1. Interest and portion of face value of the bonds fall due on June 1 every year, which means that they are amortization bonds (with annuity payment of interest and principal) with 10 years maturity. Following the adoption of the request for listing on the official market, the bonds are traded on the secondary market of the MSE. Trading with the bonds, listed on the MSE, is carried out on the basis of the market price. Payment upon executed purchase of the bonds on the secondary market is carried out at the price at which they have been traded on the Stock Exchange, including the accrued interest for the period from the last interest payment up to the transaction day.

II. CALCULATION OF RISK-FREE RATE

The valuation process starts with a determination of the risk-free rate for the securities quoted at MSE, having in mind all the relevant factors that affect emerging stock-markets, like low liquidity, small number of traded securities and short history of the market. Most risk and return models in finance start off with an asset that is defined as risk- free and use the expected return on that asset as the risk- free rate. In order to define an asset as risk-free it has to fulfill some requirements. In particular, an asset is risk- free if we know the expected returns on it with certainty, or when the actual return is equal to the expected return. It means that first, there is no default risk for this type of security and second, there is no reinvestment risk (Damodaran, Damodaran on Valuation: Security Analysis for Investment and Corporate Finance, 2011).

Macedonian Government as issuer of the Bonds for denationalization has to be viewed as a default-free entity. When doing valuation, the risk- free rate should be the long term government bond rate that will be used as a discount rate. First option is to use the risk-free rate of return on Treasury Security with ten years maturity issued by the Government of the Republic of Macedonia. However, there are several reasons why this bond yield is not suitable for use as a discount rate. Macedonian government does not issue long-term denar-denominated state securities, T-Bonds are not issued regularly as well in amounts that can be planned in advance, they are not zero-bonds which means that they have reinvestment risk, have low liquidity on capital market and they also have included country risk premium. It is important to emphasize that a country risk premium can be added as a separate element in the changed CAPM equation. Due to the above mentioned reasons and in order to avoid double calculation of the country risk premium when using CAPM, we decide to use an alternative model for risk-free rate calculation. Second option is to calculate risk-free rate from estimated 3% or 3.5% for ten-year euro-denominated bonds and add the spread to risk-free interest rates, with the minimum estimated spreads determined on the basis of expected annual inflation and Macedonia's credit rating (BBB, according to the Standard and Poors in 2009), being 3,3 percentage points for denar bills and 3,3 percentage points for long-term bonds. Third option is to use Svensson method for interest rate calculation, and based on that model to proceed with the current German IDW method (the Institute of Public Auditors in Germany). In accordance with that methodology, the interest curve is established on the basis of a Svensson approximation (Ferenczi, 2006) and that fixed cash flows growing at a constant rate can be discounted using that interest curve.

We decide to use alternative methodology (Bloomberg 2009) and calculate risk-free rate by using 10-years T-Bonds denominated in euro issued by countries-members of European Union. We use yield-to-maturity (YTM) of these bonds with date of calculation, which has to represent forecasting of risk-free rates in the EU countries in the future. Due to the fact that this yields can be affected from volume of issue, we measure yields from forecasted GDP for these countries. Risk-free rate for MSE calculation presented in this paper was made in 2009 in order to make valuation of T-Bonds RMDEN09, so we have measured yields from forecasted GDP for countries members of EU for the entire 2009. We calculate a single value for YTM – as a weighted average of YTM for 10-years Bonds denominated in euro, issued by European Governments. This process is presented in Table 1:

TABLE 1. CALCULATION OF YTM ON 10 – YEARS EU T-BONDS (DATE 30/09/2009)

Country	*YTM 10y Bonds (%)*	*GDP (EUR bn)*	*GDP weight*	*W avg. YTM*
1	2	3	4	5
Austria	3,70	381,1	3,22%	0,12%
Belgium	3,72	436,7	3,69%	0,14%
Finland	3,59	232,1	1,96%	0,07%
France	3,54	2625	22,17%	0,79%
Germany	3,33	3107	26,25%	0,87%
Greece	4,46	354,3	2,99%	0,13%
Ireland	4,74	219,2	1,85%	0,09%
Italy	3,93	2073,3	17,51%	0,69%
Holland	3,57	785,5	6,64%	0,24%
Portugal	3,88	219,9	1,86%	0,07%
Spain	3,79	1403,7	11,86%	0,45%
Average			100%	3,65%

Source: Authors' calculation

Description for above table: Second column presents YTM on 10- years T-Bonds issued from 11 countries members of EU. Next column (no.3) presents GDP of individual countries in EUR. In column no.4 we calculate individual participation of countries GDP as a percentage of the total GDP of EU countries. In column 5 we calculate weighted average YTM: we multiply YTM on 10-years T-Bonds in % (column no. 2) and column no.4. Finally, we sum all results from column no.5 and get weighted average of 3,65%.

Valuation has to be done in real terms. This means that cash flow is estimated using real growth rates and without allowing for the growth from price inflations. It implies that discount rates used in these cases have to be real, not nominal risk-free rate (Damodaran, Investment Valuation: Tools and Techniques for Determining the Value of Any Asset, 2012). We have calculated weighted average YTM, that contains investors' expectations for future inflation rates in Euro–zone, so it is necessary to decrease the nominal return by the expected inflation rate, using Fisher Formula (Fisher, (1977) (1930)):

where
$$1 + r_n = (1 + r_r)(1 + i) \quad (1)$$

r_n – nominal rate of return;

r_r – real rate of return;

i – inflation rate.

Expected inflation was calculated as a geometric average of 10-years forecasting for Euro-zone (1,50%), based on European Central Bank forecasting. Using formula for nominal calculated weighted average for bonds denominated in euro, we calculate real YTM for these bonds (2,12%). We add to the real return, using Fisher formula, geometric average for 10-years expected rates of inflation in Macedonia (3,32%), in order to determine the nominal 10 – years risk-free rate of return denominated in Macedonian national currency - Denars.

TABLE 2. CALCULATION OF RISK-FREE RATE IN MACEDONIA (DATE 30/09/2009)

EU T-Bonds	Risk-free rate	Inflation EU	Real Risk-free rate	Inflation Macedonia	Risk-free rate Macedonia
1	2	3	4	5	6
EU T-Bonds	3,65%	1,50%	2,12%	3,32%	5,49%

Source: Authors' calculation

Description for above table: Using Fisher formula we calculate real risk-free rate in EU. We add inflation rate calculated as 10-years geometric average and get risk-free rate in Macedonia.

Following this approach, 10-years denominated risk-free rate of return in Macedonia is calculated to be 5,49%. The entire process explained above is based on an assumption that the purchasing power parity of Macedonian Denar and Euro will remain constant. Risk-free rate that will be used for valuation of T-Bonds is 5,5%.

III. VALUATION OF T-BOND FOR DENATIONALIZATION – RMDEN09

MSE started trading with T-Bonds RMDEN09 on 26 April 2010 in the total amount of 30 million Euros. This bond has same characteristics like the previously issued T-Bonds for Denationalization: 10 years maturity, the principal repaid over the life of the bond, i.e. - annuity payment of par value, 2% interest rate and first date of payment on 1 June 2011. It means that RMDEN09 and other T-Bonds for Denationalization have amortization schedule of principal and interest repayment. Analysis shows that this bond is attractive for investors due the to possibility to be protected from the risk of possible depreciation/devaluation of Denar since bonds are denominated in Euro, so they can provide protection to investors from foreign-exchange risks. This bond also gives the investors an opportunity to invest in risk-free instruments as there is evidently a lack of similar risk-free instruments on MSE, which constantly raises the demand for risk-free securities.

Valuation of T-Bond RMDEN09 is focused on the determination of the intrinsic value of the bond. The price of a security in a competitive market should be the present value of the cash flow that investors will receive from owning it. In order to determine present value of future cash flows we will have to discount them with required rate of return (yield). Due to the fact that T-Bond is risk-free i.e. the promised cash flow will be paid with certainty, we use the method of discounted cash flows and we discount bond's cash flows with required rate of return (risk-free rates) equal to 5,5% and determine the intrinsic value of RMDEN09 on 84,83. (Table 3).

TABLE 3. RMDEN09 AMORTIZATION PLAN AND NPV CALCULATION (NOMINAL VALUE 100.000 EUR)

Year	*Principal*	*Interest*	*Total Payment*	*Total amount of debt*
1	2	3	4	5
2011	10.0	2.0	12.0	90.0
2012	10.0	1.8	11.8	80.0
2013	10.0	1.6	11.6	70.0
2014	10.0	1.4	11.4	60.0
2015	10.0	1.2	11.2	50.0
2016	10.0	1.0	11.0	40.0
2017	10.0	800	10.8	30.0
2018	10.0	600	10.6	20.0
2019	10.0	400	10.4	10.0
2020	10.0	200	10.2	-
NPV (5,5%)	84.83			

Source: Authors' calculation

In Table 4 we present the average prices of T-Bonds for Denationalization in appropriate year.

TABLE 4. AVERAGE BONDS PRICES ON MSE (2002-2011) (IN PERCENTAGES)

Bonds and Date of Issue	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
RMDEN01 25.06.2002	60%	63.50%	70%	69%	85%	83,5%	89,3%	90%	93%	95,5%
RMDEN02 26.03.2003		50%	65%	68%	82,6%	84,1%	88%	89,7%	92%	98,3%
RMDEN03 01.03.2004			60%	67,6%	81,3%	83,5%	85%	87%	89%	97,2%
RMDEN04 08.03.2005				60,9%	80%	82%	84%	85%	89%	96%
RMDEN05 15.03.2006					73.50%	80%	84,5%	85%	87%	95,2%

continued table

RMDEN06 13.03.2007	78%	85%	81%	86%	94,5%
RMDEN07 26.08.2008		80%	84%	85%	92%
RMDEN08 08.04.2009			79%	81%	92%
RMDEN09 26.04.2010				78,5%	91%
RMDEN10 30.03.2011					90%

Source: www.mse.com.mk

If we compare T-Bonds average market prices (in percentages of par value) with intrinsic value, we can see that bonds quoted and traded on MSE have lower market prices at the beginning of period of their issue compared with intrinsic value, which means that they were traded with discount. Their market prices rise in following years and keep around the intrinsic value and rise again in the last period of bond maturity, which means that they are traded with premium. If we compare T-Bonds YTM calculated at MSE (rate that equal market price and present value of cash flows of the bonds), presented in Table 5, with our determined risk-free rate (5,5%), we can see that the rates are equal only for RMDEN08. Three other T-Bonds (RMDEN07, RMDEN03 and RMDEN02) have 5% YTM which is near our calculated risk-free rate, while all others are below 5%.

TABLE 5. YTM OF T-BONDS AT MSE

RMDEN10	*RMDEN09*	*RMDEN08*	*RMDEN07*	*RMDEN06*	*RMDEN05*	*RMDEN04*	*RMDEN03*	*RMDEN02*
3,77	4,33	5,5	5	4,67	4,86	4,87	5	5,07

Source: www.mse.com.mk

This mean that all T-Bonds at MSE (beside RMDEN08) were traded with premium. A deeper analysis of bond price fluctuations leads to a conclusion that the discounted price of the bonds in first years from issuing are due to the higher volume of traded T-Bonds, i.e. bigger supply on the market when bond holders are trying to sell their bond portfolios and get faster return. As a result of a strong demand for risk-free instruments especially from institutional investors (pension funds, insurance companies and investment funds) that are obliged by Law to keep a significant part of their portfolios in risk-free instruments, this situation increases demand in the next period and provokes rise of the bond prices and they were traded with premium.

Although T-Bonds for Denationalization promised just 2% interest rate, they provide higher YTM compared with similar investment opportunities on financial markets in the Republic of Macedonia, due to the possibility for reinvestment. Higher demand for the bonds increases bond market prices.

IV. VOLATILITY OF THE BONDS: EMPIRICAL TEST OF THE DURATION, MODIFIED DURATION AND CONVEXITY OF THE T-BONDS ON MSE

There is a difference between nominal maturity and time of effective return of initial investment in bonds. In order to see the difference we will calculate duration of the T-bonds on MSE. Duration is weighted-average time needed for effective return of investment in bonds. We use as weighted average- present value of interest and principle payment divided by the bond price. Duration is given by the following equation (Arnold, 2008), and it is measured in years:

$$D = \frac{\sum t\ PVCF}{P} \tag{2}$$

Modified duration is defined as:

$$D^* = D/(1+y) \tag{3}$$

Bonds with shorter duration are less sensitive on interest-rate changes compared with bonds with longer duration. Duration is expressed as calculated average maturity of the bond, where we use discounted cash flows for each period (DeMarzo, 2008). Our calculation of Macaulay duration shows influence of different bonds maturity on duration. Using duration we can quantify bond sensitivity on interest rate change, maturity and bond price as given by the following equation:

$$\frac{\Delta P}{P} = -D^* \Delta y \tag{4}$$

A key bond-interest rate relationship is that bond prices are inversely proportional to changes in market interest rates. This means that all else equal, long-term bonds are more sensitive to interest rate changes than short - term bonds. All else equal, low-coupon bonds are more sensitive to interest rate changes than high-coupon bonds. Bond convexity can be explained as - all else equal, the higher duration (longer time to maturity or lower coupon payment), the more convexity will be and all else equal, the bigger the change in interest change, the more convexity will be. Convexity is given by following equation:

$$C = \frac{\sum (t^2 + t) PVCF}{P(1+y)^2} \tag{5}$$

Duration and convexity can be used to estimate the sensitivity of bond price on changes in interest rate:

$$\frac{\Delta P}{P} = -D^* \Delta y + 0.5C(\Delta y)^2 \tag{6}$$

We start our calculation with the duration of RMDEN10. We use interest rate *i*=2%, YTM (*y*) is 3,77%, maturity (*t*) is 10 years and nominal value (*M*) is 100. Duration of RMDEN10 is 5,04 years calculated using Eq. (1). Modified duration is calculated using Eq. (2) to be 5,04 / ((1+3,77%))= 4,865159 years. Convexity is calculated from Eq. (4) and for RMDEN10 is equal to 3539,54*0.01014147= 35,89614. If interest rate *y* rises to 4%, which is an increase of Δ*y* = 0,23%,

then the price of the bond (see Eq. (3)) will drop to 90,54585 which is a decrease of -1,02466%:

$$\frac{\Delta P}{P} = -D^{*}\Delta y = -4,865*0,0023 = -0,01119$$

$$\Delta P = 91,57*(-0,01119) = -1,02466\%$$

$$P = 91,57 - 1,02466 = 90,54585$$

We can also confirm that there is a small difference between forecasting of bond price change with duration and discounting of bond cash flow directly with 4% discount rate. This difference is minimal, and it means that by discounting directly all cash flows with 4% YTM we get almost the same result (bond price 90,55%). We can derive conclusion that duration can be used with great certainty for forecasting of bond prices change for the bonds with 10 years maturity.

Next we analyze the possibility to use convexity for forecasting of bond price change. Making the same assumptions that market interest rates increase by 0,23%, bond price will decrease by 1,02308%, and new bond price will be 90,554% (see Eq.(5)):

$$\frac{\Delta P}{P} = -D^{*}\Delta y + 0.5C(\Delta y)^{2} = -4,865159*(0,0023) + 0.5*35,89614(0,0023)2$$

$$= -0,01109$$

$$\Delta P = 91,57*(-0,01109) = -1,01596$$

$$P = 91,57 - 1,01596 = 90,55404$$

We can conclude that the convexity effect is relatively small for the analyzed bond, and due to the fact that there is no difference between forecasting of bond price change with convexity and discounting of bond cash flow directly with 4% discount rate, convexity can be used as accurate measure for bonds price forecasting.

Figure 1 gives the sensitivity of bond value *P* (RMDEN10) on changes in the interest rate *y*. Interest rate *y* is given on the *x*-axis, while ΔP is given on the *y* axis. First, ΔP is calculated using the correct formula:

$$\Delta P = P\left(y + \Delta y\right) - P(y) \tag{7}$$

and then it is estimated using duration (see Eq.(3)) and convexity (see Eq.(5)). In a wide range of values for *y* between 2.5% and 5%, true change in bond value (circles) can be closely estimated using Duration (squares), and using Duration and Convexity (triangles). Dotted line with triangles almost completely overlaps and hides the solid line with circles since the true change in bond value can be estimated with high precision using Duration and Convexity.

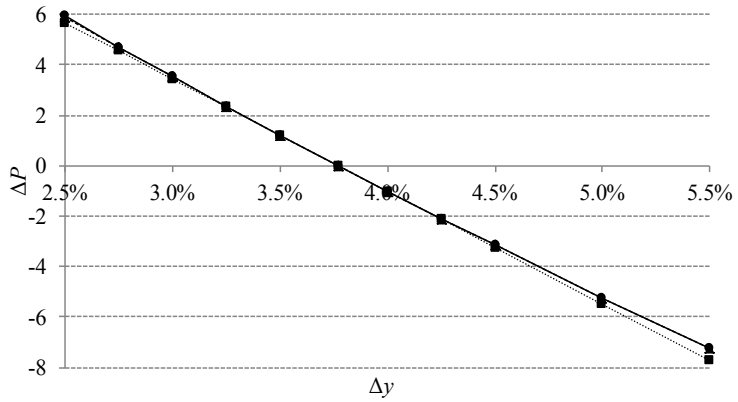

FIGURE 1. SENSITIVITY OF BOND VALUE P ON CHANGES IN THE INTEREST RATE Y

Source: Author's calculation

Figure 2 depicts how correct the estimation is. Dependence of estimation errors $\frac{P_D - P}{P}$ and $\frac{P_C - P}{P}$ on the change Δy in the interest rate is shown. Clearly, estimation of bond value *P* using both Duration and Convexity significantly reduces the estimation error compared to the case when only Duration is used.

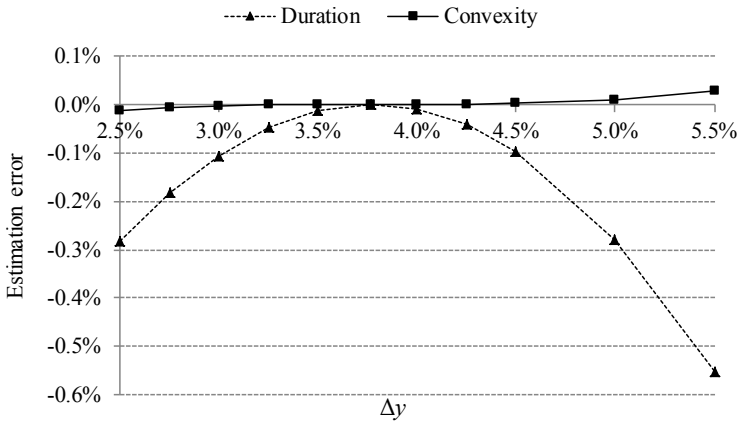

FIGURE 2. DEPENDENCE OF ESTIMATION ERROR ON CHANGES IN THE INTEREST RATE Y

Source: Author's calculation

Table 6 gives the data from Figure 1 and Figure 2 in a tabular form. Figure 1 visualizes rows ΔP, ΔP_D and ΔP_C, while Figure 2 visualizes the last two rows from Table 6.

TABLE 6. ESTIMATION OF BOND VALUE P USING DURATION AND CONVEXITY

Y	2.50%	2.75%	3.00%	3.25%	3.50%	3.77%	4.00%	4.25%	4.50%	5.00%	5.50%
P	97.504	96.291	95.101	93.932	92.785	91.571	90.554	89.469	88.404	86.330	84.330
P_D	97.228	96.115	95.001	93.887	92.773	91.571	90.546	89.432	88.318	86.091	83.863
P_C	97.494	96.286	95.098	93.932	92.785	91.571	90.555	89.470	88.406	86.339	84.355
ΔP	5.934	4.721	3.530	2.362	1.215	0.000	-1.016	-2.101	-3.167	-5.240	-7.240
ΔP_D	5.658	4.544	3.430	2.317	1.203	0.000	-1.025	-2.138	-3.252	-5.480	-7.707
ΔP_C	5.923	4.715	3.528	2.361	1.215	0.000	-1.016	-2.101	-3.165	-5.231	-7.215
$(P_D - P)/P$	-0.2828%	-0.1833%	-0.1049%	-0.0481%	-0.0130%	0.0000%	-0.0095%	-0.0417%	-0.0969%	-0.2776%	-0.5539%
$(P_C - P)/P$	-0.0109%	-0.0057%	-0.0025%	-0.0008%	-0.0001%	0.0000%	0.0001%	0.0006%	0.0022%	0.0105%	0.0294%

Source: Author's calculation

Next we calculate Duration of RMDEN09. We use interest rate *i*=2%, YTM (*y*) = 4,33%, maturity (*t*) = 9 years, and nominal value (*M*) = 90. RMDEN09 Duration is 4.598 years. Modified Duration is 4,4075, and Convexity is 29,67973. If we assume that market interest rates decreases from 4,33% to 4%, which means a decrease of 0,33%, then using duration we can calculate bond price change (increase) $\frac{\Delta P}{P}$ 1,3088%:

$$\frac{\Delta P}{P} = -D^* \Delta y = 4,4075*0,0033 = 0,014545$$

80.98552/90*0,014545=1,308806%

New bond price will be 80.98552/90+1,3088%=91,2927%

If we discount bond cash flows with 4% YTM, then we get bond price of 91.30%, which is a small deviation from the duration-based calculation. If we use same assumptions for yield decrease of 0,33% and forecast bond prices change with convexity, the we get bond prices change of 1,323% and new bond price of 91,307, which means small deviation of the bond:

$$\frac{\Delta P}{P} = -D^* \Delta y + 0.5C(\Delta y)^2 = 4.407*(-0.0033) + 0.5*29.679*(0.0033)2$$

$$= 1,3233\%$$

80.98552/90+1,3233%=91,307%

Figure 3 gives the sensitivity of RMDEN09 bond value *P* on changes in the interest rate *y*, in a wide range of values for *y* between 3.25% and 5.5%. True change in bond value (circles) can be closely estimated using Duration (squares), and using Duration and Convexity (triangles).

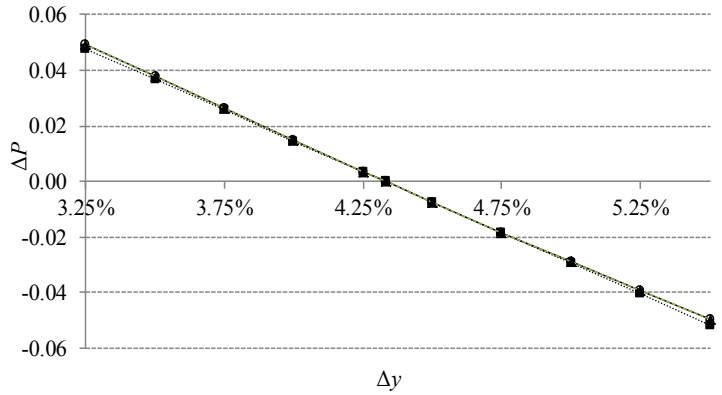

FIGURE 3. SENSITIVITY OF BOND VALUE P ON CHANGES IN THE INTEREST RATE Y.

Source: Author's calculation

Figure 4 depicts how correct the estimation is. We draw the same conclusion as in Figure 2. Namely, estimation of bond value *P* using both Duration and Convexity significantly reduces the estimation error compared to the case when only Duration is used.

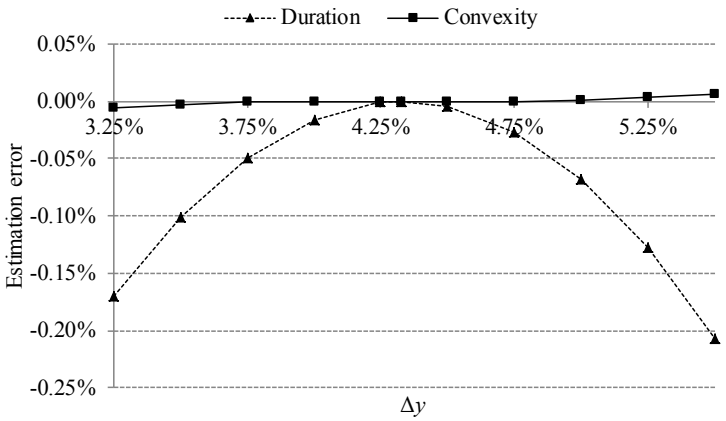

FIGURE 4. DEPENDENCE OF ESTIMATION ERROR ON CHANGES IN THE INTEREST RATE Y.

Source: Author's calculation

We have calculated Duration, Modified duration and Convexity for all other T-Bonds traded at MSE. They are presented in Table 7.

TABLE 7. DURATION, MODIFIED DURATION AND CONVEXITY OF T-BONDS ON MSE

BONDS	*D*	*Dmod*	*Conv*
RMDEN10	5,04	4,86	35,89
RMDEN09	4,59	4,40	29,67
RMDEN08	4,12	3,90	23,62
RMDEN07	3,73	3,55	19,26
RMDEN06	3,31	3,16	15,68
RMDEN05	2,86	2,73	11,89
RMDEN04	2,41	2,30	8,64
RMDEN03	1,95	1,86	5,84
RMDEN02	1,48	1,411	3,56

Source: Authors' calculation

Description of above table: Calculated Duration, Modified Duration and Convexity for all T-Bonds on MSE presented in one table.

We conclude that when forecasting bonds price changes, deviations are smaller for bonds with shorter maturity. This means that duration is a good approximation and that T-Bonds traded at MSE have lower convexity. This also confirms the fact that duration and convexity jointly are a better measure for bond price changes prediction on MSE compared with duration of the bonds. Duration determines bonds sensitivity on interest rate changes and shows approximately the time in which risk of price changes offset the reinvestment risk. Holding bonds in period of duration protects investors from interest rate changes.

The empirical results also provide support for the existence of a non-linear relationship between interest rate risk and prices of the T-Bonds for Denationalization on MSE. If we analyze T-Bonds price changes at MSE we can conclude that T-Bonds for denationalization on MSE that are not issued regularly and in equal series do not react on interest rate changes. As previously elaborated there are no other risk-free securities at MSE as well financial derivatives that can be used for hedging or for portfolio optimization of institutional investors. This keeps demand for T-Bonds higher and makes them not sensitive on interest rate risk.

V. CONCLUSIONS

This study presents practical valuation of T-Bonds on MSE in order to determine how standard valuation models fit in case of T-Bonds that are traded on MSE and to verify whether they offer reliable results compared with average bonds prices at MSE. We compare T-Bonds average market prices (in percentages of par value) to intrinsic value of the bonds, and conclude that bonds quoted and traded on MSE have lower market prices at the beginning of the period of their issue compared with intrinsic value, which means that they were traded with discount. Their market prices rise in the following years and keep around the intrinsic value, and then rise again in the last period of bond maturity, which means that they are traded with a small premium. All T-Bonds quoted at MSE (besides RMDEN08) were traded with premium. A deeper analysis of bond price fluctuations leads to a conclusion that discounted price of the bonds in first years from issuing are due to the higher volume of traded T-Bonds, i.e. bigger supply on the market when bond holders are trying to sell their bond portfolios and get a faster return. As a result of the strong demand for risk-free instruments especially from institutional investors (pension funds, insurance companies and investment funds) that are obliged by Law to keep significant parts of their portfolios in risk-free instruments, the demand increases in the next period and provokes rise of the bond prices and they are traded with premium. These results suggest that for bond valuation at MSE, besides the intrinsic value calculation it is also necessary to take into consideration YTM and Total Return of the bonds with reinvestment.

We also suggest an alternative methodology for risk-free rate calculation at MSE, that uses a weighted average YTM of 10-years T-Bonds denominated in euro issued by EU countries. We use YTM of these bonds with date of calculation, which is a forecast of risk-free rates in the EU countries in the future. Due to the fact that these yields can be affected from volume of issue, we measure yields from forecasted GDP for these countries for the entire 2009. We calculate a value for YTM – as a weighted average of YTM for 10-years Bonds denominated in euro, issued by European Governments. Using Fisher formula we eliminate inflation in EU zone and add expected inflation in the Republic of Macedonia. This leads to a final value for the risk-free rate in the Republic of Macedonia. This methodology eliminates shortages of using directly Macedonian T-Bonds long-term bond yield as a discount rate. Macedonian government securities are not issued regularly as well in amounts that can be planned in advance, they are not zero-bonds which means that they have reinvestment risk, have low liquidity on capital market and they also have included country risk premium. It is important to emphasize that country risk premium can be added as a separate element in the changed CAPM equation. Due to the above mentioned reasons and in order to avoid double calculation of country risk premium when using CAPM, we offer an alternative model for risk-free rate calculation.

We also make empirical test of duration, modified duration and convexity of the T-bonds at MSE in order to determine sensitivity of bonds prices on interest rate changes. A key relationship between bond prices and interest rate is that bond prices are inversely proportional to changes in market interest rates. Calculating duration, modified duration and convexity we test the sensitivity of T-Bonds for Denationalization on MSE on interest rate changes and determine the measure that is better for bond prices forecasting. We analyze annual data that covered the 2001-2011 sample period. The empirical results provide evidence that convexity and duration provide a more accurate approximation of bond prices changes than duration only.

Final conclusion of this study is that T-Bonds traded at MSE are not sensitive on interest rate changes due to the institutional investors' permanent higher demand and the limited offer of risk-free instruments on the market.

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KAMATNI RIZIK CIJENA OBVEZNICA NA MAKEDONSKOJ BURZI – EMPIRIJSKI TEST TRAJANJA, PROMJENE TRAJANJA, KONVEKSNOSTI I PROCJENE VRIJEDNOSTI OBVEZNICA

SAŽETAK

Članak predočuje procjenu vrijednosti trezorskih obveznica (T-obveznice) na Makedonskoj burzi (MSE) i empirijski test trajanja, promjene trajanja i konveksnosti trezorskih obveznica na MSE-u, kako bi se utvrdila osjetljivost cijena obveznica na promjene kamatnih stopa. Glavni cilj ovog istraživanja je utvrditi kako se standardni modeli procjene vrijednosti uklapaju u slučaj državnih obveznica kojima se trguje na MSE-u i provjeriti da li oni nude pouzdane rezultate u odnosu na prosječne cijene obveznice na MSE-u. Testira se osjetljivost trezorskih obveznica na MSE-u uslijed promjene kamatnih stopa i utvrđuje da li su trajanje i konveksnost zajedno preciznija mjera ujednačavanja promjena cijena obveznica nego samo trajanje. Konačni zaključak je da T-obveznice kojima se trguje na MSE-u nisu osjetljive na promjene kamatnih stopa uslijed stalnog povećanja potražnje institucionalnih ulagača,dok u isto vrijeme tržište ima ograničenu ponudu nerizičnih instrumenata.

Ključne riječi: trezorske obveznice, nerizični, procjena vrijednosti, intrinzična vrijednost, trajanje, konveksnost

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EVALUATION OF RESEARCH AND DEVELOPMENT TAX INCENTIVES SCHEME IN CROATIA

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ABSTRACT

According to the European Innovation Scoreboard metrics Croatia belongs to the group of moderate innovators, i.e. a country with below average innovation performance in comparison to the EU average in the period 2009-2010. Government subsidies are frequently introduced to improve countries' innovation performance. Whether existing R&D tax scheme in Croatia produces expected results is the key research question analyzed in the paper. Based on the microeconometric analysis of individual firms' data, we confirm positive effect of the subsidies on expenditures in research and development as well as on product innovation. However, the significant effect on process innovation is not found.

The analysis relied on the data accumulated for the project Evaluation of the Tax Incentives Aimed at Stimulating R&D Projects in the Business Sector, conducted in Croatia during March-May 2011 and financed by the World Bank and Ministry of Science, Education and Sports. Authors gratefully acknowledge helpful comments from two anonymous referees.

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I. INTRODUCTION

Research and development (R&D) and innovation activities are characterized by significant heterogeneousness, with apparent diversities within both categories. This is explained by various types of knowledge that are created and used in innovation process, described by the concept of the learning economy (Lundvall and Johnson, 1994). Dominant presence of these activities within the firms' assets complicates investment activities as the investments' results are not easily predicted. The asymmetric information where the inventor has more appropriate knowledge about a project in relation to the investor causes the undervaluation of innovative projects by investors (Bergman and Friedl, 2008). Second, the cost structure of innovation is specific and relies on sunk costs (Cohen and Klepper, 1996). Finally, the social rate of R&D expenditure returns exceeds the private rate, leading to a socially suboptimal rate of R&D investment (Guellec and van Pottlesberge, 2003). All these issues result in diminishing investments in innovation and R&D within the business sector, thus requiring government initiatives aimed at promoting these investments.

R&D and innovation activities have been recognized as a crucial factor enabling profitability increases at firm level (Schumpeter, 1942) as well as a contributing factor of economic growth (e.g. Romer, 1986, 1990). Policy makers in developed and developing countries have been planning and implementing programmes aimed at enhancing R&D and innovation investments on the firm level. Thus, the goals of tax incentives for R&D are clear: facilitate additional investments into R&D and innovation of business entities, encourage investments and produce positive socio-economic impacts (e.g. increase employment in the investment area). A significant increase in the number of countries using R&D tax incentive schemes has triggered an interest in the evaluation of their effectiveness (e.g. EC, 2008).

R&D tax incentives in their current form were introduced into the Croatian tax system in 2007[1]. Assistance to research and development and innovation projects is managed by the Ministry of Science, Education and Sports (MSES)[2]. The process of the verification was regulated by the Regulation on State Aid for Research and Development Projects[3]. The value of the tax advantage as a state aid for research and development was 21.1 mil EUR in 2009, and at the same time period amounted to 1.6% of total state aid in Croatia. According to the MSES data the number of beneficiaries had been increasing in the period 2007-2009 and amounted to 77 in 2009. This information, although encouraging, is insufficient for assessment of current subsidy scheme effectiveness.

The evaluation of the public policy measures, in particular at the microeconomic level, is relatively scarce in Croatia. The main objective of the paper is to evaluate the result of introduction of R&D tax incentives in Croatia in order to assess whether the policy measures introduced actually achieved the desired effect, i.e. an increase in R&D expenditure. Using individual firm data, and by applying propensity score matching method[4] to estimate the average treatment effect of the

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[1] Act on the Amendments to the Scientific Activity and Higher Education Act (OG, 2007a).

[2] The business entities apply their R&D projects to the MSES according to three categories: fundamental research, industrial research and development research. The positive decision from the MSES is taken into consideration when submitting profit and loss statement to the tax authority, within the annual profit tax payment obligation.

[3] Regulation on State Aid for Research and Development Projects (Official Gazette No. 116/2007 (OG, 2007b).

treated (ATT), we try to confirm three hypotheses. First, that tax incentives increase the number of R&D performers. Second, that tax incentives influence radical product innovation and finally, (third) that tax incentives do not influence process innovation. Therefore the contribution of this paper is twofold. Firstly, it will provide the answer to the question whether the public funds used produced desirable outcome. Secondly, the paper examines the relation between tax incentives and specified types of activities relating to technology use, i.e. innovation products, innovation processes as well as research and development activities.

The paper is organized as follows: we start with a literature review related to R&D tax incentives evaluation and present empirical findings from various countries. Section 3 introduces the dataset and presents the estimation strategy. Section 4 discusses the results and the final section draws concluding remarks.

II. R&D TAX INCENTIVES EVALUATION – EXPERIENCES FROM OTHER COUNTRIES

Two categories of instruments have been implemented within the innovation policy practice. The first category is aimed at increasing private returns on investments oriented towards encouraging intellectual property rights. Second category aims to decrease sunk costs and asymmetric information related to these projects, taking the form of e.g. tax incentives for R&D or R&D government subsidies. Empirical studies about tax incentives impacts on business R&D reveal that those depend on the characteristics of the R&D and innovation activities on the firm level. Main questions within empirical research include the relation between R&D tax incentives and propensity to receive R&D incentives as well as the relation between R&D tax incentives and R&D investments. Empirical studies differentiate the interdependence between tax incentives on the one hand and R&D investments (i.e. innovation input) and innovation activities (i.e. innovation output). This approach has been followed in present paper.

Köhler, Larédo and Rammer (2012) provide systematic overview of the empirical studies of R&D fiscal incentives. They review two groups of studies. The first one consists of those primarily interested in the impact on input additionality, to which the most reviewed studies belong to. This question is addressed in this paper through assessing the effect on R&D expenditures. The second group of studies are interested in output additionality and the authors further separate effects on innovation success (the issue we are dealing in the present paper by assessing the effect on innovation activity indicators) and the effect on productivity.

The main research question is whether existing tax incentives scheme in Croatia leads to more R&D expenditures (input additionality) and/or more innovation activities (output additionality). Experiences from other countries do not provide decisive answer. Comprehensive surveys of regression analysis at various level of aggregation have been provided by David, Hall, and Toole (2000) showing ambiguous results, where one out of three cases report that public R&D funding substitutes private R&D investments.

Evaluation methods can be broadly divided into four categories: performing surveys, creating quasi-natural experiment (Haegeland and Moen, 2007), statistically constructing control groups and structural economic modelling (Lokshin and Mohnen, 2012). Present paper methodology relies on the statistical methods to construct counterfactuals. However, it is

[4] Specific benefits of applying propensity score matching in policy evaluation studies are presented in Bryson, Dorsett and Purdon (2002).

important to notice that the chosen method cannot be directly related to the outcome of the evaluation exercise, as various studies use different methodology and come up with different conclusions. Non-exhaustive list of studies that have found positive effect of public spending on private R&D include following:

- Klette, Moen and Grilliches, (2000) focused on the effect of public R&D efforts on the R&D investments and in four out of five cases found that the subsidy schemes had positive effect on firm performance.
- Lach (2000) investigates the effects of R&D subsidies granted by the Israeli Ministry of Industry and Trade on local manufacturing firms and found evidence that the R&D subsidies have stimulated long-run company-financed R&D expenditures.
- Bloom, Griffith and Van Reenen (2002) examine the impacts of tax incentives on the R&D investment levels (thus primarily focusing on input additionality) for nine OECD countries in the period 1979-1997. By using the dynamic panel data model the authors conclude that tax incentives are effective in increasing R&D intensity in various time periods.
- Busom (2000) applied an econometric selection model on a cross-sectional sample of Spanish manufacturing firms. The author concluded that public funding induced more effort for the majority of firms in the sample, but for one of third the participants, complete crowding-out effects cannot be ruled out.
- Hussinger (2006) estimated parametric two-steps selection model and confirmed that public funding increases firms' R&D expenditure.
- Aerts and Czarnitzki (2004) examined the interdependence between R&D subsidy and R&D expenditure using matching estimator and found R&D subsidies support R&D investment in the Flemish sample which covers the manufacturing sector as well as the specific services sectors (computer services), R&D services as well as business related services.
- Duguet (2003) employs the matching methodology with a large panel of French firms, finding that tax subsidies stimulate private expenditure on R&D.
- Lööf and Heshmati (2005) evaluate the Swedish subsidy policy using matching estimation, and found public funds contribute to an increase in the total R&D efforts in Sweden, but small manufacturing and services firm are only beneficiaries.
- Ozcelik and Taymaz (2008) analyzed Turkish manufacturing industry and found that public R&D support significantly and positively influences private R&D investment. They stated the importance of the use of a combination of knowledge own R&D activities with external knowledge, as a result of technology transfer within the business entities.

Studies that were not able to confirm the positive effect of public spending on private R&D include following:

- Klette and Moen (1998) analysed Norwegian high-tech firms and found subsidies do not considerably stimulate private R&D.
- Wallsten (2000) found that Small Business Innovation Research Program (SBIR) grants crowd out private investment dollar for dollar in the USA. However, the results confirm that for SBIR grants only, the program could still has positive effects, as the recipient firms are able to keep their innovative projects while in the absence of a subsidy business entities might have to abandon them.

Previous non-exhaustive list of studies implies that we cannot a priori assume that the current tax scheme in Croatia will yield positive results, even though both policy makers and business community are in favour of such measures. Thus, empirical evaluation is necessary to reveal the effectiveness of the existing policy measures. The approach and the data used are presented in following section.

III. DATASET AND EMPIRICAL STRATEGY

The analysis in the paper is performed on the level of individual firms. The original database used for the analysis was the Community Innovation Survey (CIS) for the period 2006-2008, as conducted by the Croatian Central Bureau of Statistics (CBS)[5]. These had been amended by the MSES internal data on business entities that have applied for the tax incentives scheme in the period 2008 – 2009. Thus we have detailed information on the enterprises from CIS and information from MSES which of these enterprises have applied for tax incentives. Since CIS includes business entities with ten employees and more, this approach yielded a population of 65 firms. As a result of the comparison between CIS dataset and available data from MSES, 36 business entities out of 65 were included in the analysis.

The main goal is to establish if the examined enterprises had more or are more likely to have increased research and development expenditures. Additionally, even though the period since the introduction of the measure has been relatively short, we want to explore whether the treated enterprises already introduced innovative products or innovative processes.

This may appear as a result of mutual interdependence of activities related to use of knowledge and technology such as innovation activities and research development activities (c.f. Patel, Pavitt (2005: 20-23). Since we are not able to observe the before-after effect, we have opted for the creation of the counterfactual via propensity score matching method[6]. We have, consequently, three outcome variables – R&D expenditures (in two variations – value of expenditures and number of business entities with this type of expenditures), product innovation and process innovation. The treatment variable is participation in the tax incentives scheme.

The key question in policy evaluation is to prove the benefits of specific program under evaluation. The basic concepts are following. If Y0 is the outcome without treatment and Y1 is the outcome with treatment, D is an indicator of the recipient under the treatment (thus equals 1 if under the treatment and zero otherwise), the overall observed outcome is following:

$$Y = DY_1 + (1 - D)Y_0 \tag{1}$$

[5] Community Innovation Survey (CIS) is conducted according to the same methodology in EU Member States. Interested reader should refer to Eurostat website for more information (http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis) on methodology or the results comparable across countries (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database). For the methodology application and specific results for Croatia, one should refer to Croatian Bureau of Statistics (www.dzs.hr).

[6] Due to the fact that we rely on previously developed methodology, detailed description of the propensity score method, its application in the evaluation as well as some methodological concepts utilized in the empirical section (such as average treatment effect of the treated) is not replicated in the paper to save the space. Readers requiring more details on the methodology could find Heckman and Vytlacil (2007a), Heckman and Vytlacil (2007b), Blundell and Costa-Dias (2008) or Gertler et al (2011) extremely helpful.

The treatment effect, which we cannot directly observe and thus must estimate with appropriate method, is:

$$\Delta = Y_1 - Y_0 \tag{2}$$

In evaluation, we would be typically interested in the overall effect of the program (on treated and untreated participant), but we would in particularly be interested in whether the treatment actually produces any results. That is, whether there is a desired effect of specific policy scheme, and whether it is significant. Thus, we are interested in average treatment effect of the treated (ATT), which theoretically is derived for X participants in the program from the following:

$$E(Y_1 1 - Y_1 0 \mid D = 1, X) - \tag{3}$$

The best approach in policy evaluation is to have the access to the random sample of participants in program that either received treatment or not. However, such cases are relatively rare in economic policy evaluation. Instead, we have to attempt to recreate such case in order to assess the policy effect. When using matching procedure, we first assume that we have data on individuals that are under treatment and those that are not (in our case we have the data on enterprises applying for tax incentives and other enterprises that participated in CIS). Another assumption is that we have the data on a set of variables X whose distribution is not affected by the participation in tax incentives scheme decision (D). In our case, we have the variables resulting from the CIS survey. In that case, matching estimators match up the treated enterprises with observably (according to the X set of variables) similar untreated enterprises. In cases when there is a large set of X variables, there could be present various points of similarity and dissimilarity.

To reduce this to a single measure, propensity scores - $\Pr(D = 1 \mid X) -$ - can be assessed following Rosenbaum and Rubin (1983) theorem.

The propensity score matching algorithm entails estimation of probabilistic or logistic function of the treatment variable, resulting from the specific observable characteristics of the program participants (X variables). In our case, the goal is to determine the factors behind the probability to receive tax incentives. Since our population sample, which actually received tax incentives, is relatively small, we have included a larger set of independent variables in our specification in order to be able to detect the counterfactuals with similar characteristics. Furthermore, Heckman, Ichimura, and Todd (1997) warn against omitting important variables in the procedure, since this can seriously increase bias in resulting estimates. Following their reasoning, variables that influence both participation decision and the outcome variable should be included in the probit estimates. However, regarding the tax incentives scheme, little can be argued in relation to the participation decision of the enterprises. Since the cost of participation is negligible, the participation decision is probably related to the information of the programme availability.

The choice of independent variables in our probit equation is guided by the data source (i.e. CIS), but also by the notion that the choice of mutually uncorrelated independent variables must reflect the potential to receive the tax credits. Since the eligibility criteria are relatively wide, this implies that we have to rely on the previous research on the important characteristics of the innovation process development in Croatia, as well as studies in other countries. Having all these considerations in mind, we have finally chosen the following set of independent variables:

- The enterprise size variables. Based on the number of employees, we have created three dummy variables that represent the size of the enterprise. The small enterprises (with the number of employees below 49); medium size enterprises (between 50 and 249 employed), large enterprises (with more than 250 employees). The reason behind this

segmentation is that the innovation performance is not evenly spread throughout the economy (see also Lokshin and Mohnen, 2012; Haegeland and Moen, 2007). Furthermore, larger enterprises might be more inclined to participate in the tax credit scheme, since they are more likely to have developed resources within the firm to respond more quickly to new policy measures.

- Employment change variable, which equals the change in employees between 2006 and 2008, based on the CIS data. The inclusion of this variable was guided by the descriptive statistics analysis of the innovative enterprises (Švaljek, 2012), which indicated that these are more likely to increase their employment.
- Participation on the international market, which is a dummy variable that takes value 1 if the enterprise sells goods and/or services on EU/EFTA/EU candidate countries or other countries markets[7]. The inclusion of this variable is related to the concept that enterprises oriented towards small domestic markets, such as Croatian, are less likely to pursue innovatwion activities and consequently seek government support for these activities.
- A dummy variable if the enterprise belongs to an enterprise group[8]. The motivation for the inclusion of this variable is related to the assumption that there might be some prior experience with the tax credit scheme within the group, which consequently acts as a positive incentive for the enterprise in question to participate in this specific economic policy measure.
- A set of innovation cooperation variables, also included as dummy variables in the specification. The innovation cooperation with other firms and/or specialised institutions might also have beneficial influence on increase of informal cooperation such as spreading information about the tax incentives scheme. Although this assumption would require additional testing.

CIS contains a large number of non-responses to specific questions, which leads to a large number of missing values, both in case of dependent variables and independent variables. Thus, although the number of CIS respondents is more than 3000, the final sample size used in the empirical section is reduced to 523. This sample is the basis for the analysis presented in following section.

IV. ESTIMATION RESULTS AND DISCCUSSION

The estimation strategy relies on propensity score method, which in its first step requires identification of the probabilities to receive tax incentive. The left hand side of the estimated equation is thus the dummy variable of whether the enterprise received tax incentive, and the right hand side variables are all the variables that appear in Table 1. The results of the estimated probit model are presented in the following table.

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[7] We have to clarify that we cannot directly measure firm's participation on the international market, but have to rely on the participant's answer to the following question in the CIS "In which geographic markets did your enterprise sell goods and/or services during the years 2006 to 2008?".

[8] We have to clarify that we cannot directly measure the belonging to the group of enterprises, but rather rely on the participant's answer to the following question in the CIS "In 2008, was your enterprise a part of an enterprise group?".

TABLE 1 – PROBABILITY TO RECEIVE TAX INCENTIVES

Variable	*Coefficient (standard error)*	*p-value*
Constant	-2.65*** (0.58)	0.00
Small size enterprises	0.29 (0.31)	0.34
Large enterprises	0.42 (0.29)	0.16
Employment growth	-0.12 (0.36)	0.73
Participation in international markets	0.38 (0.28)	0.18
Part of a group	0.61** (0.26)	0.02
Cooperation variables, cooperation with:		
National suppliers	0.48* (0.26)	0.07
National clients or customers	0.07 (0.27)	0.80
National competitors	-0.91*** (0.35)	0.01
National consultants, commercial labs, etc.	0.33 (0.26)	0.21
EU/EFTA/EU-CC suppliers	0.16 (0.26)	0.56
EU/EFTA/EU-CC clients or customers	-0.09 (0.31)	0.77
EU/EFTA/EU-CC competitors	0.03 (0.37)	0.94
EU/EFTA/EU-CC consultants, labs, etc.	-0.56 (0.39)	0.16
US suppliers	0.44 (0.36)	0.21
US clients or customers	0.16 (0.53)	0.76
US competitors or other firms	0.96* (0.55)	0.08
Diagnostics		
Number of observations	N=523	
Log likelihood	=-68.75	
Pseudo R^2	=0.19	
LR $Chi^2(16)$	=32.27*** (p-value=0.01)	

Source: Authors' estimates.

*Notes: Coefficients marked *** are significant at level of 1%, ** at level of 5%, and * at level of 10%. Restricted to common support. The balancing property of the propensity score procedure is satisfied.*

[9] We emphasize that other specifications have also been estimated. For example, we have specified aggregated variables for the types of cooperation. However, these specifications did not yield satisfactory results in terms of the desirable diagnostic properties of the estimates.

All the variables are jointly significant and the model has obtained satisfactory pseudo R^2. However, when it comes to individual variables, not many have been found significant. Since this issue has not been previously analyzed in Croatia, we briefly summarize the main results[9]. It seems that the probability of receiving a tax incentive is significantly related only to being part of a group of enterprises, having cooperation with national suppliers (positive predictor), having cooperation with national competitors (negative predictor), and having cooperation with US competitors. In order to substantiate these findings, a larger dataset with more identified cases of tax scheme participation would be required. For the purposes of identifying propensity scores, we consider this model satisfactory.

To further elaborate the relevance of our variables selection, we have performed matching covariates balancing property test (see Table A1 in the Appendix). The purpose of the test is to identify the differences between the treated and control group before and after the matching. Table A1 shows that reduction of the bias in the difference of the mean between target and control group is large as a result of the performed matching. Based on the performed t-test, we cannot reject the null-hypothesis that the mean differences between treated and control groups are equal for the selected covariates. Based on these tests, the choice of the covariates has been confirmed.

Relying on the available propensity scores, we have estimated the average treatment effect of the treated (ATT) for four outcome variables – research and development expenditures values, research and development expenditures (as dummy variable), introduction of new or significantly improved goods on the market (as dummy variable), introduction of a new or significantly improved method of production on the market (as dummy variable). Thus, we want to assess whether the introduced policy measure had significant effect on the R&D expenditures and on the innovation activity. Having in mind all the data restrictions, we have used several frequently used in the literature algorithms – nearest neighbour, calliper matching and kernel matching (Cochran and Rubin, 1973; Heckman, Ichimura and Todd, 1997).

The nearest neighbour algorithm iteratively finds pair of subjects with the shortest distance. This might not always lead to good matching results. The improvement can be achieved by caliper matching, which finds all the matched within a specified tolerance. We specify the standard radius frequently used in analysis (0.005). Finally, we also use Epanechnikov kernel function[10]. In all cases, the standard errors presented here were obtained by a bootstrapping procedure with 1000 replications.

Since we have no prior estimates to compare our results, and there is a priori no best matching approach, we present all the results to gain more insight from the empirical exercise.

[10] This has been obtained by following psmatch2 procedure in STATA 11.

TABLE 2–ATT ON THE SELECTED OUTCOME VARIABLES

	Outcome variable			
	Expenditures on R&D - value	***Exp. on R&D***	***Product innovation***	***Process innovation***
	Nearest neighbor (20 treated, 19 control)			
ATT	3817880	0.10	0.25	0.30
Standard error	2700000	0.126	0.175	0.188
	Caliper matching (17 treated, 174 control)			
ATT	1650000	0.18**	0.31**	0.20
Standard error	2060000	0.058	0.218	0.154
	Kernel matching			
ATT	37902655	0.14**	0.23**	0.17
Standard error	24100000	0.062	0.109	0.133

Source: Authors' estimates.
*Notes: bootstrapped standard (1000 replications) errors in parentheses. ATTs marked ** are significant at level 5%.*

The results presented in Table 2 show that we were able to identify positive effect of tax incentives scheme for research and development in Croatia on the product innovation and on the expenditures on research and development. Thus, it seems that this policy measure obtains desirable results. Since the expenditures on research and development are on average low in Croatia comparative to EU average, as well as the innovation activity, it seems important that current policy measures are able to enhance this important channel for growth prospects creation.

We were not able to establish the significant relationship between the participation in the tax incentive scheme and the amount of expenditures on research and development. However, further research, comprising of the amount of tax incentive received in the individual enterprise might give more insight into this link. Based on the additionality principle, we would expect that higher tax credits should lead to more R&D expenditures.

The encouraging results of the empirical exercise is that the difference in the estimated effect is not extremely different across matching methods, even though we had small number of identified tax credit beneficiaries. Presumably precisely due to the small sample, the nearest neighbour matching was not able to significantly identify the average treatment effect of the treated. However, also encouraging is that both calliper and kernel matching identified as significant the same ATTs and of approximately the same magnitude.

In order to address the sensitivity of presented results, we have relied on the Rosenbaum bounds testing procedure, which analyze the degree to which unobserved variables affect the

treatment effects (Rubin, 1980). If we are having, for example, a significant positive bias, it may lead to an overestimation of the true treatment effect and therefore, reported test-statistic should be adjusted downwards. In case of initial values, that is when Γ=1 there is no hidden bias, while higher values of Γ indicates more influence of unobserved factors.

The results of this analysis are presented in Table A2 in the Appendix. Here, we will briefly summarize the main implications for the treatment effects found to be significant – expenditures on R&D and product innovation. In the case of first outcome variable, under the assumption of no hidden bias, the treatment effect is significant. Since the interpretation of the Q_mh+ statistics is that it adjusts the MH statistics downwards for positive (unobserved) selection, it would seem that those most likely to participate in the tax credit scheme would be more likely to have expenditures on R&D without tax incentives. Since we are having in our case positive estimated treatment effect and if we would look in more details on the bounds under the assumption that we have overestimated the treatment effect (Q_mh+), we would find that it becomes insignificant at 10 % level already for Γ=1.4. This implies that the possible unobserved variables could significantly affect our findings of the positive effect of the current tax credit scheme.

In case of product innovation, the general findings are similar. We have also identified positive treatment effect (which is desirable in our case), and also are more interested in the issue of overestimating our results. The MH statistics follows the same dynamics as in previous case, but here the Q_mh+ becomes insignificant (10 % level) at higher Γ=2.05. So it seems that our results that the tax credit scheme achieves significant positive effects is more robust to possible unconsidered covariates for the product innovation that the R&D expenditures.

The sensitivity analysis reveals that our results should be taken with caution. Since this is the first evaluation of tax incentive schemes with propensity score matching method in Croatia, we believe that this requires further research on the subject.

V. CONCLUSION

The main goal of the paper was to evaluate the effectiveness of the tax incentives for R&D in Croatia. We have confirmed that tax incentives have increased the number of firms having R&D expenditures, although not necessary the value of expenditures itself. These results in Croatia for the period under analysis are expected. A plausible explanation is the fact that innovation performances differ across countries as a result of interaction of innovation performance and different stages of economic development models applied within the national economies. Due to the fact that acquisition of foreign technologies by local firms (via new machinery and equipment) is dominant mode of technological capability building, the tax incentives in the field of R&D, i.e. fostering internal innovation capability, may generate positive results within a national economy.

Two additional hypotheses are also confirmed. First, the results confirm our initial assumption that it is highly relevant in case of transition and developing economies to consider not only the innovation activity in general, but to distinguish between product and process innovation. Furthermore, in case of Croatia, which is a relatively small market, these differences might be even more pronounced. We have been able to confirm that current tax incentives scheme has positive significant effect on product innovation, but in case of process innovation this effect is statistically not significant.

Finally, we speculate that the explanation for results lie in the nature of process innovation and possible foreign ownership of the firms involved in these activities.

Before offering more reliable conclusions additional empirical research is required. In Croatia the analyses of the tax incentive scheme for research and development in the near future should include the structure of research and development expenditures of the beneficiaries as well as more comprehensive dataset of the tax beneficiaries for the longer time period. Finally, due to the fact that the analyzed companies are the propulsive segment of the Croatian economy, an interesting topic for further research would be the analyses of human resources (especially research and development staff) and their linkage to the tax incentive scheme.

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APPENDIX

TABLE A1 – COVARIATES BALANCING PROPERTIES (KERNEL MATCHING)

Variable	*% reduction in bias*	*p-values*
Small size enterprises	47.0	0.776
Large enterprises	46.9	0.472
Employment growth	65.8	0.801
Participation in international markets	54.4	0.787
Part of a group	73.2	0.541
National suppliers	77.9	0.819
National clients or customers	50.1	0.862
National competitors	78.3	0.731
National consultants, commercial labs, etc.	-5.1	0.843
EU/EFTA/EU-CC suppliers	95.7	0.972
EU/EFTA/EU-CC clients or customers	40.7	0.828
EU/EFTA/EU-CC competitors	64.5	0.840
EU/EFTA/EU-CC consultants, labs, etc.	-109.3	0.897
US suppliers	93.4	0.933
US clients or customers	47.0	0.731
US competitors or other firms	55.7	0.595

Source: Authors' estimates.

TABLE A2 – MANTEL-HAENSZEL* BOUNDS FOR OUTCOME VARIABLES

Outcome variable	Test statistics	Gamma Γ			
		1	1.5	2	2.5
Expenditures on R&D-value*	t-hat+	2700000	-503427	-2100000	-2900000
	sig+	0.227	0.515	0.723	0.849
	t-hat-	2700000	9200000	12000000	17000000
	sig-	0.227	0.059	0.015	0.003
Expenditures on R&D	Q_mh+	1.606	1.209	0.956	0.773
	p_mh+	0.054	0.113	0.169	0.219
	Q_mh-	1.606	2.069	2.441	2.761
	p_mh-	0.054	0.019	0.007	0.003
Product (good) innovation	Q_mh+	2.561	1.830	1.353	1.002
	p_mh+	0.005	0.034	0.088	0.158
	Q_mh-	2.561	3.390	4.051	4.613
	p_mh-	0.005	0.000	0.000	0.000
Process innovation	Q_mh+	1.333	0.564	0.033	-0.197
	p_mh+	0.091	0.286	0.487	0.578
	Q_mh-	1.333	2.153	2.799	3.300
	p_mh-	0.091	0.016	0.003	0.000

Source: Authors' estimates

Notes: * In case of expenditures value, which is not a discrete variable, Rosenbaum bounds are used. t-hat+ is upper bound Hodges-Lehmann point estimate, sig+ is upper bound significance level (for "-" the analogy applies). Q_mh+ is MH statistics under the overestimation of treatment effect assumption, p_mh+ is the corresponding p-value (for "-" the analogy applies). Gamma represents odds of differential assignment due to unobserved factors. We calibrate the MH bound test for different values of Γ between 1 and 3 with an increment of 0.05 but only a selection is presented here. For the Rosenbaum test, Γ values are the same, but the increment is 0.1. More detailed results are available from the authors upon request.

Zoran Aralica, Valerija Botrić

EVALUACIJA SHEME POREZNIH POTICAJA ZA ISTRAŽIVANJA I RAZVOJ U HRVATSKOJ[11]

SAŽETAK

Sudeći po mjerenjima Europske ljestvice uspjeha u inoviranju Hrvatska pripada grupi umjerenih inovatora, odnosno zemljama u kojima je inoviranje ispod prosjeka u usporedbi s prosjekom u EU u periodu 2009-2010. Često se uvode vladini poticaji kako bi se popravila razina inovacija u pojedinoj zemlji. Ključno pitanje ovog rada je donosi li shema poreznih poticaja za istraživanje i razvoj u Hrvatskoj očekivane rezultate. Na osnovu mikroekonometrijske analize podataka pojedinih poduzeća, potvrdili smo pozitivni učinak poticaja na potrošnju za istraživanja i razvoj te za inovacije proizvoda. Ipak, nije uočen značajan učinak u inovaciji procesa.

Ključne riječi: porezni poticaji za istraživanja i razvoj, evaluacija, Hrvatska, sličnost u vjerojatnosti sudjelovanja u mjerama

11 Analiza se bazira na podacima prikupljenima za projekt Evaluacija poreznih poticaja usmjerenih na stimulaciju projekata istraživanja i razvoja u poslovnom sektoru, koja je u Hrvatskoj provedena od ožujka do svibnja 2011 i koja je financirana sredstvima Svjetske banke i Ministarstva znanosti, obrazovanja i sporta. 2011. Autori se također zahvaljuju vrijednim komentarima dvaju anonimnih sudaca.

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COMPARING THE BANK FAILURE PREDICTION PERFORMANCE OF NEURAL NETWORKS AND SUPPORT VECTOR MACHINES: THE TURKISH CASE

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ABSTRACT

Experience from the banking crises during the past two decades suggest that advanced prediction models are needed for helping prevent bank failures. This paper compares the ability of artificial neural networks and support vector machines in predicting bank failures. Although artificial neural networks have widely been applied complex problems in business, the literature utilizing support vector machines is relatively narrow and their capability for predicting bank failures is not very familiar. In this paper, these two intelligent techniques are applied to a dataset of Turkish commercial banks. Empirical findings show that although the prediction performance of the two models can be considered as satisfactory, neural networks show slightly better predictive ability than support vector machines. In addition, different types of error from each model also indicate that neural network models are better predictors.

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I. INTRODUCTION

Banking is an activity that influences all the other activities and the economy as a whole. The risk of a banking crisis suggests an important need of identifying banks with potential problems even before they face severe liquidity or solvency crises. Many reasons have been denoted for bank failures including poor management practices, expanded risk-taking, inadequate accounting standards, interest rate volatility, pervasive internal control weaknesses, and increased competition from nondepository institutions (Miletić, 2008; Alam, Booth, Thordason, 2000). The last crisis has demonstrated that banks play very important role in the economy. In contrast to past crises, the current crisis began in developed countries and their economies have been influenced adversely. Unemployment has increased considerably, investments and consumption have decreased and all the governments are looking at possible ways to exit the crisis. In such cases, early warning systems help to monitor banks and prevent similar problems. Thus, the development of early warning systems is very important for regulators and policymakers. If successful, the governments could take actions to protect their markets from financial crisis, by avoiding crises in the banking sector and poor banking supervision (Ioannidis, Pasiouras, Zopounidis, 2010; Yim and Mitchell, 2004).

In this paper, Turkish banking failures investigated. The Turkish economy is important to the world since Turkey has the world's 15th largest GDP-PPP and 17th largest nominal GDP. Nowadays, the Turkish banking sector is among the strongest in Central Asia, the Middle East, and East Europe. In 2010, five Turkish banks were listed in the Forbes Global 2000 which is an annual ranking of the top 2000 public companies in the world. Eichengreen (2002) captures attention to threats coming from Turkey and Argentina. He also argues that the problems of these countries have not received sufficient attention and they must be addressed to safeguard global financial stability. Hence, we have selected Turkey as the application domain and the proposed models for failure prediction are tested for the Turkish banking sector.

Turkey has a larger number of financial crises than many of the countries in the world. The Turkish banking sector was severely tested in the 1994 financial crisis and was recovered rapidly by the Turkish government. However, the Asian crises together with the two ruinous earthquakes had a negative impact on the Turkish economy and the banking sector at the end of 1990s. A November 2000 crisis led to a significant erosion of the capital base of the banking sector and exposed further the fragility of the system. The political uncertainties, the loss of credibility of the exchange rate regime, and the abolition of the exchange rate peg in February 2001 further hit the banking sector. During the November 2000 and February 2001 crises, some banks failed financially.

Consequently, some banks ended their operations and some banks were taken over by the Savings Deposit Insurance Fund. The last crises affected 25 percent of the banks in Turkey and the total cost of them was estimated to be 50 billion dollars (Boyacioglu, Kara, Baykan, 2009; Ozkan-Gunay and Ozkan, 2007).

The study of bank failures is interesting because if examiners can detect problems early, regulatory actions can be taken either to minimize the cost to the governments or to prevent a bank from failing. It is therefore desirable to explore new prediction models and to provide early warnings to regulatory agencies (Thomson, 1991; Tam and Kiang, 1992). Since 1990s, artificial neural networks (ANNs) have widely been used to solve complex problems and have proven quite successful in many business applications. They can be an efficient tool to reveal critical issues in business decisions (Wu and Wang, 2000). Recently, support vector machines (SVMs) have applied complex problems in business. The SVMs have been used to financial applications such as bankruptcy prediction, credit ratings, and the detection of insurance claim fraud (Kumar and

Ravi, 2007). However, especially in the banking failure, the literature exploiting this approach is exiguous.

The purpose of this paper is to compare the prediction performances of ANNs and SVMs for predicting Turkish banking failures. For this purpose, we implemented ANOVA test on 36 financial ratios. 22 out of 36 financial ratios were eliminated by the ANOVA and the rest 14 financial ratios were thought to be more useful in making a difference between the failed and healthy banks. Then, the data set was divided into training and validation sets. The training set and the validation set were created using the banks for one year prior to failure and two years prior to failure respectively. Both the two sets consisted of randomly chosen 34 banks in which 17 banks were failed and 17 banks were healthy. In addition, the output variable of two models is the status of banks failed or healthy. Finally, we applied different ANN models and SVMs to bank failure problem in the Turkish case and presented a comparison of the prediction performance of these models.

The remainder of this paper is organized as follows: Section 2 positions the survey within the existing literature on bankruptcy forecasting studies. Section 3 briefly reviews some prediction models used in this paper. Section 4 discusses the research design including sampling and variables. Experimental results are presented in Section 5. Discussions are presented in Section 6. Finally, Section 7 summarizes our conclusions.

II. RELATED STUDIES

In literature, ANNs and SVMs have been applied to solve bankruptcy problems. Both of these models are categorized into artificial intelligent models and provide examiners with more precise predictions. However, the literature on comparing these models for bank failure problems is relatively narrow in the Turkish case.

Since the early 1990's, much of the research on ANNs have focused on finance problems, with special attention to bankruptcy prediction (Du Jardin, 2010; Paliwal and Kumar, 2009). Odom and Sharda (1990) are the first researchers who used ANNs to predict the failures of firms. They developed an ANN model for bankruptcy prediction and tested using financial data from various firms. The same set of data was analyzed using multivariate discriminant analysis (MDA). Results showed that ANNs could be applicable to this problem. Tam (1991) employed backpropagation neural network (BPNN) for bank bankruptcy prediction. He showed that ANNs offered better predictive accuracy than discriminant analysis (DA), factor-logistic, K-nearest neighbour (kNN), and ID3. Tam and Kiang (1992) compared the predictive accuracy performance of linear discriminant analysis (LDA), logistic regression (LR), kNN, ID3, and two ANN models on bank failure problems. Their results demonstrated that ANNs outperformed other models for one year prior training sample, whereas for two years prior training sample DA outperformed others. However, ANNs outperformed others in both the one year prior and the two years prior validation samples. Coats and Fant (1993) proposed an ANN model as an alternative method of the same ratios used by MDA. They showed ANN model outperformed MDA. Bell (1997) compared LR and ANNs in predicting bank failures. He concluded ANNs and LR performed equally well. Swicegood and Clark (2001) compared DA, ANNs, and human judgment in predicting bank failures. They found ANNs outperformed other two models. In addition, research efforts have been directed to the integration of ANN models with other soft computing tools such as genetic algorithm (Tsakonas, Dounias, Doumpos, Zopounidis, 2006), fuzzy sets (Tung, Queka, Cheng, 2004), and rough sets (Zaini, Shamsuddin, Jaaman, 2008). For further literature, readers may refer to Salchenberger, Cinar and Lash (1992), Zhang, Hu, Patuwo and Indro (1999), Lee, Booth and Alam (2005), Chen,

Marshall, Zhang and Ganesh (2006), and Kim (2011).

Recently, SVMs have gained popularity due to many attractive features and generalization performance on a wide range of problems. SVMs became a focus of interest for failure prediction and the applications of SVMs into financial failure prediction began in 2005. However, especially in the banking failure, the literature exploiting this approach is relatively narrow. For example, Boyacioglu, Kara and Baykan (2009) compared ANNs, SVMs, k-means cluster analysis, and LR to the bank failure prediction problem. They found that SVMs outperformed the majority of other approaches.

Min and Lee (2005) proposed SVMs for bankruptcy prediction. They compared the SVMs with MDA, logit, and ANNs. They concluded that the SVMs outperformed other models for the training and validation data. Wu, Tzeng, Goo and Fang (2007) suggested a model which was a genetic algorithm-based SVMs to predict bankruptcy and compared this model with that of DA, logit, probit, and ANNs. Their findings showed that the genetic algorithm-based SVMs model performed the best predictive accuracy. Chen (2011) compared some models using data collected from 200 Taiwan firms. He revealed that SVMs provided a good balance of high-accuracy short and long-term performance predictions for healthy and failed firms. Feki, Ishak and Feki (2012) classified the banks using the Bayesian and SVMs models. They found that SVMs were shown to be superior to Gaussian Bayes models. Yeh, Chi and Hsu (2010) proposed a prediction of business failure model to increase accuracy with the integration of rough set theory and SVMs. Their results showed that rough set theory with SVMs model provided better classification results than rough set theory with BPNN model.

III. PREDICTION MODELS FOR BANK FAILURES

Real-world financial data and its underlying economic processes are often nonlinear in nature. The rapid developments of computing power have allowed nonlinear models to become applicable to modeling and forecasting a host of financial relationships. ANNs are very suitable to study problems in finance with poorly defined system models and presence of nonlinear effects. They are parallelized computing systems that have the ability to learn from examples and to adapt to new conditions. In other words, ANNs do not ignore past information; instead past information's importance will be steamed up step by step as new examples are fed into the network (Aminian, Suarez, Aminian, Walz, 2006; Boyacioglu, Kara, Baykan, 2009; Tam and Kiang, 1992). They contain mathematical and algorithmic elements that mimic the biological neural networks of the human nervous system. ANNs contains two working phases, the phase of learning and that of recall. Like the synapses in the brain, the weights determine the power of the signals between the layers. As the network learning, the weights are adjusted until the error is at the minimum. The recall phase is realized by one pass using the weight obtained in the learning phase (Demyanyk and Hasan, 2010; Kauko, 2003; Boyacioglu, Kara, Baykan, 2009). There are several neural network architectures to perform various categories of tasks. In this paper, Multilayer Perceptron (MLP) and Radial Basis Function (RBF) were utilized to predict bank failures.

The MLP network was developed by Rumelhart, Hinton and Williams (1986). This network is based on a supervised learning process and a feedforward network architecture. It contains three types of layers: the input layer, one or more hidden layers, and the output layer. Any neuron of a layer is connected with another neuron of the following layer.

The neurons in the input layer receive the signals from the outside and deliver them for the neurons in the next layer. During this process, the neurons of the output layer send the information of the hidden layer(s) neurons for the outside (Kauko, 2003; Alves Portela Santos, Carneiro Affonso da Costa, dos Santos **Coelho, 2007).** Statistically, each input neuron represents one of the independent variables, whilst the output neuron(s) represent dependent variable(s) (Palmer, Montano, Sese, 2006). The training process of the MLP is usually realized with the backpropagation (BP) algorithm. The BP algorithm is based on the error correction learning rule (Alves Portela Santos, Carneiro Affonso da Costa, dos Santos **Coelho, 2007).** The error is the actual output less the output calculated by the network (n_k). In a two-layer network, the output is

$$n_k = \sum_j \left[w_{kj} \tau \left(\sum_i w_{ji} x_i \right) + w_{jC} \right] \tag{1}$$

w_{kj} = the weights between the hidden layer (j) and the output layer (k)

$\tau(.)$ = the nonlinear activation function of the neuron

w_{ji} = the weights between the input layer (i) and the hidden layer (j)

x_i = the input vector

w_{jC} = a bias-term, where C is a constant.

The RBF network has the same structure of layers as the MLP network, but a quite different information process in the hidden layer which increases the speed of solution. Although this network has a feedforward structure and consists of a single hidden layer and an output layer, it differs from the MLP network because it does not have weights in its hidden layer, but instead it has centers. The basic feature of this network is that all neurons in the hidden layer have locally tuned response characteristics. These neurons are fully interconnected to a number of linear neurons in the output layer (Moshiri, Cameron, Scuse, 1999; Charalambous, Charitou, Kaourou, 2000). According to Charalambous, Charitou and Kaourou (2000), the purpose of RBF networks is to transform a non-linearly separable classification problem into a linearly separable one. Once an input vector is presented to the network, the hidden unit outputs are obtained by calculating the closeness of the input vector X to the weight vector (center) of each one of the hidden units. The function used to calculate the closeness is as follows:

$$\varphi(r_i) = \exp\left[-\frac{r_i^2}{2\sigma_i^2} \right] \tag{2}$$

$r_i = \|X - w_i\|$: the distance between X and w_i

w_i : weight vector associated with neuron i in the hidden layer

σ_i^2 : variance associated with neuron i

X : input vector.

In order to reach the final output of the network, we have to multiply the output vector of the hidden layer by the corresponding weight vector associated with the neuron in the output layer. This weight vector is computed using the pseudoinverse method, and the given target values. Since the output neuron is linear, the actual output of the network is:

$$y = v_0 + \sum_{i=1}^{H} v_i^* \phi(r_i) \tag{3}$$

where *H* is the number of neurons in the hidden layer.

SVMs which introduced by Vapnik (1995) are based on the structural risk minimization principle from computational learning theory and seek to minimise an upper bound of the generalization error rather than minimise the training error (Fethi and Pasiouras, 2010). The mapping function in SVMs can be either a classification function or a regression function. For classification, nonlinear kernel functions are used to transform the input data to a high dimensional feature space in which the input data become more separable compared to the original input space. Then, two parallel hyperplanes are constructed on each side of the hyperplane that separates the data by maximizing the distance between the two parallel hyperplanes. An assumption is made that the larger the margin or distance between these parallel hyperplanes the lower the generalization error of the classifier will be. The training points that are closest to the maximum margin hyperplane are called support vectors (Olson, Delen, Meng, 2012; Fethi and Pasiouras, 2010).

Let us define labeled training examples $[x_i, y_i]$, consisting of an input vector $x_i \in \Re^n$, and a class value $y_i \in -1,1 \;\; i = 1,...,I$. For the linearly separable case, the decision rules defined by an optimal hyperplane separating the binary decision classes are given in the following equation in terms of the support vectors (Lin, Yeh, Lee, 2011),

$$Y = sign\left\{\sum_{i=1}^{N} \alpha_i y_i (x.x_i) + b\right\} \tag{4}$$

where Y is the outcome, y_i is the class value of the training example x_i and represents the inner product. The vector corresponds to an input and the vectors x_i, $i = 1,..., N$, are the support vectors. In Eq. (4), b and α_i are parameters that determine the hyperplane.

As to the nonlinear separable data, it can be mapped into a high dimensional feature space with a nonlinear mapping in which we can search the optimal hyperplane. Then the problem is converted into searching the nonnegative Lagrange multipliers α_i by solving the following optimization problem,

Maximize
$$\theta(\alpha) = \sum_{i=1}^{n} \alpha_i - \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_i \alpha_j y_i y_j K(x_i x_j) \tag{5}$$

Subject to
$$\sum_{i=1}^{n} \alpha_i y_i = 0$$
$$0 \le \alpha_i \le C, \; i = 1,2,...,n$$

where C is a penalty parameter on the training error, which is now the upper bound on α_i is determined by the user. Hence, the final classification function is given as follows:

$$Y = sign\left\{\sum_{i=1}^{N} \alpha_i y_i K(x, x_i) + b\right\} \quad (6)$$

The function K is defined as the kernel function for generating the inner products to construct machines with different types of nonlinear decision surfaces in the input space.

Kernels have the advantage of operating in the input space, where the solution of the classification problem is a weighted sum of kernel functions evaluated at the support vectors. In this study, we conducted the experiments with four different kernels such as linear, radial basis, sigmoid, polynomial, as follows (Dash, Patra, Tripathy, 2012):

- A linear machine with kernel function

$$K(x_i, x_j) = x_i^T x_j$$

- A radial basis machine with kernel function

$$K(x_i, x_j) = \exp(-\gamma \left\| x_i - x_j \right\|^2) \quad \gamma > 0$$

- A sigmoid machine with kernel function

$$K(x_i, x_j) = \tanh(\gamma x_i^T x_j + r)$$

- A polynomial machine with kernel function

$$K(x_i, x_j) = (\gamma x_i^T x_j + r)^d, \ \gamma > 0$$

where d is the degree of the polynomial kernel.

Linear kernel is a linear classifier and it should be used as a test of the nonlinearity in the training set, as well as a reference for the eventual classification improvement obtained with nonlinear kernels. The polynomial kernel is an efficient method for modeling nonlinear relationships. Radial basis kernel is one of the widely used kernels and usually in the Gaussian form. Finally, sigmoid kernel is related to neural networks. Figure 1 shows partitioning of any dataset with a linear kernel and with a degree two polynomial kernel (Ivanciuc, 2007).

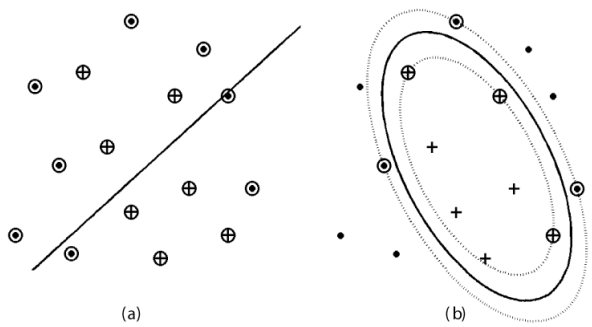

FIGURE 1. (A) LINEAR KERNEL, (B) POLYNOMIAL KERNEL WITH DEGREE 2 .

Source: Ivanciuc, 2007

IV. DESCRIPTION OF THE DATA AND VARIABLE SELECTION

The data employed in this paper were collected from The Banks Association of Turkey web site (http://www.tbb.org.tr/eng/default.aspx). The sample consists of a total of 34 Turkish commercial banks, 17 of which failed the periods 1994-2001 and contains 36 ratios available for those types of banks. Alam, Booth and Thordason (2000) indicate that it may be useful to use different time periods before bankruptcy, e.g. one year, two years, or more, before actual bankruptcy occurs.

Hence, the data sample consists of Turkish commercial banks data one year ($t-1$) and two years ($t-2$) prior to failure. 34 banks (17 failed and 17 healthy) were selected as the training set in the year $t-1$. Similarly, 34 banks (17 failed and 17 healthy) were selected in the year $t-2$ as the validation set to validate the prediction performance of each model. Hence, our comparison is based on a validation set with an equal proportion of failed and healthy banks.

In the present study, financial ratios of failed banks changed as to the date of failure. For instance, for the banks failed in 1997, $t-1$ and $t-2$ are 1996 and 1995 respectively. For the banks failed in 2001, $t-1$ and $t-2$ are 2000 and 1999 respectively. Because of most of the failures occurred between the period of 1998-2001, the year $t-1$ and $t-2$ are considered as 2000 and 1999 respectively for the healthy banks. The original classification of the failed and healthy banks is made as to the date of July 2001. Table A.1 of Appendix presents failed banks, healthy banks, and date of failure.

Firstly, we implemented ANOVA test to the 36 ratios of year $t-1$ and determined 14 ratios as the early warning indicators which have the discriminating ability for failed and healthy banks in the one year advance. Therefore, these 14 ratios can be described as early warning ratios (EWRs). Table 1 presents means and standard deviations of the ratios for the failed and healthy banks and significance tests for the equality of group means for each ratio. F statistics and their observed significance levels are shown in the last two columns. The significant level is small (<5%) for the EWRs. Hence, the EWRs are thought to be more useful in making a difference between the failed and healthy banks. In other words, they may be more suitable for predicting bank failures. In Table 1, we also calculated Wilk's lambda (λ) which is the ratio of the within groups sum of squares to the total sum of squares. λ takes the value between 0 and 1. $\lambda = 1$ means all observed group means equal whereas $\lambda = 0$ means within groups variability is small compared to the total variability (Canbas, Cabuk and Kilic, 2005). As can be seen in Table 1, the groups' means of the EWRs are different for failed and healthy banks.

TABLE 1. TEST EQUALITY OF GROUP MEANS FOR THE FINANCIAL RATIOS

Ratios	*Failed*		*Healthy*		*Test statistics*		
	Mean	SD	Mean	SD	λ	F	Sig.
Interest Expenses/Average Non-Profitable Assets	0.30	0.15	0.15	0.05	0.6666	15.989	0.000
Interest Expenses/Average Profitable Assets	0.47	0.33	0.17	0.04	0.6941	14.107	0.001
Interest Income/Interest Expenses	1.44	0.45	2.10	0.65	0.7278	11.966	0.002
(Shareholders' Equity+T.Income)/(Deposits+Non-depodit Funds)	0.03	0.19	0.23	0.15	0.7371	11.422	0.002
Total Income/Total Expenditure	0.94	0.32	1.22	0.19	0.7718	9.461	0.004
Interest Income/Average Profitable Assets	0.62	0.39	0.33	0.06	0.7745	9.308	0.005
Liquity Assets/(Deposits + Non-deposit Funds)	0.34	0.17	0.58	0.29	0.7784	9.123	0.005
Non-Interest Expenses/Total Expenses	0.30	0.11	0.41	0.11	0.7811	8.947	0.005
Interest Expenses/Total Expenses	0.70	0.11	0.59	0.11	0.7811	8.953	0.005
(Salary and Emp'ee Bene.+Res. for Retire.)/No.of Personel	0.11	0.05	0.17	0.08	0.7849	8.870	0.005
Liquid Assets/Total Assets	0.29	0.13	0.44	0.19	0.8128	7.339	0.011
(Shareholders' Equity+ T.Income)/(T.Assets+Contin.and Com.)	0.00	0.11	0.07	0.07	0.8571	5.320	0.028
(Shareholders' Equity+T.Income)/Total Assets	-0.01	0.31	0.17	0.09	0.8641	5.026	0.032
Net Working Capital/Total Assets	-0.13	0.39	0.08	0.08	0.8668	4.920	0.034
Net Income(Loss)/Average T.Assets	-0.12	0.31	0.03	0.03	0.9030	3.436	0.073
Income Before Tax / Average Total Assets	-0.11	0.32	0.03	0.03	0.9030	3.443	0.073
Non-Interest Income/Non-Interest Expenses	-0.35	0.89	0.15	0.69	0.9065	3.300	0.079
Reserve for Seniority Pay/No.of Personel (billion TL)	0.01	0.00	0.01	0.00	0.9123	3.080	0.089
Non Performing Loans/Total Loans	0.47	1.08	0.03	0.02	0.9189	2.822	0.103
Provisions except Provisons for Income Tax/Total Income	0.07	0.14	0.02	0.02	0.9294	2.422	0.129
Net Income(Loss)/Average Share-in Capital	-2.25	7.38	0.49	0.36	0.9320	2.332	0.137
Provisions including Provisons for Income Tax/Total Income	0.08	0.14	0.03	0.02	0.9363	2.211	0.147
Provision for Loan Losses/Total Loans	0.23	0.62	0.01	0.02	0.9378	2.118	0.155
Provision for Loan Losses / Total Assets	0.06	0.16	0.01	0.01	0.9411	1.935	0.174
Net Interest Income After Provision/Average T. Assets	0.04	0.22	0.11	0.06	0.9530	1.560	0.221
Fx Liquid Assets/Fx Liabilities	0.33	0.17	0.39	0.23	0.9739	0.867	0.359
Non-Interest Income/Total Income	0.81	3.56	0.02	0.22	0.9745	0.836	0.367
Interest Income/Total Income	0.19	3.56	0.98	0.22	0.9745	0.836	0.367
Net Income(Loss)/Shareholders' Equity	-0.13	1.97	0.29	0.24	0.9766	0.764	0.389
No. of Personnel / No. of Branches	21.21	6.81	22.96	8.82	0.9869	0.423	0.520
(Salaries and Emp'ee Benefits+Reserve for Retirement)/T.Assets	0.03	0.01	0.03	0.02	0.9876	0.285	0.597
Fx Assets/Fx Liabilities	0.65	0.23	0.70	0.21	0.9882	0.388	0.538
Total Loans/Total Assets	0.36	0.10	0.34	0.13	0.9934	0.269	0.608
Operational Expenses/Total Assets	0.04	0.02	0.04	0.03	0.9956	0.153	0.699
Fx Position/Shareholders' Equity	2.38	2.53	2.13	1.98	0.9967	0.104	0.749
Permanent Assets/Total Assets	0.17	0.14	0.16	0.09	0.9978	0.040	0.842

Source: Author's calculation

In this paper, the prediction performance is calculated both training and validation sets. However, when evaluating the performance of any model, its performance in validation data sets is considered as primary measures. The prediction performance is the ratio of the number of correctly classified banks to the number of incorrectly classified banks. The experiments using ANNs were performed SPSS 17.0 for Windows whereas SVMs experiments were performed in RapidMiner 5.01.

V. EMPIRICAL FINDINGS

In this section, the prediction performance of ANNs and SVMs are presented. It is determined by comparing a bank's actual membership with its predicted membership.

A. Artificial Neural Networks

The best MLP network developed to predict the bank failures is shown in Figure 2. It is composed of three layers, namely, an input layer, a hidden layer, and an output layer. Inputs for the MLP network are the 14 EWRs and output is 2 classifications, healthy or failed bank. The best MLP network contains 14 input neurons, one hidden neuron, and 2 output neurons to represent 14 explanatory variables and 2 possible outcomes. Each neuron is represented by a circle and each neuron interconnection, with its associated weight, by a line terminated by an arrow. Signals in the MLP network feedforward from left to right. The BP algorithm uses the sigmoid output function whose values range between 0 and 1. Once the network is configured, the set of initial weights is assigned at random. During the training process, the various learning rates α are examined and optimal solution is determined $\alpha = 0.4$. Besides, the momentum term μ which helps to prevent instabilities caused by a too-high learning rate is determined $\mu = 0.9$.

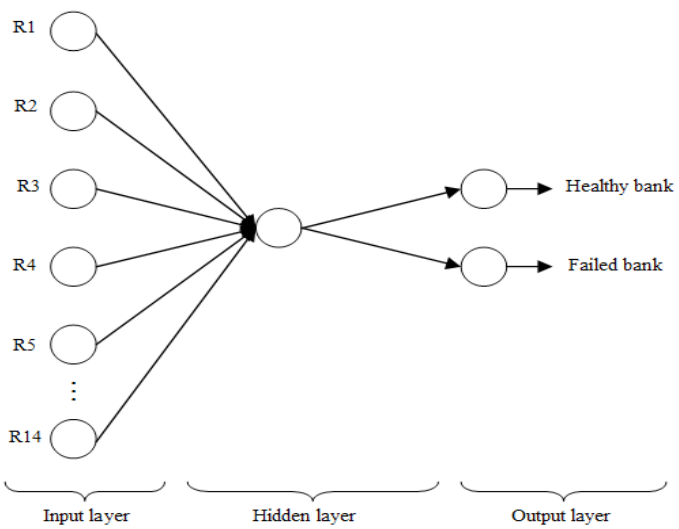

FIGURE 2. MLP ARCHITECTURE

Source: Author's calculation

The results of the MLP network are represented in Table 2 below. It accurately classifies 94.12 percent of the banks in the training data set and 97.06 percent of the banks in the validation set, two years prior to the failure. In addition, the overall error rate is 2.94 percent, with 5.88 percent type I error and 0 percent type II error in the validation set. Hence, the low type I/II errors in MLP network are relatively increased the network's reliability.

TABLE 2. PREDICTION PERFORMANCE OF MLP NETWORK

		Predicted
Actual	Failed	Healthy
Failed	16 (94.12%)	1 (5.88%)
Healthy	0 (0%)	17 (100%)

Source: Author's calculation

The best RBF network includes 14 neurons, one hidden neuron, and 2 output neurons. Thus, it accurately classifies 88.24 percent of the banks in the training data set and 91.18 percent of the banks in the validation set. Type I/II errors are 11.76 percent and 5.88 percent respectively in the validation set. Results of RBF network are represented in Table 3 below.

TABLE 3. PREDICTION PERFORMANCE OF RBF NETWORK

		Predicted
Actual	Failed	Healthy
Failed	15 (88.24%)	2 (11.76%)
Healthy	1 (5.88%)	16 (94.12%)

Source: Author's calculation

Finally, results of MLP and RBF networks indicate that ANNs accurately classify most of the input patterns of validation data set. As seen from the results, the performance of ANNs can be considered as satisfactory.

B. Support Vector Machines

For a comparative evaluation, we utilize four important kernels (linear, radial basis, sigmoid, and polynomial) and test on the training and the validation sets with a stopping criteria 0.001. Results for each kernel type are presented in Table 4.

TABLE 4. PREDICTION PERFORMANCE OF SVMS

	Prediction performance	
Kernel function	Training (%)	Validation (%)
Linear	78.33	82.35
Radial basis	81.67	82.35
Sigmoid	82.35	82.35
Polynomial (1st degree)	82.35	82.35
Polynomial (2nd degree)	88.24	85.29
Polynomial (3rd degree)	85.29	79.41
Polynomial (4th degree)	79.41	79.41

Source: Author's calculation

According to Table 4, the linear, polynomial, radial basis, and sigmoid kernels have similar results that are of reasonably quality, whereas the polynomial kernel has very well classification in the validation set. In other words, SVMs yield its best performance with a second degree polynomial kernel function. SVMs accurately classify 88.24 percent of the banks in the training data set. Besides, they correctly classify 14 out of 17 healthy banks (82.35 percent) and 15 out of 17 failed banks (88.24 percent) in the validation set. Furthermore, type I/II errors are 17.65 percent and 11.76 percent respectively.

VI. DISCUSSIONS

The performance results of prediction models are presented in Table 5 and illustrated graphically in Figure 3.

TABLE 5. PERFORMANCE RESULTS FOR TRAINING AND VALIDATION OF PREDICTION MODELS

	Performance		*Errors of the validation set*		
Model	Training (%)	Validation (%)	Type I Error (%)	Type II Error (%)	Total (%)
MLP	94.12	97.06	5.88	0	2.94
RBF	88.24	91.18	11.76	5.88	8.82
SVMs	88.24	85.29	17.65	11.76	14.71

Source: Author's calculation

According to the experimental results, we conclude that prediction performance of ANNs models are more precise than SVMs in the validation set. While MLP network remains high in the ranking list, RBF network and SVMs remain second and third place respectively. In addition, type I/II errors of ANNs models are smaller than those of SVMs. MLP network remains the best classifier in terms of fewer type I, type II, and total errors. This is followed by RBF and SVMs. Besides, SVMs' best performance with a second degree polynomial kernel function and the remaining kernels has same predictions. The empirical findings reinforce the superiority of ANNs and report that ANNs are better alternatives for prediction of bank failures.

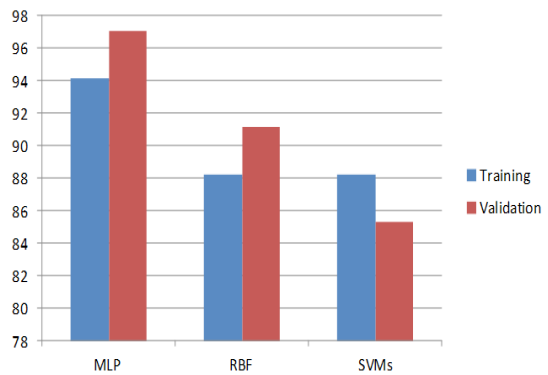

FIGURE 3. PREDICTION PERFORMANCE OF ALL MODELS

Source: Author's calculation

VII. CONCLUSIONS

In this paper, MLP and RBF networks are the most successful prediction models for bank failures. As many studies in the literature reported, the superiority of ANNs in classifying problems is proven again. However, both ANNs and SVMs are promising prediction models in identifying potentially failing banks since they achieve validation prediction performance above 85 percent. Thus, we conclude that ANNs and SVMs models adopt to solve bank failure problems and they can be useful models for bank regulators, supervisors, and others interested in early warning systems in identifying potentially failing banks. Further research could be conducted other business sectors for failure prediction.

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APPENDIX

TABLE A.1 SAMPLE OF TURKISH COMMERCIAL BANKS

Banks	*Date of failure*	$t-1$	$t-2$
Adabank A.Ş.	-	2000	1999
Akbank T.A.Ş.	-	2000	1999
Alternatif Bank A.Ş.	-	2000	1999
Anadolubank A.Ş.	-	2000	1999
Birleşik Türk Körfez Bank	-	2000	1999
Denizbank	-	2000	1999
Finans Bank A.Ş.	-	2000	1999
Koçbank A.Ş.	-	2000	1999
MNG Bank A.Ş.	-	2000	1999
Oyak Bank A.Ş.	-	2000	1999
Pamukbank T.A.Ş.	-	2000	1999
Tekstil Bank A.Ş.	-	2000	1999
Türk Dış Ticaret Bank A.Ş.	-	2000	1999
Türk Ekonomi Bank A.Ş.	-	2000	1999
Türkiye Garanti Bank A.Ş.	-	2000	1999
Türkiye İş Bank A.Ş.	-	2000	1999
Yapı ve Kredi Bank A.Ş.	-	2000	1999
Bank Ekspres A.Ş.	December 12, 1998	1997	1996
Bank Kapital Türk A.Ş.	October 27, 2000	1999	1998
Bayındırbank A.Ş.	July 9, 2001	2000	1999
Demirbank T.A.Ş.	December 6, 2000	1999	1998
Ege Giyim Sanayicileri Bank	July 9, 2001	2000	1999
Egebank A.Ş.	December 22,1999	1998	1997
Eskişehir Bank T.A.Ş.	December 22,1999	1998	1997
Etibank A.Ş.	October 27, 2000	1999	1998
Interbank	January 7, 1999	1998	1997
İktisat Bank T.A.Ş.	March 15, 2001	2000	1999
Kentbank A.Ş.	July 9, 2001	2000	1999
Milli Aydın Bank T.A.Ş.	July 9, 2001	2000	1999
Sitebank A.Ş.	July 9, 2001	2000	1999
Sümerbank A.Ş.	December 22,1999	1998	1997
Toprakbank	November 30, 2001	2000	1999
Türkiye Tütüncüler Bank A.Ş.	December 22,1999	1998	1997
Yurt Ticaret ve Kredi Bank	December 22,1999	1998	1997

Source: Author's calculation

Fatih Ecer

USPOREDBA PERFORMANSI NEURONSKIH MREŽA PRI PREDVIĐANJU PROPASTI BANAKA I STROJEVA S POTPORNIM VEKTORIMA: SLUČAJ TURSKE

SAŽETAK

Iskustvo stečeno u bankarskoj krizi u posljednja dva desetljeća upućuje na potrebu korištenja naprednih modela predviđanja u svrhu prevencije propasti banaka. Ovaj rad uspoređuje sposobnost umjetnih neuronskih mreža i strojeva s potpornim vektorima da predvide propast banaka. Iako se umjetne neuronske mreže često koriste za složene probleme u poslovanju, literatura koja spominje strojeve s potpornim vektorima je relativno malobrojna a njihova sposobnost predviđanja propasti banaka nije previše poznata. U ovom radu su ove dvije inteligentne tehnike primijenjene na sklop podataka turskih komercijalnih banaka. Empirijski rezultati pokazuju da iako se predviđanje dvaju modela može smatrati zadovoljavajućim, neuronske mreže pokazuju nešto bolju sposobnost predviđanja od strojeva s potpornim vektorima. Osim toga, različite vrste grešaka u svakom modelu također ukazuju na to da su modeli s neuronskim mrežama bolji prediktori.

Ključne riječi: propast banaka, ANN (umjetne neuronske mreže), SVM (strojevi s potpornim vektorima), Turska

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TESTING INTRADAY VOLATILITY SPILLOVERS IN TURKISH CAPITAL MARKETS: EVIDENCE FROM ISE

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ABSTRACT

The aim of this article is to examine the presence of volatility transmission between futures index and underlying stock index by using intraday data in Turkey. We first examined the sudden changes in the variance of futures index return and the underlying spot index return. Then we employed the causality in the variance tests proposed by Hong (2001) and Hafner and Herwartz (2006). According to the empirical results, the spot market was found to be Granger cause of futures market and this result suggests that the spot market plays a more dominant role in the price discovery process in Turkey.

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I. INTRODUCTION

Deep and strong financial markets are crucial because of the need for market-based and diversified channels of intermediation between borrowers and investors. Therefore, many emerging countries have introduced futures contracts in order to deepen and stabilize their financial markets, and accordingly futures contracts have become one of the fastest growing financial products over the last 20 years in the world. According to the Bank for International Settlements (BIS) statistics, the trading value of futures products rose by 894% from $1.540 billion at the end of 1990 to $1.380 trillion at the end of 2010 and the total number of the contracts exceeded $6.346 million at the end of 2010 in the world. Although, the global financial crisis that started in the US hit the developed and developing economies and led to a decrease in the global financial markets, the trading value of future contracts increased by 10% between the periods of 2007 and 2010.

As one of the fastest-growing financial products in the world, futures markets have received attention of the investors and academicians and, for that reason, the benefits of futures markets have been widely argued in the finance literature. For instance, Min and Najand (1999) indicated that the price discovery ability between futures and spot market can provide great benefits for investors because this argument suggests that the information is transmitted from informed traders to uninformed traders. Second, the empirical literature that is especially based on developed economies implies that futures market helps to improve market depth and efficiency and, therefore, decreases volatility in the spot market. At this point, the policymakers, regulators and investors in these economies are concerned about the impact of futures trading on the underlying spot market (Avramov et al., 2006). Especially, volatility transmission between futures and spot markets become a widely discussed topic in finance literature.

Regulators, investors and academicians can be interested in the causal link in the variance between futures price and the underlying spot price, because volatility spillovers effects between futures and spot market can be used to explain volatility transmitting and to decide hedging and budget planning by the investors in the market. Therefore, volatility transmission has been widely examined in the finance literature and there is a substantial body of studies that especially focuses on the developed countries.

These studies mainly claim that an increase or decrease in the volatility of futures market affects the volatility of the underlying spot market (Arshanapalli and Doukas 1994; Chan et al. 1991; Chan and Chung 1995; Abhyankar 1995; Iihara et al. 1996; Grunbichler et al. 1994; Koutmos and Tucker 1996; Zhong et al. 2004; Kavussanos et al. 2008). On the contrary, Shyy et al. (1996) detected a causal relationship running from the spot price to the future price in France. They indicated that market is with asynchronous trading, and differences in trading mechanisms used in cash or futures markets can help to find the reverse relation. Similarly, Booth and So (2003) examined the volatility spillovers among futures price, options price and underlying spot price in Germany by using intraday data. They evidenced that the futures, options and spot markets are integrated in Germany. They also found out the presence of information spillover running from the spot market to the futures markets. Liu et al. (2008) investigated the information transmission between the Chinese copper futures and the underlying spot market. Their result showed that there are significant two-ways spillovers between the markets. However, they concluded that the spillover from the futures market to the spot market is stronger. Bohl et al. (2009) investigated the direction of information flows between the futures price and the underlying spot price in Poland by using daily data. Their empirical results suggested that the introduction of index futures trading does not destabilize the spot market. Yang et al. (2012) investigated intraday price discovery and volatility transmission between the stock index and the stock index futures markets in China by

using asymmetric GARCH model. They showed that, even if the stock index started to decline after the stock index futures were introduced, the cash market was found to play a more dominant role in the price discovery process.

Turkish Derivatives Exchange (TURKDEX) is a new established futures market and hence there is a limited number of studies analyzing the relationship between the futures and the spot market in Turkey. For instance, Baklaci and Tutek (2006) examined the impact of the futures price on the underlying spot price. Therefore, they separated their sample set according to the pre- and post-futures trading periods and concluded that the degree of volatility persistence in the spot market significantly decreased after the post-futures periods.

Cevik and Pekkaya (2007) employed causality in mean and variance tests of Cheung and Ng (1996) to determine the causal pattern between the futures and the spot market. Their empirical results showed that there is a causal link running from the spot price to the futures price. Kasman and Kasman (2008) analyzed the impact of the introduction of the stock index futures on the volatility of the underlying spot market by means of asymmetric GARCH model. Hence, they constructed a dummy variable with respect to the pre- and post-futures trading periods and concluded that starting of the futures trading significantly decreases volatility in the stock market. Furthermore, they examined the causal relation between the level of futures and spot price series and found a causal link running from the spot price to futures price by using the error-correction model.

The aim of this paper is to examine volatility transmission between the futures price and the underlying spot price in Turkey. Therefore, we employed causality in the variance test of Hong (2001) and Hafner and Herwartz (2006). We also investigated the existence of sudden changes in the variance of both series. Our empirical results showed that the structural breaks in the variance of the return series lead overestimated GARCH parameters. Although causality in variance test results indicated mixed results for the causal relation between futures and the underlying spot price, the spot market was found to play a more dominant role in the price discovery process in Turkey.

The paper contributes to this literature in several aspects. First of all, to our knowledge, no-one has yet examined the relation between the futures price and the underlying spot price by using intraday data in Turkey. However, Silvapulle and Moosa (1999) indicated that intraday financial data is important to determine the financial market dynamics and market microstructure. Secondly, although a large number of studies have employed the Granger causality test to investigate the causal link between the futures price and the underlying spot price, the test procedure is very sensitive to the choice of lag length. Moreover, the Granger causality test relies on distributional assumptions (e.g. normality, homocedasticity, etc.) and it is well known that most of the stock return series exhibit non-normality and ARCH effect. Therefore, in this study a new causality in variance test which does not rely on distributional assumptions was employed.

Also, causality in variance test is important for financial return series because it indicates a general pattern to volatility transmission. In this context, Li et al. (2008) indicated that this information would enhance volatility forecasting in foreign markets by academics and practitioners. Thirdly, different from the other studies that focused on the futures market in Turkey, we examined the existence of sudden changes in the variance of the futures return and the spot return**.** This is very important to determine the causal link between financial markets because the effects of the structural break on the GARCH model have been widely examined, and these studies have showed that the GARCH model tends to overestimate the persistence of volatility in the series when there are structural breaks in the variance of the series.

The remainder of this article is organized as follows. In the following section, we briefly present the theoretical background of the research and especially focus on the approach of causality in variance test. Our empirical findings are presented in Section 3. Finally, Section 4 briefly discusses the empirical findings of the research and gives the conclusion.

II. METHODOLOGY OF THE RESEARCH

Causality relation between financial markets has been widely examined in the literature where a large number of studies generally use traditional Granger causality test. However, Mantalos and Shukur (2010) determined that the Wald test based on VAR model over-rejects the null hypothesis of noncausality when there are volatility spillover effects and the over-rejection is more severe in larger samples when Monte Carlo simulations are used. Furthermore, the traditional Granger causality test focuses only on changes in the mean of two variables and causality in variance is as important as causality in mean for the financial variables because it implies a general pattern to volatility transmission between financial markets. Moreover, Cheung and Ng (1996) indicated that changes in variance are said to reflect the arrival of information and the extent to which the market evaluates and assimilates the new information.

In addition, the causation pattern in variance provides an insight concerning the characteristics and dynamics of economic and financial prices, and such information can be used to construct better econometric models describing the temporal dynamics of the time series. In this context, we focused on and examined the presence of volatility spillover (or in other words, causality in variance) between spot and futures return series in this study.

The two approaches have been widely used in the literature for testing causality in variance. One of them is a two-step methodology of Cheung and Ng (1996) that is based on the cross correlation function (CCF) of squared residuals obtained from univariate GARCH model. The other approach depends on a dynamic specification of multivariate GARCH (MGARCH) model and causality in variance can be represented in terms of specific parameter restrictions. On the other hand, Hafner and Herwartz (2006) indicated that likelihood based tests within multivariate dynamic models typically suffer from a curse of dimensionality. In addition, the multivariate GARCH models that require large number of imposition of parameter constraints to ensure covariance stationary in the estimation procedure are widely criticized in the literature. Furthermore, Caporale et al. (2006), Pardo and Torro (2007), and Qadan and Yagil (2012) empirically showed that the two step methodology of Cheung and Ng (1996) and Hong (2001) still have a powerful fit when the data is large and leptokurtic and also residuals are non-correlated. Therefore, we employed causality in variance test based on the estimation of univariate GARCH models.

Causality in variance between two variables can be described as follows:

$$E\left\{\left(X_{t+1}-\mu_{x,t+1}\right)^2|I_t\right\} \neq E\left\{\left(X_{t+1}-\mu_{x,t+1}\right)^2|J_t\right\} \quad (1)$$

where Xt and Yt are two stationary and ergodic time series, It and Jt are two information sets defined by $I_t=\left\{X_{t-j};j\geq 0\right\}$ and $J_t=\left\{X_{t-j},Y_{t-j};j\geq 0\right\}$. In the Equation (1), Y_t can be said to cause X_{t+1} in variance.

The most common approach in the literature is S statistic of Cheung and Ng (1996) to examine causality in variance. On the other hand, the criticism of the S test statistic is that it may not be fully efficient when a large M is used because it gives equal weighting to each of the M sample cross-correlations.

However, the empirical studies exhibit that the cross-correlation between financial assets decays to zero when lag order l is increased. In this context, Hong (2001) modified S statistic by using the non-uniform kernels weighting function.

He indicates that his test statistics, in which the null hypothesis shows that there is no causality, outperforms in the Monte Carlo simulation studies. The Hong's (2001) test statistic is defined as:

$$Q_1 = \frac{T\sum_{l=1}^{T-1} k^2\left(\frac{l}{M}\right)\hat{\rho}^2_{\xi_i\xi_j}(l) - C_{1T}(k)}{\sqrt{2D_{1T}(k)}} \tag{2}$$

where $\hat{\rho}^2_{\xi_i\xi_j}(l) = \left\{\hat{C}_{\xi_i\xi_i}(0)\hat{C}_{\xi_j\xi_j}(0)\right\}^{-1/2}\hat{C}_{\xi_i\xi_j}(l)$, $\hat{C}_{\xi_i\xi_i}(0) = T^{-1}\sum_{t=1}^{T}\hat{\xi}^2_{i,t}$, $\hat{C}_{\xi_j\xi_j}(0) = T^{-1}\sum_{t=1}^{T}\hat{\xi}^2_{j,t}$ and $\hat{\xi}_{i,t}$ and $\hat{\xi}_{j,t}$ are standardized residuals derived from GARCH model. In Equation (2), $k(l/M)$ is a weight function, for which we use the Barlett kernel[1]

$$k(l/M) = \begin{cases} 1-\left|l/(M+1)\right| & if\ \ k/(M+1) \le 1 \\ 0 & otherwise \end{cases} \tag{3}$$

where $C_{1T}(k) = \sum_{l=1}^{T-1}\left(1-|l|/T\right)k^2\left(l/M\right)$

and $D_{1T}(k) = \sum_{l=1}^{T-1}\left(1-|l|/T\right)\left\{1-\left(|l|+1\right)/T\right\}k^4\left(l/M\right)$

Q_1 test statistics is a one-sided test and upper tailed normal distribution critical values should be used. For example, the asymptotic critical value at the 5% level is 1.645. The test procedure summarized by Hong (2001) is given as:

- Estimate univariate GARCH (p, q) models for time series and save the standardized residuals.
- Compute the sample cross-correlation function $\hat{\rho}_{\xi_i\xi_j}(l)$ between the centered standardized residuals.
- Choose an integer M and compute C_{1T} (k) and D_{1T} (k).

Then compute the test statistic Q_1 by using Equation (2) and compare it to the upper-tailed critical value of normal distribution at an appropriate level. If Q_1 is larger than the critical value, there is no causality and accordingly the null hypothesis is rejected.

Hafner and Herwartz (2006) determined that in case of small and medium sample sizes S statistic appears to suffer from significant oversizing if the innovations underlying a conditionally heteroskedastic process are leptokurtic by means of Monte Carlo simulations.

[1] In this study, we used Barlett kernel because Hong (2001) shows that several non-uniform kernels are performed similar results.

Therefore, they proposed a new test statistic that is based on Lagrange Multiplier (LM) principle to test for noncausality in variance and showed that their test statistic outperforms than S statistic. LM test statistic in which null hypothesis is noncausality in variance can be formulated as follows:

$$\lambda_{LM} = \frac{1}{4T}\left(\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)z_{jt}'\right)V\left(\theta_i\right)^{-1}\left(\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)z_{jt}\right) \xrightarrow{d} \chi^2\left(2\right) \tag{4}$$

where ξ_{it} is standardized residuals, $V\left(\theta_i\right) = \frac{\kappa}{4T}\left[\sum_{t=1}^{T} z_{jt}z_{jt}' - \sum_{t=1}^{T} z_{jt}x_{it}'\left(\sum_{t=1}^{T} x_{it}x_{it}'\right)^{-1}\sum_{t=1}^{T} x_{jt}z_{jt}'\right]$ and $\kappa = \frac{1}{T}\sum_{t=1}^{T}\left(\xi_{it}^2 - 1\right)^2$. Also $z_{jt} = \left(\varepsilon_{jt-1}^2, \sigma_{jt-1}^2\right)'$, $\sigma_{it}^2 = \omega_i + \alpha_i\varepsilon_{i,t-1}^2 + \beta_i\sigma_{i,t-1}^2$, $x_{it} = \sigma_{it}^{-2}\left(\partial\sigma_{it}^2/\partial\theta_i\right)$ and $\theta_i = \left(\omega_i, \alpha_i, \beta_i\right)'$

.

Hafner and Herwartz (2006) summarized the test procedure as follows:

- Estimate a GARCH(1,1) model for εit and εjt and obtain standardized residuals ξ_{it}, erivatives xit and the volatility process σ_{jt}^2 entering z_{jt}.
- Regress $\xi_{it}^2 - 1$ on x_{it}' and the misspecification indicators in z_{jt}' .
- λ_{LM} is equal to T times the degree of explanation (R^2) of the latter regression.

The asymptotic distribution of λ_{LM} will depend on the number of the misspecification indicators in z_{jt}. In our case λ_{LM} test statistic follows χ2 distribution.

However, extensive literature that focused on estimating of GARCH models argued that the presence of structural breaks in the unconditional variance of series leads us to overestimate GARCH parameters. For instance, Hillebrand (2005) showed that parameter regime changes in GARCH models that are not accounted for in global estimations cause the sum of estimated GARCH parameters to converge to one via Monte Carlo simulations, and he referred to this effect as "spurious almost-integration". These findings are very important for testing causality in variance because the test statistic that is considered in this study relies on estimating of univariate GARCH models. Therefore, biased GARCH model results can generate misleading causality results. In this context, Van Dijk et al. (2005) and Rodrigues and Rubia (2007) determined that causality in variance test suffers from severe size distortions when there are structural breaks in the variance of series. Accordingly, we examined the presence of structural breaks in the unconditional variance of both returns series before testing causality in variance.

Inclan and Tiao (1994) proposed a test procedure that is based on ICSS (Iterative Cumulative Sum of Squares) to detect structural breaks in the unconditional variance of a stochastic process. In order to test the null hypothesis of constant unconditional variance against the alternative hypothesis of a break in the unconditional variance, Inclan and Tiao (1994) proposed using the statistic given by:

$$IT = \sqrt{T/2}D_k \tag{5}$$

where $D_k = (C_k / C_T) - (k/T)$ and $C_k = \sum_{t=1}^{k} r_t^2$ be the cumulative sum of squares of a series of uncorrelated random variables with mean 0 and variance σ_t^2, t = 1, 2, ...,T . The value of k $(k = 1,\ldots, T)$ that maximizes $\left|\sqrt{T/2}D_k\right|$ is the estimate of the structural break date. Under the variance homogeneity IT statistic behaves like a Brownian bridge asymptotically. At the 5% significance level, the critical value computed by Inclan and Tiao (1994) is $C_{0.05}$ = 1.358.

The most serious drawback of the IT test statistic is that it is designed for independently and identically distributed random variables.

However, Andreuo and Ghysels (2002) and Sanso et al. (2004) determined that the test statistic generates oversized results when the dependent variable exhibits a conditional heteroskedasticity process. In this context, Fernandez (2006) determined that IT test statistic fails to find the effect of the terrorist attacks on September 11 on the volatility of the world stock markets. Sanso et al. (2004) modified the IT test statistic for GARCH process in the dependent variable and they showed that the modified test statistic outperforms than IT test statistic by means of Monte Carlo simulation. In this study modified IT test statistic was used to detect break points in the variance of spot and futures return series as in Arago-Manzana and Fernandez-Izquierdo (2007), Rapach and Strauss (2008) and Ewing and Malik (2010). The modified IT test statistic given by

$$\kappa = \sup_k \left|T^{-1/2} G_k\right| \tag{6}$$

where $G_k = \hat{\omega}_4^{-1/2}\left(C_k - \frac{k}{T}C_T\right)$ and $\hat{\omega}_4$ is a consistent estimator of ω_4. Non-parametric stimator of ω_4,

$$\hat{\omega}_4 = \frac{1}{T}\sum_{t=1}^{T}\left(r_t^2 - \hat{\sigma}^2\right)^2 + \frac{2}{T}\sum_{l=1}^{m}\omega(l,m)\sum_{t=l+1}^{T}\left(r_t^2 - \hat{\sigma}^2\right)\left(r_{t-1}^2 - \hat{\sigma}^2\right) \tag{7}$$

where $\omega(l,m)$ is a lag window, such as the Barlett, defined as $\omega(l,m) = 1 - l/(m+1)$, or the quadratic spectral.

In the test procedure, if we were looking for only the possibility of a single point change, then the G_k function would provide a satisfactory procedure. But when we are interested in finding multiple change points on an observed series, the usefulness of the G_k function becomes questionable because of the masking effect. A solution is an iterative scheme based on successive application of G_k to pieces of the series, dividing consecutively after a possible change point is found (see Inclan and Tiao (1994) for ICSS procedure details).

III. DATA AND EMPIRICAL RESULTS

A. Turkish Derivative Exchange Market

The TURKDEX was established in 2002 to launch the derivatives exchange in Turkey and formal trading in futures contracts started in February 2005. The TURKDEX has a fully electronic exchange system with a remote access and all trading activities for derivates contracts listed at the Exchange are carried out by the TURKDEX Exchange Operations System (TEOS). There is a single trading session that starts at 9:15 a.m. and finishes at 5.35 p.m. Although the only futures contracts are listed in the TURKDEX, an application has been made to the Capital Markets Board of Turkey (CMBT) for options contracts by the TURKDEX. The futures contracts include index futures (ISE-30 and ISE-100), currency futures (US Dollar/TRY, Euro/TRY), interest rate futures (for 91-day T-bill, 365-day T-bill and T-benchmark), commodity futures (cotton, wheat, and etc.) and precious metal futures (gold and others).

Although the TURKDEX is a newly established market, the total trading value has sharply increased since 2005. The trading value rose by 141% from 3.029 million TRY at the end of 2005 to 431.681 million TRY at the end of 2010. In 2010, the annual trading value increased by 29% in comparison to the trading value of the year 2009. The highest trading between the futures contract in the TURKDEX is equity index contracts that constituted 88% in the annual number of contracts traded and 97% share of the trading value (in TRY terms) in 2010.

B. Data

The Istanbul Stock Exchange 30 (ISE-30) index that is traded as a futures contract in the TURKDEX consists of 30 stocks which have been selected among the stocks of the companies listed on the National Market and the stocks of the real estate investment trusts and venture capital investment trusts listed on the Corporate Products Market. Because the ISE-30 index consists of large capitalization common stocks listed on the ISE, the index may reflect an overall market performance. Therefore, in this study, we examined whether there are volatility spillovers between ISE-30 futures index price and the underlying stock index price.

For this aim, we considered intraday data in which 5 minute stock index and futures index prices were collected from the ISE and TURKDEX covering the period from May 01, 2006 to May 31, 2010. The logarithmic stock and futures return series were calculated by using the $r_t = \ln (P_t / P_{t-1})$ formula.

C. Empirical Results

The expressions in the previous sections indicate that Turkish derivatives exchange market is new established market and hence there are limited numbers of studies that examine relationship between futures price and underlying stock price in Turkey. However, understanding of price discovery process between futures price and underlying stock prices is very important for investors and hedgers and it would provide several benefits to construct optimal portfolio. Therefore, in this study we focus on Turkish derivatives exchange market to fill the gap in the literature.

The descriptive statistics are presented in Table 1. As shown in Table 1, while the mean of both return series is quite small, the mean return is higher for the futures market than for the spot market. Additionally, the futures return series exhibit evidence of a higher volatility according to the greater volume of its standard deviation. These results are consistent with the expectations because Turkish Derivatives Exchange (TURKDEX) is still a new financial market for investors. Therefore, the trading volume in the TURKDEX is low in comparison to the trading volume in the ISE.[2] In addition to this, the presence of leverage effect in the futures market can be the cause of

the increase in the volatility and hence futures returns series are found to be more risky.

Also both series show the evidence of strong skewness and excess kurtosis, which indicates that both of them are leptokurtic. Jarque-Bera normality test results show that the distributions of both returns series are not normal. Ljung-Box Q statistics strongly indicates the presence of a serial correlation in the returns and squared returns series. Finally, we examined the existence of the unit root in the spot and futures return series by means of the augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root tests. Both unit root tests results suggest that spot and futures return series are stationary.

TABLE 1 - DESCRIPTIVE STATISTICS FOR SPOT AND FUTURES RETURN SERIES FOR ISE30 INDEX

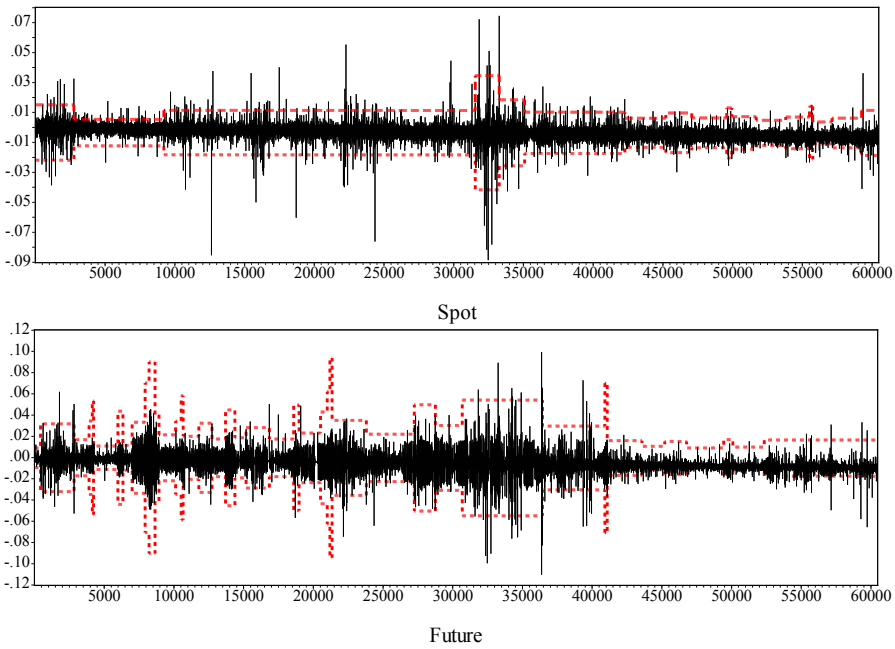
	ISE30 Index Spot Returns	ISE30 Index Futures Returns
n	60459	60459
Mean (x10000)	0.035	0.038
Maximum	7.830	10.566
Minimum	-8.488	-10.414
Std. Dev.	0.300	0.523
Skewness	-1.143	-0.149
Kurtosis	88.369	38.019
Jarque-Bera	18372522 [0.000]	3089610 [0.000]
ARCH (5)	16.606 [0.000]	1401.5 [0.000]
Q (20)	167.471 [0.000]	6767.89 [0.000]
Qs (20)	95.742 [0.000]	9209.75 [0.000]
ADF	-150.419***	-130.254***
PP	-250.965***	-381.087***
KPSS	0.096***	0.083***

Source: Author's calculation

*Notes: The figures in square brackets show the probability (p-values) of rejecting the null hypothesis. ARCH (5) indicates LM conditional variance test. Q(20) and Qs(20) indicates Ljung-Box serial correlation test for return and squared return series respectively. *** indicate that the series in question is stationary at the 1% significance level.*

We started our empirical analysis first by testing the presence of sudden changes in the variance of spot and futures return by means of modified IT statistic. Figure 1 illustrates the return for each series with the points of the sudden change and ± 6 standard deviations. In addition to this, Table 2 indicates the time periods of sudden changes in volatility, as identified by the ICSS algorithm.

[2] The total trading value in the ISE is 635.664 million TRY at the end of 2010.



Source: Author's calculation
Notes: Dashed line indicates ± 6 standard deviations.

TABLE 2 -STRUCTURAL BREAKS IN THE VARIANCE OF ISE30 SPOT AND FUTURES RETURN SERIES

Spot Returns		Futures Returns			
Break Points	**Break period**	**Break Points**	**Break period**	**Break Points**	**Break period**
1	July 19, 2006	1	May 11, 2006	21	September 3, 2007
2	January 18, 2007	2	July 21, 2006	22	October 18, 2007
3	September 11, 2008	3	August 22, 2006	23	October 26, 2007
4	October 28, 2008	4	August 28, 2006	24	December 6, 2007
5	December 17, 2008	5	August 31, 2006	25	December 19, 2007
6	June 1, 2009	6	October 17, 2006	26	December 27, 2007
7	July 30, 2009	7	October 31, 2006	27	January 2, 2008
8	September 7, 2009	8	November 17, 2006	28	March 3, 2008
9	October 27, 2009	9	December 12, 2006	29	May 28, 2008
10	November 5, 2009	10	December 20, 2006	30	July 4, 2008
11	December 11, 2009	11	December 29, 2006	31	August 21, 2008
12	January 21, 2010	12	January 11, 2007	32	January 16, 2009
13	February 23, 2010	13	February 13, 2007	33	April 28, 2009
14	March 1, 2010	14	February 23, 2007	34	May 4, 2009
15	March 25, 2010	15	March 1, 2007	35	June 29, 2009
16	May 6, 2010	16	April 3, 2007	36	July 30, 2009
		17	May 2, 2007	37	September 1, 2009
		18	May 30, 2007	38	October 23, 2009
		19	June 19, 2007	39	November 9, 2009
		20	July 12, 2007	40	December 24, 2009

Source: Author's calculation

The spot return shows sixteen sudden change points, making for seventeen distant volatility regimes, whereas the futures return evidences forty sudden change points, corresponding to forty-one distinct volatility regimes. In order to eliminate the effects of the structural breaks, we constructed dummy variables regarding to the time periods of sudden changes as in Lamoureux and Lastrapes (1990), Aggarwal et al. (1999), Arago-Manzana and Fernandez-Izquierdo (2007), Wang and Thi (2007), and Ewing and Malik (2010).

Next, we estimated univariate GARCH model of Bollerslev (1986) with and without dummy variables for spot and futures return series and GARCH(1,1) model was found to be sufficient for an adequate model volatility for both return series.[3],[4]

According to the results in Table 3, when the structural breaks in the variance of series are ignored, the sum of the alpha and beta parameters is found to be 0.777 for the spot return and 0.985 for the futures return series. On the other hand, the inclusion of dummy variables significantly reduces the sum of the parameters for both return series (0.633 for spot return and 0.799 for futures return). Especially, we spotted an overly dramatic decrease in the beta parameter for futures return (from 0.617 to 0.255). These findings are consistent with IT test statistic results because the number of the sudden changes was found to be higher for futures return than for spot return. Hence, it can be expected that the decrease in the persistence of the volatility is greater for the futures return than for the spot return.

TABLE 3 – GARCH (1,1) MODEL RESULTS FOR ISE30 SPOT AND FUTURES RETURN SERIES

Spot	**ω**	**α**	**β**	**ν**	**α + β**	***Log likelihood***	***Q (20)***	***Q_s (20)***
Without dummies	1.67E-06 [0.000]	0.166 [0.000]	0.611 [0.000]	0.975 [0.000]	0.777	279097.8	75.105 [0.000]	4.214 [0.997]
With dummies	3.77E-06 [0.000]	0.141 [0.000]	0.492 [0.000]	1.006 [0.000]	0.633	279590.0	59.988 [0.000]	6.479 [0.971]
Futures	***ω***	***α***	***β***	***ν***	***α + β***	***Log likelihood***	***Q (20)***	***Q_s (20)***
Without dummies	1.27E-06 [0.000]	0.368 [0.000]	0.617 [0.000]	0.545 [0.000]	0.985	279165.0	689.95 [0.000]	30.296 [0.003]
With dummies	1.81E-06 [0.000]	0.544 [0.000]	0.255 [0.000]	0.555 [0.000]	0.799	280914.9	596.52 [0.000]	11.591 [0.561]

Source: Author's calculation

Notes: The figures in square brackets show the p-values. ν is GED parameter. Q(20) and Qs(20) indicates Ljung-Box serial correlation test values for the return and the squared return series respectively.

[3] We consider the Schwarz BIC in selecting the number of autoregressive parameters in the ARMA model. We find that the AR (5) model is adequate to describe time series behavior of the data for spot and futures return series during the sample period.

[4] We also implemented EGARCH and GJR-GARCH models to determine the presence of leverage effect in the volatility of spot and future series. However, EGARCH and GJR-GARCH models do not outperform than GARCH model according to log likelihood values.

Log likelihood values in Table 3 indicate that GARCH model with dummy variables gives a better fit for both return series. In addition to this, we employed a likelihood ratio (LR) test to determine the significance of the dummy variables in the volatility process. The LR test can be calculated by using LR = 2[L(Md)–L(M)] where L(Md) and L(M) are the maximum log likelihood values derived from the GARCH models with and without dummy variables respectively. The test statistic is asymptotically $\chi 2$ distributed with degrees of freedom that is equal to the number of the restrictions (or number of the dummy variables).

For spot return, LR test statistics was determined as 984.4 (p-value = 0.000), so the null hypothesis of no change was rejected at the %1 significance level. For futures return, LR = 3499.8 (p-value = 0.000) and this result suggests the rejection of the null hypothesis at the 1% level. Therefore, the LR test results strongly indicated that the existence of dummy variables in the GARCH model increases the explanatory power of the model.

Then we employed Hong's test to determine the causal relation between the spot and the futures market and the results are presented in Table 4. When we ignored structural breaks in the variance (in other words, when we used standardized residuals derived from GARCH model without the dummy variables), we determined a causal link running from the spot market to futures market. Especially, the highest cross-correlation coefficient was found at third lag in the Hong's test and this result suggests that spot market influences the futures market within 15 minutes.

On the other hand, when the structural breaks were considered (or standardized residuals obtained from GARCH model with dummy variables were used), we determined a bidirectional causality between the variance of the spot and the futures return series. These results are very interesting because if we had not eliminated the effects of structural breaks, we could not have determined the presence of the feedback effect between spot and futures market. In addition to this, these results are consistent with the findings of Van Dijk et al. (2005) and Rodrigues and Rubia (2007) because they indicated that the causality in variance tests suffered from severe size distortions if structural breaks are ignored.

TABLE 4 - HONG'S CAUSALITY IN VARIANCE TEST RESULTS FOR ISE30 SPOT AND FUTURES RETURN SERIES

	Causality Direction	M=1	M=2	M=3	M=4	M=5
Breaks ignored	Spot →Futures	-0.322 [0.626]	4.953*** [0.000]	400.7*** [0.000]	835.5*** [0.000]	1127.6*** [0.000]
	Futures → Spot	0.198 [0.422]	0.027 [0.489]	0.395 [0.347]	0.840 [0.200]	1.101 [0.135]
Breaks accounted for	Spot →Futures	-0.481 [0.685]	3.247*** [0.000]	396.9*** [0.000]	830.1*** [0.000]	1120.9*** [0.000]
	Futures → Spot	2.679*** [0.004]	2.445*** [0.007]	2.302** [0.011]	2.197** [0.014]	2.068** [0.019]

Source: Author's calculation

*Notes: The figures in square brackets show the p-values. *, ** and *** indicates the existence of causal link at the 1%, 5% and 10% level respectively.*

We also employed the LM test statistic of Hafner and Herwartz (2006) to determine whether Hong's test results are robust and the test results are given in Table 5. As in Hong's test, we computed two different test statistics by considering and by ignoring the effects of structural breaks. The test results in Table 5 strongly indicate the existence of causality relation going from spot return to futures return series. Differently from Hong's test results, the causal link running from the futures market to spot market cannot be determined at the conventionally significant levels (the null hypothesis can only be rejected at the 18% significance level). On the other hand, the test statistics significantly increases (and p-value decreases) for this causality relation when structural breaks are considered and this is consistent with Hong's test results. Therefore, it can be said that both of the causality in variance tests suffered from size distortions in the case of structural breaks in variance of the series.

Finally, as in Cheung and Ng (1996) we re-estimated GARCH model in which squared return series for futures and spot price take place in the variance estimation to determine the size of volatility transmission between the futures market and the underlying spot market. Therefore, we considered the lags of squared return series in the variance equation and determined the optimal model according to the model selection criteria (Akaike and Schwarz) and Log likelihood value.[5]

TABLE 5 - LM CAUSALITY IN VARIANCE TEST RESULTS FOR ISE30 SPOT AND FUTURES RETURN SERIES

	Causality Direction	λ_{LM}
Breaks ignored	Spot →Futures	177.55* [0.000]
	Futures → Spot	1.874 [0.391]
Breaks accounted for	Spot →Futures	21.823* [0.000]
	Futures → Spot	3.444 [0.179]

Source: Author's calculation

*Notes: The figures in square brackets show the p-values. * indicate the existence of causal link at the 1% level.*

Augmented GARCH model results are presented in Table 6. As seen in Table 6, squared futures return was not found to be statistically significant in the spot return model. On the other hand, squared spot return is statistically significant at the 1% level and these results are consistent with the LM test statistic of Hafner and Herwartz. Consequently, we determined that the spot market plays a more dominant role in the price discovery process in Turkey and these findings are consistent with Shyy et al. (1996), Booth and So (2003), Liu et al. (2008), Bohl et al. (2009) and Yang et al. (2012).

[5] Initially, we start with five lags of the squared return series and also evaluate them together and separately in the variance equation. In the spot and future model estimation, optimal lag is found to be 2 for squared futures and spot return series.

TABLE 6 - AUGMENTED GARCH MODEL RESULTS FOR ISE30 SPOT AND FUTURES RETURN SERIES

Spot	ω	α	β	δ	ν	*Log likelihood*	*Q (20)*	Q_s *(20)*
	3.79E-06 [0.000]	0.141 [0.000]	0.491 [0.000]	0.0001 [0.490]	1.006 [0.000]	279590.1	59.992 [0.000]	6.446 [0.971]
Futures	ω	α	β	δ	ν	*Log likelihood*	*Q (20)*	Q_s *(20)*
	1.13E-06 [0.000]	0.427 [0.000]	0.301 [0.000]	0.019 [0.000]	0.615 [0.000]	283488.8	775.89 [0.000]	19.045 [0.212]

Source: Author's calculation

Notes: The figures in square brackets show the p-values. ν is GED parameter and δ is volatility parameter of spot and futures return series. Q(20) and Qs(20) indicates Ljung-Box serial correlation test for return and squared return series respectively.

IV. CONCLUSION

In this study, we examined the presence of volatility transmission between the futures return and the underlying spot return series in the Turkish market. First, we investigated whether there are structural breaks in the variance of both returns series because a vast literature that focused on the effects of structural breaks on the GARCH parameters showed that structural break in the variance caused to overestimate the volatility persistence. Our empirical results are in line with the findings of the previous studies in the related literature. (Booth and So (2003); Shyy and Vijayraghavan (1996); Yang et al. (2012)) The empirical findings indicate that the sum of alpha and beta parameters for both return series declines significantly when we consider the effects of structural breaks. Causality in variance test results strongly indicated the causal link running from the spot market to futures market. Furthermore, the augmented GARCH model result verifies these findings.

Regardless of the large literature that has discussed the information transmission mechanism between the futures and spot market, little consensus has emerged. Furthermore, hardly any study has been conducted so far to investigate intraday spillover effects between stock index futures and spot market with respect to the Turkish financial markets. At this point it should also be emphasized that the intraday data set used in this study is essential as it it leads us to capture the market dynamics more accurately. This article will help investors and especially the institutional investors to prudently make up their investment strategies in Turkish financial markets, by hedging their risks more efficiently. Furthermore, as the Turkish equity market has been one of the best performing emerging markets in recent years, the findings of this study could also be a good benchmark point for the institutional investors in other emerging markets. The article will also provide foreign institutional investors with a better understanding of the Turkish Market which will generate new ways for researchers to a more comprehensive investigation of the Turkish market and will encourage the researchers for further studies.

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TESTIRANJE UNUTARDNEVNIH PRIJENOSA VOLATILNOSTI NA TURSKOM TRŽIŠTU KAPITALA: DOKAZI IZ ISE

SAŽETAK

Cilj ovog rada je istražiti prisutnost prijenosa volatilnosti između indeksa terminskih ugovora i temeljnog indeksa dionica koristeći unutardnevne podatke u Turskoj. Najprije smo istražili iznenadne promjene u varijanci zarade na terminskim ugovorima i zarade na temeljnom spot indeksu. Nakon toga smo upotrijebili kauzalnost u testovima varijance kojeg su ponudili Hong (2001) i Hafner i Herwartz (2006). Sudeći po empirijskim rezultatima, spot tržište (tržište trenutačnih isporuka) se ispostavilo Grangerovim uzrokom tržišta terminskih ugovora a taj rezultat ukazuje na to da spot tržište igra nešto dominantniju ulogu u procesu otkrivanja cijena u Turskoj.

Ključne riječi: spot tržišta i tržišta terminskih ugovora, strukturalni prekidi u varijanci, prijenos volatilnosti, unutardnevni podaci, kauzalnost u varijanci

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OFF-BALANCE SHEET ACTIVITIES IMPACT ON COMMERCIAL BANKS PERFORMANCE: AN EMERGING MARKET PERSPECTIVE

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ABSTRACT

This paper examines the effect of off-balance sheet (OBS) activities on performance of the banks listed on Istanbul Stock Exchange (ISE). We use four measures of performance including bank's risk exposures, profitability, leverage, and liquidity position. We find that both bank-specific risk and foreign exchange rate risk are positively related with OBS activities. This indicates that OBS activities increase bank-specific and foreign exchange risk exposures of the banks in Turkey. The positive relationship might serve as a warning to bank's speculative action using OBS transactions in the market. The results also indicate that OBS activities, due to its hedging perception, improve bank's stock returns but have a negative impact on return on equity. In addition, OBS activities do not have a statistically significant impact on leverage or liquidity.

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I. INTRODUCTION

In today's financial markets, one of the striking developments is the increasing tendency of banks to engage in off-balance sheet (OBS) activities. In recent years the development and deregulation of the financial markets, improvements in financial innovation and decreases in banks' margins, as a result of low-quality loan applicants, encourage the banks to offer new products and services to increase their profits (Jurman, 2005). Edwards and Mishkin (1995) argue that the rate of traditional banking has been decreasing while the OBS activities have been increasing. Decreasing profitability of traditional banking and increasing competitiveness of markets actually forces banks to undertake OBS activities. Ebrahim and Hasan (2004) analysed the banks' profits from traditional and non-traditional activities. They argue that improvement of non-interest earnings of the banks arose from the development of new types of financial instruments.

OBS or fee-related items such as guarantees, commitments and derivatives sometimes become the main sources of bank revenues. By engaging in OBS activities, besides providing high earnings, banks can avoid regulatory costs or taxes since reserve requirements and deposit insurance premiums are not imposed on OBS activities. However, these activities can involve risks such as market, operational and credit risks, which might affect bank's solvency and liquidity. On the other hand, significant growth in derivatives activities by commercial banks might be explained by increased interest rate, credit and foreign exchange risk exposures, which banks face in domestic and international markets. Derivatives offer a way to hedge these risks without having to make extensive changes on the balance sheet.

This paper aims to examine the effect of OBS activities on the performance of the banks listed on Istanbul Stock Exchange (ISE). We examine the effect of OBS activities on bank's risk exposures, profitability, leverage, and liquidity position. Since we could not find any study dealing with this topic in Turkey we try to fill this gap.

The paper proceeds as follows; section 2 presents the background on banking system and OBS activities in Turkey, section 3 provides a review of the literature, section 4 discusses methodology and data, section 5 presents our empirical results and analysis. Section 6 presents our conclusions.

II. TURKISH BANKING SYSTEM AND THE DEVELOPMENT OF THE OFF- BALANCE SHEET TRANSACTIONS

After 1982, in Turkey, commitments were excluded from the balance sheet and became the main item of OBS. It continued to be the major item in the following years. With the increase in public sector borrowing during 1990s the repo transactions became more attractive and their share increased within OBS items. Repo transactions were subsequently excluded from OBS items and included into balance sheet. Since 2000 the use of derivative financial instruments has become widespread and after excluding safe-custody and pledged securities, the derivatives constituted 43 percent of OBS items at the end of 2008. Safe-custody and pledged securities item which is a subaccount of OBS items includes the securities deposited in Settlement and Custody Bank of Istanbul Stock Exchange (ISE). Following the change of methodology applied in calculating and accounting of these securities, the share of safe-custody and pledged securities item within total OBS items accounts for approximately 95 percent since 2005. Figure 1 indicates that the derivative transactions experienced an increasing trend during the period of 2002-2007. As a result of the fact that banks reduced their on-balance sheet foreign exchange positions since the global crisis, derivative transactions in general experienced a decrease in 2008.

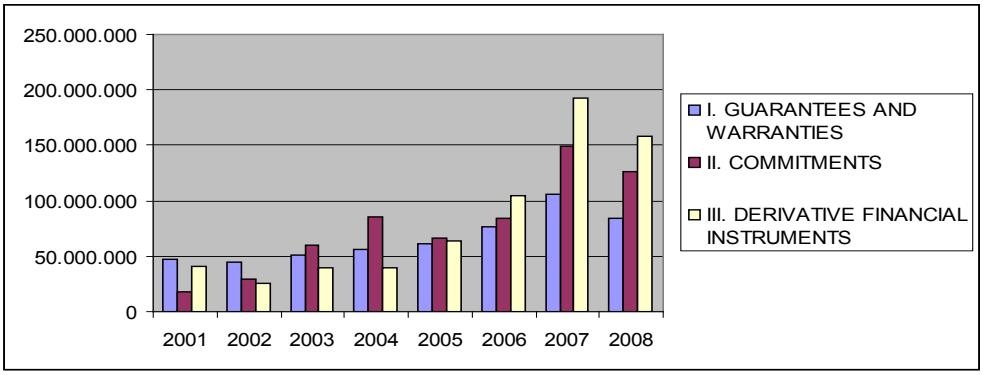

FIGURE 1. STRUCTURE OF OBS ITEMS (SAFE-CUSTODY AND PLEDGED SECURITIES EXCLUDED) (TRY THOUSANDS).

Source: Central bank of Turkey

Figure 2 shows that the share of the derivative financial instruments rose from 39 percent in 2001 to 43 percent in 2008; commitments item to 34 percent from 17 percent; while guarantees and warranties fell to 23 percent from 45 percent in the same period.

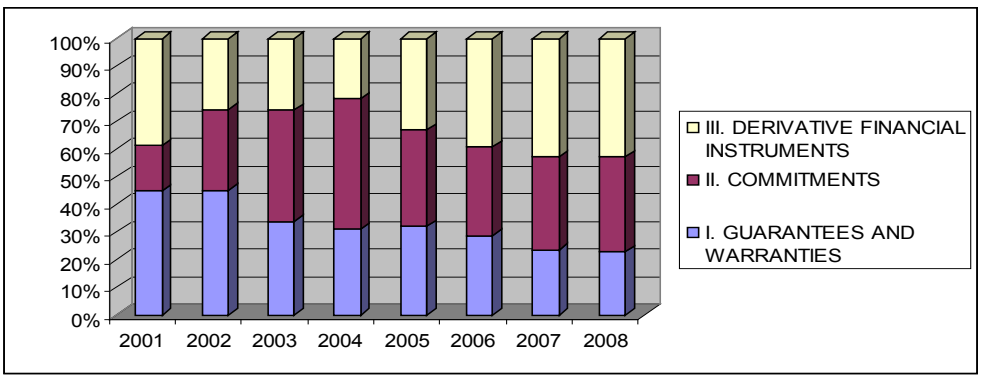

FIGURE 2. DISTRIBUTION OF OBS ITEMS (SAFE-CUSTODY AND PLEDGED SECURITIES EXCLUDED).

Source: Central bank of Turkey

Figure 3 depicts that the share of the swap transactions increased from 21 percent in 2001 to 50 percent in 2008; options to 28 percent from 0.1 percent. On the other hand forward transactions fell to 21 percent from 64 percent and futures to 2 percent from 15 percent. In 2008, options transactions increased the most within derivative transactions since these instruments were perceived by investors as the most profitable.

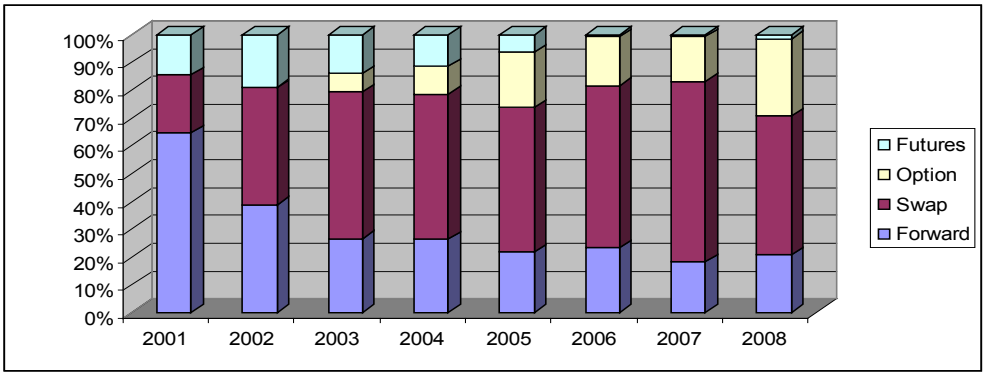

FIGURE 3. DISTRIBUTION OF THE DERIVATIVES IN TURKISH BANKS.

Source: Central bank of Turkey

III. PREVIOUS STUDIES

There are a number of studies on the changing patterns of the structure of banks' income with the inclusion of OBS activities. Among them, Rogers and Sinkey (1999: 8) investigated the relationship between the non-traditional activities and some variables by analyzing financial statements of 8.931 banks for the period 1989-1993. They found a negative and significant relationship between net interest margin and non-traditional activities. In addition, they argued that mostly the big banks focused on non-commercial activities.

Davis and Tuori (2000) analyzed the structure of banks' income in OECD countries for the period 1979-1995, using the data on bank profitability. They found evidence of changes in the income structure from interest income to non-interest income, with rapid growth of OBS activities in most of the EU countries. In addition, their results indicate that larger banks tend to maintain high levels of non-interest income. In addition to the analysis done on the changing patterns of the structure of banks' income with the inclusion of OBS activities, empirical investigation has also been done on the risks associated with these activities. Among these studies, Boyd and Graham (1986: 10) examined the risks associated with diversification of banks into non-bank activities for the period 1971-1983. They found no significant relationship between non-bank activities and risk. However, non-bank activities were positively related to the risk of the banks during the period 1971-1977. They highlighted that the level of association between risk of failure and non-bank activities increases when there is no tight regulation on non-bank activities. As a result, the positive relationship between the two variables disappears when there are more stringent regulations.

Hassan (1993: 33) examined the relationship between OBS activities and market risk of large commercial banks of the US. He found that OBS activities contribute to the overall diversification of the bank portfolio risk by reducing the total risk. Nevertheless, OBS items do not influence the systematic risk of banks and this may be due to the fact that OBS items are not a concern of well-diversified stockholders.

Chaudhry (1994) investigated the impact of OBS activities on commercial banks' exposure to market-based risk in the US by utilizing a two-stage model. He found that larger banks are more efficient in interest rate risk management as compared to the smaller ones. In contrast, in their study, DeYoung and Roland, (2001) found that the banks' earnings volatility increased

when banks tilted their product mixes towards fee based activities and away from traditional intermediation activities. Lepetit et al. (2005) found that the banks which expanded into non-interest income activities, presented a higher level of risk than banks which principally supplied traditional intermediation activities.

More recently, Karim and Gee (2007: 5) examined how OBS activities of the locally owned commercial banks in Malaysia affected the performance of the banks through banks' exposure to various forms of risks, bank profit, leverage and liquidity by conducting a panel regression and indicated that only the market risk is significantly positively related with OBS activities. According to them, this might be due to the fact that OBS activities were not the main source of funds for these banks since the use of OBS items was still in its emerging phase. In addition, they found that the stock returns were negatively related to OBS activities. There was no significant relationship between return on equity, leverage and liquidity ratio with the OBS activities.

De Jonghe, Baele and Vennet (2007: 31) investigated whether functionally diversified banks have a comparative advantage in terms of long-term performance and risk profile compared to their competitors. They used market-based measures of return potential and bank risk and calculated the franchise value over time of European banks as a measure of their long-run performance potential. In addition, they measured risk as both the systematic and the unsystematic risk sensitivities derived from a bank stock return model. Finally, they analyzed the return/risk trade-off implied in different functional diversification strategies using a panel data analysis over the period 1989-2004. They found that a higher share of non-interest income in total income affected banks' franchise values positively. Diversification of revenue streams from distinct financial activities increased the systematic risk of banks while the effect on the unsystematic risk component was non-linear and predominantly downward-sloping.

As we mentioned in the previous section, although there has been an increasing trend in the OBS bank activities in Turkey, there are no studies which examine the effects of OBS activities on the bank's performance.

IV. METHODOLOGY AND DATA

This study examines the influence of OBS activities on the performance of Turkish commercial banks in terms of banks' risk, profitability, leverage, and liquidity. The study starts with the analysis of the effect of OBS activities on bank risk exposures. The first estimation takes into account the influence of OBS activities on banks' market risk, unsystematic risk, and total risk. The traditional market model which assumes that banks are subject to systematic risk and unsystematic risk will be utilized in estimating market risk, unsystematic risk, and total risk for the commercial banks studied.

Systematic risk is non-diversifiable since it resulted from changes in the market and economic environment where the bank operates and therefore, known as market risk. On the other hand, the bank-specific risk is measured by unsystematic risk and can be diversified with proper portfolio management. The traditional market model is given by Equation (1).

$$R_{i,t} = \alpha_i + \beta_i R_{M,t} + e_{i,t} \tag{1}$$

where:

$R_{i,t}$ = holding period return of bank *i*th stock over the period ending at time *t*.

$R_{M,t}$ = holding period return of market portfolio over the period ending at time t.

$e_{i,t}$ = error-term measure bank-specific factors for bank *i*th over the period ending at time *t*

and assume to be independent of $R_{M,t}$.

Banks' market returns are calculated by taking the first difference of the natural logarithm of the daily closing stock price of the bank and market index respectively. These data is obtained from ISE. β_i represents the systematic risk for bank *i*th over the period ending at time *t* will be estimated from Equation (1). The standard deviation of the error-term will be used as a proxy for bank's unsystematic risk. Total risk of the bank's return is proxied by the standard deviation of the individual stock return. To examine in detail the bank exposure towards market factors, the multi-factor market model is employed. The model is given in Equation (2).

$$R_{i,t} = \alpha_i + \beta_1 R_{M,t} + \beta_2 R_{EX,t} + \beta_3 R_{ST,t} + \beta_4 R_{LT,t} + e_{i,t} \quad (2)$$

where:

$R_{i,t}$ = holding period return of bank *i*th stock over the period ending at time *t*.

$R_{M,t}$ = holding period return of market portfolio over the period ending at time *t*.

$R_{EX,t}$ = change in foreign exchange rates over the period ending at time *t*.

$R_{ST,t}$ = change in short-term interest rates (3-month t-bills) over the period ending at time *t*.

$R_{LT,t}$ = change in long-term interest rates (government bond) over the period ending at time *t*.

$e_{i,t}$ = error-term measure bank-specific factors for bank *i*th over the period ending at time *t*

and assume to be independent of $R_{M,t}$.

β_2 , β_3 , and β_4 are used to measure bank's exposure in terms of foreign exchange rate and interest rate risks due to OBS activities. These variables are included since OBS activities has been widely used as a tool for banks in hedging against interest rates risk and foreign exchange rate exposures. Therefore, it is expected that the OBS activities would contribute to the changes in the interest rate risks in both the short and long-term. Besides that, the use of derivatives and foreign exchange swaps is believed to contribute further to the foreign exchange rate risk. If commercial banks are successful in hedging their interest rate and foreign exchange exposures then a negative relationship between OBS activities and the interest rate and foreign exchange rate risks is expected. Nevertheless, positive relationship is expected if banks used OBS transactions as a speculative tool rather than for risk management purposes. The empirical model given by Equation (3) is used in analyzing the effect of OBS activities on bank's risk.

$$Risk_{it} = \alpha + \beta_1 OBS_{it} + \beta_2 TLTA_{it} + \beta_3 LTA_{it} + \beta_4 EA_{it} + \beta_5 FATA_{it} + \beta_6 LIQ_{it} + \beta_7 PLTA_{it} + \varepsilon_{it} \quad (3)$$

where:

$Risk_{it}$ = risks of bank *i*th at time *t*.

OBS_{it} = off-balance sheet activities of bank *i*th at time *t*.

$TLTA_{it}$ = ratio of total loans to total assets of bank *i*th at time *t*.

LTA_{it} = natural logarithm of total assets of bank *i*th at time *t*.

EA_{it} = shareholder's equity to total assets of bank *i*th at time *t*.

$FATA_{it}$ = fixed asset to total assets of bank *i*th at time *t*.

LIQ_{it} = liquid assets to total assets of bank *i*th at time *t*.

$PLTA_{it}$ = ratio of provision for loan losses to total assets of bank *i*th at time *t*.

ε_{it} = random error-term.

The values for the risk variables are obtained from the estimation of Equations (1) and (2) while other variables are from the bank's annual reports. Besides affecting the risk exposures of commercial banks, the OBS activities are believed to affect bank's performances, leverage, and liquidity. Equation (4), (5), and (6) are manipulated for this estimation.

$$Performance_{it} = \alpha + \beta_1 OBS_{it} + \beta_2 TLTA_{it} + \beta_3 LTA_{it} + \beta_4 EA_{it} + \beta_5 FATA_{it} + \beta_6 LIQ_{it} + \beta_7 PLTA_{it} + \varepsilon_{it} \quad (4)$$

$$Leverage_{it} = \alpha + \beta_1 OBS_{it} + \beta_2 TLTA_{it} + \beta_3 LTA_{it} + \beta_4 EA_{it} + \beta_5 FATA_{it} + \beta_6 LIQ_{it} + \beta_7 PLTA_{it} + \varepsilon_{it} \quad (5)$$

$$LIQ_{it} = \alpha + \beta_1 OBS_{it} + \beta_2 TLTA_{it} + \beta_3 LTA_{it} + \beta_4 EA_{it} + \beta_5 FATA_{it} + \beta_6 PLTA_{it} + \varepsilon_{it} \quad (6)$$

where:

$Performance_{it}$ = return on equity or stock return of bank *i*th at time *t*.

$Leverage_{it}$ = ratio of total debts to total assets of bank *i*th at time *t*.

OBS_{it} = off-balance sheet activities of bank *i*th at time *t*.

$TLTA_{it}$ = ratio of total loans to total assets of bank *i*th at time *t*.

LTA_{it} = natural logarithm of total assets of bank *i*th at time *t*.

EA_{it} = shareholder's equity to total assets of bank *i*th at time *t*.

$FATA_{it}$ = fixed asset to total assets of bank *i*th at time *t*.

LIQ_{it} = liquid assets to total assets of bank *i*th at time *t*.

$PLTA_{it}$ = ratio of provision for loan losses to total assets of bank *i*th at time *t*.

ε_{it} = random error-term.

We employ stock returns and return on equity as proxies for profitability. Debt to total assets ratio is used to measure the bank's leverage position while the liquid assets to total assets ratio is used to measure the bank's liquidity position. Equations (3), (4), (5), and (6) are estimated to determine the effects of OBS activities on banking risk exposure, performance, leverage, and liquidity. The ratio of total loans to total assets and the ratio of provision for loan losses to total assets are used to control for the effect of credit risk. In addition, total assets is included in the estimation to control for bank's size since it is believed that bank's risk exposure and performance are affected by the scale of the operation. The ratio of equity to total assets is used to control for bank's leverage since the use of debts might result in better management. However, the use of debts can also expose the bank to excessive risk. Finally, the ratio of fixed assets to total assets and liquidity ratio are used to control for banks liquidity. We used the unbalanced panel data estimation with both and random effects. The fixed effect model assumes that the idiosyncratic

error ε_{it} is uncorrelated with all the explanatory variables across all time periods and this method is therefore used to remove the unobserved effect. Consequently, any time-constant explanatory variables will be removed from the model prior to the estimation. Nevertheless, this model allows for arbitrary correlation between the unobserved effects with the explanatory variables across time. On the other hand, the random effect model is estimated with the assumption that the unobserved effect is independent of the explanatory variables in the estimated model. The standard Hausman test will be employed to identify the final model to be used in the study. The null hypothesis of standard Hausman test states that the conditional mean of the disturbances given the regressors is zero. The fixed effect model will be use if the null hypothesis is rejected (Baltagi et al., 2003:79).

V. EMPIRICAL FINDINGS

A. Off-Balance Sheet Activities and the Risks of Locally-Owned Commercial Banks

The results of the Hausman test are presented in Table 1. The null hypothesis that the unobserved effect is independent from other explanatory variables cannot be rejected. Hence, the random effect model will be used to estimate the relationship between OBS activities and bank's performance.

TABLE 1. HAUSMAN TEST ESTIMATION

Variable	*Hausman Test*	*p-value*
Total risk	10.71	0.15
Market risk	9.11	0.24
Unsystematic risk	10.95	0.14
Return	0.63	0.99
ROE	1.53	0.98
Debt	0.84	0.99
Liquidity	6.05	0.42

Source: Authors' estimation

*Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level*

The results of the estimation on the effect of OBS activities on Turkish bank's total risk, market risk and unsystematic risk are presented in Table 2.

TABLE 2. PANEL DATA ESTIMATION OF THE IMPACT OF OBS ACTIVITIES ON TOTAL, MARKET AND UNSYSTEMATIC RISK OF COMMERCIAL BANKS IN TURKEY

Variable	*Total risk*	*Market risk*	*Unsystematic risk*	*Variable*	*Total risk*	*Market risk*
	Coefficient	*t-ratio*	*Coefficient*	*t-ratio*	*Coefficient*	*t-ratio*
Constant	0.055	3.31***	-0.125	-0.26	0.072	5.29***
OBS	-0.001	-1.15	0.003	0.10	0.001	1.76*
TLTA	-0.004	-0.83	0.033	0.18	0.005	1.05
LTA	-0.000	-0.31	0.065	1.89*	-0.004	-4.43***
ETA	0.023	1.88*	-0.272	-0.62	0.007	0.64
FATA	-0.005	-1.26	0.100	0.69	0.002	0.42
LIQ	-0.001	-0.63	0.047	0.57	-0.001	-0.65
PLLTA	-0.090	-2.00**	0.050	0.03	-0.021	-0.52

Source: Authors' estimation

Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level

The results show that the bank's unsystematic risk is positively correlated with the OBS activities and is significant at the 10% level. This indicates that OBS activities induce risk on individual bank's operation and management. Therefore, banks need to carefully evaluate their engagement in OBS activities in the banking operations so as to reduce bank's exposure. In addition, OBS activities are found to increase risk exposure of the banking industry as a whole. This is shown by the positive correlation between market risk and OBS activities even though it is not significant. Therefore, to further analyse the effects of market factors on OBS activities, the multi factor market model as in Equation (2) is estimated by taking into consideration the effects of OBS activities on interest rate risks and foreign exchange risk. The estimation results of Equation (2) are presented in Table 2. The results show that when more risk factors are included in the model, the OBS activities are positively correlated with all the risk factors such as market, short-term interest rate, foreign exchange rate, unsystematic and total risk. The effect of OBS on the foreign exchange rate risk is significant at the 10% level. This suggests that bank's engagement in OBS activities increases foreign exchange exposure. This is not surprise since significant amount of OBS activities in Turkish banks are precisely in foreign exchange and derivatives products.

As pointed out by Allayannis and Ofek (2001:20), positive relationship between bank exposures and OBS activities may result from speculative action by banks in generating higher earnings through the use of OBS transactions in the market. This indirectly resulted in higher risk associated with the use of OBS products. The result is consistent with Choi and Elyasiani (1997:12) which found that OBS activities are more prominent in affecting foreign exchange risk exposure of US commercial banks compared to the interest rate risk. Based on the Hausman test results for different types of risk, the random effects model is also selected in explaining the influence of OBS activities on risk exposures of Turkish commercial banks.

TABLE 3. PANEL DATA ESTIMATION OF THE IMPACT OF OBS ACTIVITIES ON RISK EXPOSURES OF COMMERCIAL BANKS IN TURKEY

Variable	*Market risk*		*Short term rates*		*Long-term rates*		*Forex*		*Unsystematic risk*		*Total risk*	
	Coefficient	*t-ratio*	*Coefficient*	*t-ratio*	*Coefficient*	*t-ratio*	*Coefficient*	*t-ratio*	*Coefficient*	*t-ratio*	*Coefficient*	*t-ratio*
Constant	-0.606	-1.23	-0.037	-0.81	-0.023	-1.49	-1.502	-2.95***	0.061	4.32***	0.0700	5.26***
OBS	0.039	1.56	0.002	0.71	-0.000	-0.06	0.053	1.75*	0.001	0.78	0.000	0.48
TLTA	0.209	1.20	0.000	0.02	-0.004	-0.58	0.400	1.88*	0.001	0.18	-0.003	-2.56**
LTA	0.050	1.44	0.000	0.06	0.001	1.08	0.026	0.67	-0.003	-2.84***	-0.005	-0.29
ETA	-1.764	-3.23***	-0.080	-1.29	-0.015	-0.69	-0.649	-0.99	0.016	1.06	0.018	2.83***
FATA	0.664	3.21***	-0.022	-0.98	0.007	0.87	-0.114	-0.48	0.001	0.17	0.000	0.11
LIQ	0.215	2.33**	0.012	1.12	0.009	0.22	0.124	1.11	-0.002	-0.70	-0.076	-1.16
PLLTA	2.600	1.324	0.347	1.53	0.044	0.56	1.702	0.71	-0.068	-1.26	0.000	0.48

*Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level*

TABLE 4. HAUSMAN TEST ON THE IMPACT OF OBS ACTIVITIES TOWARDS DIFFERENT TYPES OF RISK EXPOSURES

Variable	*Hausman Test*	*p-value*
Total risk	1.90	0.97
Market risk	11.94	0.10
Short-term risk	8.35	0.30
Long-term risk	5.88	0.55
FOREX	7.84	0.35
Unsystematic risk	10.32	0.17

Source: Authors' estimation

*Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level*

B. Off-Balance Sheet Activities and Bank's Profitability

To further analyze the impact of OBS activities on bank's performance, we also run the estimation with stock returns and returns on equity ratio as the dependent variables. This is because, besides risk exposures, OBS activities might also affect bank's profitability. The results of the estimation of the effect of OBS activities on bank's profitability are presented in Table 5. Based on the results, it is clear that OBS activities improve bank's stock returns, which is statistically significant even at 1% level. However, the return on equity is negatively related to OBS activities and is significant at 10% level. As suggested by Brewer et al. (1996: 20), the negative relationship might be due to the fact that stockholders expect returns to drop when OBS activities significantly reduce the risk exposure of the banks. Thus, this contributes to higher stock returns due to the perception of lower risk.

TABLE 5. RESULTS OF PANEL DATA ESTIMATION OF THE EFFECT OF OBS ACTIVITIES ON BANK'S PROFITABILITY

Variable	*Stock Return*		*ROE*	
	Coefficient	*t-ratio*	*Coefficient*	*t-ratio*
Constant	-0.0031	-0.811	-66.9294	-0.192
OBS	0.0006	2.823***	-35.8807	-1.866*
TLTA	0.0008	0.525	-246.0416	-1.890*
LTA	-0.0004	-1.359	43.4396	1.766*
ETA	-0.0028	-0.764	616.4242	1.934*
FATA	-0.0021	-1.762*	-274.7340	-2.654***
LIQ	0.0012	1.756*	-20.8669	-0.348
PLLTA	-0.0036	-0.256	-2180.3872	-1.821*

Source: Authors' estimation

*Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level*

Finally, the effects of OBS activities on bank's leverage and liquidity positions are analyzed. The results of the panel data estimation are shown in Table 6.

TABLE 6. . RESULTS OF PANEL DATA ESTIMATION OF THE EFFECT OF OBS ACTIVITIES ON BANK'S LEVERAGE AND LIQUIDITY RATIO

Variable	*Leverage*		*Liquidity*	
	Coefficient	*t-ratio*	*Coefficient*	*t-ratio*
Constant	-0.0268	-0.124	1.6573	2.824***
OBS	0.0136	1.188	-0.0478	-1.264
TLTA	0.0565	0.730	0.1769	0.688
LTA	-0.0140	-0.936	-0.0393	-0.862
ETA	2.1107	11.061***	4.1726	11.125***
FATA	0.0099	0.159	0.5031	2.709***
LIQ	0.0231	0.644	-	-
PLLTA	1.2393	1.732*	-3.7624	-1.647*

Source: Authors' estimation

*Notes: * significance at 10% level, ** significance at 5% level, *** significance at 1% level*

The results in Table 6 indicate that OBS activities do not have significant impact on liquidity and leverage position of the Turkish commercial banks. From the estimated results, one can conclude that the OBS activities by Turkish commercial banks significantly affect bank performance in terms of both stock return and profitability ratio.

VI. FINAL REMARKS

This study analyzes the effect of OBS activities on risks and performance of Turkish banks. The performance of commercial banks studied includes bank's risk exposures, bank's profitability, leverage, and liquidity position. The results show that bank's risk exposures are positively correlated with OBS. The bank-specific risk and foreign exchange rate risk are found to be positively correlated with OBS activities. This indicates that OBS activities increase bank-specific risk and foreign exchange exposures of Turkish commercial banks. The positive relationship might serve as a warning to bank's speculative action through the use of OBS transactions in the market, which is in line with Allayannis and Ofek (2001) findings.

The results also indicate that OBS activities improve bank's stock return but have a negative impact on return on equity. As suggested by Brewer et al. (1996), the negative relationship might due to the fact that stockholders expect return to drop when OBS activities significantly reduces risk exposure of the banks. The perceived lower risk contributes to higher stock returns.

We can conclude that OBS activities are more prominent in affecting bank's performance in terms of earning capability rather than directly contributing to banks risk exposure. The results of this study are consistent with Brewer et al. (1996), Lynge and Lee (1987) and Hassan (1992) in their analysis of OBS effect on the US banks' performance. Similar to Avery and Berger (1991) study, we found a modest positive relationship between OBS activities and bank's risk exposure suggesting that OBS activities create some degree of risk in Turkish commercial banks.

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UTJECAJ VANBILANČNIH AKTIVNOSTI NA POSLOVANJE KOMERCIJALNIH BANAKA: PERSPEKTIVA TRŽIŠTA U NASTAJANJU

SAŽETAK

Ovaj rad istražuje utjecaj vanbilančnih aktivnosti na poslovanje banaka koje kotiraju na Istambulskoj burzi (ISE). Istraživanje je provedeno na četiri mjere uspješnosti bankovnog poslovanja: izloženost rizicima, profitabilnost, zaduženost i likvidnost. Rezultati pokazuju da su nesistemski, bankovno-specifični rizik te valutni rizik u pozitivnoj vezi s vanbilančnim aktivnostima. Ovakvo stanje je pokazatelj da vanbilančne aktivnosti povećavaju nesistemski i valutni rizik banaka u Turskoj. Dokazana pozitivna veza može služiti kao upozorenje u slučaju špekulativnog korištenja vanbilančnih aktivnosti na tržištu. Dobiveni rezultati također pokazuju da zbog percepcije njihovog korištenja u svrhu zaštite, vanbilančne aktivnosti povećavaju prinose na bankovne dionice ali istovremeno smanjuju prinos na kapital banaka. Osim toga, vanbilančne aktivnosti nemaju statistički signifikantan utjecaj na zaduženost i likvidnost banke.

Ključne riječi: bankarstvo, vanbilančne aktivnosti, izloženost rizicima, Istambulska burza, Turska

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DOES IDIOSYNCRATIC VOLATILITY MATTER IN THE EMERGING MARKETS? ISTANBUL STOCK EXCHANGE EVIDENCE

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ABSTRACT

In finance literature, Capital Asset Pricing Model predict only systematic risk is priced in equilibrium and neglect firm specific (idiosyncratic) risk which can be eliminated by diversification. However in real world investors, who are disable to diversify their portfolios, should take into consideration idiosyncratic risk beside of systematic risk in prediction of expected return. In this article, we examine real market conditions in Istanbul Stock Exchange (ISE), an emerging market stock exchange, over the period 2007:01 to 2010:12 by studying market wide and idiosyncratic volatility following the methodology of Campbell et al.(2001). Our findings suggest that, in 2007-2010 period, idiosyncratic volatility is the biggest component of total volatility and shows no trend in this period. Beside that our analyses about the predictive ability of various measures of idiosyncratic risk provide evidence that idiosyncratic volatility is not a significant predictor for future return.

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I. INTRODUCTION

Today, international and domestic financial crisis, risk management, advancing usage of derivatives and increasing financial awareness leads to increase interest for prediction of volatility and its components. On the other hand, there is an ongoing debate in financial literature about which factors drives volatility. Standard asset pricing models such as Capital Asset Pricing Model (CAPM), predict that only systematic risk is priced in equilibrium. It should be noted that full diversification plays an important role in the assumption of the studies carried out for the validity of CAPM.

Malkiel (2003) suggests that 200 stocks may be necessary to the same level of diversification that would be achieved with 20 stocks in 1960's. With remarkable increase in the market volatility, it is obvious that a portfolio of 20 or 30 stocks seems inadequate to diversify investment risk (Xu, 2009). Campbell et al. (2001) suggest that the number of randomly selected stocks needed to achieve relatively complete portfolio diversification is about 50. In terms of Turkish market conditions, Cura and Gokce (2003) find 12-14 stocks, Demirci ve Keskinturk (2007) find 8 stocks and Altay, Ungan and Akdeniz (2003) find 10 stocks would be necessary in order to hold well diversified portfolio.

However in real world, investors cannot diversify their portfolios because of budget and liquidity constraints, taxes, transaction costs etc. Goetzmann and Kuma (2008) show that based on a sample of more than 62,000 household investors in the period 1991-1996 in U.S., more than 25% of the investor portfolios contain only one stock, over half of the investor portfolios contain no more than three stock, and less than 10% of the investor portfolios contain more than 10 stocks. The situation of Turkish investors is not quite different. The fact that average portfolio size of retail investors was nearly 760 U.S. Dollar in 2010, gives opinion about diversification ability of Turkish investors[1]. In light of the foregoing, idiosyncratic risks should be taken into consideration beside of systematic risk in asset pricing.

At this point, what the idiosyncratic risk is and which factors effect idiosyncratic volatility should be remembered. Idiosyncratic risk is defined as the risk that is unique to a specific firm, so it is also called firm-specific risk. By definition, idiosyncratic risk is independent of the common movement of the market (Fu, 2008). A number of studies have investigated which factors such as market capitalization (Rosenberg et al., 1985; Banz, 1981; Fama and French, 1992; Malkiel and Xu, 1997;2002), book to market equity (Fama and French, 1992, 1993, 1996 and 1998), earnings yield (Basu, 1983), cash flow yield (Chan et al., 1991), leverage (Bhandari, 1988; Dennis and Strickland, 2004), sales-price ratio (Barbee et al., 1996), institutional ownership, increased firm focused (Dennis and Strickland, 2004) explain stock returns in addition to firm's systematic risk. For each stock, such variables come together with different combinations and effect idiosyncratic risk of that stock.

Another dimension of volatility is its time varying property. Since idiosyncratic volatility is a component of total volatility, some important studies have dealt with trends of idiosyncratic volatility for different markets and find conflicting evidence relating to rise and fall in the idiosyncratic volatility levels. Campbell et al. (2001) apply monthly data over the 1962-1997 periods and show that average idiosyncratic risk is the most important component of average total volatility which has increased noticeably over the period while market volatility shows

[1] "Turkish Capital Markets Report 2010" published by The Association of Capital Market Intermediary Institutions of Turkey.

no significant trend. Moreover this result relating to US market was confirmed by the study of Malkiel and Xu (2003). Yet more recent evidence, Brandt et al. (2010) suggests that the increase in idiosyncratic volatility through the 1990s was not a time trend but, rather, an episodic phenomenon, at least partially associated with retail investors.

Even reporting different conclusion about time trend, some recent important studies which examine different markets should also be mentioned. Sault (2005) investigates Australian market firm level volatility in 1973 to 2003 period by using Campbell's methodology and found clear downward trend which is confirmed with Hodrick Prescot Filter and OLS tests. Kearney and Poti (2008) study on the markets of the European Monetary Union over the period of 1974-2004 and find that idiosyncratic volatility has upward trend in Euro-zone area. Angelidis and Tessoramatis's (2008) evidence suggests that idiosyncratic volatility based on either large or small market capitalization stocks has been increasing during the 1990's in the UK. Unlike previous studies, Sousa and Serra (2008) find no evidence of a statistically rise in firm specific volatility in Portuguese market over the 1991-2005 period. Bekaert et al. (2010) examine aggregate idiosyncratic volatility in 23 developed equity markets and found no evidence of upward trends when they extend the sample till 2008.

Whether idiosyncratic risk is priced in asset returns has also been the subject of considerable attention in the finance literature. Levy (1978) theoretically shows that idiosyncratic risk affects equilibrium asset prices if investors do not hold many assets in their portfolios. Merton (1987) argues that expected idiosyncratic volatility may explain expected stock returns if investors are under diversified. Therefore, firms with larger total *(or idiosyncratic)* variance require higher returns to compensate for imperfect diversification.

Although some studies find a positive relation between idiosyncratic volatility and expected returns at the firm or portfolio level, often the cross sectional relation has been found insignificant, and sometimes even negative. Malkiel and Xu (2002) find a significantly positive relation between idiosyncratic risk and the cross section of expected returns at the firm level. The discovery by Goyal and Santa-Clara (2003) shows that there is a positive relation between the equal-weighted average stock volatility and the value-weighted portfolio returns from NYSE/AMEX/NASDAQ stocks, and the lagged volatility on the market level may mean no predictability of the expected market returns.

Nevertheless, Ang, Hodrick, Xing and Zhang (2006) find a result that is opposite to the previous studies. Their investigation indicates a substansive puzzle that has a strong negative relation between lagged idiosyncratic volatility and future returns. Guo and Savickas (2006) also report a negative relation between aggregate stock market idiosyncratic volatility and future quarterly stock market returns. Fu (2008) points out that the findings of Ang's et al. (2006) are largely explained by the return reversal of stocks with high idiosyncratic volatility and also finds a significantly positive relation between the estimated conditional idiosyncratic volatilities and expected returns. In this study, Fu employs Exponential Generalized Autoregressive Conditional Heteroskedasticity *(EGARCH)* models and uses out of sample data to capture the time varying property of idiosyncratic risk.

Bali and Cakici (2008) investigate why the existing literature provides conflicting evidence on the link between idiosyncratic risk and the cross section of expected returns. They use different volatility measures *(daily and monthly data)*, weighting schemes *(value-weighted, equal weighted, inverse volatility-weighted)*, breakpoints *(CRSP, NYSE, equal market share)* and samples *(NYSE/AMEX/NASDAQ and NYSE)* and find that no robustly significant relation exists between idiosyncratic volatility and expected return.

Huang, Liu, Rhee and Zhang (2010) take the return reversals into consideration while explaining the relation between idiosyncratic volatility and expected return. Their results suggest that short term return reversals are a primary reason for the negative relation between realized idiosyncratic volatility and stock returns in the subsequent month, with more accurate estimate from the daily data, they confirm that the idiosyncratic risk is positively related to expected returns.

Besides the conflicting results for the US markets, series of studies relating to some other markets also reach divergent conclusions. Ang et al. (2004) prove that their determination of the negative relation between idiosyncratic volatility and expected return are valid for G7 stock market[2]. Angelidis and Tessoromatis (2008) analyze relation of idiosyncratic volatility with return in UK market and report evidence that the idiosyncratic volatility of small stocks predicts the small capitalization premium but has no forecasting power for "pure" market risk or the value/growth spread. Bollen, Skotnicki and Veeraraghavan's (2009) findings suggest that idiosyncratic volatility is not priced in the Australian market. Drew ve Veeraraghavan's (2002) study relating to Hong Kong, Indian, Malaysia and Philippines markets and Drew, Marsden and Veeraraghavan's (2007) study relating to New Zelland market find evidence of a negative relationship between firm size and a stocks idiosyncratic volatility. They also find that high idiosyncratic volatility firms have high betas and generate low earnings.

Following the adoption of related regulations launched in the beginning of 1980's, the ISE was officially established in 1985 and started its operations on 1986. ISE has made a great progress in its short history. The number of corporations whose shares are traded on the ISE equities market was 80 by the end of 1986, the year in which the ISE was established. By the end of 2010, there are 338 corporations traded on ISE. Market capitalization, which was only 938 million US Dollar by the end of 1986, reached 308 billion US Dollar by the end of 2010.

In 2010, the daily average trading volume has been 1,703 million US Dollar and total trading volume has been 425.7 billion US Dollar. This figure indicates an increase of 34.6% in Dollar terms over the previous year. There are approximately one million investors and the ratio of equities owned by foreign customers to total equities in custody is 66.8% by the end of 2010.

With a market capitalization of US$ 308 billion, the ISE ranks 14th among emerging markets in terms of market capitalization. ISE maintains its position as the most developed and liquid exchange in its region, ranks 6th among the emerging markets in terms of stock trading value and 3rd in terms of bond trading value. The total amount of funds rose through the ISE from its establishment in1986 to the end of 2010 totaled US$ 48.6 billion.

In 2010, the return of the ISE-100 Index on US dollar basis was registered as 21% while the returns of the MSCI Developed Markets and the MSCI Emerging Markets indexes[3] were 10% and 16%, respectively. Following Figure 1 shows performance of ISE National 100 Index over against MSCI Developed and MSCI Developing Indexes.

[2] Canada, France, Italy, Japan, US and UK.
[3] Canada, France, Italy, Japan, US and UK.

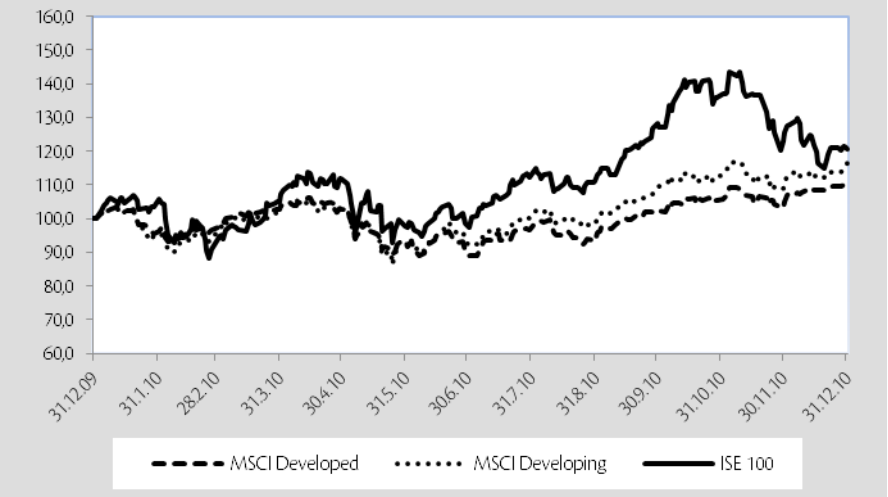

FIGURE 1. ISE NATIONAL 100 AND MSCI INDEXES.

Source: Bloomberg

The main indicator of the Stock Market is the ISE-100 Index, constituted of 100 companies traded on the National Market and real estate investment trusts, venture capital investment trusts on the Collective Products Market, with high market capitalization and liquidity. ISE 100 Index was among the best performing indexes in 2010 with 24.9% of return in TL terms.

As an emerging market, Istanbul Stock Exchange (ISE) shows high volatile character in its short history and has huge rate of foreign investors' ownership in stock market so that, analyzing idiosyncratic volatility on ISE is critically important especially for investors and other parties. In this context, our study aims to introduce structure and behavior of idiosyncratic volatility and find evidence that even if idiosyncratic volatility is the variable to be used in calculation of expected return in ISE. Therefore, we have dealed with answers of some specific questions such as, what is the ratio of idiosyncratic volatility in total volatility, what kind of relationship exist between idiosyncratic volatility and market volatility, does market capitalization of a firm effect idiosyncratic volatility, is there a time trend of idiosyncratic volatility and what is the predictive ability of idiosyncratic volatility for future return.

The paper proceeds as follows: Section 2 provides brief information about measuring idiosyncratic risk. Section 3 presents empirical evidence and in Section 4, the findings will be explained and finally our conclusions and evaluations will be given in 5th Section.

II. MEASURING IDIOSYNCRATIC RISK

Idiosyncratic volatility is unobservable and model dependent; therefore one of the wide used method in literature is Campbell et al.'s (2001) *Indirect Method* which uses the market model under the assumption that the betas of all securities are one and calculates idiosyncratic return as the difference between stock and market return.

A. Indirect Method

Campbell et al.'s (2001) Indirect method decomposes the return on a "typical" stock into three components: the market wide return, an industry specific residual and a firm-specific residual. Based on this return decomposition, they construct time series of volatility measures of the three components for a typical firm. So, they can define volatility measures that sum to the total return volatility reach firm specific risk series without having to keep track of covariances and without having to estimate betas for firms or industries.

Goyal and Santa Clara (2003), Guo and Savickas (2003) and Angelidis and Tessoramatis (2008) compute the monthly variance of a portfolio *p* using within-month daily return data as,

$$V_{pt} = \sum_{d=1}^{d_t} r_{pd}^2 + 2\sum_{d=2}^{D_t} r_{pd} r_{pd-1} \quad (1)$$

By using the approach proposed by French et al. (1987). In this equation, D_t is the number of days in month *t* and r_{pd} is the portfolio's return on day *d*. Surprisingly, the equation above do not compute the stock variance accurately, since it does not demean the returns. However for short holding periods, because of the impact of the subtracting the means is minimal, so it may be omitted of the monthly variance computation, as French et al (1987) and Goyal and Santa Clara (2003) stated. Nonetheless French et al. (1987) pointed out that non-synchronous trading of securities causes daily portfolio returns to be autocorrelated, particularly at on lag one. So, the second term of the *Equation 1* adjusts the variance to the autocorrelation of the stock returns (Angelidis and Tessaromatis, 2008).

In this context, the calculation of the average equal-weighted total variance at month *t*, TV_t^{Equal} is,

$$TV_t^{Equal} = \frac{1}{N}\sum_{i=1}^{N_t} V_{i,t} \quad (2)$$

Alternatively, it is also possible to calculate total variance on market value-weighted basis TV_t^{Value} as follows:

$$TV_t^{Value} = \sum_{i=1}^{N} \omega_{i,t} V_{i,t} and \omega_{i,t} = \frac{v_{i,d_{t-1}}}{\sum_{i=1}^{N} v_{i,d_{t-1}}} \quad (3)$$

Where N is the number of stocks during month *t*, while $v_{i,d_{t-1}}$ is the market capitalization of stock *i* in day *d* in month *t-1*.

While Xu and Malkiel (2001) suggest that the value-weighted aggregate volatility of individual stocks consists of the volatility imparted by movements in the broad market index and aggregate idiosyncratic volatility, Angelidis and Tessoramatis (2008) point out that using the market model under the assumption that the betas of all securities against the market is one, the variance of stock *i* at time *t*, $V_{i,t}$, can be decomposed in two parts: a systematic part which equals to the variance of the market, MV_t and an idiosyncratic part which equals to the variance of the idiosyncratic return, $IV_{i,t}$.

$$V_{i,t} = MV_t + IV_{i,t} \tag{4}$$

Therefore, the aggregate idiosyncratic variance is calculated as follows:

$$IV_t = TV_t - MV_t \tag{5}$$

Where TV_t is the aggregate total volatility calculated from individual stock's variance, (Equations 2 or Equation 3) and MV_t is the variance of the market. The average equally weighted idiosyncratic variance is defined as follows:

$$IV_t^{Equal} = TV_t^{Equal} - MV_t \tag{6}$$

And the average value weighted idiosyncratic variance as follows:

$$IV_t^{Value} = TV_t^{Value} - MV_t \tag{7}$$

III. THE EMPIRICAL STUDY

A. Data and Methodology

Closing prices and market capitalizations are collected from ISE and return of each stock is calculated on daily basis. We employ with the companies in ISE National-100 Index which constitute 78% of total trading volume and 80% of total capitalization as of December 31th 2010.

We measure idiosyncratic risk with indirect method by following Campbell's (2001), Goyal and Santa Clara (2003) Guo and Savickas (2006) and Angelidis and Tessoramatis (2008) in 01.01.2007-31.12.2010 period. The sample includes 135 different stocks, some of which in the meanwhile added to or dropped from the Index.

Average idiosyncratic risk is calculated on monthly basis with daily returns of stocks which are traded on every trading day on that month. Bali and Cakici (2008) state that realized idiosyncratic volatility measure obtained from monthly data is a more accurate proxy for the expected future volatility than the idiosyncratic volatility measure obtained from daily data.

Points to be considered in our analysis as follows:

- Monthly return variance of each stock traded in ISE National-100 Index is calculated for each month by using *Equation 1*,
- For monthly average variance calculation, we include all stocks which are traded all trading days in that month. *Equation 2* and *Equation 3* are used in calculation of equally and value weighted average variance. In calculation of value weighted average variance we take into account market capitalization of the stock as of last day of previous month.
- We classified the stocks considering market capitalization of previous month into three portfolios for each month, BIG, SMALL and ALL. For the creation of size portfolios, we use median by following Fama and French (1993).
- Monthly market variance *(MV)* is calculated with daily closing value of the Index.
- *Equation 6* and *Equation 7* are used to gather equally and value weighted idiosyncratic variance series of BIG, SMALL and ALL portfolios.

IV. FINDINGS

A. Descriptive Statistics

Following Table 1 presents descriptive statistics on the various measures of volatilities based on BIG, SMALL and ALL stocks and ISE National 100 Index which is assumed as market portfolio in the period of 01.01.2007-31.12.2010.

TABLE 1 - DESCRIPTIVE STATISTICS*

	Mean	*Median*	*Max*	*Min*	*S.D.*	*Skew*	*Kurt.*	*J.B.*	*AR1*	*AR6*	*AR12*
TV_{ALL}^{Equal}	0.0245	0.0197	0.1193	0.0050	0.0187	3.19	15.62	399.603	0.507	0.009	-0.103
TV_{BIG}^{Equal}	0.0246	0.0195	0.1175	0.0058	0.0185	3.02	14.89	355.827	0.428	0.009	-0.087
TV_{SMALL}^{Equal}	0.0243	0.0203	0.1210	0.0042	0.0199	2.89	13.43	284.338	0.527	0.009	-0.144
TV_{ALL}^{Value}	0.0223	0.0178	0.1145	0.0051	0.0177	3.34	16.98	480.346	0.537	0.025	-0.119
TV_{BIG}^{Value}	0.0210	0.0165	0.1088	0.0046	0.0169	3.33	16.96	478.692	0.529	0.032	-0.12
TV_{SMALL}^{Value}	0.0013	0.0010	0.0057	0.0002	0.0010	2.47	10.51	161.789	0.458	-0.123	-0.078
IV_{ALL}^{Equal}	0.0240	0.0369	0.1172	0.0049	0.0183	3.19	15.69	403.248	0.498	0.007	-0.102
IV_{BIG}^{Equal}	0.0242	0.0192	0.1154	0.0057	0.0181	3.02	14.91	356.892	0.417	0.007	-0.085
IV_{SMALL}^{Equal}	0.0239	0.0199	0.1189	0.0041	0.0196	2.88	13.42	283.517	0.519	0.007	-0.144
IV_{ALL}^{Value}	0.0218	0.0175	0.1124	0.0050	0.0174	3.35	17.08	486.009	0.529	0.024	-0.116
IV_{BIG}^{Value}	0.0205	0.0161	0.1067	0.0045	0.0165	3.34	17.06	484.549	0.52	0.031	-0.117
IV_{SMALL}^{Value}	0.0008	0.0007	0.0036	0.0001	0.0007	2.11	8.35	92.793	0.162	-0.254	0.031
MV	0.0005	0.0003	0.0022	0.0001	0.0005	2.64	7.60	142.145	0.625	0.051	-0.093

Source: Authors' calculation

** TV is the total variance, IV is the idiosyncratic risk, while MV is the variance of the market. "SD" is the standard deviation, "Skew" is the skewness, "Kurt" is the kurtosis. "J.B" is the Jarque-Bera statistic. AR1, AR6 and AR12 are the autoregressive coefficients of order 1, 6 and 12 respectively.*

Table 1 shows that idiosyncratic volatility is the largest component of total volatility irrespective of the size and employed weighting scheme, similar to findings of Campbell et al. (2001), Goyal and Santa Clara (2003) for the US market and Angelidis and Tessaromatis (2008) for the UK market. The average idiosyncratic volatility represents between *64.62%* and *98.17%* of total average volatility and therefore market variance is only fraction of the total variance.

Equally weighted total variances of BIG and SMALL stocks take very similar values. On the contrary, variance of SMALL stocks is only 4% of variance of ALL stocks in value weighted volatility calculation. The reason of this difference between weighting schemes is that SMALL stocks take very low weights because of their very small sizes in value weighted calculation, while they show similar volatilities as compared with BIG and ALL in equally weighted calculation. Although there

are empirical findings which display that small sized stocks have high volatility, we reach divergent finding of positive relation between size and idiosyncratic volatility.

B. Correlation Analysis for ISE Portfolios

Table 2 reports the correlation between the various risk measures of the ISE-100 ALL, BIG and SMALL portfolios for 2007-2011 period.

TABLE 2. CORRELATION MATRIX*.

	TV^{Equal}_{ALL}	TV^{Equal}_{BIG}	TV^{Equal}_{SMALL}	TV^{Value}_{ALL}	TV^{Value}_{BIG}	TV^{Value}_{SMALL}	IV^{Equal}_{ALL}	IV^{Equal}_{BIG}	IV^{Equal}_{SMALL}	IV^{Value}_{ALL}	IV^{Value}_{BIG}	IV^{Value}_{SMALL}
TV^{Equal}_{ALL}	1.000											
TV^{Equal}_{BIG}	0.940	1.000										
TV^{Equal}_{SMALL}	0.937	0.767	1.000									
TV^{Value}_{ALL}	0.900	0.925	0.775	1.000								
TV^{Value}_{BIG}	0.884	0.922	0.748	0.999	1.000							
TV^{Value}_{SMALL}	0.895	0.953	0.953	0.760	0.728	1.000						
IV^{Equal}_{ALL}	1.000	0.939	0.937	0.898	0.881	0.896	1.000					
IV^{Equal}_{BIG}	0.939	1.000	0.765	0.923	0.920	0.731	0.938	1.000				
IV^{Equal}_{SMALL}	0.935	0.763	1.000	0.770	0.743	0.954	0.935	0.761	1.000			
IV^{Value}_{ALL}	0.898	0.924	0.773	1.000	0.999	0.759	0.897	0.922	0.768	1.000		
IV^{Value}_{BIG}	0.882	0.921	0.745	0.999	1.000	0.727	0.880	0.919	0.740	0.999	1.000	
IV^{Value}_{SMALL}	0.659	0.474	0.766	0.478	0.443	0.855	0.667	0.480	0.775	0.484	0.448	1.000
MV	0.697	0.687	0.639	0.693	0.692	0.539	0.685	0.675	0.627	0.681	0.680	0.095

Source: Authors' calculation

** This table reports the bivariate correlation between the various variance measures, which are log-transformed.*

The correlation between the equally and value weighted total and idiosyncratic volatility are almost 1 *(99.98%)*. Correlations change between *95.40%* and *77.46%* when the weighting scheme is changed for the same portfolio *(BIG, SMALL or ALL)* and same measure *(total or idiosyncratic)*. But correlations between total and idiosyncratic volatilities appear by the range of *99.98%* and *85.53%*, when all the other things are constant. We believe that high correlations are resulted from high percentages of idiosyncratic volatility in total volatility.

On the other hand, correlations between variance of the individual stocks *(total or idiosyncratic)* and market variance are relatively low. These correlations which are shown at the last row of the table change by the range of *69.70%* to *9.50%*.

At the same time, our correlation matrix gives chance to analyze size effect. Regarding to high correlations, total volatility measures of BIG stocks are similar to ALL stocks' *(Equally-weighted: 93.96%; Value-weighted: 99.98%)*. SMALL stocks have relatively low correlation between ALL stocks when it is value-weighted *(75.97%)*.

In summary, we arrive at a conclusion that BIG, SMALL and ALL stocks have similar volatility structure on the basis of high correlations. But SMALL stocks show relatively lower volatility when their market value weights are taken into consideration.

C. Results of the Idiosyncratic Models Relating to Size Effect

In order to measure influence of idiosyncratic volatility of BIG and SMALL stocks on total volatility and find which weightening scheme captures behavior of size effect more accurately, we follow Angelidis and Tessaromatis (2008) and employ following regressions[4]. In this regard, given the evidence presented in Table 1 that volatility display large skewness and kurtosis, we log transform the variance measures[5]. Regression on equally weighted volatility is as follows;

$$TV_{ALL}^{Equal} = 0.0435 + 0.5277 * IV_{BIG}^{Equal} + 0.4593 * IV_{SMALL}^{Equal} + 0.0067 * MV + 0.0348 \quad (8)$$

(0.4178) (0,000) (0,0000) (0,4662) (R^2:99,66%)

Because of insignificant coefficient of market variance at any confidence level, we dropped MV from the model and reperform as follows:

$$TV_{ALL}^{Equal} = 0.0139 + 0.5319 * IV_{BIG}^{Equal} + 0.4614 * IV_{SMALL}^{Equal} + 0.0346 \quad (9)$$

(0.6895) (0,000) (0,0000) (R^2:99,66%)

Eliminating the market variance from the model does not affect the value of adjusted R square because of limited effect of market variance *(MV)* on total variance of ALL stocks. A regression between total volatility and volatility based on LARGE and SMALL stocks shows that for the equally weighted volatility, LARGE stock volatility accounts for *53.19%* of its movements while the remaining *46.14%* is due to SMALL stock volatility *(R^2=99.66%)*. The regression value weighted Eliminating the market variance from the model does not affect the value of adjusted R square because of limited effect of market variance *(MV)* on total variance of ALL stocks. A regression between total volatility and volatility based on LARGE and SMALL stocks shows that for the equally weighted volatility, LARGE stock volatility accounts for *53.19%* of its movements while the remaining *46.14%* is due to SMALL stock volatility *(R^2=99.66%)*. The regression value weighted is:

[4] Values under the coefficients show the *p*-values.

[5] The log transformation reduces both skewness and kurtosis and brings the distribution closer to the normal.

$$TV_{ALL}^{Value} = 0.3300 + 0.9272 * IV_{BIG}^{Value} + 0.0336 * IV_{SMALL}^{Value} + 0.0362 * MV + 0.0162 \quad (10)$$

(0,0000) (0,0000) (0,0000) (0,0000) (R^2=%99,93)

In value weighted analysis, since market variance (MV) is a significant predictor, we keep it in the model. The corresponding estimates for the value weighted total volatility is 92.72% due to LARGE stocks volatility (R^2=99.93%).

Regressions of equally weighted ISE portfolios *(Equation 8 and Equation 9)* reveal almost equal residual terms. Besides, regression of value weighted ISE portfolios demonstrates lower residual terms as given in Equation 10. In this respect, the determination coefficient (R^2) of *Equation 10* is slightly higher than *Equation 8* and *Equation 9* due to the minor decreases in the residual terms.

Table 3 set below shows the results of stationary tests using the Dickey and Fuller (1979) and Philips-Perron (1988) tests.

TABLE 3 - STATIONARY TESTS*.

	ADF Statistics				***Phillips-Perron Statistics***			
	Intercept		***Intercept and Trend***		***Intercept***		***Intercept and Trend***	
	t-stat	***p-value***	***t-stat***	***p-value***	***t-stat***	***p-value***	***t-stat***	***p-value***
TV_{ALL}^{Equal}	-3.77	0.0060	-3.83	0.0235	-3.72	0.0068	-3.71	0.0312
IV_{BIG}^{Equal}	-4.33	0.0012	-4.38	0.0057	-4.27	0.0014	-4.30	0.0070
IV_{SMALL}^{Equal}	-3.86	0.0046	-3.94	0.0181	-3.88	0.0044	-3.95	0.0174
TV_{ALL}^{Value}	-3.75	0.0063	-3.86	0.0220	-3.70	0.0073	-3.82	0.0242
IV_{BIG}^{Value}	-3.91	0.0040	-4.03	0.0143	-3.85	0.0048	-3.98	0.0160
IV_{SMALL}^{Value}	-4.80	0.0003	-4.74	0.0021	-4.78	0.0003	-4.71	0.0022
MV	-3.59	0.0098	-3.99	0.0154	-3.54	0.0111	-3.97	0.0168

Source: Authors' calculation

**This table reports unit root tests for the log-transformed risk measures.*

The hypothesis of the presence of a unit root for all volatility measures is rejected at 5% confidence level, whether we include a trend or not.

D. Results of the Trend Analysis

Figure 3 shows equally and value weighted idiosyncratic variances of BIG, SMALL and ALL portfolios and market variances on monthly basis.

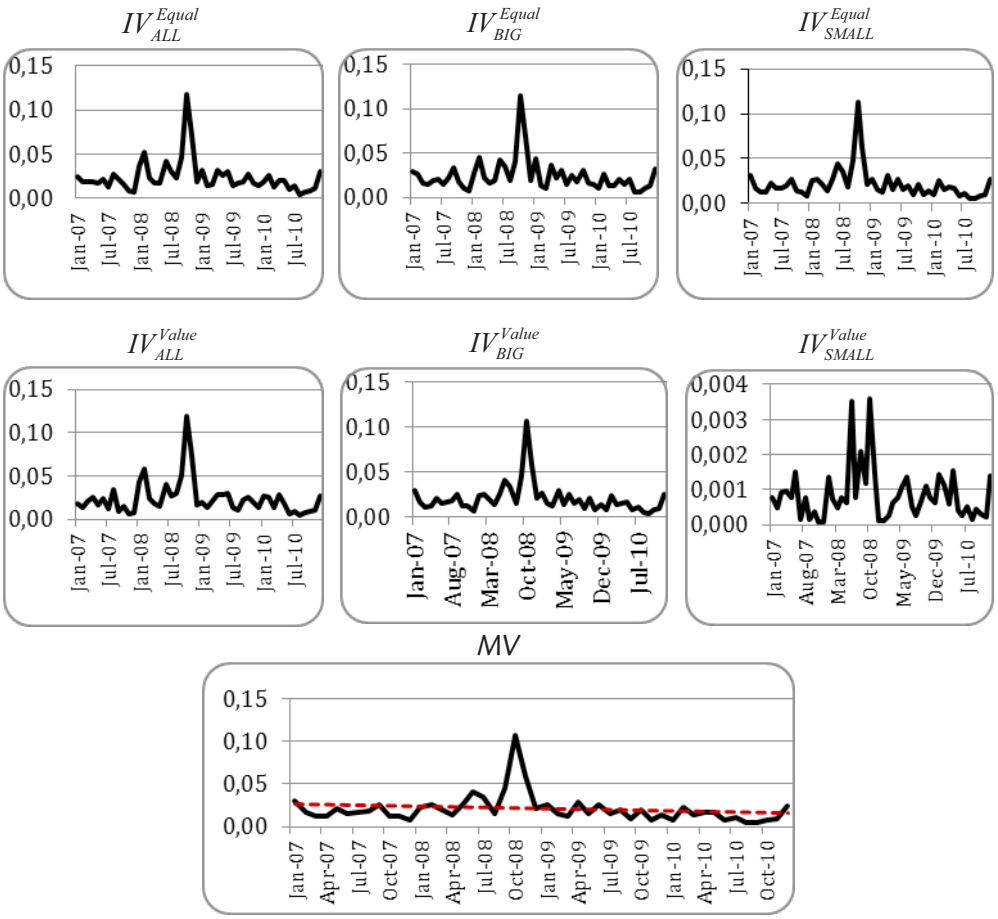

FIGURE 2. GRAPHICAL ANALYSIS OF VALUE WEIGHTED AND EQUALLY WEIGHTED IDIOSYNCRATIC RISK.

Source: Authors' calculation

As graphs show, there is not an observable trend in all idiosyncratic and market variances. But the dashed line in graph of market variance points a slightly decreasing trend. On September 2008 reveals a huge peak, which is thought as effect of World Economic Crisis in 2008 to the ISE, formed in each graph. As of January 2009, the peaks turn to usual level and fluctuate in narrow band until 2010. Generally all types of variances have similar movements except value weighted idiosyncratic variance graph. In this regard, given the evidence presented in Table 2 that correlation between value-weighted idiosyncratic variance of SMALL stocks and ALL stocks was *48.35%*, and market variance was *9.5%*.

Due to the difficulty in determining presence of any trend graphically, we follow Guo and Savickas (2003) and Angelidis and Tessaromatis (2008) and estimate the following linear trend model:

$$\mathrm{Ln}\left(\mathrm{V_t}\right) = \pm + \mathrm{bTime} + \mathrm{cLn}\left(\mathrm{V_{t-1}}\right) + \mathrm{e_t} \qquad (11)$$

where V_t is the corresponding volatility measure. Table 4 shows the estimated parameters and the corresponding Newey-West (1987) adjusted p-values.

TABLE 4 - LINEAR TREND MODEL.

	α	b	c	R^2-Adj.
IV_{ALL}^{Equal}	-3.6884	-0.0089	0.4791	23.51%
p-value	0.0000	0.4073	0.0009	
IV_{BIG}^{Equal}	-3.7106	-0.0082	0.3759	14.25%
p-value	0.0000	0.3909	0.0115	
IV_{SMALL}^{Equal}	-3.6956	-0.0104	0.4719	22.64%
p-value	0.0000	0.3916	0.0010	
IV_{ALL}^{Value}	-3.7513	-0.0113	0.4717	25.98%
p-value	0.0000	0.2880	0.0012	
IV_{BIG}^{Value}	-3.8100	-0.0117	0.4443	23.74%
p-value	0.0000	0.2618	0.0024	
IV_{SMALL}^{Value}	-7.4443	0.0006	0.3141	5.57%
p-value	0.0000	0.9630	0.0355	
MV	-7.4287	-0.0235	0.4798	30.94%
	0,0000	0,0864	0,0006	

Source: Authors' calculation

Coefficient of the trend variable (b) of all measures of idiosyncratic volatility is not statistically significant. Verifying graphical analysis, this finding shows that idiosyncratic volatility had not a rising or falling trend in period of 2007-2010. On the other hand, coefficient (b) of market variance is negative and statistically significant at 10% confidence level. This finding points out a very slow decreasing trend of market volatility in period of 2007-2010.

Our finding about time trend of idiosyncratic volatility of ISE is consistent with Sousa and Serra's finding (2008) which report no significant increase in firm specific volatility in Portuguese market and inconsistent with Campbell et al.'s (2001) and Angelidis and Tessaromatis's (2008) studies which report that idiosyncratic risk in US and UK markets rose during last decades.

E. Investigating the Forecasting Ability of Idiosyncratic Risk

Contrary to standard asset pricing theories which claim that idiosyncratic risk is not priced because of diversification ability of investors, it is possible to test whether idiosyncratic risk is a significant predictor or not, in forecasting of future return. By following Goyal and Santa Clara (2003) and Angelidis and Tessaromatis (2008) we investigate the relationship between volatility and subsequent stock returns in ISE, by regressing value and equally weighted market stock returns on various measures of lagged volatility.

$$r_{t+1} = \pm + {}^{2} X_t + \mu_{t+1} \quad (12)$$

Where r_{t+1} is the log return of the market portfolio at month *t+1* and X_t includes different combinations of monthly market and idiosyncratic volatilities. Because of difficulties of each month portfolio return calculation resulted from stocks added to and dropped from the Index, we studied with 59 stocks which are continuously traded in 2007-2010 period and calculated idiosyncratic volatility with on the basis of equally weighted and value weighted. Considering that our 59 stocks are the biggest stocks in terms of size, liquidity, and trading volume, we did not reform BIG, SMALL and ALL portfolios. So, our findings do not give information about size effect of forecasting ability of idiosyncratic volatility.

Following Table 5 presents the regressions *(Equation 12)* results of the equally and value weighted market return on lagged measures of market and idiosyncratic volatility.

TABLE 5 - FORECASTS OF EQUALLY AND VALUE WEIGHTED MARKET RETURN.

Equation	*Constant*	*$LnIV^{Equal}(-1)$*	*$LnIV^{Value}(-1)$*	*LnMV(-1)*	*Adj. R^2*
1	-0.0159	-0.0032			-0.12%
p-value	0.4543	0.3911			
2	-0.0084	-0.0028		0.0005	-0.74%
p-value	0.7411	0.5124		0.8838	
3	-0.0031			-0.0007	-0.46%
p-value	0.8976			0.7955	
4	-0.0176		-0.0035		-0.05%
p-value	0.3917		0.3210		
5	-0.0029		-0.0045	0.0023	-0.4%
p-value	0.9125		0.2841	0.5270	
6	0.0030			0.0000	-0.04%
p-value	0.9059			0.9972	

Source: Authors' calculation

Our regression analysis relating to relationship of idiosyncratic risk and return in ISE are employed with different combinations and none of the coefficients are found as statistically significant. Moreover, adjusted R squares of the models take negative and low values. As a result, we find that idiosyncratic volatility is not a predictor in forecasting future returns in Turkish market in period of 2007-2010.

At this point, remembering divergent findings in literature helps to evaluate our finding. While Lehman (1990), Campbell (1992), Xu and Malkiel (2001) and Goyal and Santa Clara (2003) and Fu (2009) report a significant positive relationship for US market, Ang et al. (2004) and Guo and Savickas find negative relationship. However, Bali and Cakici's (2008) results indicate that there is no robust evidence for a significant relation between idiosyncratic risk and the cross section of expected returns. Okpara and Nwezeaku (2009) and Bollen et al.'s (2009) findings suggest that idiosyncratic volatility is not priced. In this context, our result is consistent with some of the foregoing evidence that suggested that idiosyncratic risk is not priced.

V. DISCUSSION

As an emerging and volatile market, ISE has shown a great improvement and became attractive for investors and international portfolio managers gradually, producing information about volatility and its components is also crucial. We aimed to analyze the idiosyncratic volatility which is identified as a biggest component of total volatility by empirical evidences regarding different markets in ISE.

In this context, we decompose total volatility into the market wide and idiosyncratic by following Campbell et al. (2001) and Xu and Malkiel (2001)'s Indirect method and investigate the behavior of the idiosyncratic volatility and its pricing ability on monthly basis, in the period of 2007-2010.

Our findings suggest that idiosyncratic volatility is the biggest component of total volatility and show no trend. We also find that small size stocks and big size stocks have similar idiosyncratic risk behavior in the period of 2007-2010. But when the market value weights are taken into consideration, small size stocks show relatively lower volatility contrary to literature. Finally, our analyses about the predictive ability of various measures of idiosyncratic risk provide evidence that idiosyncratic volatility is not a significant predictor for future return.

Since the adequacy of diversification depends on the firm level volatility of the stocks making up to the portfolio and studies about Turkey's stock market have been scarce so far, this paper may originally contribute to the understanding of stock market volatilities in Turkey and affect investment portfolios in this market afterward.

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