FOREWORD

It is my great pleasure and honor to present the third volume of *International Journal of Business Development and Research* (IJBDR). It has been created to provide academics and practitioners a platform for exploration of new ideas, concepts, systems and practices in the areas of business innovation, applied technologies, and industrial & organizational management right across the world. The world is changing; there is a continuation of needs in exploring new ideas. For this, we must hear from individuals who are dynamic in professional management, business development and research. Theory and practice are interrelated, and we want to bridge the gaps.

This issue covers the areas of real situations of business development and existing practices in a numerous areas such as*:* Business perspectives, Competitiveness, Competitive advantage, Exchange fluctuations, Individual investors, Knowledge, Knowledge acquisition, Knowledge source, legal issues, Manufacturing, Market activity of investors, Robotics regulation, Technological development, and Turnover value/volume.

We hope that the research featured here will set up new milestones. We have had an overwhelming response from very eminent editors and researchers globally to support as editorial team. I look forward to make these endeavors very meaningful. Let me take this opportunity to express my appreciation and indebtedness for the contribution of authors and editorial board members to the journal. Their work, either by contributing articles, reviewing them or by working as a board member, has framed the journal leading to accomplishment of its goal.

Editor-in-chief

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Activity of Individual Investors on Turbulent Market

Ewa Widz, Ph.D.
Department of Financial Markets
Maria Curie-Sklodowska University, Lublin, Poland
Email: ewa.widz@umcs.lublin.pl

ABSTRACT

The paper investigates the impact of the exchange fluctuations on market activity of individual investors based on analysis of the investors' share in financial instruments trading on Warsaw Stock Exchange in the period between 2001 and 2015. The risk of investment on exchange markets is particularly high at time of strongly variable prices. The exchange fluctuations, measured by returns of stock market indices, cause profits and losses for investors. High volatility of the returns determines the value of turnover created by investors, but not always in the same way for each type of investors (individual and institutional investors, domestic and foreign investors) and each type of instruments (stocks, derivatives). The latest financial crisis resulted in dramatic drop of individual investors' trading while at the same time the turnover of domestic institutional investors didn't change fundamentally on the Polish market. This study aims to examine the correlation between the returns of main market indices, their volatility and the turnover value/volume generated by individual investors on stocks market and futures market of WSE.

Keywords: Exchange fluctuations, Individual investors, Market activity of investors, and Turnover value/volume.

1) INTRODUCTION

The analysis of the significance of stock investments most frequently focuses on the influence of the stock market on the economy – one main aspect is considered here: benefits for the economy and the economic growth resulting from the functioning of stock exchange. In this respect, literature gives a thorough description of the main functions of stock exchange: mobilising, allocating and evaluating capital, and researchers create models explaining dependencies between the development of the capital market and long-term economic development. In the meanwhile, it is often forgotten that this capital comes from numerous investors who achieve their own goals through stock investments. The participation of investors and a resulting movement of capital to the real economy are the factors determining the development of enterprises reaching for this capital. High stock market activity of investors on the primary and secondary market is a basic condition of implementing the main functions of stock exchange effectively. The significance of stock investments should be considered then with regard to the achievement of investors' goals. If the expectations of investors are met, the supply side will shrink and the activity of investors will decrease, limiting the possibility of economic development and the development of stock exchange (Dziawgo, 2004).

Basic expectations of investors as to stock investments consist in security of trading and settlements. Institutions responsible for these issues which are of crucial importance here can be divided with respect to their function: regulatory (Polish Financial Supervision Authority), clearing (Central Securities Depository of Poland), and managing (Warsaw Stock Exchange). Investors' positive perception of the capital market depends on their activity. It builds the prestige of the capital market as a place of long term and safe allocation of one's savings. Investors' activity is next influenced by the investment climate in a specific country resulting from its current financial, economic and socio-political situation (e.g. the level of interest rates, inflation and capital gains tax). Last but not least, investors' engagement into the stock market is determined by present stock exchange situation and investors' expectations as to the future level of stock market prices (Wasilewski & Juszczyk, 2015). Accompanied by optimism, a boom is a period of time when investors are more interested in the stock market. On the contrary, slumps and investors' pessimistic expectations as to future stock trends discourage from such investments. High exchange rate volatility may not only bring profits, but also the risk of losses. Significant stock market fluctuations can encourage some investors (with bigger inclination to risk-taking) to invest on the stock exchange, creating opportunities to achieve an over-average return (Frączek, 2011; Andrzejczak, 2013). In the meantime, other investors are likely to restrain themselves from making investments, especially short-term ones. Long-term investments should be profitable, and investors acting within such a time horizon should be rewarded for the risks incurred due to this form of allocating their savings. Only in such circumstances, the stock exchange is going to attract private equity of individual investors for longer periods of time.

The aim of the current study is to determine dependencies between stock market fluctuations – measured with the return rate on selected stock indices – with their volatility and the engagement of individual investors in stock investments – measured with the level of trading they generate. This area has been poorly researched due to the lack of data concerning the activity of individual investors on the capital market. Most stock exchanges do not keep records in this regard systematically. The objective of the current analysis was to study dependencies occurring on the Warsaw Stock Exchanges in the period between 2001 and 2015.

2) EXAMINATION OF INDIVIDUAL INVESTORS' PERFORMANCE

Factors determining the performance of individual investors can range from the temptation of speculative gains and arbitrage to securing oneself against risk. Accordingly, investors can be divided into: speculators, arbitrageurs and hedgers, where the first group seems to be dominant. A more thorough analysis of investors' motivation indicates a variety of motives depending on whether these are individual or institutional investors.

In "2015 Nationwide Investor Survey in Poland" conducted annually by the Individual Investors Association (an organization uniting individual investors in Poland), individual investors indicated the following motives for stock investments: diversification of income, saving for one's retirement, protection against inflation, source of income, fun and hobby (order according to the meaningfulness of motivation). An investor type emerging here is the one who manages his finances consciously, makes sure his money keeps its value and thinks about retirement. Only 11% of respondents pointed to earing income as the main objective of their investments.

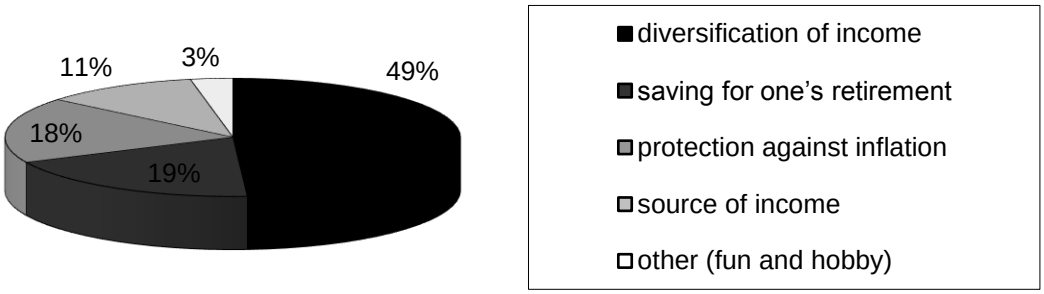

Figure 1: Individual investors' motives for investment in Poland
(Source: 2015 Nationwide Investor Survey in Poland, p. 15)

The analysis of the investment horizon of Polish individual investor's shows that 33% of them are long-term investors and almost 39% invest for the medium term horizons (from one month to one year). Only 5.6% of investors are day-traders. In comparison with German investors, Polish ones seem to lose. Most German investors invest for the long term – using a dividend-based investment strategy – and they have more partnerships in their portfolios (on average 19; for a Polish investor this number is 7). Since individual investors have a limited analytical capacity, the strategy of investing based on the long term investment horizon and diversified portfolio of financial instruments is much more rational.

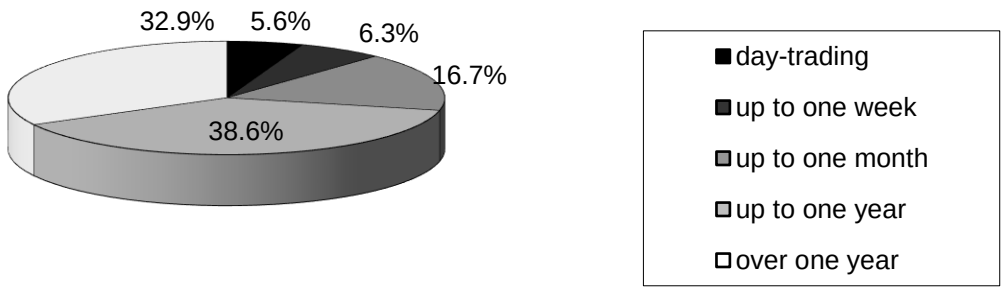

Figure 2: The investment horizon of Polish individual investors
(Source: 2015 Nationwide Investor Survey in Poland, p. 22)

Polish investors are most often employed people (57%) or running their own business (21%). Only 3% of them are professional stock exchange investors. The survey identifies characteristic features of Polish investors: a lack of time to conduct analyses systematically (29% of investors spend maximum one hour a day and 26% a few hours a week), short-term orientation (the investment horizon of 67% of investors is shorter than one year) (Black & Fraser, 2002; Szyszka, 2009), relatively small (of small value) investment portfolio (52% of investors have a portfolio up to 50,000 PLN), using various methods of analysis of financial instruments (42% of investors use jointly technical and fundamental types of analysis) with a large percentage of people who cannot do it (19%). Polish investors fail to attend the General Meetings of Shareholders and meetings with management boards and analysts, contrary to German investors. This provides evidence that the self-awareness of a Polish investor is still poor, although the situation seems to be better among investors with large investment portfolios.

Individual investors can invest on the capital market either directly or through institutional investors, who act in the name of their clients but also in their own name. Investment objectives of institutional investors are specified in their statutory documents and differ from one institution to another. Main groups of institutional investors can be divided into: investment funds, hedge funds and private equity, pension funds, securities firms (brokerage houses), commercial and investment banks, insurance companies, and asset managements. As seen above, these are large financial institutions professionally dealing with allocating funds on the financial market and having a much broader knowledge which investments are the most attractive at their disposal than individual investors. It naturally results from the fact that institutional investors employ professionals and have tools facilitating the analysis of the market and specific financial instruments. It gives them an advantage over individual investors, who normally rely on their own skills and predictions with respect to market analysis which are grounded only on recommendations and commentaries from market analysts. In other words, individual investors are in a weak position, and their decisions are often irrational (Kalinowski & Krzykowski, 2012; Czerwonka & Gorlewski, 2012) or late which results from late identification of trends on the market (Zielonka, 2006).

3) STRUCTURE OF STOCK EXCHANGE INVESTORS ON THE WARSAW STOCK EXCHANGE (WSE)

Since 1997, the Warsaw Stock Exchange has systematically examined the structure of trading achieved by individual groups of stock exchange investors on the Polish market. The basis is provided by the data acquired from Exchange Members (entities authorised to operate on the market, which includes concluding transactions in their own name and on behalf of their clients). This study reveals to what extent different groups of investors (divided into domestic individual investors, domestic institutional investors and foreign investors) contribute to ensuring liquidity on the market of various instruments (shares on the Warsaw Stock Exchange, shares on NewConnect, futures contracts, options, and recently also structured finance instruments and bonds).

The analysis of the number of investment accounts in brokerage houses in Poland indicates a gradual increase in the number of investors along with the development of the Polish stock exchange, where the most dynamic increase was observed during large privatizations and public offerings of renowned partnerships. For instance, in 2009 when the PGE Capital Group in Poland was being privatized (it was the second largest offering in the history of the Polish capital market and the largest in Europe in 2009 – the value of shares in a public offering was almost 6 billion PLN), the number of accounts increased for over 25% and the number of so called active accounts for over 53%. In 2010, when the WSE was being privatized (in public offering, the State Treasury sold over 26 million shares, where slightly over 8 million shares were acquired by individual investors), the number of accounts increased for over 31% and the number of active accounts for over 50%.

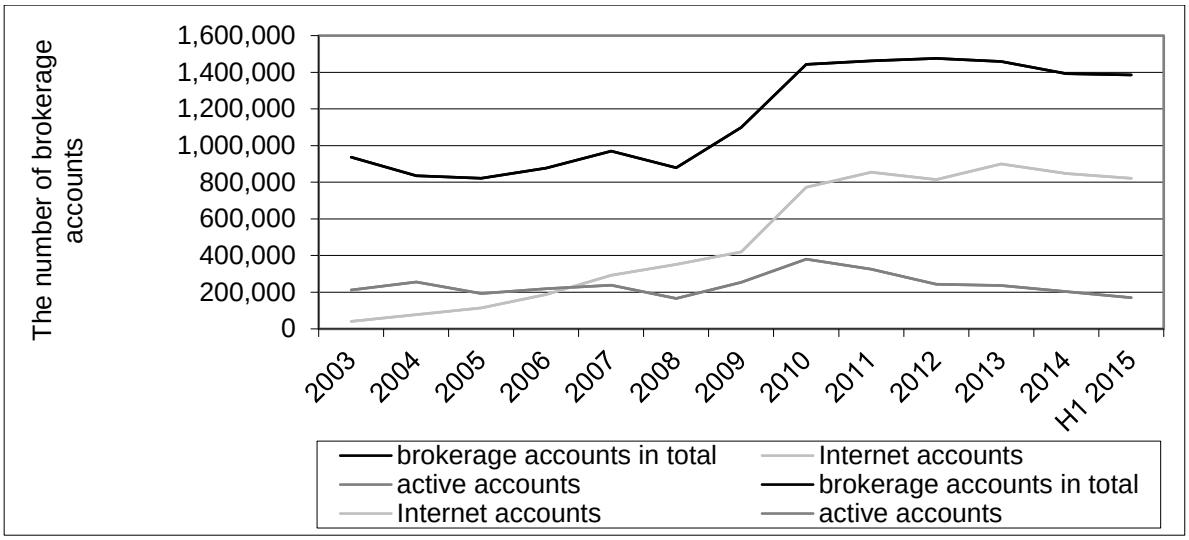

Figure 3: The number of brokerage accounts in Poland from 2003 to 2015
(Source: own presentation based on the WSE data)

Simultaneously, poor situation on the WSE was accompanied by the decrease in the number of brokerage accounts. It was the downturn on the stock exchange in 2007, however, that brought such a dramatic fall of this number. Subsequent years made this trend reverse – the number of accounts increased dynamically along with a good situation on the stock exchange, and it became stable in 2010 at the level of approximately 1.4 million. As it can be observed, these fluctuations were related to the changes in the situation on the stock market.

Analysing the data, one should take notice of the fact that the number of active accounts is a better indicator of individual investors' activity than the number of brokerage accounts. The former are believed to be active if at least one transaction is registered in a given six months. The number of active accounts and their share in the total number of brokerage accounts fell dramatically in 2008, and since 2010 this number has been falling systematically and accompanied the pessimistic mood of investors on the Polish market, which resulted from prolonged recession and uncertainty.

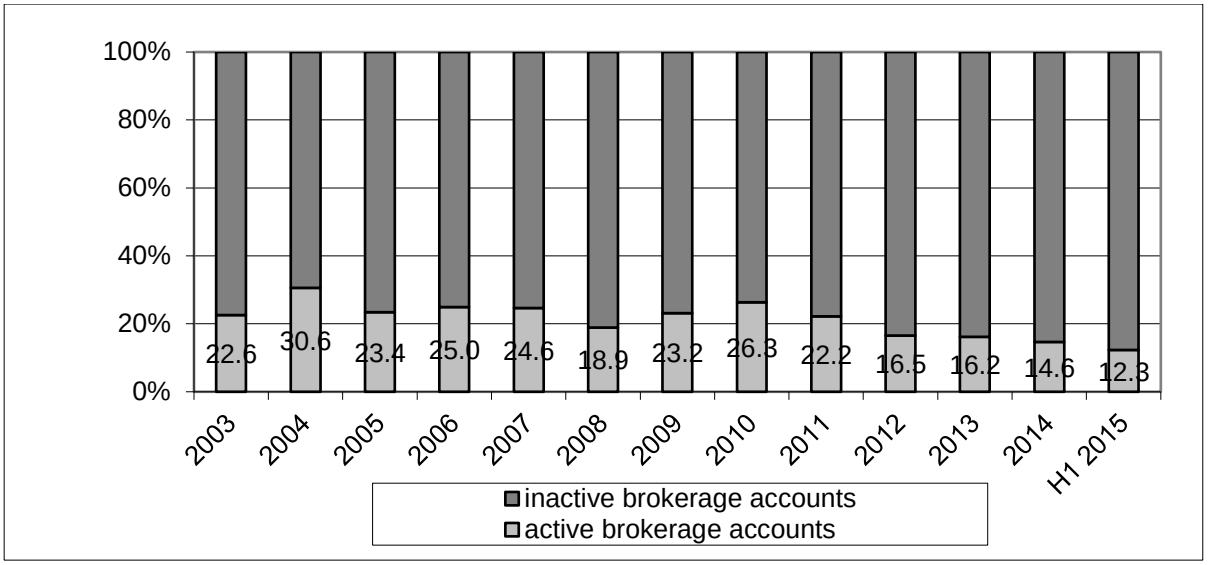

Figure 4: The share of active accounts in the total number of brokerage accounts between 2003 and 2015
(Source: own presentation based on the WSE data)

Recent years have witnessed considerable changes in the share of trading by individual groups of investors. The main tendency is the declining share of domestic trading by individual investors. In the first half of 2015, their share of stock trading on the WSE Main Market was only 12%. It has been the lowest value in the history of the stock exchange so far. In this period, foreign investors generated over the half of trading in equities (51%). Domestic institutional investors generated the rest of it (picture 5).

In 2002–2007, the shares of individual groups of investors were similar and ranged from 30% to 40%. The turning point was the year 2007 when the share of trading by individual investors declined in favour of foreign investors. On the other hand, the share of domestic institutional investors was maintained on the level of 30-40%. The conclusion is that the behaviour of individual investors and the level of trading they generate are greatly influenced by the economic crisis which began in 2007 and its consequences. The declining share of trading by individual investors is visible not only on the equity market (picture 5), but also on the derivatives market (picture 6), which in Poland is dominated by one kind of instruments – futures contracts.

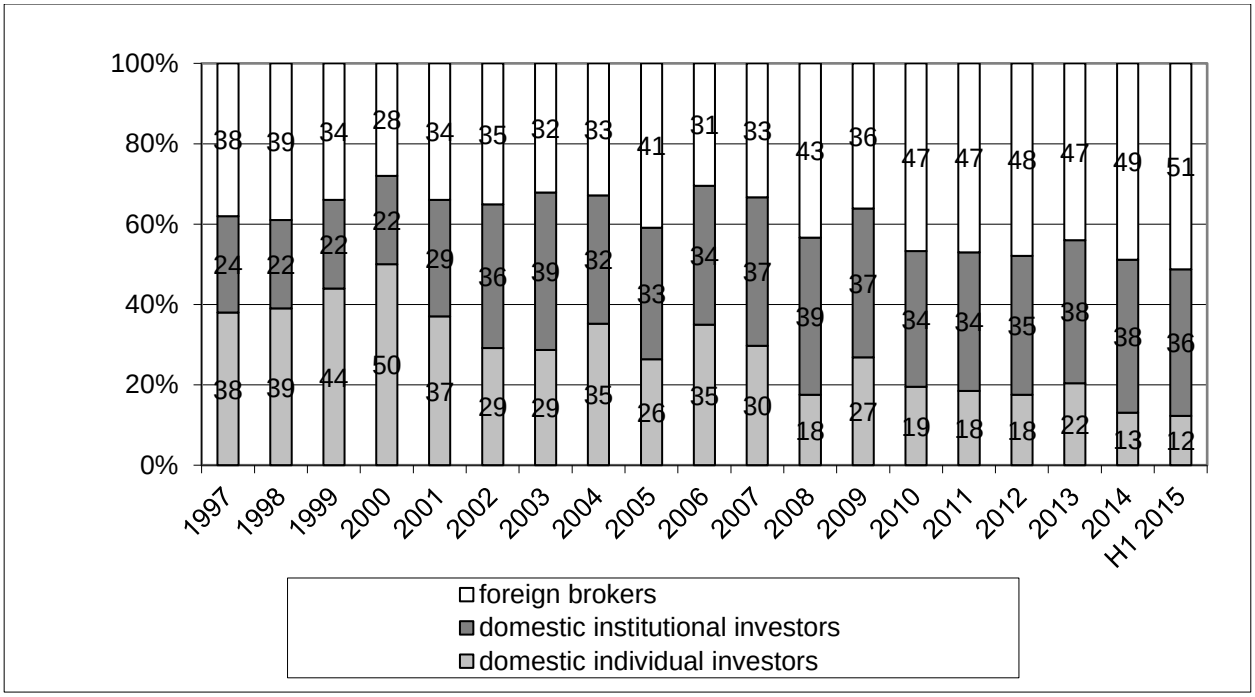

Figure 5: The share of turnover value by investors on the Main Market of the WSE
(Source: own presentation based on the WSE data)

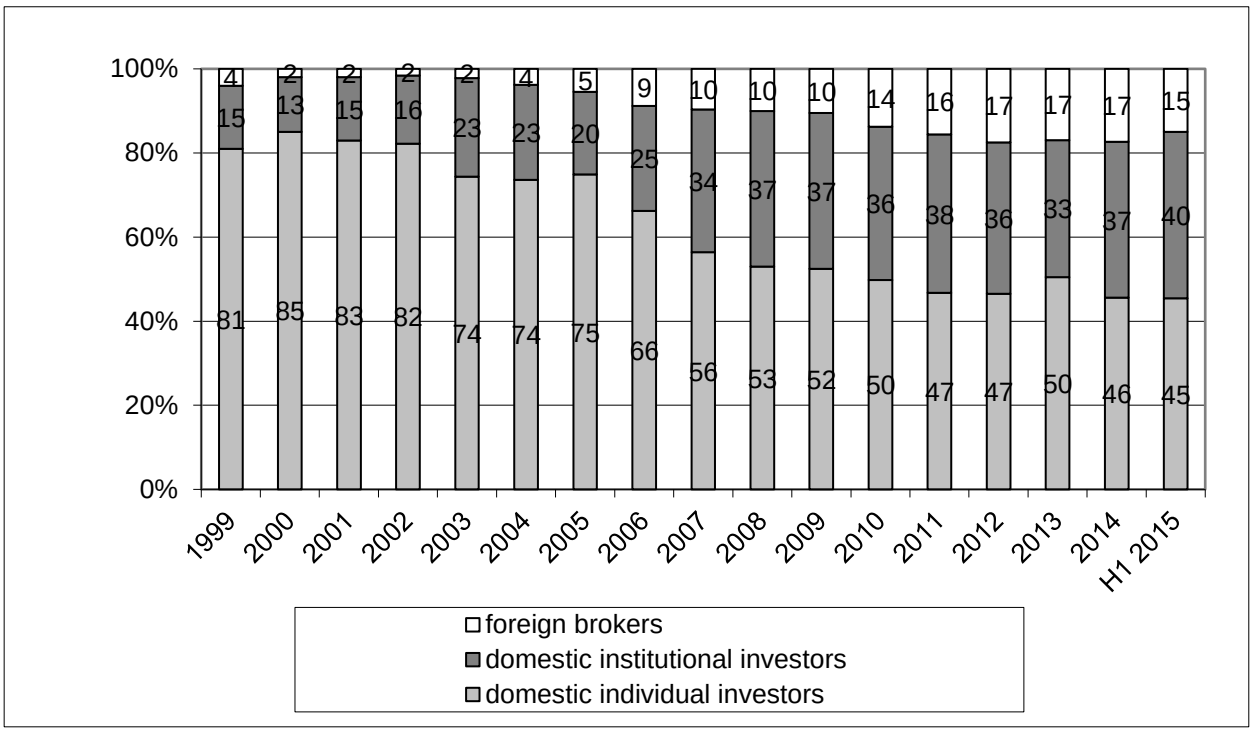

Figure 6: The share of trading volume on the futures market of the WSE
(Source: own presentation based on the WSE data)

4) INFLUENCE OF MARKET FLUCTUATIONS ON INDIVIDUAL INVESTORS' TURNOVER ON THE WARSAW STOCK EXCHANGE

In the first years of the WSE, its turnover grew regardless of current economic situation. It resulted from a gradual development of the newly created market and was connected with dynamic increase in the number of listed companies, among others, due to the privatization of Polish companies carried out by the capital method. Because of that, the current analysis of dependencies between turnover and market situation takes into account the data after January 1, 2001. It is believed to be a cut-off date after which the WSE reached maturity making it possible to conduct such research. Research was conducted on the basis of data up to the first half of 2015, since only this data was available. The value assumed to stand for the market situation consists in the rates of return of two indices: the broad market – WIG and the largest and the most liquid companies on the Polish market – WIG20. The engagement of investors in trading in shares was determined on the basis of the value of this turnover (for both sides to each trade – double-counted) and not their volume since these are the statistics kept by the WSE.

The current research focused on the development of the Pearson correlation coefficient for the dependency between the turnover value on the Main Market of the WSE and the return rate on indices, WIG and WIG20 respectively, and between the turnover value and the volatility of return rates on the analysed indices on a monthly and annual basis. The volatility of return rates measured by the standard deviation was treated as a risk measure of the volatility of the market situation. Next, the analysis of dependencies addressed only the turnover on the equity market generated by individual investors which helped assess whether individual investors reacted to the changes of economic situation in the same way as the whole group of investors. It resulted from the comparison of correlation coefficients, their value and sign (+/-), which was indicative of the direction and the strength of analysed dependencies. Then, the assessment moved on to the linear correlation coefficient for dependencies between the turnover value of shares generated by individual investors and the share of this group of investors in the turnover on the WSE.

The analysis of diagram 7 indicates that individual investors' turnover by the end of 2010 was more dynamic than the turnover of all investors put together – both growth and fall in turnover were higher for individual investors. It means that they overreacted (the influence of emotions) (Kwaśniewski, 2009). It is particularly visible in 2006 and in the first half of 2007 when individual investors' turnover (as a result of excessive optimism) grew definitely quicker than the total turnover, and also in 2008 when turnover fell faster than the total turnover. Improved economic situation in 2009 caused another dynamic growth in turnover in this group of investors. In 2011, the volatility of individual investors' turnover was fixed on the level of the total turnover.

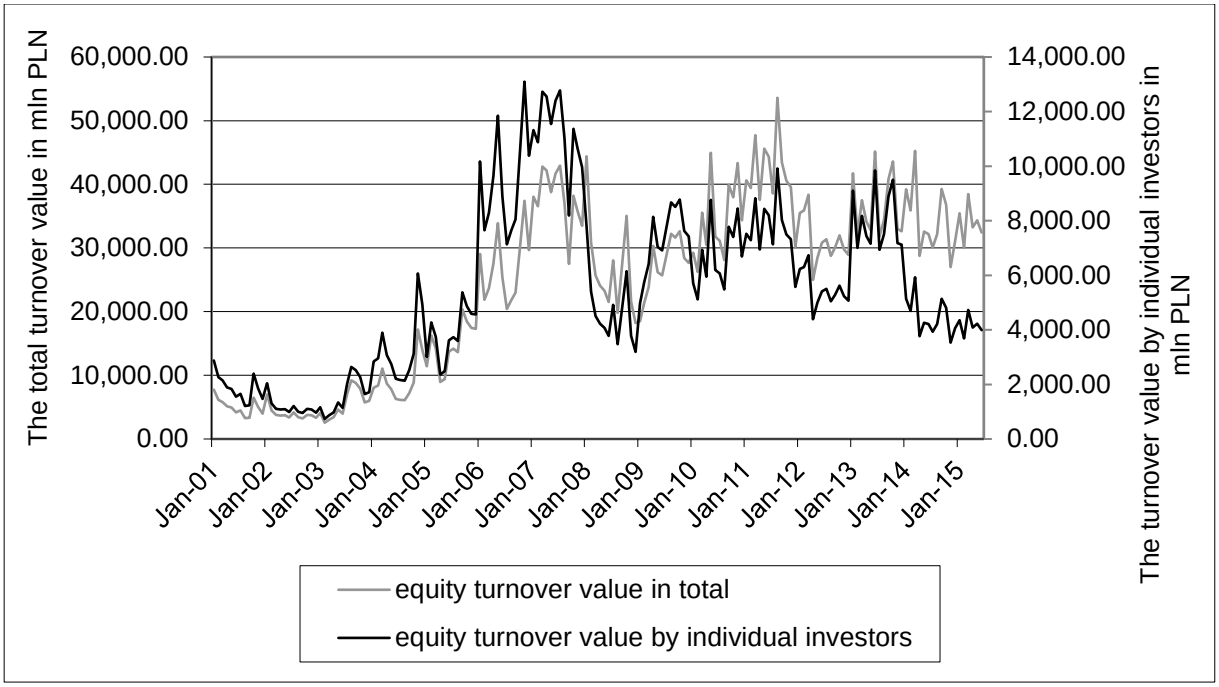

Figure 7: The volatility of the turnover value on the Main Market on the WSE
(Source: own presentation based on the WSE registers)

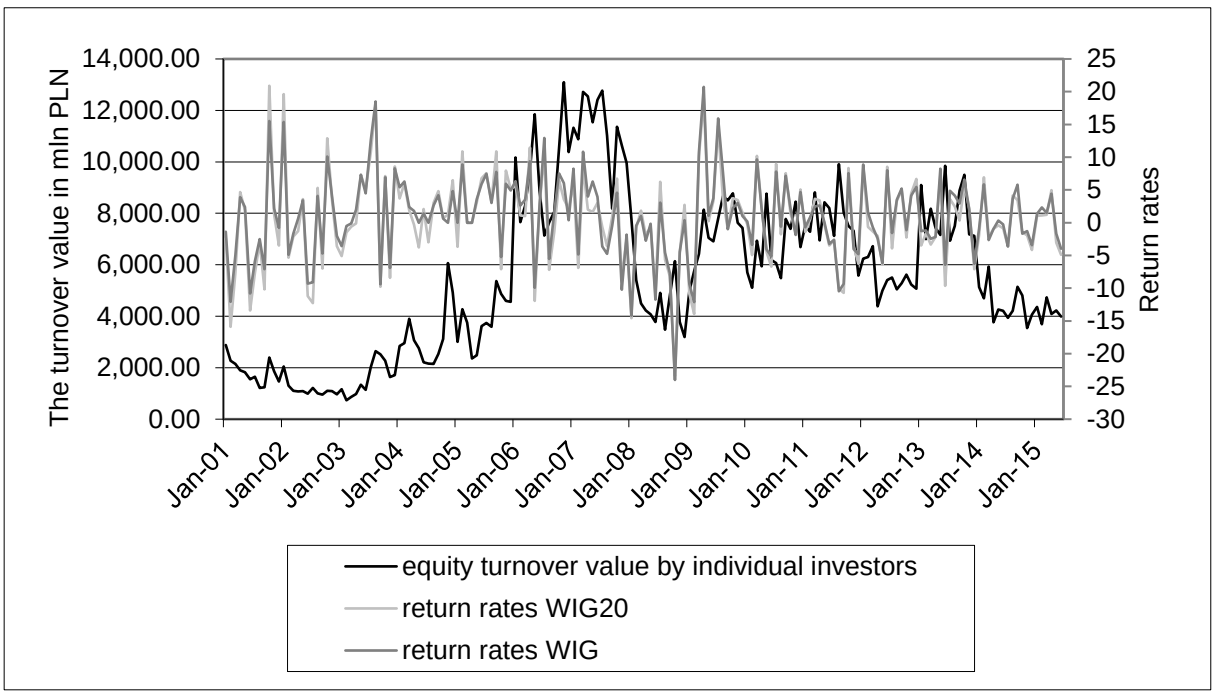

Figure 8: Individual investors' turnover value on the Main Market on the WSE against the return rates on indices WIG and WIG20
(Source: own presentation based on the WSE registers)

Since the middle of 2011, individual investors' turnover has been falling systematically. The year 2012 did not bring any changes even though the situation improved – as a matter of fact, individual investors lost interest even more, and their turnover was low. Since the middle of 2013, the turnover of individual investors has been falling systematically regardless of the

economic situation, reflecting the pessimism of this group of investors (picture 8). Interestingly, in the meantime, the total turnover on the equity market was strongly correlated with the changes of the economic situation. This means that the performance of individual investors ceased to depend on the current market situation, contrary to the rest of investors.

The study of the whole sample period (years 2001–2015) showed no statistically significant correlation between turnover and market situation either in the case of all investors or the group of individual investors. The reason might be that the growth in turnover can happen not only in the period of dramatic increase in prices, but also during their dramatic fall (as a result of the increase in the volume of turnover). That is why it seems that the volume of turnover would be a better reference point to measure against (Rogalski, 1978; Karpoff, 1987; Smirlock & Starks, 1988; Lee & Rui, 2002; Wójtowicz, 2010), but the WSE does not keep such statistics though. Contrary to expectations, strong correlations between the turnover value and volatility of return rates on indices were not observed. Only the correlation between the total turnover and volatility of return rates on WIG20 index was statistically moderately negative (-0.4548). It has also been revealed that there is a weak positive correlation between a market situation (return rates on WIG) and share of turnover by individual and foreign investors, but it is statistically insignificant as it is not present among institutional investors.

Table 1: Correlation matrix of the Main Market of the WSE (based on monthly data)

Correlation	Turnover value	Turnover value of individual investors
The return rate on the WIG20 index	-0.0408	0.0443
Volatility of the return rate on the WIG20 index	**-0.4548**	**-0.2382**
The return rate on the WIG index	-0.0604	0.0497
Volatility of the return rate on the WIG index	**-0.2353**	0.0043

Statistically significant parameters (α=0.05) are in bold.
(Source: own calculations based on the WSE registers)

5) **INFLUENCE OF MARKET FLUCTUATIONS ON INDIVIDUAL INVESTORS' TRADING ON FUTURES MARKET OF THE WARSAW STOCK EXCHANGE**

The study of the futures market was conducted in the same way as in the case of the equity market. The only difference here was that the level of trading was determined on the basis of trading volume, which resulted from the statistics kept by the exchange.

Relative volatility of individual investors' trading on the futures market were similar to those generated by all investors put together (picture 9). Individual investors reacted similarly to other investors. This may indicate a greater knowledge of individual investors on the futures market than on the equity market. Being aware of higher risk, only well-qualified investors

who can use various analytical tools supporting their decision process enter the derivatives market (Osińska et al., 2011a).

On the futures market – as in the case of the equity market – no significant dependency between the market situation and investors' trading volume was detected, both in the case of the total trading and individual investors' trading. Most probably, it results from the fact that income on the derivatives market can be generated either by growing or falling share prices since investors can open not only long position but also short ones. Even a slump can be the source of income. Investors should find the information about the volatility of return rates more crucial, even though the conducted research indicates no increase in trading in the case of an increase of return rate volatility. It may result from taking into account various types of contracts: equity, index, currency, and interest rate, which behave in a different way and react differently to the changes of market situation measured by the fluctuation of indices WIG and WIG20. Earlier research of the currency futures market confirmed a positive correlation between the volatility of currency rates and trading fluctuations on this market.

Table 2: Correlation matrix of the futures market on the WSE (based on monthly data)

Correlation	Trading volume	Trading volume of individual investors
The return rate on the WIG20 index	-0.1290	-0.1176
Volatility of the return rate on the WIG20 index	**-0.2588**	-0.1224
The return rate on the WIG index	**-0.1709**	**-0.1633**
Volatility of the return rate on the WIG index	-0.0656	0.0614

Statistically significant parameters (α=0.05) are in bold.
(Source: own calculations based on the WSE registers)

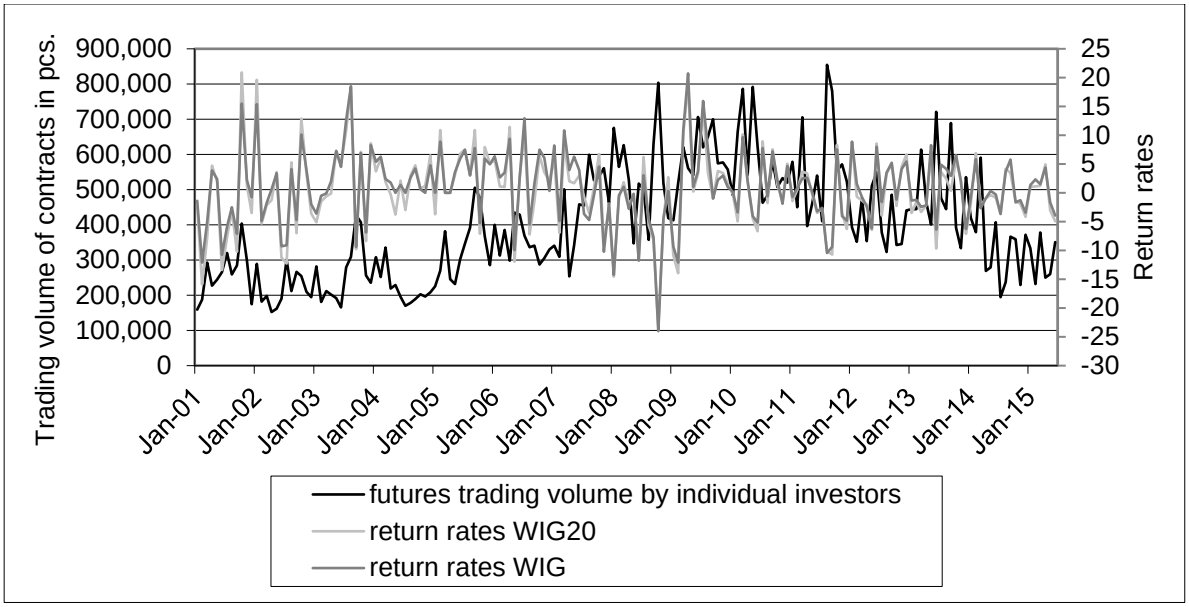

Figure 9: Individual investors' turnover volume on the futures market on the WSE against the return rates on indices WIG and WIG20
(Source: own presentation based on the WSE registers)

6) CONCLUSIONS

Since the financial crisis in 2007, the Polish market of financial instruments listed on the WSE has changed considerably. For the first time, Polish investors could feel the results of the slump so powerfully. It seems to be a turning year which changed the approach of individual investors to investing on the market. At the same time, it exposed the weak points of Polish capital market, which after the crisis could not rebuild its market power. With falling confidence to financial institutions, short periods of an improved situation could not attract new individual investors for long, and existing investors – discouraged by the extent of losses they could not make up for – are slowly resigning from long-term investment. As a result, since 2010 the share of individual investors' trading both on the equity market and on the futures market has been declining, and since the middle of 2013 the turnover value and trading volume of individual investors has been falling in absolute terms. This is the effect of prolonged market downturn on the Polish exchange, as well as uncertain situation on the world financial markets. The study revealed that the value of individual investors' turnover has never been strongly correlated with the market situation measured by return rates of the main market indices in the history of the Polish market. The factors which appear to determine the performance of this group of investors are the following: the mood on the market and how investors assess the attractiveness of investing, especially in the long time horizon. As long as the perspectives of long-term investing – and how it is perceived by Polish people – do not improve, there seems to be very little chance to increase the share of individual investors in trading.

7) REFERENCES

Andrzejczak, M. (2013). Zmiany struktury inwestycji dokonywanych na Giełdzie Papierów Wartościowych w Warszawie w latach 1992−2010. *Zeszyty Naukowe Wyższej Szkoły Bankowej we Wrocławiu, 2(34)*, 15−40.

Black, A., & Fraser, P. (2002). Stock market short-termism-an International perspective. *Journal of Multinational Financial Management, 12(2),* 135−158.

Cohen, R. B., Gompers, P. A., & Vuolteenaho, T. (2002). Who blinks in volatile markets, individuals or institutions? *Journal of Finance, 57,* 1923−1950.

Czerwonka, M., & Gorlewski, B. (2012). *Finanse behawioralne. Zachowania inwestorów i rynku*. Warszawa: SGH.

Dziawgo, D. (2004). *Indywidualni inwestorzy na rynku finansowym*. Toruń: Wydawnictwo Uniwersytetu Mikołaja Kopernika.

Frączek, B. (2011). Egzogeniczny charakter skłonności behawioralnych inwestorów. *Prace Naukowe / Uniwersytet Ekonomiczny w Katowicach: Internacjonalizacja i konkurencyjność współczesnych podmiotów gospodarczych,* 203−212.

Individual Investors Association. (2015). 2015 Nationwide Investor Survey in Poland. Retrieved from http://www.sii.org.pl/8867/edukacja-i-analizy/badania-i-rankingi/ogolnopolskie-badanie-inwestorow-obi-2015.html#ak8867.

Kalinowski, M., & Krzykowski, G. (2012). Racjonalność decyzji inwestycyjnych inwestorów indywidualnych na polskim rynku akcji. *Problemy Zarządzania, 10(4),* 169−177.

Karpoff, J. M. (1987). The relation between price changes and trading volume: A survey. *Journal of Financial and Quantitative Analysis, 22(1),* 109−126. DOI: 10.2307/2330874.

Kwaśniewski, M. (2009). Wpływ koniunktury giełdowej na zachowania inwestorów indywidualnych w latach 2006−2008. *Prace Naukowe / Akademia Ekonomiczna w Katowicach: Koniunktura gospodarcza a funkcjonowanie rynków,* 245−252.

Lee, B. S., & Rui, O. M. (2002). The dynamic relationship between stock returns and trading volume: Domestic and cross-country evidence. *Journal of Banking and Finance, 26(1),* 51−78.

Littre, K. E. (2008). *Oswoić bessę, czyli inwestowanie na rynku niedźwiedzia*. Gliwice: Helion.

Nagraba, K. (2010). Decyzje inwestora indywidualnego w Polsce na tle zachowań na świecie. *Zeszyty Naukowe Państwowej Wyższej Szkoły Zawodowej w Płocku. Nauki Ekonomiczne, 11*, 5−20.

Osińska, M., Pietrzak, M. B., & Żurek, M. (2011a). Ocena wpływu czynników behawioralnych i rynkowych na postawy inwestorów indywidualnych na polskim rynku kapitałowym za pomocą modelu SEM. *Przegląd Statystyczny, 58(3−4),* 175−194.

Osińska, M., Pietrzak, M. B., & Żurek, M. (2011b). Wykorzystanie modeli równań strukturalnych do opisu psychologicznych mechanizmów podejmowania decyzji na rynku kapitałowym. *Acta Universitatis Nicolai Copernici. Ekonomia, 42*, 7−21.

Rogalski, R. J. (1978). The Dependence of Prices and Volume. *Review of Economics and Statistics, 60,* 268−274.

Smirlock, M., & Starks, L. T. (1988). An Empirical Analysis of the Stock Price-Volume Relationship. *Journal of Banking and Finance, 12(1),* 31−41.

Szyszka, A. (2009). *Finanse behawioralne. Nowe podejście do inwestowania*. Poznań: Uniwersytet Ekonomiczny.

Warsaw Stock Exchange. (2013). Share of Investors in Trading on the Exchange, Aggregate Data 1996−2013. Retrieved from http://www.gpw.pl/pub/files/PDF/badanie_inwestorow_2013_en.pdf.

Warsaw Stock Exchange. (2015). Fact book 2015. Retrieved from http://www.gpw.pl/2358.

Wasilewski, M., Juszczyk, M. (2015). Czynniki kształtujące decyzje inwestorów na rynku kapitałowym. *Zeszyty Naukowe Uniwersytetu Szczecińskiego, 855, Finanse, Rynki Finansowe, Ubezpieczenia, 74,* 203−216. DOI: 10.18276/frfu.2015.74/1-18.

Wójtowicz, T. (2010). Wielkość obrotów a wzajemne korelacje stóp zwrotu spółek z GPW w Warszawie. *Zeszyty Naukowe Uniwersytetu Szczecińskiego, 29*, 277−290.

Zielonka, P. (2006). *Behawioralne aspekty inwestowania na rynku papierów wartościowych*. Warszawa: CeDeWu.

Internet of Mobile Things: The Influence of Law on Technological Development and Business Choices for Autonomous Cars

Augusto Sebastio
Ph.D of Fundamental Freedom, Globalization
University of Bari Ionian Dept.
Email:ausebas@tin.it

Alessio Caracciolo
Ph.D Student
University of Bari Ionian Dept.
Email: Alessio.caracciolo.3@gmail.com

ABSTRACT

In everyday life IT tools have become indispensable in social life, but what for certain can represent a mere loud relegated to the category "comfort and optional", in other ways can constitutes a saving possibility to overcome barriers which were insurmountable until a short time ago. This paper has the objective to analyze the impact of law on technological development in the field of one of the most innovative modern discoveries, the automated cars. Cars, symbol of democracy, freedom and emancipation, become suppliers of services, the internet of things becomes internet of mobile things. Legal and economic implications, even more of those ethical or moral, orient entrepreneurial choices in this matter, particularly regards arrangements for non-contractual liability.

Keywords: Business perspectives, Legal issues, Robotics regulation, and Technological development.

1) INTRODUCTION

When the novel "Sally" (Asimov, 1953) was published, no one could have predicted scientific and technological progress would have been able to bring, in less than a century, at a level of technological development to make possible a car without a pilot. From the original suggestions of K.I.T.T., the intelligent car of the Knight Rider TV series, partly put into practice with the invention of advanced devices nowadays used on many models in commerce, to the attractions of the self-pilot with remote control and voice command, the collective imagination has always been fascinated by the possibility of seeing a vehicle moving without human control. Although in other fields, such as aviation or nautical, systems of self-drive are customary statement, differences with a road moving device are evident. The field of discussion related to a vehicle without driver implementation has a wide range from the ethical to legal implications. It's a natural choice for a company to devote themselves to the development and production of a "connected vehicle" to dedicate investments to an attractive market with a probable expansion, considering risks linked to the current lack of provisions. Economic operators will be the main recipients of laws which will govern Robotics and interaction of new scientific discoveries with daily world implications. Until today the placing on the market of a product undertake the producer to a responsibility connected to a limited range of aspects, in the trilateral relationship involving producer, driver and a potential victim is evident as the second, in case of automobiles with the maximum autonomy degree, may see its liability greatly lowered to the detriment of the first. Therefore it's necessary to analyze possible implications, at economic level, of a rigid regulation, considering the losses related to pathological conditions of the legal involvements may exceed the benefits of placing on the market a new competitive product, and it is precisely on this risk, comparable to the application of punitive damages in the field of companies liability during the second industrial revolution, which rely the future choices of enterprises. A rigid law could lead to a research paralysis, given the low interest for companies to develop a product which is not ensured to be merchantable or that may involve an unexpected increase of costs in case of liability. It is not a case that Google has heavily invested in research and development to provide an advanced system, focusing in states which already have laws in force to regulate this new phenomenon.

2) THEORETICAL FRAMEWORK

2.1) Automated cars categories and technical overview

To define the subject of the present research there is a preliminary technical discussion that needs to be addressed. After the economic challenge between producers of mobile telephony and technology suppliers as search engines and sophisticated smartphone, won by the second, now the comparison moves on "hardware", a new definition for cars, and "software" connectivity and on the role that cars manufacturers will assume in the future by renouncing to leadership in their own scope of market where companies such as Google, Apple and all suppliers of connection phagocyte new market niches, with a transversally worrying in terms of social reorganization of principles and rights inherited by the analogical era. Cars charming won't be represented by power, engine, glaring red or speed, but it will be represented by memory, on-board services, connection speed, travel time. Does it have a sense to speak about cars manufacturers as mere hardware manufacturers? Is it reasonable to consider the software producers as car optional producers? The car sharing and ride sharing services (as Uber) generate the growth of services society, where cars are always in motion and properties of none, the era of the ownership and the collection ends with the passage to the era of sharing and

immediate experience, and in the automotive field coincides with leaving the concept of own car, definitely anachronistic, giving space to the concept of the car "*a la carte"*, at the need, every day different. The car will no longer be a status symbol or a mobility product but a mobility service, sold by subscription as any other service. The direction toward a society that does no more distinguish between private and public service is undertaken. Internet *of things*, applied to cars, becomes internet *of mobile things*. Cars technology index, according to an Accenture's study conducted in 2015, shows a 35% percentage of connection: on a sample of 88 million vehicles, 16 million were directly connected in network, 6 million indirectly and 9 million only through the use of the smartphone. The remaining 57 million are mere de-cerebrate cars, hardware without any intelligence. Always according to this research, in 2020 the index will reach the 98% of connectivity for cars, and only in 2025 the 100%, with an exponential growth of the so-called embedded connectivity. It is therefore possible to subsume, within the same category of "autonomous vehicle", a series of different technological apparatus equipped with varied characteristics and it becomes necessary an analytical approach intended to restrict the field of study. With reference to the automated vehicles, the cornerstone of programming is founded on the assumption that 95% of car accidents are caused by human error. The introduction of highly computerized vehicles would reduce the loss caused by inadvertent performed actions or illnesses and it would optimize fuel costs and reduce the traffic problems. To achieve this objective, however, it is necessary to reach an operating advanced step compared to the current state, which is stressed by the actual classification efforts and statements by the main producers, which indicate the year 2020 as a possible date of release for the first models time to market.

It's possible to classify three different automation degrees, as indicated by German researchers of the BAST-project: partial, high automation and complete automation (Gasser, 2012). The first is not very dissimilar from the current stage, involving supporting technologies to human guide stretched until the application of systems of advanced cruise control similar to those used by airline flights, with the necessity of a constant driver supervision and its propensity to take control whenever it is necessary. The second degree is characterized by a level of semi-autonomy, thanks to which car does not require a human driver until it encounters highly unforeseen circumstances, so in the remaining cases the vehicle take decisions in autonomy, while the driver becomes a simple passenger. The third and last degree represents an advanced stage of the second degree, since the car reacts autonomously in all situations in which, although human intervention would be required, the driver does not react in time. At last, we have to consider the absolute unpredictability factor represented by pedestrian. The passage from one level to another of those just listed, involves implementing technologies similar to the most advanced computer systems, a sort of "supercomputer on wheels" (Hodson, 2013), which has the ability to interact with the surrounding world through sensors, satellite links and communication systems with other vehicles, or with the potential to adapt itself to the existing infrastructure (Smith, 2012), a sort of collective consciousness of the transport system, similar to the actual capacity to estimate the arrival time of an urban bus, a necessary step in the era of the driverless car.

2.2) Ethical analysis and critical issues

The possibility of using means of transport which overcome the problems related to human guide are enchanting without any doubt to the point of capturing the community's interest and a substantial quantity of investments. From a pragmatic perspective, the introduction of automated vehicles should "increase traffic safety by reducing accidents, improve traffic efficiency by redistributing, according to an intelligent methodology, cars between lanes,

support sustainability by reducing emissions of pollutants, promoting accessibility for the elderly or the disabled" (Robolaw, 2014).

Following an opposite orientation, while not disapproving the scientific research in the field of autonomous vehicles, the conclusion is the existence of critical profiles potentially insuperable. The NHTSA (National Highway Traffic Safety Administration- agency that deals with safety regulations American Road) recognition of self-help cars, raises the equivalence between the robot and the vehicle driver. The artificial intelligence is equal to that of a human being. The world of law, insurance and moreover the concept of responsibility must upgrade, as any software. If the 95% of the accidents starts from an human error, it's necessary the accumulation of data about automatic conduction accidents. Cars would increasingly seems an aircraft and the following responsibility will need to be set in the same direction, not only in terms of use of black boxes, but of mobility code. The Street rules of any country should be directed toward the precepts of Codes of flight, closer to the concept of automation. Already known in the literature, the application of ethics class of moral paradox allows to fully seize the concern of some Authors (Lin, 2012) that exemplify the problem in the following way: «Imagine a "no win scenario", a vehicle must decide whether to divert and kill a person or maintain trajectory and killing five». In such a situation, a software programmed to optimize the damage would be led to choose the more advantageous situation (Lin, 2013), which would not be morally acceptable, especially if it is assumed that the automatic driver has between parameters of evaluation the economic implications of the incident. To this reconstruction can be argued that, although a human driver could assess the situation from the moral point of view and take a decision based not only on the simple comparison between risks and benefits, the various components of the human psyche can influence the event, positive or negative, therefore if it's possible to predict a human attempt, an emergency maneuver unpredictable for a preset software, reducing to a minimum the damages, it is also possible that for a psychological component unexpectedly the same person could remain inert, putting in place the worst possible scenario. A possible solution to this problem is to adopt a level of technology like the second degree of development, for which the autonomous vehicles should circulate under the constant supervision of a human driver that can intervene where necessary (Lin, 2013). On the same issue, it was argued that a focal point of discussion should concern the impossibility for an automatic system to interpreting rules, since it can only limit to obey commands inserted in the programming phase. It would therefore be conceivable a scenario in which a programming too protective would raise to fault a driver that does not respect the rules of the street code avoiding, for example, of wearing the helmet, resulting for the software "most at risk" with respect to a driver that has applied all the rules on safety in road, a situation which in a fatal accident would unfairly prejudice the latter (Goodall, 2014).

Beyond hypothetical scenarios, on which it will be necessary to deepen studies as technological development will make it more likely an actual implementation of certain technologies, the fear that a hermeneutic mediation between means of transport and users would be likely to lead to a reduction of the "driving skills" of motorists appears shareable, thus reducing the reaction capacity and the countermeasures evaluation in case of danger. If the decisive intervention must be substantiated by the human driver, but the latter is not accustomed to the guide or is not able to drive for psycho-physical problems, security control desired as solution to possible limit situations could be circumvented by insuperable circumstances. It will also be needed a different type of training, different from that currently required for motorists, with a consequent integration of teaching programs. Conclusively, an instrument designed to raise the driver from the task of keeping alive the attention on the road justifies a negligent attitude, transforming the

distraction from error to normality, and therefore making it necessary a balance by additional tools that would require promptly to the driver what to do in case of need.

In the final analysis, it must be considered the diversity among the players involved in the new category of "smart mobility" (Schijndel-de Nooij, 2011), whose interests are numerous and range from those of producers, subdivided between those who develop vehicles, software and protection systems, up to those of insurers, as well as those of users, also distinguished between simple consumers and other weak groups which would benefit from new technologies to meet mobility needs to develop relations and interpersonal interactions. It will be imperative, therefore, a particular legal attention to provide an accurate balancing of interests.

2.3) Liability issues, existing regulations, and perspectives

Since the time of Roman law the responsible of a damage to others generated by a vehicle (at the time the chariot) should be liable. The Roman law, pillar of modern laws, had the aim to regulate the social life also carried out through the use of mobility instruments, of course rudimental. The rules have survived, with normal evolutions, for centuries, without upheavals, keeping faith to their basic principles. Today, those certainties and foundations loses their reason of existence, swept by a technology that serves the person taking the role of protagonist making him a passive spectator and taking responsibility away from. The car is always more similar to a household appliance with an assistance system and guarantee, more similar to a "gadget", flexible and multi-faceted, towards a system with less refilling and more updates: a transformation that will affect the world of insurance and the concept of "liability". The responsibility of the product will become more important that the one of the driver. The main consequence of the introduction of cars that are apart from the man’s intervention for its own operation consists in a redistribution of roles and responsibilities (Polinsky & Shavell, 2009). For example, if the car is equipped with an automatic system for adjusting the speed on the basis of the data received from the conformation of the surrounding environment, taking into account the indications of road signals or receiving them electronically from a satellite system, a possible excess of speed cannot be attributed to the driver because its role in this case is totally irrelevant. This potentially represents a new category of objective liability, since both to the driver, which does not take a decision on the speed, that to the producer, which prepares the instruments so that the vehicle can decide autonomously, is not possible to ascribe any type of psychological element or etiological connection with the event. It could be even hypothesized a further branch of possible responsibilities, where the error is not attributable to a manufacturing defect but to a lack in the software that manages the data processing received from the outside, to the inaccuracy of an automatic upgrade, to a dysfunction of the satellite or to the inadequacy of the technologies used in signage. In a varied scenario, as the one described, is evident as the possibility of being responsible for something that goes beyond our own conduct may represent a brake with respect to the willingness to use, or to produce a given technology.

The Law approach to the new case studies have to be preliminarily aimed to a definition. Only through the description of an abstract case to which relate legal consequences it is possible to regulate the phenomenon, in order to direct it in the riverbed of the lawful behaviors. In absence of a standard definition it is necessary to use an analogical or systematic interpretation, in the specific case with provisions concerning the liability of the producer. A comparative approach leads to taking into account the laws of Countries in which has already been identified a first normative definition, as Nevada, California, Michigan and Florida in the United States (Walker Smith, 2012).

> Nevada (www.leg.state.nv.us) – The term "autonomous vehicle" […] exclude a vehicle enabled with a safety system or driver assistance system, including, without limitation, a system to provide electronic blind spot assistance, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane keep assistance, lane departure warnings and traffic jam and queuing assistance, unless the vehicle is also enabled with artificial intelligence and technology that allows the vehicle to carry out all the mechanical operations of driving without the active control or continuous monitoring of a natural person.
>
> California (http://apps.dmv.ca.gov) – "Autonomous vehicle" means any vehicle equipped with technology that has the capability of operating or driving the vehicle without the active physical control or monitoring of a natural person, whether or not the technology is engaged, excluding vehicles equipped with one or more systems that enhance safety or provide driver assistance but are not capable of driving or operating the vehicle without the active physical control or monitoring of a natural person.
>
> Michigan (www.legislature.mi.gov) – "Automated motor vehicle" means a motor vehicle on which automated technology has been installed, either by a manufacturer of automated technology or an upfitter that enables the motor vehicle to be operated without any control or monitoring by a human operator. Automated motor vehicle does not include a motor vehicle enabled with 1 or more active safety systems or operator assistance systems, including, but not limited to, a system to provide electronic blind spot assistance, crash avoidance, emergency blocking, parking assistance, adaptive cruise control, lane-keeping assistance, lane departure warning, or traffic jam and queuing assistance, unless 1 or more of these technologies alone or in combination with other systems enable the vehicle on which the technology is installed to operate without any control or monitoring by an operator.
>
> Florida (www.leg.state.fl.us) – Autonomous vehicle: Any vehicle equipped with autonomous technology. The term "autonomous technology" means technology installed on a motor vehicle that has the capability to drive the vehicle on which the technology is installed without the active control or monitoring by a human operator. The term excludes a motor vehicle enabled with active safety systems or driver assistance systems, including, without limitation, a system to provide electronic blind spot assistance, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane keep assistance, lane departure warning, or traffic jam and queuing assistant, unless any such system alone or in combination with other systems enables the vehicle on which the technology is installed to drive without the active control or monitoring by a human operator.

The point in common of the definitions mentioned above is certainly the concept that "secondary" systems, in the part related to the mere assistance to the driver, are excluded from the autonomous technologies. The essential element of an automatic system is therefore its independence not only by human action, also by the control of an operator who, through monitoring, would render marginal the main characteristic of the system, reducing it to a condition of subsidiarity with respect to the capacity of the human driver who is ready to take control in every moment, remaining the true driver. It can be easily reached the conclusion that the definition of an autonomous vehicle is following:

> A vehicle enabled with artificial intelligence and technology that have the capability of operating or driving the vehicle without the active control or monitoring of a natural person. (Robolaw, 2014)

The European perspective about automatic vehicles is journaled in a gradual path, started with the Directive 5 September 2007 n. 2007/46/EC, which lays down the eligibility criteria for the mechanical components of the motor vehicles. It can be accordable to sustain these criteria will have to gradually adapt following technological progress, by introducing new standards to be respected, toward a full discipline of automatic vehicles. One must be consider as a necessity to rewrite the rules for periodic review of passenger cars, driving licenses and finally also the Code of the road, in the hope of a uniform change at international level, in order to avoid disparities which could bring from one side to the inhomogeneity of the development and deployment of new technologies, on the other hand to practical difficulties in the displacements caused by the need to adapt each time the standards provided for by the individual State, creating a disparity between firms operating in one or the other Country (Fagnant & Kockelman, 2013). Finally, the Vienna Convention of 1968 could only foresee the presence of a driver to consider a means of transport such as "vehicle", the possibility of placing on the road fully automated systems will inevitably lead to a rewriting of the concept of "driver", and therefore of "vehicle" for how is known today. Between the various consequences of such a change there could be the removal, desired by Google, of prohibitions of telephones use while driving: they can even become indispensable tools for monitoring vehicle functions. It would be needed to assess whether these perspectives will be made in the context of the achievement of a greater social welfare, in line with the benefits highlighted by supporters of the introduction on the market of autonomous vehicles, or if will prevail a consumerist approach aimed to optimize vain benefits at the expense of possible disseminated benefits.

2.4) Economic aspects of liability and investment risk

The rules concerning producer's liability, accordingly to labor discipline, have always been conditioned by economic development and entrepreneurial choices. The distinction between being, or not, deemed eligible for certain events external not only to his own will but also to his own work is surely an aspect which take into account deciding to invest in a particular innovative technology, considering that the choices of the law makers can affect researchers ideas and especially of their lenders. Today some multinationals, among which Google, Mercedes-Benz and Volvo, have expressed their intention to ensure in a direct way for damage caused by its own car with advanced safety technology, but it will be necessary to wait for higher automation levels (and objective responsibility) to fully assess the consistency of this commitment.

A fundamental principle in the field of responsibility of the manufacturer is constituted by the adequacy of prevention measures. Being in the field of a form of strict liability, policy statements most widely used consists in the burden placed on the producer to prove his utmost diligence as well as the application of the most widely used protocols, characterized by a concrete possibility of reducing the damage potential arising from the marketing of the potentially dangerous product. In a field highly experimental this means that the presence of a swinging concept of "standards" does not allow to apply a single protocol and, therefore, to standardize the criteria on the basis of which establish the liability of the various players involved. The search for a universal policy therefore appears to be one of the major objectives to be put in a legal and economic reflection. The concept that seems to assert itself in a diffused way, especially among the producers who have already decided to heavily invest in this market, is that "an autonomous vehicle must be at least as secure as a vehicle driven by a human being". This happen for the simple fact that if a vehicle driven by a person is subject to the ordinary criteria of responsibility and is subject to regular insurance on civil liability for damage caused, a product with the same degree of safety can similarly (and analogically) be subjected to the

same regulatory regime. The criterion proposed presents an inherent problem due to two possible reading keys of the same. The automatic vehicle, in order to meet this standard, may need to be on average more reliable than medium human driver, or must be at least as secure as, if not more, a vehicle driven by the best human driver. In the first case it is entrusted to a statistical judgment, which is subjected to large scale practical study, not being possible to perform this kind of ex-ante assessment. In the second case, instead, the judgment put into place is about capacity, i.e. it is based on a sieve that takes into account the human reactions in the same circumstances so that if in that situation even the best driver would have achieved the same result (and would not have avoided the damage) the automatic vehicle is suitable to be put into circulation.

The liability of the producer may also depend on the expectations of the consumer. A damaging event caused by an automatic vehicle, for which should be deemed responsible for the automaker, may constitute a brake to the marketing of the same product, especially when advertised as being extremely safe. The standard can therefore be determined also on the basis of what users expect from the product and from their tolerance threshold in respect of defects and faults related to the experimental phase. This means that in the same condition a vehicle defined as experimental and "high risky" may attract less purchasers who are looking for stability and security, but at the same time can generate less expectations and therefore a reduced tendency to litigation in case of damage. It is difficult to determine in an objective manner the expertise of the automatic driver in order to be considered reliable, and the parameter is much more inconstant where are taken into account many external factors that can influence harmful events. The consequence of this uncertainty, joined to the risk of a premature introduction on the market of products that, once proved defective, could questioning the future sales of the entire range of products, leads to a stagnation defined "chilling effect" (Calabresi & Bobbitt, 1978). A possibility to reduce this effect is constituted by the sign of appropriate insurance contracts from both the producer and the purchaser. This way, the victims would be adequately compensated, while buyers would perceive the risk more distant from its legal sphere. This reasoning conclusion can be the object of criticism, in particular with reference to the inhomogeneous States legislation in the field of insurance for the movement of motor vehicles, and secondly for the potential criticality in the distribution of responsibilities between the various actors involved in the legal relationship of a non-contractual nature, stemming from the occurrence of the accident.

3) CONCLUSIONS

3.1) Responsible research and blindfold regulation

A Classification of a sector in quick evolution is not simple, it is necessary to reconcile the need of a solid regulatory taking account of possible implications for the future and at the same time the research unpredictability (Collingridge, 1981), which can lead to unexpected results. Although a regulations issued at the beginning of new product development can appear as a premature incomplete step, we can conclude that it is more appropriate a legislative intervention, albeit partial and subject to further developments, rather than a legal vacuum in which economic operators must bear the whole risk that once invested capital and obtained results, all efforts could be placed into nothing by prohibitions which could be suddenly put into effect. This is certainly a form of "blindfold regulations', the application of which may entail risks due to lack of data on which to base a fully conscious decision. There are, on the other hand, countries in which the address of the legislator is quite clear, as an example for

South Korean law- Korean Act n. 9014 2008 - Intelligent Robots Development and Distribution Promotion Act - IRDDPA, which at art. 1 provides that

> «The purpose of this act is to contribute to the enhancement of the quality of life of citizens and the national economy by establishing and promoting a policy for the sustainable development of the intelligent robot industry to facilitate the development and distribution of intelligent robots and lay down the foundation therefor».

Conclusively, according to the application of a precautionary principle (Parente, 2013; Del Prato, 2009) in respect of new technologies, the legislator have to intervene wherever appropriate, directing research and development toward areas that have positive social implications (Black, Lodge & Tatcher, 2005). Only following this way it is possible to reach widely useful and collectively appreciable results.

3.2) Research perspectives: auto-cars and privacy

The legal implications of the introduction of automated vehicles on the market aren't confined to liability regimes applicable to stakeholders. An important field of research in which it will be necessary to develop future studies is constituted by implications of highly developed computerized systems installation, which will be able to communicate with satellites and between them, processing personal data and, more generally, potentially compressing the rights of freedom. Although it may appear an excess of concernment, similar to the one generated by the introduction of "GPS" devices inside mobile phones or the installation of a "black box" for insurance purposes, it seems acceptable from the point of view of those who argue the need for public control, in particular in the provision of a specific legislation about the use of data collected by the appliances designed to drive the vehicle (Sanfeliu et al., 2010).

4) REFERENCES

Aasimof, I. (1953), *Sally*, in *Fantastic*, May/June Issue.

Black, J., Lodge, M. and Tatcher, M. (2005), *Regulatory Innovation. A Comparative Analysis*, Cheltenham, UK: Elgar Publishing.

Calabresi, G., Bobbitt, P. (1978), *Tragic choices*, New York: W.W. Norton

Collingridge, D. (1981), *The social control of technology*, Houndmills: Palgrave Macmillan.

Del Prato, E. (2009), *Il principio di precauzione nel diritto privato: spunti*, in *Rass. dir. civ.*, 3, p. 634.

Fagnant, D. J., and Kockelman, K. M. (2013), *Preparing a Nation for Autonomous Vehicle Opportunities, Barriers and Policy Recommendations*, Eno-Center for Transportation.

Gasser, T. M. (2012), *Rechtsfolgen zunehmender Fahrzeugautomatisierung, Berichte der Bundesanstalt für Straßenwesen*, Fahrzeugtechnik Heft F83.

Goodall, N. J. (2014), *Ethical Decision Making During Automated Vehicle Crashes*, in *Transportation Research Record: Journal of the Transportation Research Board*.

Hodson, H. (2013), *Cars that look around to work out where they are*, in *New Scientist*, August issue, published online at www.newscientist.com.

Lin, P. (2012), *Introduction to Robot Ethics*, in P. Lin, K. Abney & G. A. Bekey (edited by), *Robot Ethics. The Ethical and Social Implications of Robotics*, Cambridge (MA): MIT Press.

Lin, P. (2013), *The ethics of autonomous cars*, in *The Atlantic*, published online at www.theatlantic.com.

Palmerini, E., Azzarri, F., Battaglia, F., Bertolini, A., Carnevale, A., Carpaneto, J., Cavallo, F., Di Carlo, A., Cempini, M., Controzzi, M., Koops, B-J., Lucivero, F., Mukerji, N., Pirni, A., Shah, H., Salvini, P., Schellekens, M., and Warwick, K. – RoboLaw (2014), *Guidelines on Regulating Robotics*, D6.2 deliverable of Project *Regulating Emerging Robotics Technologies in Europe: Robotics facing Law and Ethics*, published on www.robolaw.eu

Parente, F. (2013), *Campi elettromagnetici e tutela della persona*, in A.A.V.V., *Esposizione a campi elettromagnetici, precauzioni e limiti a tutela della salute*, Taranto, p. 5-9.

Polinsky, A. M., and Shavell, S. (2009), *The Uneasy Case for Product Liability*, in *Harvard Law Review*, Stanford Law and Economics Olin Workin Paper no. 381, Harvard Law and Economics Discussion Paper no. 647, Harvard Public Law Working Paper no. 09-46.

Sanfeliu, A., Llàcer, M. R., Gramunt, M. D., Punsola, A. and Yoshimura, Y. (2010), *Influence of the privacy issue in the Deployment and Design of Networking Robots in European Urban Areas*, in *Advanced Robotics*, 24(13), p. 1873-1899.

Schijndel-de Nooij van, M., Krosse, B., van den Broek, T., Maas, S., van Nunen, E., Zwijnenberg, H., Schieben, A., Mosebach, H., Ford, N., McDonald, M., Jeffery, D., Piao, J., Sanchez, J. (2011), *Definition of necessary vehicle and infrastructure systems for Automated Driving. SMART - 2010/0064 study report*, Brussels: European Commission.

Smith, B. W. (2012), *How does a Traffic Cop Ticket a Driverless Car?* in *New Scientist*, December issue, published online at www.newscientist.com.

Walker Smith, B. (2012), *Automated Vehicles are Probably Legal in the United States*, The Center for Internet and Society.

Knowledge Acquisition and Competitiveness of Manufacturing Enterprises

Dr. Marcin Soniewicki
Poznan University of Economics and Business
Al. Niepodległości 10
61-875 Poznań, Poland
Email: marcin.soniewicki@ue.poznan.pl

ABSTRACT

This article concentrates on companies operating in the manufacturing industry. These entities are currently put under pressure to constantly innovate to generate as much profit as possible. However, to perform this task they need to continuously gain new, valid knowledge. This work concentrates on knowledge acquisition processes in manufacturing enterprises, particularly knowledge sources they use. The main aim of the article is checking if intensity of knowledge acquisition processes by manufacturing companies influence their competiveness. Moreover, it tries to learn if particular categories of knowledge sources cause that manufacturing companies are more competitive as well as to check if there are differences in the matter of knowledge acquisition processes' influence on competitiveness depending on type of manufacturing company. This paper is based on quantitative study conducted in Poland on the sample of 334 manufacturing enterprises. The research results reveal that: practically every increase in intensity of knowledge acquisition increase competitiveness of manufacturing enterprises, firms need to try out various knowledge sources' combinations in order to be competitive, acquiring as much knowledge as possible from many sources is especially important in case of high and medium-high technology manufacturing companies. The article also lists series of valuable recommendations for manufacturing companies' managers.

Keywords: Competitiveness, Competitive advantage, Knowledge, Knowledge acquisition, Knowledge source, and Manufacturing.

1) INTRODUCTION

This work is the follow-up of the article published by author in journal "Kwartalnik Nauk o Przedsiębiorstwie" in which the differences in knowledge acquisition intensity among various types of manufacturing enterprises were examined (Soniewicki, 2015b). Nevertheless, what really counts for every company, not only for those in the industry of manufacturing is profit. However, to generate it the crucial element is firms' competitiveness. In the current economy, knowledge is the most important resource, and its acquisition processes may determine a company's competitiveness level. Moreover, manufacturing industry is still important element of today's economy, it is also put under greater and greater pressure to innovate, not only to generate higher income but even to survive. Still, the basis and crucial element for creating innovations is constant inflow of valid knowledge to an enterprise. In order to provide it, companies need to use proper knowledge sources. On the basis of literature, the most popular knowledge sources which companies use have been distinguished by the author. They are the base to fulfill the goals of this work which have been listed below:

- to check whether intensity of knowledge acquisition processes by manufacturing companies influence their competiveness;
- to learn if particular categories of knowledge sources cause that manufacturing companies are more competitive;
- To check if there are differences in the matter of knowledge acquisition processes' influence on competitiveness depending on type of manufacturing companies.

The article is based on a quantitative study. It consists of the 6 parts. After introduction there is a literature review and methodology of research. Later research results have been presented. At the end, final conclusions and limitations as well as suggestions for further research have been shown.

2) LITERATURE REVIEW

The last decades of twentieth century brought notable change to the global economy – increasing importance of knowledge resource (Karlsson et al., 2006; Soniewicki, 2015a). This phenomenon has been named in 1996 by OECD "knowledge based economy" (OECD, 1996, p. 1). In fact, knowledge resource was also important before, still in the knowledge based economy its role became crucial (Welfe, 2007, p. 9). Knowledge is now key element of firms' competitiveness (Rothberg and Erickson, 2005, p. 8) and sometimes it is perceived as activator of other kinds of resources (Omerzel and Gulev 2011, p. 335). Another, very important characteristic of knowledge based economy is constant change. New products are revealed more and more frequently (Powell and Snellman, 2004, pp. 199-220). For example companies in the area of information technology draw around 70 percent of their income out of products (as well as services) that did not even exist two years before (Neef et al., 1998, p. 7). Today's companies, in order to stay competitive in the described conditions need to adjust by developing series of competences in the matter of knowledge resource (Soniewicki, 2015a).

In literature one can find a lot of concepts that are supposed to help enterprises to operate in the area of knowledge resource, for instance knowledge management, learning organization and organizational learning (Handzic and Zhou, 2005, p. 3; Evans, 2005, p. 11). Nevertheless, the most popular, due to its practical aspects, is the first one – knowledge management (Vera and Crossan, 2006, p. 124). There are many definitions of the mentioned concept but in the author's opinion the most interesting is the one created by Cranfield Business School which defines

knowledge management as processes enabling creation, dissemination as well as knowledge resource use in order to achieve company's goals (Perechuda, 2005, p. 74). This definition is relatively short and simple, it shows the essence, but is not detailed enough in the matter of distinguishing knowledge management processes. This article, in the mentioned aspect, adopts the proposition of Probst et al. (2004, p. 42) who differentiate six such processes: knowledge location, knowledge acquisition, knowledge development, knowledge sharing, knowledge dissemination, knowledge exploitation and knowledge protection.

Knowledge location and acquisition are the first and crucial element of knowledge management in a company. Without their correct execution enterprise cannot perform the following processes well. This shows the importance of this issue for any firm's competitiveness which itself is becoming more and more dynamic and complicated matter. Currently, external knowledge is prevailing as well as crucial part of companies' knowledge resource (Probst et al., 2004, p. 42) and should constantly be acquired by companies (Kowalczyk and Nogalski, 2007, p. 93).

Organizing external knowledge acquisition in an enterprise may cause problems as it is not an easy process. In practice, necessary elements of this resource are often sought by firms in improper sources (Paliszkiewicz, 2007, p. 69). In the literature one can find numerous possible knowledge sources which can be used by companies. The most important of them, chosen by author after thorough literature review have been classified and listed in the table 1.

The another problem in this matter is that many firms and employees prefer not to look for knowledge outside their company but create knowledge on their own. Such attitude is often uneconomical and expensive (Probst et al., 2004, pp. 119-120). For example, the research conducted by Liu and Liu among employees of Taiwanese high-tech firms revealed that they prefer to acquire necessary knowledge from not from outside, but from members of their teams (Liu and Liu, 2008). Such attitude can hamper company's innovativeness and in a longer period of time decrease its competitiveness. This underlines the importance of external knowledge acquisition for a company's performance.

It is also very likely that every industry's enterprises need different kinds of knowledge (Soniewicki, 2015b). That is why when analyzing various aspects of knowledge management it is better to limit study to similar types of enterprises or single industry.

In today's world, we can observe expansion of the service industry. In such environment manufacturing industry becomes sometimes unappreciated. Nevertheless, this industry is still important, even in developed economies (Bryson et al., 2013, p. 13). The results of several studies conducted in 2010, 2013 and 2016 show that manufacturing to some extent is driving global economies (Deloitte Touche Tohmatsu Limited et al., 2016). Moreover, Manyika et al. (2012, p. 1) calls such enterprises "critical force" both in developing as well as advanced economies. Manufacturing, is also often neglected in the matter of knowledge and knowledge management. This is because knowledge is rather associated with service industry and when it comes to manufacturing it is less obvious case (Grönroos, 2005, p. 8-9; Soniewicki, 2014, p. 41; Soniewicki, 2015b, p. 90). In the traditional perception manufacturing was conceived as quite simple process of producing goods from raw materials, but today it is these are complex processes that frequently include knowledge based service (Bryson et al., 2013, p. 13). Bryson et al. (2013, p. 13) also emphasize that one should not underestimate knowledge demand in numerous manufacturing activities. What more, Global Manufacturing Competitiveness Index (GMCI) survey in the year 2016 showed that innovation, which is closely related with

knowledge resource, is important element for manufacturing companies' competitiveness (Deloitte Touche Tohmatsu Limited et al., 2016). This shows the importance and necessity of examining the role of various knowledge management processes for manufacturing companies' competitiveness.

3) METHODOLOGY

This article and the research on which it is based were financed by Polish National Science Center [1], Preludium 2 grant, no. 2011/03/N/HS4/00429. The quantitative data used in the paper have been collected during the larger study which was examining companies from every kind of industry. It was carried out in Poland in the year 2012 and the beginning of the year 2013. The sampling frame was a database of companies created by Kompass Poland.

The research questionnaire has been prepared in the electronic and paper based form. The former has been dispatched through electronic custom-based surveying system. It has been prepared by the author with technical help of computer scientist. The other, paper based questionnaire has been send to the respondents by post. Such solution helped to receive more than 1200 filled questionnaires from enterprises, among them there were 334 questionnaires from manufacturing companies. These enterprises were later divided into two parts with use of manufacturing companies division developed by OECD. The original division distinguishes four groups: high technology, medium-high technology, medium-low and low technology (Hatzichronoglou, 1997). In this article author decided to divide analyzed companies into two groups: low and medium-low technology as well as medium-high and high technology. The motive of such approach was receiving groups of companies large enough to conduct statistical analyses and receive statistically significant results.

The research examined the intensity of use of particular knowledge sources by companies [2]. On the basis of literature, author has chosen 12 most important and popular knowledge sources used in the companies (table 1). These sources were divided into 4 categories – knowledge purchase, market related knowledge sources, governmental and non-governmental institutions and research and development. The examined companies were indicating in the questionnaires intensity of their use of particular knowledge sources with 5-grade Likert scale in which 1 meant the lack of use and 5 the most intensive use.

In the article, in the analyses of use intensity of particular categories of knowledge sources, arithmetic average of knowledge sources usage intensity that comprised such category was calculated. In the analyses of all knowledge sources, arithmetic average was not calculated directly but out of four distinguished categories. Such method has been used in order not to decrease importance of categories with fewer knowledge sources examined such as research and development.

The sample of manufacturing companies examined in this article consisted of 334 entities, 180 of them were low and medium-low technology companies, 154 were high and medium-high technology enterprises (table 2).

Table 1: The examined knowledge sources and their categories

No	*Knowledge source*	*Knowledge source's categories*
1.	External trainings	Knowledge purchase
2.	Consulting companies	
3.	Publications (scientific, industry)	
4.	External expertise / external expert advice	
5.	Market research	Market related knowledge sources
6.	Customers	
7.	Suppliers	
8.	Competitors	
9.	Networking groups or associations	Governmental and non-governmental institutions
10.	Scientific institutions (including universities)	
11.	Governmental or local government institutions	
12.	Own research and development	Research and development

Source: Own study table published before in (Soniewicki, 2015b, p. 91) on the basis: (Soo et al., 2002, p. 17; Darroch, 2003, p. 45; Probst et al., 2004, pp. 126-133; Kowalczyk and Nogalski, 2007, p. 94; Paliszkiewicz, 2007, pp. 71-73; Mazur et al., 2008, p. 151; Sparrow, 2010; Soniewicki, 2015a, p. 78).

Table 2: The examined sample's composition

Type of manufacturing companies	*No. of companies in the examined sample*
Low and medium-low technology	180
High and medium-high technology	154
Total:	**334**

Source: own study, table published before in (Soniewicki, 2015b, p. 91).

In the opinion of Barney (2011) currently various accounting methods, which rely on financial data, are the most common way of assessing companies' performance. Nevertheless, they have many disadvantages. One of them is the fact that firms' management may influence their financial results. This is possible for example through choice of particular depreciation method. Moreover, financial methods do not take into account companies' intangible assets which are crucial tool for creating value added by contemporary firms (Barney, 2011; Soniewicki, 2015). That is why to determine the competitiveness level of examined companies Competitiveness Index has been used. This method uses financial but also non-financial measures. The mentioned index was developed by Fonfara (2007) and since then it has been successfully used for example by Ratajczak-Mrozek (2010) or Małys (2013). This Index is based on the idea of Obłój (2007, p. 409) and Gorynia (2000, p. 49, 52, 53) who note the need of relating competitiveness measure to particular company's competitors. The Competitiveness Index

consists of four elements: profit, return on investment (ROI), value of sales and market share. These are measured in the 5-grade Likert scale in relation to examined companies' closest competitors. The particular responses have the following meaning: 1 – much worse, 2 – worse, 3 – almost the same, 4 – better, 5 – much better. The arithmetic average of responses (four elements) is the value of Competitiveness Index for particular company.

In order to check statistical significance of discovered differences U Mann Whitney test has been used. It was applied with use of IBM SPSS statistical software.

4) RESEARCH RESULTS

The research results of quantitative study have been divided into the several parts. At the beginning the competiveness level of companies with particular intensity of all categories of knowledge sources' use will be presented. Later the influence of particular categories of knowledge on competitiveness will be shown. Afterwards, such analyses will be limited to particular types of manufacturing companies – low and medium low as well as high and medium-high. At the end the influence on competitiveness of number of knowledge sources used by companies with above average intensity will be presented – both for all as well as specified types of manufacturing enterprises.

The first analysis (table 3) concentrates on intensity of use of all categories of knowledge sources.

As table 3 shows, manufacturing companies with equal or below average usage intensity of all examined knowledge categories are more less similarly competitive as their closest competitors (Competitiveness Index – 2.99). These enterprises constitute also more than three quarters of all examined firms (76.9%). Companies with above average intensity in analyzed area are much more competitive – Competitiveness Index – 3.52. This difference in competitiveness is also statistically significant. Nevertheless, there are more than three times less of such firms – they constitute only 23.1% of the sample. When we look further, we find two last groups with high (>3.5) and very high (>4) usage intensity of all knowledge categories. Especially, the latter group is worth attention as competitiveness of companies it gathers is much higher than average.

Table 3: The competitiveness of companies with particular intensity of all categories' knowledge sources use

All categories of knowledge sources – intensity of use	*Competitiveness Index*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	2.99	-	-	76.9%
>3 (above average)	3.52	0.53	**<0.001**	23.1%
>3.5 (high)	3.76	0.77	**<0.001**	7.5%
>4 (very high)	4.21	1.22	**0.002**	1.8%

Source: Own study

The results in the table 3 show that increasing usage intensity of all knowledge sources categories always pays off for manufacturing companies as it always improves their competitiveness. However, it is especially profitable to move from the first group (equal or below average intensity: <=3) to the second (above average intensity: >3) or from the third (high intensity: >3.5) to the fourth (very high intensity: >4).

The analysis presented in the table 3 shows very important results, but it also has one disadvantage – it is quite general as it concerns all knowledge categories. Interesting and important issue is finding what kind of knowledge sources are the most important for manufacturing companies' competitiveness. That is why the following four tables analyze all four knowledge categories separately. The first of them (table 4) concerns the following category: knowledge purchase.

Table 4: The competitiveness of companies with particular intensity of knowledge sources use from the category knowledge purchase

Intensity of use – knowledge purchase	*Competitiveness Index*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	3.07	-	-	88.0%
>3	3.44	0.38	**0.005*****	12.0%
>3.5	3.55	0.48	**0.022****	4.5%
>4	3.91	0.84	**0.003*****	2.4%

Source: Own study

As we can read from table 4, in the vast majority of manufacturing companies (88%) the intensity of use of knowledge sources from the knowledge purchase category is below average. It means that purchasing knowledge is not very important method of obtaining this resource for the most of manufacturing companies. The higher the intensity of knowledge purchase in companies is, the more competitive are manufacturing companies. All the differences are also statistically significant.

The another knowledge sources' category distinguished in the article are market related knowledge sources. The values of competitiveness of manufacturing companies with various intensities of using these sources have been presented in the table 5.

Table 5: The competitiveness of companies with particular intensity of market related knowledge sources use

Intensity of use - market related knowledge sources	*Competitiveness Index*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	2.93	-	-	56.9%
>3	3.36	0.43	**<0.001*****	43.1%
>3.5	3.46	0.53	**<0.001*****	21.9%
>4	3.84	0.91	**<0.001*****	6.0%

Source: Own study

Market related knowledge sources are crucial for all kind of companies as they operate in the current, fast changing, market economy. Despite this, as table 5 shows, more than half of examined companies (56.9%) do not use intensively market related knowledge sources. As one could expect, these companies are less competitive entities in comparison to their competitors – Competitiveness Index – 2.93. Nevertheless, there is also substantial number of companies that use these knowledge sources with more than average intensity. Actually, in this category of knowledge sources there are the most of companies with above average intensity of their use. There are also substantial shares of examined companies which intensities of use of market related knowledge sources are high – 21.9%, and very high – 6%. Moreover, in case of market related knowledge sources the gains in competitiveness of examined companies taking place with increase of use of this kind of knowledge sources are greater in comparison to previously examined category of knowledge purchase. In conclusion, the results of examining market related knowledge sources we may expect that these knowledge sources are very important, to some extent basic, for creating highly competitive manufacturing company. However, intensive use only of them probably does not give examined firms stable competitive advantage. That is why other knowledge categories need to be examined as well. The following table – 6 – concentrates on acquiring knowledge from governmental and non-governmental organizations.

Table 6: The competitiveness of companies with particular intensity of use of knowledge from governmental and non-governmental organizations

Intensity of government and non-government knowledge sources use	*Competitiveness Index*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	3.08	-	-	94.0%
>3	3.63	0.54	**0.005*** **	6.0%
>3.5	3.88	0.79	**0.001*** **	3.6%
>4	3.00 [3]	-0.08	0.850	0.6%

Source: Own study.

As table 6 shows governmental and non-governmental knowledge sources to some extent are also useful for companies. Nevertheless, there are not so many companies that get advantage of them as 94% of examined entities use these sources with equal or below average (<=3) intensity. Moreover, there are only two companies in the sample with very high intensity of use of these sources (>4) what shows that is a very specific group of knowledge sources. However, one need to note that companies with high intensity (3.5) of use of knowledge from governmental and non-governmental sources are quite competitive – Competitiveness Index – 3.88. This shows these sources could be a chance for some manufacturing companies of gaining additional, rarely used by competitors, value helpful in building competitive advantage of an enterprise.

The last category of knowledge sources examined in the article is own research and development activities undertaken by companies. The results have been presented in the table 7.

Table 7: The competitiveness of companies with particular intensity of use of knowledge from own research and development [4]

Intensity of R&D use	*Competitiveness Index*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	2.94	-	-	61.4%
>3	3.39	0.45	**<0.001*** **	38.6%
>4	3.60	0.66	**<0.001*** **	13.2%

Source: Own study

As table 7 shows for 61.4% of manufacturing companies use research and development with average or lower intensity. This probably makes them less competitive than their competitors – Competitiveness Index – 2.94. Nevertheless, quite large share of examined entities use this category with a more than average (>3) intensity and it is the only knowledge category in this study with such large share of enterprises with very high (>4) intensity of its use – 13.2%. Unfortunately, it does not give the latter too much competitive advantage – their Competitiveness Index is only 3.60. This may indicate that this source is important for companies in order not to become less competitive than their competitors. However, it is not enough on its own to build stable competitive advantage.

In conclusion, the examination of particular types of knowledge sources shows that every increase of almost any knowledge category also increases the competitiveness of manufacturing companies. Nevertheless, mentioned gains are almost always lower than in case of all knowledge types (table 3). This may indicate that combination of various knowledge sources, from many categories is necessary to more effectively enhance manufacturing companies' competitiveness.

In order deepen the analysis, the other attitude will be applied. In the following two tables manufacturing companies have been divided into two groups: low and medium-low technology (table 8) as well as high and medium-high technology (table 9).

Table 8: The competitiveness of low and medium-low technology companies with particular intensity of all categories' knowledge sources use

All categories of knowledge sources – intensity of use	*Competitiveness Index of low and medium low technology companies*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	3.00	-	-	81.1%
>3	3.46	0.46	**0.004*** **	18.9%
>3.5	3.62	0.62	**0.007*** **	7.2%
>4	4.19	1.19	**0.008*** **	2.2%

Source: Own study

Table 8 shows that in more than 80% of low and medium-low technology companies the intensity of knowledge acquisition is average or below, this probably influences their competitiveness which is similar to their competitors' level. Among companies that more intensively use examined knowledge sources, competitiveness is much higher and rises quickly with increase of knowledge acquisition intensity. The next table (9) analyzes the competitiveness of high and medium-high technology manufacturing companies.

Table 9: The competitiveness of high and medium-high technology companies with particular intensity of all categories' knowledge sources use

All categories of knowledge sources – intensity of use	*Competitiveness Index of high and medium high technology companies*	*Difference (x against <=3)*	*p-value of Mann Whitney test*	*Share in the sample*
<=3	2.98	-	-	72.1%
>3	3.58	0.59	**<0.001*** **	27.9%
>3.5	3.92	0.93	**<0.001*** **	7.8%
>4	4.25	1.27	**0.081***	1.3%

Source: Own study

Table 8 shows that 72.1% of high and medium-high technology manufacturing companies are characterized with average or below use of examined knowledge sources. It is less than in case of previously analyzed firms. In this case companies with such a low intensity of knowledge acquisition are also less competitive than those analyzed in table 8. This may indicate that knowledge acquisition is more important for competitiveness of these entities. Another important conclusion that can be drawn from table 9 is that every increase of knowledge acquisition intensity is followed by greater increase of competitiveness than in case of low and medium-low manufacturing companies.

The last three tables in the article, analyze the same issue, but in the completely different way in order to show knowledge acquisition from another perspective. In these analyzes companies were divided into groups depending on how many knowledge sources they use intensively (>=4). The first such analysis which concentrates on all manufacturing companies has been presented in the table 10.

As table 10 shows, companies that do not use any or use only one of examined knowledge sources in intensive way are substantially less competitive than their closest competitors. Moreover, such entities constitute more than one third of all manufacturing companies in the sample. The another conclusion which can be made out of the results in the discussed table is quickly increasing competitiveness in line with greater number of intensively used knowledge sources. This means that manufacturing companies, to increase their competitiveness, need numerous as well as diversified and intensively used knowledge sources. In order to understand evaluated issue better, the same analysis has been conducted among low and medium-low technology companies (table 11) as well as high and medium-high technology companies (table 12) separately.

Table 10: The competitiveness of all manufacturing companies with above average intensity of use of particular number of knowledge sources

No. of knowledge sources used with above average intensity (>=4)	*Competitiveness Index*	*Difference (x against 0 - 1 knowledge sources used with above average intensity: >=4)*	*p-value of Mann Whitney test*	*No. of companies in the group*	*Share in the sample*
0 - 1	2.79	-	-	117	35.0%
2 - 3	3.16	0.37	**<0.001*** **	125	37.4%
4 - 5	3.38	0.59	**<0.001*** **	54	16.2%
6 or more	3.58	0.79	**<0.001*** **	38	11.4%

Source: Own study

Table 11. The competitiveness of low and medium-low technology companies with above average intensity of use of particular number of knowledge sources

No. of knowledge sources used with above average intensity (>=4)	*Competitiveness Index*	*Difference (x against 0 - 1 knowledge sources used with above average intensity: >=4)*	*p-value of Mann Whitney test*	*No. of companies in the group*	*Share in the sample*
0 - 1	2.80	-	-	80	44.4%
2 - 3	3.15	0.35	**0.007*** **	55	30.6%
4 - 5	3.56	0.76	**<0.001*** **	27	15.0%
6 or more	3.40	0.60	**0.017** **	18	10.0%

Source: Own study

Table 11 points out that 44.4% of low and medium-low manufacturing companies do not use any or use only one of examined knowledge sources intensively. Moreover, two thirds of such companies use intensively not more than 3 knowledge sources. It shows that this kind of companies are rarely characterized by diversified knowledge acquisition. Even more interesting is the fact that low and medium-low technology manufacturing companies that intensively acquire knowledge from 6 or more sources are less competitive that those that concentrate on acquisition from 4-5 sources. It means that this kind of companies should concentrate on intensive knowledge acquisition from limited, most important sources.

In the last table (12), results of the same kind of analysis have been shown, but for high and medium-high technology companies.

Table 12. The competitiveness of high and medium-high technology companies with above average intensity of use of particular number of knowledge sources

No. of knowledge sources used with above average intensity (>=4)	*Competitiveness Index*	*Difference (x against 0 - 1 knowledge sources used with above average intensity: >=4)*	*p-value of Mann Whitney test*	*No. of companies in the group*	*Share in the sample*
0 - 1	2.77	-	-	37	24.0%
2 - 3	3.16	0.39	**0.027****	70	45.5%
4 - 5	3.20	0.43	**0.089***	27	17.5%
6 or more	3.74	0.97	**<0.001*****	20	13.0%

Source: Own study

As the table 12 demonstrate there are substantially less high and medium-high technology companies that do not use any or only one of examined knowledge sources intensively. Such entities are also much less competitive in comparison to their closest competitors. Nevertheless, the largest group of examined entities use only 2 or 3 knowledge sources intensively and their competitiveness is not very higher than average. However, the most important conclusion is the fact that the most competitive are high and medium-high technology manufacturing companies using 6 or more knowledge sources intensively. Their competitiveness is not only the highest than others that use less knowledge sources intensively, but one needs to underline that it is also much higher than others. This shows that high and medium-high technology manufacturing companies need to gain more knowledge and from more different sources in order to beat the competitors and create competitive advantage. The increase of number of knowledge sources does not give these companies a lot until they do not use 6 or more knowledge sources.

5) CONCLUSIONS AND RECOMMENDATIONS

Presented research results demonstrate that knowledge acquisition processes are important element for manufacturing companies' competitiveness. Practically, every increase in the intensity of knowledge acquisition from examined knowledge sources increased competitiveness of analyzed enterprises.

The results also indicate that manufacturing firms should not concentrate only on one category of knowledge sources as such approach does not bring them competitive advantage. It seems that they need to try to use various knowledge sources', from different categories, combinations in order to create stable, long term competitive advantage. Nevertheless, this issue needs to be investigated in more details. Especially the use of various combinations of most important knowledge sources for particular types of manufacturing companies.

The study also showed that there are variations between knowledge influence on different types of manufacturing companies. The results suggest that low and medium-low technology

manufacturing companies are the most competitive when they concentrate on intensive use of 4-5 knowledge sources. Nevertheless, one author is skeptical about this particular result and inclines the view that this issue should be examined more closely in the future. In case of high and medium-high technology companies these entities only when intensively use 6 or more knowledge sources become much more competitive than their closest competitors.

The article can also be the source of several valuable recommendations for manufacturing companies. Firstly, the research results showed that in many manufacturing companies intensity of knowledge sources' use is very low and probably this is the reason of their low competitiveness level. These entities should put much more attention to knowledge acquisition processes. Nevertheless, even companies which quite intensively gain knowledge from many knowledge sources should consider increasing its attention to this area as it may be relatively easy way of increasing their competitiveness. Secondly, the results suggest that using knowledge sources that are rarely used by competitors might be the sources of competitive advantage. Thirdly, especially high and medium-high technology manufacturing companies should diversify their knowledge sources' use not concentrating only on their few "favourite" sources. Fourthly, companies should adapt their knowledge acquisition policy to the type of their enterprise – low and medium-low technology manufacturing companies should apply different strategy than high and medium-high technology manufacturing companies. Especially the latter should concentrate on intensive use of knowledge from as many sources as possible.

6) LIMITATIONS AND FURTHER RESEARCH

Despite the large size of examined sample the research on which this article is based has particular limitations. Firstly, the sampling frame was Kompass Poland database which does not include all manufacturing entities operating in Poland. Moreover, the research was carried out among companies operating in this country and firms operating in other countries might be different. Nevertheless, probably there are some common points between all manufacturing companies and results described here are the reason to repeat this research in other countries. Among other important aspects worth examining is learning what sort of combination of knowledge sources are the best for increasing competitiveness of particular types of manufacturing enterprises. This requires more detailed researches. Maybe even combining qualitative and quantitative studies as well as using advanced statistical analyses. Another important aspect is developing other methods of distinguishing various types of manufacturing companies in order to distinguish entities with different knowledge needs.

7) ENDNOTES:

1. This article and the research were financed by National Science Center, Preludium 2 grant, no. 2011/03/N/HS4/00429.
2. In order to avoid repetition terms "knowledge acquisition" from particular source and "knowledge sources use" are used interchangeably in the article.
3. In the examined sample there were only 2 companies with such intensity of knowledge sources', from this category, use.
4. In case of research and development category there was no point in showing intensity of use >3.5. This category consists only of one element – one question assessed by respondents with total values in the 5-grade Likert scale, so the results would be the same as for >3.

8) REFERENCES

Barney, J.B., (2011), Gaining and Sustaining Competitive Advantage, Pearson Education, New Jersey.

Bryson, J.R., Clark, J., Mulhall, R. (2013), The competitiveness and evolving geography of British manufacturing: where is manufacturing tied locally and how might this change?, Future of Manufacturing Project: Evidence Paper 3, Foresight, Government Office for Science.

Darroch, J. (2003), "Developing a measure of knowledge management behaviors and practices", Journal of Knowledge Management, no. 7, iss. 5, pp. 41-54.

Deloitte Touche Tohmatsu Limited, Global Consumer and Industrial \ Products Industry Group, Council on Competitiveness (2016), The 2016 Global Manufacturing Competitiveness Index (GMCI), report, available at: http://www2.deloitte.com/content/dam/Deloitte/global/Documents/Manufacturing/gx-global-mfg-competitiveness-index-2016.pdf (accessed: 27.06.2016).

Evans, Ch. (2005), Zarządzanie Wiedzą, Polskie Wydawnictwo Ekonomiczne, Warszawa.

Fonfara, K. (2007), "Typologia zachowań przedsiębiorstw w procesie internacjonalizacji", Marketing i Rynek, PWE, No. 12, pp. 10-15.

Gorynia, M. (2000), "Luka konkurencyjna w przedsiębiorstwach a przystąpienie Polski do Unii Europejskiej", Gospodarka Narodowa, nr 10, pp. 48-67.

Grönroos, Ch. (2005), Service Management and Marketing. A Customer Relationship Management Approach, John Wiley & Sons, New York.

Handzic, M., Zhou, A.Z. (2005), Knowledge Management. An Integrative Approach, Chandos Publishing, Oxford.

Hatzichronoglou, T. (1997), Revision of the HighTechnology Sector and Product Classification, OECD Science, Technology and Industry Working Papers, 1997/02, OECD Publishing, available at: http://dx.doi.org/10.1787/134337307632 (accessed: 26.03.2012).

Karlsson, Ch., Johansson, B., Sough, R.R. (2006), Entrepreneurship and Dynamics in the Knowledge Economy, Routledge, New York.

Kowalczyk, A., Nogalski, B. (2007), Zarządzanie wiedzą. Koncepcja i Narzędzia, Difin, Warszawa.

Liu, M.-S., Liu, N.-Ch. (2008), "Sources of knowledge acquisition and patterns of knowledge-sharing behaviors - An empirical study of Taiwanese high-tech firms", International Journal of Information Management, Vol. 28, Iss. 5, pp. 423-432.

Małys, Ł. (2013), Siła powiązań sieciowych w procesie internacjonalizacji a wyniki przedsiębiorstwa, Difin, Warszawa.

Manyika, J., Sinclair, J., Dobbs R., Strube, G., Rassey, L., Mischke, J., Remes, J., Roxburgh, Ch., George, K., O'Halloran, D. and Ramaswamy S. (2012), Manufacturing the future: The next era of global growth and innovation, McKinsey Global Institute, report, available at: http://www.mckinsey.com/business-functions/operations/our-insights/the-future-of-manufacturing (accessed: 27.06.2016).

Mazur, J., Rószkiewicz, M., Strzyżewska, M. (2008), Orientacja na wiedzę a wyniki przedsiębiorstwa. Wyniki badań średnich przedsiębiorstw funkcjonujących w Polsce, Szkoła Główna Handlowa w Warszawie, Warszawa.

Neef, D., Siesfeld, G.A., Cefola, J. (1998), The Economic Impact of Knowledge, Butterworth-Heinemann, Boston.

Obłój, K. (2007), Strategia organizacji. W poszukiwaniu trwałej przewagi konkurencyjnej, Polskie Wydawnictwo Ekonomiczne, Warszawa.

OECD (1996), The Knowledge-Based Economy, OECD report, Paris.

Omerzel, D.G., Gulev, R.E. (2011), "Knowledge Resources and Competitive Advantage", Managing Global Transitions, vol. 9, no. 4, pp. 335-354.

Paliszkiewicz, J.O. (2007), Zarządzanie wiedzą w małych i średnich przedsiębiorstwach - koncepcja oceny i modele, Wydawnictwo SGGW, Warszawa.

Perechuda, K. (2005), Zarządzanie Wiedzą w Przedsiębiorstwie, Wydawnictwo Naukowe PWN, Warszawa.

Powell, W.W., Snellman, K. (2004), "The Knowledge Economy", Annual Review of Sociology, no. 30, pp. 199-220.

Probst, G., Raub, S., Romhardt, K. (2004), Zarządzanie Wiedzą w Organizacji, Oficyna Ekonomiczna, Kraków.

Ratajczak-Mrozek, M. (2010), Sieci biznesowe a przewaga konkurencyjna przedsiębiorstw zaawansowanych technologii na rynkach zagranicznych, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu (UEP), Poznań.

Rothberg, H.N., Erickson, G.S. (2005), From Knowledge to Intelligence – Creating Competitive Advantage in the Next Economy, Elsevier Butterworth-Heinemann, Oxford.

Soniewicki, M. (2014), “The characteristics of knowledge management processes in the Polish service industry companies”, Przegląd Organizacji, nr 7, pp. 40-46.

Soniewicki, M. (2015a), The company’s international competitive advantage – the role of knowledge, Difin, Warsaw.

Soniewicki, M. (2015b), “The use of external knowledge sources in manufacturing companies”, Kwartalnik Nauk o Przedsiębiorstwie, no. 4 (37), pp. 89-97.

Soo, Ch.W., Midgley, D.F., Devinney, T.M. (2002), “The Process of Knowledge Creation in Organizations”, INSEAD Working Papers, available at: http://www.insead.edu/facultyresearch/research/doc.cfm?did=972, (accessed: 10.07.2014).

Sparrow, J. (2010), On-line initial self assessment of Knowledge Management, available at: http://interactive-audit.bcu.ac.uk/kmaudit/ (accessed: 18.03.2012).

Vera, D., Crossan, M. (2006), “Organizational Learning and Knowledge Management: toward an Integrative Framework”, in Easterby-Smith, M., Lyles, M.A. (Ed.), The Blackwell Handbook of Organizational Learning and Knowledge Management, Blackwell Publishing, Oxford, pp. 122-141.

Welfe, W. (2007), Gospodarka oparta na wiedzy, Polskie Wydawnictwo Ekonomiczne, Warszawa.

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