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Jan L. Bednarczyk[1]

CAN THE TAYLOR RULE BE A GOOD TOOL TO ANALYSE THE MONETARY POLICY QUALITY AT THE TIME OF RECENT MARKET TURBULENCES?

Abstract

Article deals with the problems of application of the Taylor rule as a practical rule, facilitating monetary authorities` decision making in the years following financial crisis 2007+. Author comes to the conclusion, that the Taylor rule seems to be a poor tool to articulate postulates for central bank`s monetary policy and even for an ex post assessment of this policy. He proposes to substitute Non-decreasing economic growth rate of inflation (NDEGRI) for the Taylor rule as an indicator of the correctness of authorities actions.

JEL Classification Codes: **E52**, **F43.**

Keywords: Non-decreasing economic growth rate of inflation (NDEGRI), low inflation trap.

1. Taylor rule and its practical connotations

The so-called Taylor rule has become an essential element in the discussion on monetary policy meeting the postulate of price stability. It was introduced to economic literature in 1993 by John Taylor, American economist[2], and it is still present in both theoretical discussions and theoretical analyses of the quality of

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[2] Taylor wrote his formula in the following way: r = p+ .5y + .5(p - 2) + 2, where: r – is interest on federal funds, p – inflation rate in the last four quarters, y – percentage deviation of real GDP from the targeted value in such a way that: $y = 100(Y - Y^*)/Y^*$ where: Y – is real GDP, and Y^* is a long-term growth rate of real GDP (trend real GDP), calculated for the USA for the period between the first quarter of 1984and the third quarter of 1992 and they stand at the level of 2.2% annually (Taylor, 1993, p. 202).

monetary policy, typical of the so-called New Consensus between the trends representing neo-classical economics and Keynesian economics, described also by the names of New Neoclassical Synthesis or New Keynesian Economics (Goodfriend, 2007, p.48). The form of the Taylor rule has evolved. This paper presents the version which was analysed by B. Bernanke, Federal Reserve Governor, at the annual meeting of the American Economic Association in January 2010 (Bernanke, 2010). In this:

$$i_t = 2 + \pi_t + \alpha(\pi_t - \pi^*) + b(y_t - y_t^*)$$

where:
i_t – means the desired value of the official interest rate at time t,
$\pi_t - \pi^*$ – are deviations of the real inflation rate (π_t) from the inflation target (π^*) set by the central bank at time t,
$y_t - y_t^*$ – „production gap", indicating deviation of the real output (y_t) from its potential value (y_t^*),
a, b – positive numbers

The essence of the Taylor rule consists in pursuing such a level of the official interest rate (in this case interest on federal funds), which would be best from the point of view of the course of inflation and economic growth. In the case when the real inflation diverges upwards from the inflation target or when real GDP diverges upwards from its potential level, a central bank should raise the official interest rate. On the other hand, it should reduce it in the case when inflation diverges downwards from the inflation target or when real GDP is lower than its potential value.

In the presented formula inflation and economic growth are treated „equally" from the point of view of postulated changes in the official interest rate; Taylor adopts the same weights for deviations of inflation and GDP (values of α and b equal 0.5). Adoption of the same weights results from a specific „optimisation" of the rule form (model) performed on the basis of econometric studies carried out by the author himself, institutions and individual researchers. A similar justification is offered to account for the use of the real interest rate at the level of 2% and the value of potential GDP in the rule. The value of potential GDP results from a simple extrapolation of the average real GDP growth rate in the USA in the years 1984–1992 (2.2% annually); on the other hand, a 2% level of the real interest rate is reputedly the equilibrium level corresponding to the growth rate calculated in such a way.

From the point of view of econometric or statistical studies it is more difficult to explain a 2% inflation assumed by Taylor as the target of the central bank

policy[3]. The average growth rate of consumer prices in the USA in the years 1981–1991 stood at 4.1% (OECD, 2006, Annex Table 18), whereas in the years 1984–1994 it oscillated around 3.6% (OECD, 2008, Annex Table 18). When Taylor put forward his formula, he assumed from the beginning that the monetary policy target in the USA should be the carrying out of the disinflation process regardless of the practical consequences of such policy for economic growth. Anyway, economic growth in this type of policy must be treated as a resulting value while bringing price dynamics to an *a priori* (intuitively) defined inflation target is the basic value.

Such a system of targets (goals) in monetary policy is confirmed also by a preliminary analysis of the central bank's reaction (formulating its decisions on the basis of the Taylor rule) to changes in inflation levels and real GDP growth. As it turns out this reaction must be unsymmetrical, which seems to indicate that the above mentioned „equal" treatment of inflation and economic growth as the economic policy targets is only apparent. For example, if inflation grows by 1 percentage point then authorities face the necessity to raise the official interest rate by 1.5 percentage points, the economic growth rate decreases by 1 percentage point, and a central bank responds by a 0.5% decrease in the official interest rate.

In this way the rule becomes an inherent part of the monetary policy tradition from the period of the „monetarist experiment" carried out in the United States and Great Britain at the turn of the 1970s and 1980s, when any symptoms of economic growth were suppressed if only symptoms of accelerated price increases had appeared in economy (Bednarczyk, 1990, p. 90-119). J. B. Taylor himself eagerly points to his doctrinal affinity with M. Friedman's views emphasizing that in fact the only significant difference which relates to its application in comparison to the implementation of the so called monetary rule is that the former one treats the interest rate – and not money supply – as a key instrument to affect the price dynamics (Taylor, 2008). It is interesting that M. Friedman did not entirely get used to such a change in regulation instruments (*An Interview with M. Friedman*, 2006).

The scope of this paper does not allow a broader SWOT (strengths, weaknesses, opportunities and threats) analysis connected with adoption of the Taylor rule as the basis of the decision-making process in a central bank's monetary policy. The rule has its advocates and radical opponents. It seems that for example the rule is not able to face up to „Lucas criticism" as it assumes that the relationships between the variables appearing in the rule will remain the same despite changes in monetary policy which, for example, may consist in multi-directional changes

[3] It should be noted that the same level of inflation target was included in the Maastricht Treaty as a postulate for future EMU participants; it was also cited by B. Bernanke, as „Fed`s assumed inflation target" in the already quoted address of 3 January 2010.

in interest rates. This definitely weakens its usefulness as a tool for shaping future economic conditions although it does not necessarily shatter its usefulness as a tool of describing past events, especially so, that in such a description one can appropriately „select' variables making up the rule (inflation measures, real interest rate of the equilibrium, etc.), as it was done by the already quoted B. Bernanke when he characterised the US monetary policy in the 2000s.

But first and foremost, the Taylor rule should not „aspire" to the role of a central bank's monetary policy basis. The results of the Kansas City Federal Reserve Bank's research indicate that although the Federal Reserve System officially has never accepted the Taylor rule as the basis of its monetary policy, yet it has always been „present" in works of the Federal Open Market Committee members and treated as one of key tools in an analysis and assessment of the current monetary policy (Asso, Kahn, Leeson, 2007, pp. 25–27).

Eventually assuming that a central bank bases in its activities on the relationships described in the Taylor rule, it should be expected that that the policy implemented by it will be particularly dangerous for the economy in the early phase of boom when the GDP growth indicators deviate rapidly from the trend and a natural tendency towards accelerated price increases occurs due to increased demand (not only for raw materials but also for e.g. modern, more productive technologies). Monetary policy following the Taylor rule will react by an increase (a major one) in interest rates, thus shaping expectations of economic units unfavourable for further boom development and knocking economy out of its natural development rhythm.

It must be noted that the effect of the nominal interest rate growth on the behaviour of real interest rates will be stronger than it may appear from simple arithmetic (deduction of the inflation index from the actual nominal interest rate level) as economic units will see in the increased interest rates the start of the whole series of interest rate increases (which is in accordance with the actual practice of central banks) and will start to consider in their decisions a future, much higher level of the real interest rate which, in turn, will have a stronger effect on their limiting business activity than it might appear from a simple calculation of the actual increase in credit costs. An ill-considered decision of a central bank will trigger off a specific mechanism of „economic hysteria" which is capable of nipping processes of investment in fixed assets in the bud and shift economic resources from the sphere of production to the sphere of speculation thus putting the whole economy at risk of further negative shocks.

This type of policy is equally useless at the time of violent demand-side or supply-side shocks triggered off by internal or external factors, when the policy of interest rates must quickly and decisively react (in a broad scope) in order to at least partly absorb the effect of shocks on the real sphere. A weak response of the interest rate to the economic growth slow-down which is built-in in the rule makes such a reaction impossible.

Table 1 presents a simulation of the official interest rate levels of selected central banks in 2010, if they had followed the Taylor rule in their policy and actual interest rate levels. It appears from the simulation that e.g. in Japan the official interest rate should have had a negative value, which, as it is widely known, cannot happen. On the other hand, in the United States and, in particular, in Great Britain very big differences occur between the values of the interest rate recommended by the Taylor rule and their actual values. In the case of Great Britain the actual value is lower by as much as 295 base points and in the United States by 145–170 base points. It is interesting that in the United States this difference has a negligible effect on the price increase rate (table 2). This effect seems to be much stronger in the case of Great Britain, but it would be very difficult to defend the thesis that the price increase in this country has got out of the authorities' control in the sense that it generates expectations of economic units which assume further significant acceleration of inflation. The data included in Table 2 suggests something quite opposite; in 2012 inflation in Great Britain should significantly slow down.

Table 1. Using the Taylor rule to determine a recommended level of the official interest rate in selected countries in 2010

Specification	Interest rate level recommended by the Taylor rule	Official interest rate level
United States	+1.7	0.0–0.25
Great Britain	+3.45	+0.5
Japan	-1.0	+0.3
Euro zone	+1.2	+1.0
Poland	+3.55	+3.75

Source: Author's own calculations based on OECD and central banks' data.

Table 2. Selected macroeconomic indices in the USA, Great Britain, Euro zone and Poland in the years 2010–2012 (%)

Specification	2010				2011				2012			
	United States	Great Britain	Euro zone	Poland	United State	Great Britain	Euro zone	Poland	United States	Great Britain	Euro zone	Poland
Real GDP growth rate	3.0	1.8	1.8	3.8	1.7	0.9	1.6	4.2	2.0	0.5	0.2	2.5
Consumer price increase rate	1.6	3.3	1.6	2.6	3.2	4.5	2.6	4.0	2.4	2.7	1.6	2.5
Unemployment rate	9.6	7.9	9.9	9.6	9.0	8.1	9.9	9.6	8.9	8.8	10.3	9.9

Source: Author's own compilation on the basis (OECD, 2011, Annex Table 1, 13, 18; OECD, 2013, Annex Table 1, 13, 18).

The relationships between the recommended and real levels of interest rates look quite different in the case of the euro zone countries and Poland[4]. Here we deal with almost full convergence. Nevertheless, in the case of euro zone countries the official interest rate was lower (by 20 base points) whereas in the case of Poland it was higher by 20 base points. Thus in 2010, the National Bank of Poland implemented even a more restrictive monetary policy than it appears from the Taylor rule.

Convergence between the ECB's and the Taylor rule recommendations caused that in 2010 the price growth rate got stabilised at the level of 1.6%, that is the one that is lower from the ECB's inflation target (2%.), but this was paid for with a much slower (even slower than in the US) recovery of the euro zone economy from the crisis. Besides, there were many other premises indicating that in 2012 the economic growth rate in Europe would further deteriorate whereas the US economy began to show clear symptoms of recovery.

When it comes to Poland, the EU's assistance, especially in the form of financing infrastructural investments, had a great impact on maintaining a favourable economic situation. The above mentioned investments provided employment which, in turn, contributed to maintaining domestic demand. Another important factor was a relatively smaller dependence of the country on trade with abroad as well as a relative underdevelopment of the Polish financial sector due to which Poland has not suffered the consequences of the financial crisis as acutely as the other, economically well-developed countries of Europe. „Observation" of the Taylor rule in Poland was of secondary nature rather. To some extent it resulted from the character of the ECB's policy (Poland is not a member of the euro zone, yet it is obliged to fulfill the Maastricht criteria and participate in the work of the ECB) and the desire to prevent the depreciation of the zloty which was under the constant pressure as the aversion to risk was growing as more and more EU member countries turned out to be threatened by insolvency.

In summary of theoretical and practical aspects of the Taylor rule it must be concluded that its main message consists in pursuing the means to stabilise inflation at low level (ca. 2%), which is believed to be the foundation for the long-term economic growth. In this way it is assumed *a priori* that a certain price increase rate is the optimum one for economy and it is economically viable in long- and short-term to incur even high costs to reach it. However here some questions arise: is the 2%-inflation the optimum price rise rate in any economy? Is not the price rise rate dependent on the phase of the economic cycle? Cannot the price

[4] In this table Poland is included as the only EU country and one of very few OECD countries which has not noted the negative GDP growth rate during the time of the recent crisis.

rise be used to some extent to absorb external shocks; or is it more appropriate to absorb these shocks by adjustments in the field of production and employment?

2. Neutral inflation as the monetary policy basis

While answering the question about the optimum price increase rate one cannot ignore the data characterising the fastest developing economies at present which the BRIC group countries belong to. In these countries inflation rates are as a rule at the level of 7–10 per cent with the exception of China where inflation approaches 6%. In the most rapidly growing European economy, which Turkey has been for years, inflation fluctuates between 8 to even above 10%. The above quoted data provide fairly strong evidence confirming the thesis that in the situation of variable currency exchange rates, economic authorities have still quite a lot of freedom in the field of shaping inflation indices.

First of all they do not have to react in advance to changes in prices conditioned by the economic situation (e.g. by „prohibitive" increases in interest rates), which enables free development of a favourable economic situation. The time for stronger corrections of monetary policy comes when economic revival is under way. In this manner inflation is kept under control without negative consequences for economic growth. The same applies also to absorption of external shocks. For instance, the higher price of oil reflected in the higher prices of fuels in internal market does not have to be treated by monetary policy as an inflation impulse which must immediately be suppressed. The effect of such an action would be the transfer of the „supply-side shock" directly to the economic growth indices. Inflation would remain at low level but with damage for the real sphere (production, employment). In this case allowing a temporary increase in inflation would give the real sector the time indispensable for adjustment to new market conditions as well as time for implementation of technologies limiting consumption of the „expensive" factor of production.

Observation of interdependencies between the price increase rate and economic growth in both industrialised countries and countries of most dynamic economies allows us to formulate the thesis that the economic policy based on tight control of inflation in order to keep it at an *a priori* set low level does not create good conditions for long-term, stable economic growth and must be replaced by a totally different theoretical approach, more friendly for economic growth.

An alternative model of determining the inflation target by a central bank could be based on the neutral inflation hypothesis or the Non-Decreasing Economic Growth Rate of Inflation (NDEGRI) understood as an average price increase in the course of 5–10 years, which co-exists with the highest economic growth indices at which inflation expectations are of stable character (i.e. inflation does not reveal a tendency towards acceleration). An attempt at graphic

determination of the neutral inflation level for the United States is presented in figure 1. The data used are the OECD data for the years 1995–2012. On the OY axis the economic growth rate at time t is marked, whereas on the OX axis – consumer price increase rate at time t-1. Adoption of the previous year inflation as the explanatory variable seems to be justified by the fact that according to the theory of rational expectations, economic entities make their economic decisions at time t on the basis of expectations formulated at time t-1. Therefore the dynamics of price increases, nominal revenues from sales, profits and individual incomes (and other economic phenomena and information) in a given year affect to a large extent decisions concerning expenditures in the following year, which in turn affect the GDP growth rate.

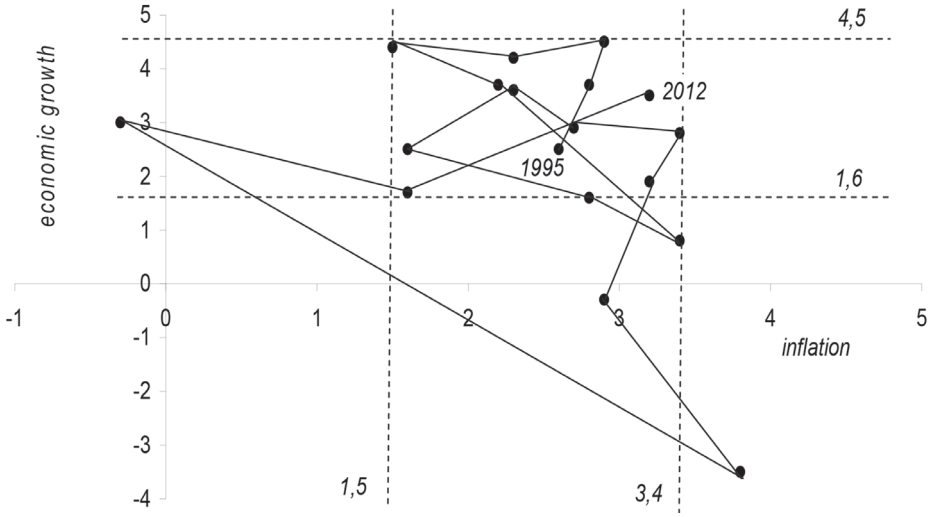

Figure 1. Inflation and economic growth in the United States in the years 1995–2012

Source: Author's own compilation on the basis (OECD, 2008, Annex Tables: 1, 18; OECD, 2011, Annex Tables: 1, 18; OECD, 2013, Annex Table 1, 18).

According to the figure 1, in the examined period the real GDP growth rate and inflation in the United States, with nearly 78% accuracy[5], were in the ranges: inflation 1.5–3.4, economic growth 1.6–4.5. Only in the years 2008, 2009 and 2010 inflation and economic growth indices deviated significantly from them, which can be accounted for by the crisis. Yet, as the economy recovered from the crisis the indices returned to previous values. Thus, it seems that inflation

[5] It results from the division of 14(the number of observations included in the ABCD rectangle in figure 1) by 18 (total number of observations).

indices within the 1.5–3.4 range reflect the natural cyclical nature of the US economy development: they threaten it neither with fuelling of the inflation expectations nor with shaping deflation expectations. First and foremost they are neutral for economic growth as they can „co-exist" with relatively high indices of real GDP growth.

The data shown in the figure 1 (despite their narrow scope) concerning dynamics of price increase and real GDP growth in the United States in the years 1995–2012 do not confirm the existence of a positive interdependence between economic growth and stable inflation frequently referred to in economic journalism and reports of central bank decision makers. Changes in prices and in real GDP periodically take the same direction, or opposite directions. Sometimes the periods of rapid GDP growth are accompanied by lower and sometimes by higher inflation. And the other way round: the periods of slowed down GDP growth are accompanied by lower or higher inflation. The character of the inflation-economic growth relationship depends on many factors, such as: budget (Krawczyk-Sawicka, 2016, pp. 41–48) and external balance, a central bank's policy of interest rates, situation of currency exchange rates, changes in expectations, etc., which in every single case may affect this relationship in a different way.

Consequences of the monetary policy based on a central bank's pursuit of the *a priori* set inflation target (different from the NDEGRI) can be theoretically analysed with the use of figure 2. In this figure oblique lines on both sides of the OY axis mean two opposing cases of disinflation: the first one – the line on the right side of the OY axis – illustrates a disinflation process carried out in the circumstances of flexible prices and wages and low tolerance for inflation processes indicated by economic life participants; the second one – on the left side from the OY axis – illustrates a disinflation process in the situation of rigid prices and wages and more tolerance on behalf of economic entities for the price increases.

In the former case, a slowed down rate of money supply (determining the disinflation process) may not cause a decline of the real amount of money in economy as it will be prevented by a quick decline in the inflation rate. The decline will be possible due to the lack of social tolerance for the price increase exceeding the historically acceptable levels (for example, exceeding the upper level of neutral inflation). Because in this type of economy inflation processes entail high social costs, welfare costs as well as costs in the form of restricting output growth (caused by reduced market mechanism efficiency due to the distortion of the relative price structure) (Thorton, 1996, 1996, p. 57 and onwards), full support for disinflation policy will translate into rapid suppression of inflation expectations. What is more, it is quite likely that the appropriately quick decrease in the inflation rate will be followed by an increase in the real amount of money, decrease in interest rates and stimulation of economic growth. Economy will move along the AC`` line up to point B`, which corresponds to the potential

output (P_p) and neutral inflation value (i_n). The balance in point B` will be of a relatively stable character and will ensure optimum development conditions to economy in the medium length term.

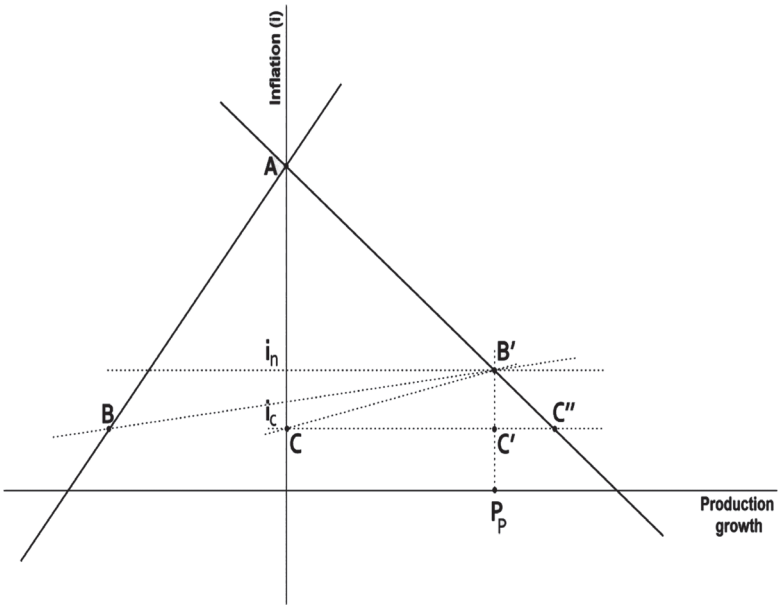

Figure 2. Variants of achieving economic balance after the period of strenuous inflation suppression

Source: author's own compilation.

The situation will change dramatically if the authorities define their goal as lowering and than maintaining inflation at the level i_c, lower than the NDEGRI . Theoretical economic equilibrium may shift from point B` towards points: C``, C` or C, for which the inflation index assumes this value. A move towards point C`` – i.e. in the situation in which exceeding a potential output size is accompanied by decrease in inflation – is less likely. The shift towards point C` (impact of anchored inflation expectations allowing to keep real interest rates at a low level) is highly probable. However, there is a risk of the equilibrium being shifted to point C, which will result from exhaustion of advantages and deepening of disadvantages that the economy may experience due to lower inflation i_c[6]. The weaker the impact of anchored inflation expectations is, the more probable the

[6] Disadvetages can arise e.g. due to the lack of possibilities of the „inflation-related" reduction of labour costs, lack of possibilities to use monetary stimulation, etc.

shifting of the equilibrium to point C is. What is more, with time authorities may become a peculiar hostage of the policy aiming at maintaining the anchored inflation expectations at i_c level which may force them to overreact to fluctuations in expected prices. This can result in maintaining exceedingly high levels of interest rates which do not favour economic recovery (see: the ECB's policy of interest rates after the 2007 crisis). Economy will find itself in a peculiar trap which can be described as „low liquidity trap", characterized by low inflation which is accompanied by stagnative economic growth and high and still growing unemployment.

In the case of the disinflation process in an economy characterized by lesser flexibility of prices and wages and higher tolerance for price increases, suppression of inflation will be a slower process. Restricting the money supply rate will entail a decrease in real amount of money and an increased interest rate which will trigger off recession processes. Economy will move to point B, which corresponds to inflation at i_c level (an *a priori* adopted inflation target), but also negative economic growth and high unemployment (the case of Polish economy in 2002). Depending on the country, the scale of the output decrease as a rule will be different and it will depend on the slope of AB curve. The equilibrium in point B is characterized by low inflation but at the same time a tendency toward growing budget deficit (if the authorities do not find an effective method of curbing public expenditure). The need to anchor inflation expectations at i_c level will entail a tendency towards maintaining excessively high interest rates which can cause a durable stagnative tendency at low inflation levels and incomplete utilization of production capacity. The economy will become a specific hostage of good looking inflation statistics –it will find itself in the „low inflation trap".

A way out of this difficult situation – provided that in the meantime no durable deflation expectations are established – is an attempt to shift the equilibrium to point B where inflation is slightly higher than i_c (attains values corresponding to the NDEGRI), but economy uses its production capacity to the full. To this end authorities can use both monetary policy tools (reduction of interest rates) and fiscal policy tools (reduction of tax rates). Indeed, in the situation of not fully utilised production capacity, reduced tax rates should not lead to deeper budget deficit as the decline in budget revenues caused by lower taxes will be compensated by higher revenues resulting from the increased tax base[7].

[7] The case of Poland in 2003 when by reducing CIT from 27% to 19% the economic boom lasting until 2008 was initiated.

3. Concluding remarks

The Taylor rule referred to in economic literature and, in particular, in the materials of some central banks seems to be a poor tool to articulate postulates for monetary policy and even for an ex post assessment of this policy. This conclusion concerns mainly the post-crisis reality in which we must definitely give up the practice of treating the *a priori* set central banks' inflation targets as a kind of a „sacred cow" on which the entire interest of the centres making decisions on economic policy is focused. We must make an authentic attempt of taking the economies of industrialised countries out of the vicious circle of stagnation and lack of future prospects. It seems that the NDEGRI may become the right tool to shape conditions for long-term economic growth as it allows us to enhance flexibility of market mechanisms and their immunity to both domestic and external turbulences.

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Nibu Raj Abraham[1]

DO MONTHLY ANOMALIES STILL EXIST AS A PROFITABLE INVESTMENT STRATEGY: EVIDENCE BASED ON THE SINGAPORE STOCK MARKET

Abstract

The presence of various calendar anomalies in the stock markets is a well-documented fact. We focus our efforts through this study to reveal any semi-monthly anomaly or turn of the month anomaly hidden in the Singapore stock market, by analysing the FTSE Strait Times data during the period 1995 to 2015, using both the calendar day approach and trading day approach. The resulting analysis discloses some startling findings including the presence of a 'reverse' turn of the month anomaly. Significant semi-monthly anomaly is not present in the market, even though the mean percentage returns during the first and second half show high relative difference. Based on these findings, a profitable trading strategy evolves which is to purchase shares representative of the index during the turn of the month and to sell them during the first half of the month. This study widens the path for further research regarding these and similar anomalies in related markets around the world.

JEL Classification Codes: **G00.**

Keywords: Semi-monthly anomaly, Reverse turn of the month anomaly, calendar days, trading days, global mean return.

Introduction

Anomalies in stock market have been a topic of interest and detailed study for both academicians and practitioners over the years. Various studies about time efficiency have revealed different anomalies like turn of the month effect, semi-monthly pattern, seasonality (eg: January effect, April effect) and day of the week

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effect, to name a few. The above anomalies, which are patterns formed based on past prices, can be used to predict future prices. The knowledge of anomalies is advantageous since it helps informed investors to make a profit without taking additional risk.

The earliest studies regarding anomalies were done by Tooke (1824) and Kemmerer (1911) (Bentzen, 2009). According to Pettengill (2003), the earliest research can be traced back to the 1920s. Among the various anomalies, semi-monthly patterns kindle profound interest among the investors. The most popular among the semi-monthly patterns was a discovery made by Ariel (1987). Based on the analysis of US stock market, he recognised that the returns during the first half of the month were considerably higher than the earnings during the second half. Calling this 'monthly effect', he specified that the returns of stock were considerably positive for the days during and immediately before the first half of the month and nearly equal to zero during the second half of the month. In continuation of this study, the stock market returns of Canada, UK, Australia and Japan were analysed by Jaffe and Westerfield(1989), but noticed 'monthly effect' only in the Australian bourses. Japan showed a reverse monthly effect whereas the anomaly was weak in Canada and UK. Barone's (1990) study of the Italian market also resulted in findings similar to the Japanese market, ie, reverse monthly effect, with higher returns in the second half of the calendar month than the first half. In his study of stock market anomalies on ten Asia Pacific countries, Yakob, Beal and Delpachitra (2005) found evidence for monthly anomalies in six countries apart from the five countries that demonstrated day-of-the-week effect.

Lakonishok and Smidt (1988) brought to limelight the anomaly 'turn of the month effect', based on their study of US stock markets. They distinguished that the average daily returns during the ending and beginning days of a month are considerably higher than the returns for the rest of the month. Cadsby and Ratner (1992) found similar results for the majority of countries among the nine countries they explored for the presence of turn of the month effect. Hensel and William (1996) found results in support of the turn of the month effect in their study on US bourses during the period 1928 to 1993. In their analysis of stock market indices of 19 countries, Kunkel, Compton and Beyer (2003) discerned that in 15 among the 19 countries, the mean return during the turn of the month accounted for 87% of the monthly return. Mc Connell and Xu (2008), who analysed the daily US returns for the 80 year period 1926-2005 demonstrated the existence of a strong turn of the month (TOM) effect during their period of study, especially during the period 1987-2005 and attributed the entire excess returns in a month to the 4-day turn of the month interval. Reschenhofer (2010) who analysed the daily returns on the S & P 500 index from 1952 to 2010, perceived a strong presence of turn of the month effect during a major part of his period of study.

Wachtel (1942) put forth the 'January effect' based on his discovery that the returns during the first month of the year were considerably higher than the rest of the year in the American stock market. It is also known as the 'turn of the year' effect. The findings with respect to the US market were substantiated by Ariel (1987), Bentzen (2009) and Dzhabarov and Ziemba (2010). Similar results were found in other markets like Australia (Officer, 1975); Japan (Kato & Schalheim, 1985; Aggarwal, Rao & Hiraki, 1990; Hamori, 2001); UK (Lewis, 1989); Canada (Tinic & West, 1987); Italy (Barone, 1990); Hong Kong, Korea, Malaysia, Singapore, Philippines (Ho, 1990); Israel (Lauterbach & Ungar, 1992); Taiwan (Mougoue, 1996); Greece (Mills, Siriopoulos, Markellos & Harizanis, 2000) and Ireland (Lucey & Whelan, 2004).

Empirical studies in the United States have pointed towards day of the week effects (weekend effects). Research based on the US market by Cross (1973), French (1980), Gibbons and Hess (1981), Keim and Stambaugh (1984), Smirlock and Starks(1986)and Choa, Lintonb and Whang (2007) have upheld the 'Monday effect' which is the occurrence of significantly negative returns in the stock markets on Mondays. The studies by Hindmarch, Jentsch and Drew (1984), Jaffe and Westerfield (1985), Chang, Pinegar and Ravichandran (1993), Tong (2000), Cai, Li and Qi (2006), and Lim, Ho and Dollery (2010) have also pointed to the presence of Monday effect in various international markets. On the contrary, many research works have reported a reversing or declining weekend effect. (Kamara, 1997; Chen & Singal 2003; Marquering, Nisser & Valla. 2006; Doyle & Chen, 2007; Liu & Li (2010) and Worthington, 2010).

Majority of the studies in the past, especially recent studies, regarding anomalies have focused on the developed markets in the West. The findings will be more relevant and authoritative, if similar results could be found in capital markets which are distant from the West such as a developed economy in South East Asia like Singapore. Meanwhile, recent studies focused on Singapore pertaining to semi-monthly anomalies and turn of the month anomalies are not evident. As a pioneering step towards further such studies, we focus our efforts on excavating monthly anomalies in the Singapore stock market.

1. Objectives

This study specifically aim at finding:

- Any significant difference between the average daily earnings for the first half of the month and the second half (semi-monthly effect)
- Any significant difference between the average daily returns during the turn of the month and the rest of the month (turn of the month effect).
- The study will also focus on suggesting the trading strategies based on the results of the above.

2. Sample data and Time period

The most popular index which truly represents the performance of the Singapore stock market is the FTSE Strait Times Index, which represents the largest and most liquid companies in the market. FTSE Strait Times Index daily values during the period 1st April 1995 to 31st March 2015 have been used for the study. Adjusted daily index prices, corrected for capital adjustment (ie, stock splits, stock dividends and rights) have been used. The data is collected from the website www.sg.finance.yahoo.com. The details regarding the index have been obtained from the website www.ftse.com. The original data has been cross-checked with similar data provided on www.sgx.com and www.google.com/finance.

Past research presents a conflicting picture regarding the days to be included in a month. Ariel (1987), Kunkel et al(2003), Cai et al(2006) and Reschenhofer (2010) have incorporated trading days in a month while Ushad (2010) and Liu and Li (2010) have taken into account calendar days alone in their study. In order to avoid a conflict in the approach and to reiterate the findings made using either method, the analysis of the presence of semi-monthly anomalies and turn of the month anomalies are done using both calendar days approach and trading days approach.

The daily market return in percentage is calculated as:

$$R_t = \ln (P_t / P_{t-1}) \cdot 100 \quad (1)$$

where P_t is the price of the index on the day *t*, and P_{t-1} is the price of the index on the previous day *t*-1.

Based on the study of Ariel (1987), the trading days are decided as shown in Table 1. Ariel (1987) defines the first half of the month as days -1 to +9 and the last half of the month as days -9 to-2, whereas trading days -1 to +4 exhaustively builds up the turn of the month.

Table 1. Trading days comprising the two halves of a month and turn of the month

Period	Abbreviation	Trading days
First half of month	FH	-1 to +9
Last half of month	LH	-9 to -2
Turn of the month	TOM	-1 to +4

Source: own.

3. Descriptive Statistics and Analysis using calendar month approach

Mean return and standard deviation (SD) for the 31 calendar days are shown in Table 2. The data available consists of returns only in which trading occurred and avoids holidays. The total no: of observations over the period 1995 to 2015

are 5043. The global mean return is -0.01007. The highest mean calendar day return is on the 14th calendar day. It shows a relative percentage increase of 2384% over the global mean return and positive also. A look at the histogram in Figure1, detailing the mean returns for the calendar days, reveals that the returns are generally high and positive during the first half of the month, especially during the days 6 to 14. Also the returns are highly negative during the end of the month and on the first day of the month. The data for the entire calendar month, taken as one, shows high variation also.

Table 2. Mean and SD of percentage returns and No: of observations for calendar days

Day	**1**	**2**	**3**	**4**	**5**	**6**
No of observations	143	161	170	168	172	166
Mean	-0.34	0.07	0.00	-0.14	0.02	0.17
SD	1.29	1.11	1.20	1.34	1.31	1.36
Day	**7**	**8**	**9**	**10**	**11**	**12**
No of observations	164	166	160	165	170	171
Mean	0.10	-0.04	0.13	-0.03	0.15	0.11
SD	1.30	1.30	1.59	1.39	1.20	1.34
Day	**13**	**14**	**15**	**16**	**17**	**18**
No of observations	168	167	164	168	170	168
Mean	-0.10	0.23	0.08	-0.09	0.02	-0.13
SD	1.32	1.51	1.46	1.23	1.17	1.43
Day	**19**	**20**	**21**	**22**	**23**	**24**
No of observations	168	168	164	166	168	167
Mean	0.08	-0.03	0.08	0.04	0.02	-0.03
SD	1.14	1.26	1.17	1.18	1.26	1.02
Day	**25**	**26**	**27**	**28**	**29**	**30**
No of observations	155	169	166	167	155	154
Mean	-0.11	-0.18	0.05	-0.02	-0.16	-0.18
SD	0.99	1.07	1.66	1.12	1.17	1.10
Day	**31**					
No of observations	95					
Mean	-0.25					
SD	1.49					

Global mean return is -0.01, which is the average of the mean returns of all the 31 days.
Source: own.

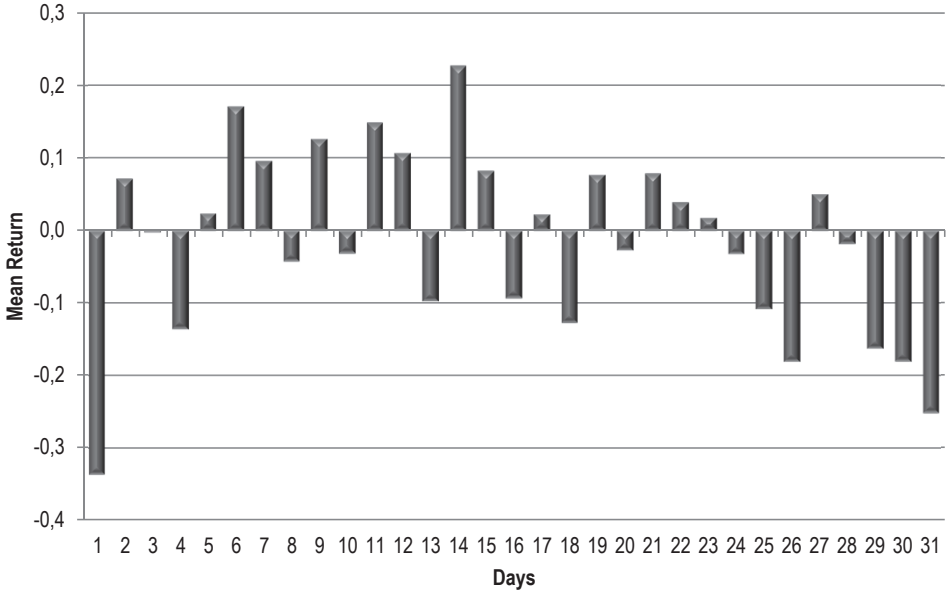

Figure 1. Mean of percentage returns in the calendar days of a month

Source: own.

4. Descriptive Statistics and Analysis using trading month approach

The data was also analysed using the concept of trading days put forward by Ariel (1987) to check for any monthly patterns in the Singapore market. Table 3 shows the mean percentage returns for the 9 trading days before and after the start of each month (-9 to-1 and 1 to 9). +1 is the first trading day of each month and -1 is the last trading day of the previous month. The trading days are limited to these 18 days in this study. Each daily percentage mean in the table is calculated from 238 observations.

The mean percentage returns are mostly negative during the trading days -1 to -9 in comparison to relatively positive data during the trading days 1 to 9. The data, as a whole, shows high variation, which is evident from the Figure 2. The absolute relative difference in percentage between the lowest and highest value is a grossly high figure of 12258%, which also supports the high variation in data. Just as in the calendar day approach, the returns are highly negative during the turn of the month.

Table 3. Mean and SD of percentage returns and No: of observations for trading days

Trading Days	Mean	Standard Deviation	No: of observations
-1	-0.20	1.57	238
-2	-0.13	1.05	238
-3	-0.09	1.14	238
-4	-0.01	1.19	238
-5	-0.03	1.03	238
-6	-0.06	1.18	238
-7	0.11	1.31	238
-8	-0.03	1.27	238
-9	-0.11	1.25	238
1	-0.18	1.26	238
2	0.04	1.18	238
3	-0.05	1.25	238
4	-0.02	1.30	238
5	0.17	1.41	238
6	0.00	1.40	238
7	0.10	1.48	238
8	0.00	1.32	238
9	0.12	1.19	238

Global Mean return is -0.022015 which is the average of the mean return of the trading days -9 to +9.
Source: own.

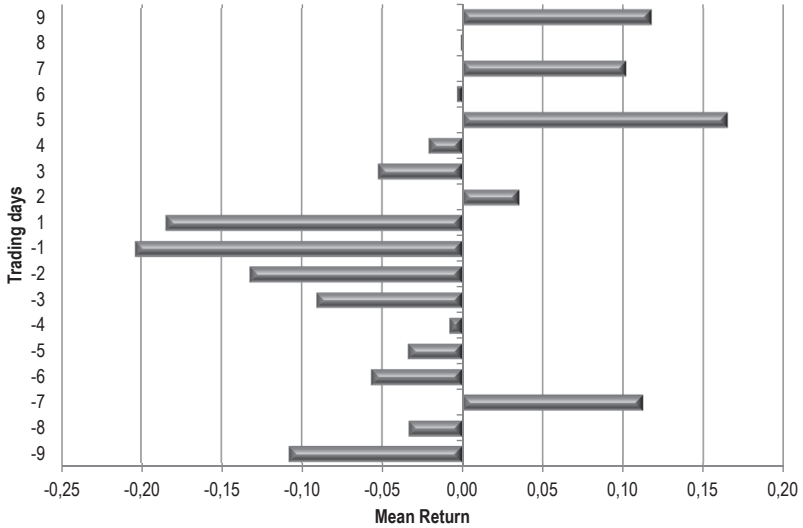

Figure 2. Mean of percentage returns in the trading days

Source: own.

4.1. Test of semi-monthly effect

4.1.1. Calendar Day approach

The semi-monthly effect is tested using both calendar and trading day returns. Null hypothesis for testing the semi-monthly effect in the calendar day approach is H_0: Mean daily returns for the first half of the calendar month is equal to the mean daily returns in the second half of the month.
H_a: Mean daily returns for the first half of the calendar month is not equal to the mean daily returns in the second half of the month.

T-test is used to test the hypothesis on the data, which comprises the first half returns and second half returns for a period of 20 years from 1995 to 2005. The result of the t-test, mean, standard deviation along with the no: of observations is shown in the Table4. The null hypothesis is not rejected based on the test at 5% level of significance. So the t-test ascertains that there is no significant difference between the average returns across the first half and the second half in the Singapore market during the period of study. So no monthly effect is present in this market, based on the calendar day approach.

Table 4. T-statistics at 5% significance level and related descriptive statistics for calendar days

Parameter	Average return across first half*	Average return across second half^
Mean	0.01	-0.03
Std.deviation	1.78	1.53
No: of observations	2560	2482
t-statistic	0.95	
t-critical at 5% significance level	1.96	
Result	Do not reject null hypothesis	

*First half means calendar days 30, 31 of previous month and days 1 to 14 of current month
^Second half means calendar days 15 to 29 of current month

Source: own.

Having stated the above, still the aspect needs to be considered that the relative difference between the mean returns in percentage between the first half and second half is as high as 136%. Also the mean returns during the second half are negative in contrast to the the positive mean returns during the first half. This warrants the need for further investigation by testing the hypothesis at a significance level of 10%. The results shown in the Table 5 also confirms the previous finding that no significant difference exists between the mean daily returns of the first half and second half in the calendar month.

Table 5. T-test results at 10% significance level in calendar day approach

t-statistic	0.95
t-critical at 10% significance level	1.65
Result	Do not reject null hypothesis

4.1.2. Trading day approach

The monthly effect is also analysed for the same period using the trading day approach. The null hypothesis is

H_0: Mean daily return for the first half of the trading month is equal to the mean daily return for the second half of the trading month

H_a: Mean daily return for the first half of the trading month is not equal to the mean daily return for the second half of the trading month

The result obtained on testing the hypothesis using t-test is given in Table6. The null hypothesis is not rejected at 5% level of significance. It means that there is no significant difference between the mean returns of first half and second half of each month. It echoes the findings made in the calendar day approach.

Table 6. T-statistics at 5% significance level and related descriptive statistics for trading days

Parameter	Average return across first half*	Average return across second half^
Mean	0.003	-0.04
Std.deviation	1.34	1.18
No: of observations	2379	1903
t-statistic	1.02	
t-critical at 5% significance level	1.96	
Result	Do not reject null hypothesis	

*First half means last trading day of previous month and days 1 to 9 of current month
^Second half means calendar days -9 to -2 trading days of current month

Source: own.

The absolute percentage relative difference between the mean returns during the first half and second half is high at 89.7%. But the returns are negative during both first half and second half. Even a t-test at 10% significance level, the results of which are shown in Table 7, supports the previous finding of no significant difference between the mean returns during both the halves.

Table 7. T-test results at 10% significance level in trading day approach

t-statistic	1.02
t-critical at 10% significance level	1.65
Result	Do not reject null hypothesis

Source: own.

Both the trading day approach and calendar day approach prove that there is no semi-monthly effect in the Singapore market during the 20 year period 1995 to 2015.

4.2. Test of Turn of the month effect

As mentioned in the introduction, various researches in different countries over the past have demonstrated the turn of the month effect. Added to this, a cursory glance at the tables 1 and 2 along with the respective histograms generates an insight that the mean returns during the start of the months along with the end of the previous months are considerably different from the mean return on the other days of the month. The returns on calendar days 30, 31 and 1 are the least. Based on the above observations, the possibility for turn of the month effect will be looked for, initially adopting the calendar day approach. In the calendar day approach, 30th and 31st days of the previous month and 1st and 2nd days of the current month collectively constitute the turn of the month whereas the days from 3 to 29 comprise the rest of the month.

4.2.1. Calendar Day approach

The null hypothesis will be
H_0: Mean daily return during the turn of the calendar month is equal to the mean daily return during the rest of the calendar month
H_a: Mean daily return during the turn of the calendar month is not equal to the mean daily return during the rest of the calendar month

The hypothesis is tested using the t-test. The results of the t-test along with the mean, standard deviation and no: of observations is detailed in the table 8. The mean return during the turn of the month is 107% relatively lower than the average return over the remaining days. The t-test also confirms this considerable difference in returns. The null hypothesis cannot be accepted, as per the result of the t-test. It substantiates that there exists a significant difference between the mean daily return during the turn of the month and the mean daily return during the rest of the month.

Table 8. T statistics and related descriptive statistics for calendar day approach (TOM)

Parameter	Average return on turn of the month*	Average return over remaining days^
Mean	-0.16	0.01
Std.deviation	1.23	1.29
No: of observations	552	4490
t-statistic	-3.06	
t-critical at 5% significance level	1.96	
Result	t stat<-tcritical;Do not accept null hypothesis	

Source: own.

4.2.2. Trading day approach

In accordance with the approach followed by Ariel(1987), the trading days from -1 to 4 build up the turn of the month and the days from -9 to -2 of the previous month added to the trading days 5 to 9 of the current month collectively build up the rest of the month. Similar to the histogram in the calendar day approach, the trading day bar chart in Figure 2 depicting the mean returns provide an insight that the returns during the turn of the month in the trading day approach are considerably lower than the returns for the rest of the month. So the data is analysed for turn of the month effect, for which, the null hypothesis is

H_0: Mean daily return during the turn of the trading month is equal to the mean daily return during the rest of the trading month

H_a: Mean daily return during the turn of the trading month is not equal to the mean daily return during the rest of the trading month

The findings using t-test are given in Table 9. Since t stat is less than t critical, the null hypothesis cannot be accepted. Thus the trading day approach also confirms the finding of the calendar day approach that there is significant difference between the mean daily returns during turn of the month in comparison to the mean daily returns for the rest of the month.

Table 9. T statistics and related descriptive statistics for trading day approach (TOM)

Parameter	Average return on turn of the month*	Average return over remaining days^
Mean	-0.09	0.002
Std.deviation	1.32	1.26
No: of observations	1189	3093
t-statistic	-1.97	
t-critical at 5% significance level	1.96	
Result	t stat<-t critical, Do not accept null hypothesis	

* Turn of the month means trading days -1 to 4

^ Remaining days means trading days 5 to 9 and -2 to -9 of current month

Source: own.

Both the approaches reinstate the presence of turn of the month effect in the Singapore stock market during the period 1995 to 2015. This turn of the month effect is unique to the extent that it can be termed 'reverse turn of the month effect' due to the inverse nature of returns demonstrated during the turn of the month, the returns during the turn of the month being lower than the rest of the month. Studies depicting reversal of return during the turn of the month is scarce, due to which supporting literature is not found.

5. Possible trading strategies

The purpose of the study was to determine the presence of semi-monthly effect or turn of the month effect in the Singapore market during the period 1995 to 2015. In order to confirm the findings made, the study was done using both calendar day and trading day approaches.

No significant difference was found between the mean daily returns in the first half and second half of the months. But turn of the month effect, even to the extent to be termed 'reverse', was very evident as proven by the hypothesis tests using both trading day and calendar day approaches.

In the calendar day approach, the mean return during the rest of the month is approximately 107% higher than the mean return during the turn of the month. The sole strategy which can be suggested would be to purchase the portfolio of stocks, representative of the index, during the turn of the month and sell it during the rest of the month. The profit generated can be further increased if the stock are sold during the first half of the month, considering the fact that the mean returns during the first half are higher by about 106% with respect to the second half. Even after taking into account the transaction costs in the Singapore market, this presents an opportunity to reap good returns in the short term. Another suggestion would be to avoid selling any shares during the turn of the month, to avoid any possible loss due to low share prices during the turn of the month. The absence of any monthly anomalies in the market limits the strategies to be pursued.

The relative difference in percentage for the mean returns between the rest of the month and the turn of the month is 102.5%, in the trading month approach. This fact also points to a similar strategy as in the calendar day approach where in, a portfolio of shares as in the FTSE Strait Times Index can be purchased at a low price during the trading days -1 to 4 and can be sold during the first half of the month (apart from the days comprising the turn of the month) to generate a profit, even after incurring the transaction costs. Similarly selling during turn of the month can be avoided to inhibit a loss.

The above strategies will be particularly suited for short term players, who can increment their current returns, by simply altering the timing of trade. Following

a strategy of limiting their purchase of stocks only to the turn of the month, be it calendar days or trading days, and selling it during the rest of the month will positively impact their portfolio returns. Stating this, it should also be noted that over an year the returns will be affected by myriad factors like economic fundamentals, political climate, natural calamities, economic shocks, to name a few. In the long term, the counterbalancing arbirtrage will eventually result in the disappearance of the anomaly and may lead to a more efficient market.

Conclusion

This study was aimed at detecting the existence of semi-monthly effect or turn of the month effect based on recent data regarding the Singapore market. To ascertain the results further and to avoid any scope for possible conflicts regarding the methodology used, the analysis was done using both calendar day approach and trading day approach. To avoid any short term influences on the data, Strait times Index data over a period of 20 years from 1995 to 2015 was used.

The tests produced some astonishing results. In contrast to the turn of the month effect which has been reported from many markets around the world (Giovanis, 2014; Yakob, Beal & Delpachitra, 2005), Singapore market produced a 'reverse' turn of the month effect. The mean returns during the turn of the month were highly negative and significantly different from the rest of the month. The resulting trading strategy suggested, purchasing a portfolio of shares representing the index during the turn of the month and selling it during the rest of the month painted a reverse picture to the strategies adopted in other markets. On the other hand, no semi-monthly anomaly was detected in the Singapore market during the period. In other words, the mean daily returns during the first half of the months are not significantly different from the mean daily returns in the second half of the months. Having said this, the absolute percentage relative difference between the mean returns during the first half and second half is around 136% in the calendar month approach and approximately 90% in the trading month approach. The returns in the first half being so higher than the returns in the second half opens wide the possibility for increasing the returns for a short term investor, adopting the strategy of purchasing the stocks during the turn of the month and selling it during the rest of the month, by limiting the sales of stocks only to the first half of the month, during which the index will be generally higher than the second half.

This study shows that anomalies do exist currently in the stock markets indicating that the markets are still far from efficient. This study, even though being current, but being limited only to the semi-monthly anomaly and turn of the month effect in the Singapore market alone, puts wide open the possibility for further studies, regarding these and other anomalies, in other markets worldwide.

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IMPACT OF EXPORTS ON THE GDP GROWTH IN POLAND IN YEARS 2009–2014

Abstract

The hypothesis of the paper is as follows: there is a significant, from the point of view of the theory and empirical studies, impact of export growth on economic growth in Poland, and it is most likely a two-way relationship. In our research we implemented econometric model VAR. Results of estimation confirmed hypothesis which we formulate in research.

JEL Classification Codes: **F310.**

Keywords: Gross Domestic Product, export, foreign exchange, trade.

Introduction

Currently, we are witnessing a very dynamic process of internationalization of economic life around the world. Determining factor in this process is the desire to increase the level of prosperity of the population of individual countries and regions in continual and escalating competitive struggle. An example of this situation is the intense competition of various economic agents in the domestic and international market. Export is a dynamic category, subject to constant changes occurring in the rules and solutions on a global scale. According to one of the views that can be seen in the economic literature, foreign trade determines the economic development of countries. The development of the international

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competitiveness of Poland, and more specifically its competitive advantage in international trade is an essential element of economic growth of our country. The aim of the study was to investigate whether there is, and if so, to what extent the Polish export influences the economic growth in Poland.

1. Export and its impact on GDP

Undoubtedly, the participation of the country in the international economic exchange can bring its national economy all sorts of benefits. It also seems that it may become an important factor in economic development. Hence, the state authorities, taking into account the characteristics of the national economy and establishing its objectives and directions for development, can shape the country's participation in the global trading system. We can distinguish here three approaches to that engage in international exchange: isolation, protectionism and the idea of free trade.

The world trading system should be understood as a historically shaped set of international treaties and agreements that serve the stability and transparency of trade between countries. The rules of these agreements are based on the foundations of the free-trade ideas and their overarching goal is to reduce the national protectionist tendencies (Dugiel, 2013, p. 9).

In the literature, exports are defined as export of the good produced or substantially processed in the country in order to sell them and provide services to citizens of other countries (Rymarczyk, 2002, p. 17). The global trading system cannot be considered as a single plane, because it was created by three mutually impacting on each other dependencies: international trade, national regulations and international agreements (Dugiel, 2013, p. 9). All transactions included in the foreign trade are carried out in order to meet the needs of consumers and conditions accepted by both parties.

The design of basic measure of the effects country population's work, which is GDP that includes the „net exports" suggests that the excess of imports over exports is slowing „growth". Foreign trade plays an important role in the growth and economic development of the country. The issue of co-existence and interaction between these two categories has long been bothering theoreticians and reveals a multitude of publications on this subject. Over the years, the subjects was taken by among others: A. Smith, D. Ricardo, E. Heckscher, B. Ohlin, P. Samuelson, G. Haberler and I. Kravis, with particular emphasis on the benefits of international trade for the participating countries (Misala, 2001, p. 9-144).

The importance of foreign trade in theories of economic growth is very often highlighted as well considered as its „spiritus movens". Foreign trade should be compiled and analyzed together with the macroeconomic data, because it affects the country's macroeconomic situation causing at the same time effects such as

the effect of the accumulation of capital, the income effect and the substitution effect. When the above-mentioned effects are cumulative, this means that the final impact of foreign trade on economic growth is gradually strengthened by the economic development of the country. Proper understanding of the benefits of international exchange is very important in determining the concept of the commercial policy of the country, which is usually a compromise between what is desired by the criterion of maximizing the benefits of trade, and what is possible due to the existing conflicts of interest group (Rymarczyk, 2002, p. 277).

In the context of the implications flowing from the very structure of commodity exports for economic growth, there are extremely important observations made by J. Bhagwati (1966, p. 156-239), who drew attention to the negative aspect of the relationship between exports and economic growth. It can occur when a significant place in the structure of export is taken by commodities. If the country is a major supplier of the goods on international markets, a big jump in the volume of deliveries, with an unchanged fixed demand will cause a decline in world prices of exported goods. This will lead to deterioration in the terms of trade of the exporting country, which in turn will lead to a decline in the overall prosperity of the country. It should be understood that the share of individual components in the total value of exports could have serious implications for economic growth in the long term. It should be noted that fewer problems are caused when changing directions and the value of exports than the change in its structure, as the latter may require a deep and long-lasting structural changes.

2. Polish goods export

In recent years, Polish exports due to the relatively lower labor costs, favorable zloty exchange rate and modernization of manufactured goods, has begun to do well on the difficult competitive in foreign markets. More and more Polish companies are successful in sales, ahead of competitors in Europe and beyond. The time of the global economic crisis has given Polish entrepreneurs the chance to spread their products, which were characterized by high quality and low prices.

The share of exports in total GDP of Poland in the period was significant (Fig. 1). The relationship of these two values is characterized by economy and allows specifying to what extent it is pro-export. Moreover, it is an indicator showing the degree of openness of the national economy. The higher it is, the better the prospects are faced by a given economy. For Poland, it is estimated that this share in the period 1999–2013 increased 2.41–fold 9 (Dominika Brzęczek-Nester, 2015, p. 19). Although it is not as large as in developed countries of Western Europe, it still largely creates the size of the GDP, which is the most common and most widely recognized measure of prosperity and a barometer of the economy.

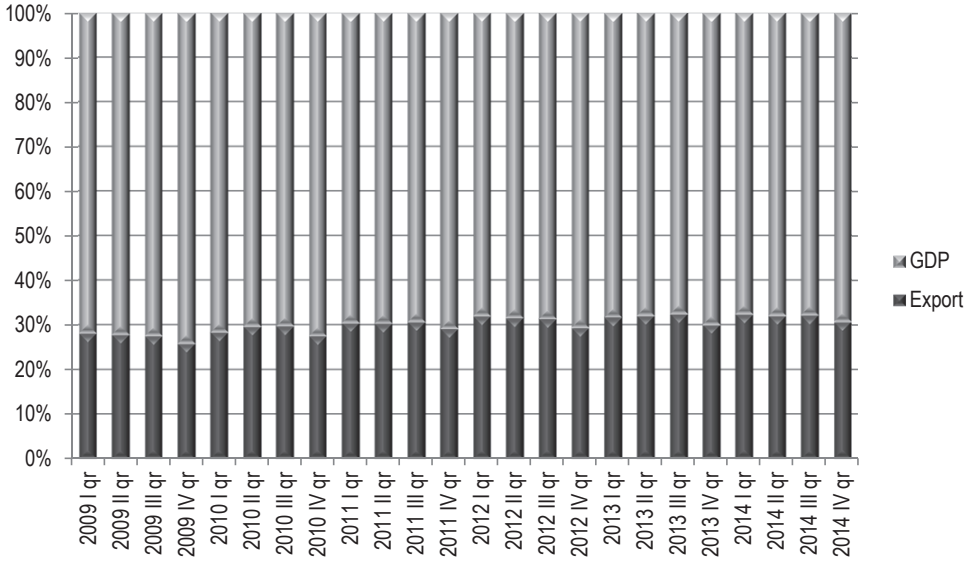

Figure 1. The share of exports in Polish GDP in 2009–2012 (quarterly data)

Source: own calculations based on data from the database: Central Statistical Office in Poland, http://stat.gov.pl (accessed: 15.01.2016).

Analysis of the commodity structure of Polish exports by sections nomenclature SITC in 2014 shows that the largest group consisted of machinery and transport equipment and manufactured goods classified mainly by raw materials and other industrial products. These three groups accounted for a total of 71.5% of total exports. The other large groups were food and live animals, and chemicals and related products (Fig. 2).

Important to examine the impact of exports on GDP Polish is also recognizing its major foreign trade partners (Fig. 3).

From the graph, which shows the direction of exports, we can draw at least three conclusions:

- the largest Polish trade partner in the analyzed period were Germany, and their share in total exports was several times higher than other countries,
- the share of exports to other countries outside of Germany, the total exports were shaped differently but retained the tendency of growth in the long term,
- apparent disproportion between the leader recipient of Polish exports and other trading partners implies the need to consider needs to diversify recipients of Polish exports in the course of further research.

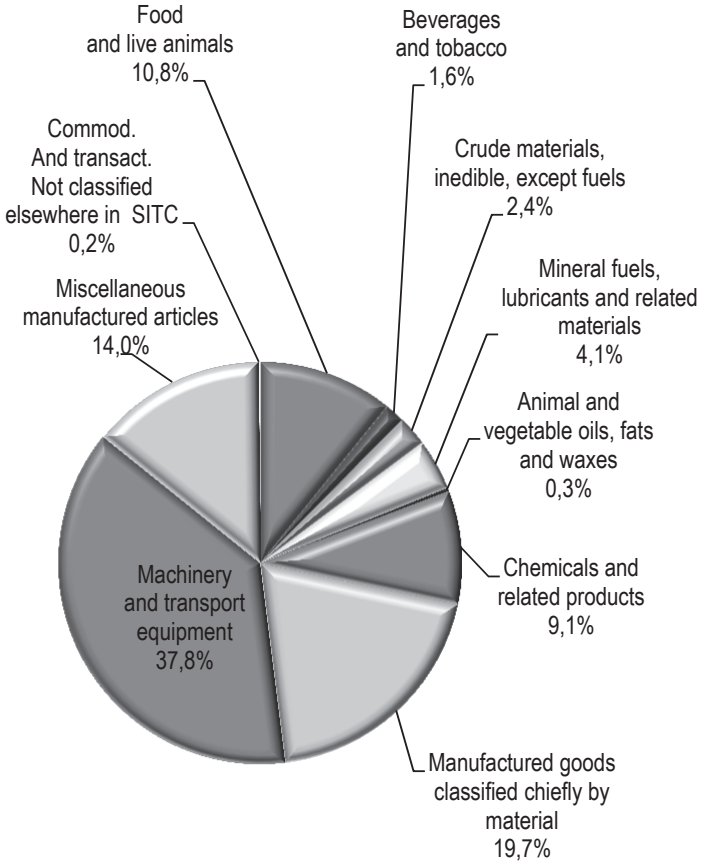

Figure 2. The structure of Polish exports by sections nomenclature SITC in 2014

Source: own calculations based on data from the database: Statistical Yearbook of Foreign Trade 2015.

Research conducted by Slawomir Ireneusz Bukowski and Joanna Garlińską-Bielawska using econometric analysis shows that exports to Germany, the main trade partner Polish, significantly affects the economic growth in Poland, and it influence is strong and long-lasting (Bukowski, 2014, p. 58) .

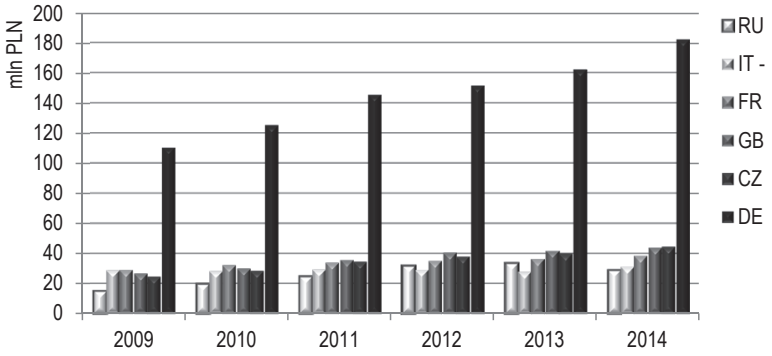

Figure 3. The value of Polish exports by the largest recipients 2009–2014

Source: own calculations based on data from the database: Central Statistical Office in Poland, http://stat.gov.pl (accessed: 15.01.2016).

3. Statistical data and model

In a study on the impact of exports on the GDP we used statistical data on the quarterly export and Poland's GDP at current prices collected by the Central Statistical Office. Unfortunately, the data on a quarterly basis at constant prices were not available. The results are therefore an approximation and give a contribution to further testing. The data are seasonally adjusted using the X12-ARIMA and covered the period 2009–2014. The analysis applied the model VAR:

$$\ln y_{1t} = \mu_1 + \alpha_1 \ln y_{1t-1} + \beta_1 \ln y_{2t-1} + \varepsilon_{1t} \quad (1)$$

$$\ln y_{2t} = \mu_2 + \alpha_2 \ln y_{1t-1} + \beta_2 \ln y_{2t-1} + \varepsilon_{2t} \quad (2)$$

where:
y_{1t} – GDP at current prices
y_{2t} – exports at current prices

4. Results of model estimation

VAR model estimation results presented in Table 1, 2, and 3 are statistically significant, as can be seen in the results of the estimation model by using the program GRETL. The results are shown in the following tables. Analysis of the content of the tables indicates a statistically significant relationship between exports and economic growth in Poland, as well as between the GDP growth in Poland and exports. On the one hand, export growth stimulates GDP growth in Poland, on the other hand – GDP growth in Poland stimulates the growth of exports. The results of the estimation of the first equation indicate that export growth by 1 percentage point causes GDP growth in Poland by 0.65 percentage points. The

results of the estimation of the second equation shows that Poland's GDP growth by 1 percentage point results in an increase in exports by 0.98 percentage points.

Table 1.

VAR system, lag order 1
OLS estimates, observations 2009:2–2014:4 (T = 23)
Log-likelihood = 89.427788
Determinant of covariance matrix = 1.43825e-006
AIC = -7.0807
BIC = -6.6857
HQC = -6.9813
Portmanteau test: LB(5) = 36.9799, df = 16 [0.0021]

Equation 1: l_y1t

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	23.8883	7.45127	3.2059	0.0047	***
l_y1t_1	−0.527841	0.238112	−2.2168	0.0390	**
l_y2t_1	0.651618	0.332216	1.9614	0.0647	*

Mean dependent var	26.69154	S.D. dependentvar	0.104741	
Sum squaredresid	0.062704	S.E. ofregression	0.057448	
R-squared	0.740199	Adjusted R-squared	0.699178	
F(3, 19)	18.04433	P-value(F)	8.68e-06	
rho	−0.205959	Durbin-Watson	2.236983	

F-tests of zero restrictions:
All lags of l_y1t F(1, 19) = 4.9141 [0.0390]
All lags of l_y2t F(1, 19) = 3.8472 [0.0647]

Equation 2: l_y2t

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	11.0943	3.39206	3.2707	0.0040	***
l_y1t_1	−0.395102	0.108396	−3.6450	0.0017	***
l_y2t_1	0.976974	0.151235	6.4600	<0.0001	***

Mean dependent var	25.85443	S.D. dependentvar	0.160056	
Sum squaredresid	0.012995	S.E. ofregression	0.026152	
R-squared	0.976943	Adjusted R-squared	0.973303	
F(3, 19)	268.3517	P-value(F)	1.00e-15	
rho	0.116570	Durbin-Watson	1.648616	

F-tests of zero restrictions:
All lags of l_y1t F(1, 19) = 13.286 [0.0017]
All lags of l_y2t F(1, 19) = 41.731 [0.0000]

*** the variable is significant at a level of significance 0,01;
** the variable is significant at a level of significance 0,05;
* the variable is significant at a level of significance 0,1.

Source: own calculations using the program GRETL.

Table 2. Decomposition of variance for l_y1t

period	std. error	l_y1t	l_y2t
1	0.0522138	100.0000	0.0000
2	0.0592115	93.6109	6.3891
3	0.0596621	92.4377	7.5623
4	0.0602485	91.2786	8.7214
5	0.0604578	90.7013	9.2987
6	0.0606152	90.3257	9.6743
7	0.0607022	90.1061	9.8939
8	0.0607572	89.9712	10.0288
9	0.0607901	89.8898	10.1102
10	0.0608103	89.8403	10.1597
11	0.0608225	89.8102	10.1898
12	0.0608299	89.7919	10.2081
13	0.0608345	89.7807	10.2193
14	0.0608372	89.7739	10.2261
15	0.0608389	89.7698	10.2302
16	0.0608399	89.7673	10.2327
17	0.0608405	89.7658	10.2342
18	0.0608409	89.7648	10.2352
19	0.0608412	89.7643	10.2357
20	0.0608413	89.7639	10.2361

Source: own calculations using the program GRETL.

Table 3. Decomposition of variance for l_y2t

period	std. error	l_y1t	l_y2t
1	0.0237694	6.6255	93.3745
2	0.035822	19.6480	80.3520
3	0.0395541	17.7137	82.2863
4	0.0420654	17.7166	82.2834
5	0.0434145	17.4813	82.5187
6	0.0442421	17.4079	82.5921
7	0.0447314	17.3514	82.6486
8	0.0450283	17.3218	82.6782
9	0.0452076	17.3032	82.6968
10	0.0453165	17.2923	82.7077
11	0.0453827	17.2856	82.7144
12	0.0454229	17.2816	82.7184
13	0.0454473	17.2792	82.7208
14	0.0454622	17.2777	82.7223
15	0.0454712	17.2768	82.7232
16	0.0454767	17.2763	82.7237
17	0.0454801	17.2759	82.7241
18	0.0454821	17.2757	82.7243
19	0.0454834	17.2756	82.7244
20	0.0454841	17.2755	82.7245

Source: own calculations using the program GRETL.

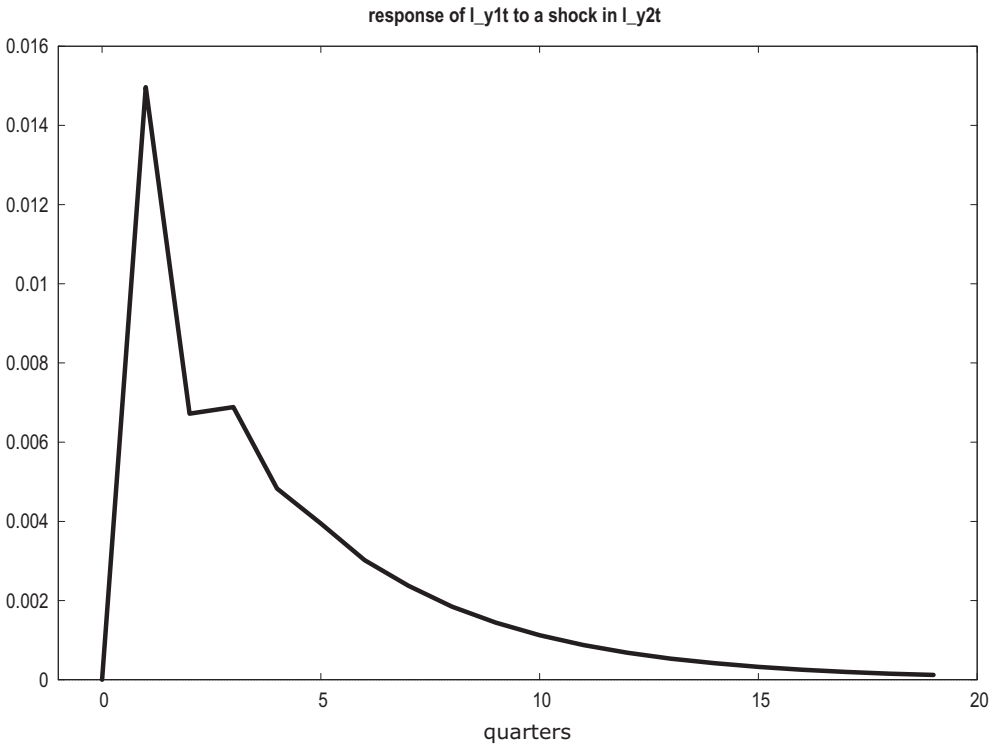

Figure 4. The response of GDP growth impulse in the form of export growth
Source: own calculations using the program GRETL.

It is worth noting that the impact of GDP growth on the export growth is stronger than the effect of export growth on GDP growth. In addition, both the descriptive analysis, and analysis of the results of the econometric model indicates that exports are a very important factor of economic growth.

Analysis of variance decomposition indicates that the GDP growth to a greater extent explained in the analyzed period export growth than GDP growth (Table 2 and 3).

The analysis of the response function of GDP growth impulse in the form of export growth (Fig. 4) shows that export growth causes an increase in GDP over the two quarters in the period considered and a decrease of the impact of this increase in subsequent quarterly periods.

Conclusions

Descriptive and econometric analysis performed using the VAR model confirms the fact that GDP growth is an important factor in the growth of Polish exports. The study shows the importance of exports as a driver of economic growth in Poland. The relationship between GDP and exports is reversible. The impact of GDP growth on exports is stronger than vice versa. The impact of exports on GDP growth in Poland is statistically significant, strong and, above all, long-lasting. The results of this study imply the need for further study on the influence of Polish exports for its economic growth and the pace of its response to changes in economic conditions. Noticeable is also a need to deepen the research strategy of diversification of Polish foreign recipients.

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Katarzyna Brożek[1], Justyna Kogut[2]

ECONOMETRIC ANALYSIS OF SELECTED FACTORS OF INNOVATIVE COMPANIES ACTIVITY IN THE POLISH ECONOMY

Abstract

Today, a particularly important role in the functioning and development of enterprises plays innovation. This is understood as the ability to create innovative space capable to the creation and diffusion of innovation. Nowadays, a thriving innovation activity is identified with the achievement of business success in the economic arena. With this in mind it is worth exploring the determinants of innovation. It is therefore this article was proposed. The study analyzed the impact of GDP, internal expenditure on R&D and capital expenditures on the size of innovative activities of enterprises located in the sixteen Polish provinces. The research was limited to a period of seven years, i.e. from 2008 to 2014. The aim of this article is therefore to determine the level of significance of some factors influencing the size of innovation activities in Polish enterprises. To achieve the objective the analysis of statistical data was carried out and the panel model calculated by the classical method of least squares was built. Conducted tests will verify three research hypotheses. The software GNU Regression Econometric and Time-Series Library - GRETL was used for calculations.

JEL Classification Codes: **C50, E22, O32.**

Keywords: Innovative activity, the companies, Poland, panel model, the classical method of least squares.

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Introduction

Currently, various types of events, for example, economical (more Krištofík, Lament, et al., 2015), social or natural are generally conditioned by the action of other phenomena. Thus, the presence of relationships between phenomena is most often the subject of scientific discussion, both theoretical and practical. Therefore, the presented article was dedicated to the examination of innovative activity of Polish companies in relation to the three selected factors. This group includes GDP, internal expenditure on R&D and capital expenditures. It is known that in the modern world the development of innovation is the result of the interaction of many different factors, therefore, it is extremely reasonable to examine the significance although some of them. So, the aim of this article is to determine the level of significance of some factors affecting the size of innovative activity managing by companies functioning in sixteen Polish provinces in 2008-2014. The studies did not include the last year, i.e. 2015 due to lack of data at the time of preparation of the proposed analysis.

1. Literature review

The literature concerning the studied matter is very rich and extensive. Therefore, in the presented considerations, the theoretical aspect was deliberately very limited and therefore encourages readers to deepen theoretical knowledge by studying widely available scientific publications (see Francik, Szczepańska-Woszczyna, Dado, 2016; Gorka 2014, Kloska 2015). While the main task of that article is to present the results of own research, and the following brief theoretical outline is only an introduction to the issue.

In the contemporary economy, no one questions the importance of innovation (Barbachowska, 2014), but it is more often emphasized that they are the foundation of the development of businesses and the main message of achieving a competitive advantage. On that point it is worth mentioning the genesis of innovation. Well, the concept of innovation comes from Latin - innovare and means to create something new. However, this concept was first introduced to the economic sciences in 1911 by J. Schumpeter. He believed that the essence of innovation is to use resources of the production in a new, not yet used method, while releasing them from current uses (Schumpeter, 1939). The following Table 1 presents summary of the various positions regarding the definition of innovation.

Table 1. A variety of approaches to define innovation

Author	The definition of innovation
P. F. Drucker	Specifies innovation from the perspective of changes. Changes form the basis for innovation as they cause that new products or services are created.
M. E. Porter	Innovations are considered as technological improvements, better methods or ways to do the things.
P. R. Whitfield	Innovation is a complex sequence of actions involving problem solving. The result is a novelty.
J. Peter	The difference between innovation and routine business activity is based on four pillars: novelty, complexity, risk and potential conflict.
OEWG	It involves the implementation of a new or significantly improved product (good or service), or process, a new marketing/organizational method in business practices.
Eurostat	Implementation of new or significantly improved (good or service), process, new marketing method or a new method of organization in business practices in the workplace and external relations.

Source: own study based on: Drucker, 2010; Peter 2011; Porter, 1990; Oslo Manual 2016.

2. Methodology/methods

Due to the prevailing empirical nature of the work it was decided to carry out the research based on two key research methods. The leading is the econometric analysis, (and therefore including the formulation of the econometric model and its estimation), but statistical analysis has also proved to be necessary (collection and interpretation of data describing the studied phenomenon).

Hypotheses:

1. The amount of expenditure on innovation activities of the companies depends directly on the GDP of individual Polish provinces.
2. The size of outlays for innovative activity is dependent on changes in the amount of internal expenditure on R&D.
3. The value of investment of Polish firms significantly affects the enhance of innovative activity.

Working hypotheses in the study were verified through the use of the ordinary least squares method. The software GNU Regression Econometric and Time-Series Library – GRETL, providing the necessary econometric methods, was used for the calculation of panel model.

3. Results and discussion

3.1. Model

The study will be conducted on a panel data - (seen at least in two dimensions, more Górecki, 2010). So, in this paper, an innovative activity of enterprises operating in the Polish provinces in 2008–2014 was examined. Assuming that the index i = 1, 2, ..., N determines more regions (provinces), and the index t = 1, 2, ..., T determines units of time (see Table 2), the constructed model has the form:

$$I_{it} = \alpha_{it} + GDP_{it} + (R+D_{it}) + INV_{it} + v_{it} \quad (1)$$

where:
I_i_t - dependent variable: expenditures on innovation activities of companies MILLION PLN explanatory variables:
GDP_i_t - GDP in current prices PLN MILLION
R+D_i_t - internal expenditure on R&D PLN MILLION
INV_i_t - investment in current prices PLN MILLION
αit - structural parameter of a model
vit - total random error (consisting of a purely random part εit and the individual effect ui, so vit = εit + ui) (Kufel, 2013).

Table 2. Assigning indexes to particular regions and periods

	i	t
1	Lower Silesia	2008
2	Kuyavia-Pomerania	2009
3	Lublin	2010
4	Lubus	2011
5	Lodz	2012
6	Lesser Poland	2013
7	Mazovia	2014
8	Opole	
9	Lower Carpathians	
10	Podlasie	
11	Pomerania	
12	Silesia	
13	Swietokrzyskie	
14	Varmia-Mazuria	
15	Greater Poland	
16	West Pomerania	

Source: own study.

In the empirical research statistical data drawn from the Local Data Bank (www.bdl.stat.gov.pl) was used. The data used are the unbalanced panel (more Franc-Dabrowska).

Outlays for innovative activity of the company became an explanatory variable. Due to the statistical confidentiality, in some cases, unfortunately, we failed to obtain data on the value of expenditures on innovative activities. So the model is unbalanced. The explanatory variables are the GDP at current prices, internal expenditure on R&D incurred in the unit and investment in enterprises.

3.2. The results of model estimation

The results of the model described above are shown in the following tables and charts, and the results of the most important and also the necessary tests are provided beneath (see Bukowski, 2012).

Table 3. OLS panel estimation using 72 observations

16 units of cross-sectional data were included
Time series length: minimum 4, maximum 7
The dependent variable (Y): I_i_t

	Factor	Student's t-	p-value	
const	−465,662	−2,4836	0,0148	**
GDP_i_t	−0,0176366	−2,6858	0,0085	***
R+D_i_t	1,52692	7,4637	<0,0001	***
Inv_i_t	0,38588	6,3404	<0,0001	***
The arithmetic mean of the dependent variable		2252,061	The standard deviation of the dependent variable	3257,159
The sum of squared residuals		77223203	The standard error of the residues	901,5963
Coefficient of determination R-square		0,925725	Adjusted R-squared	0,923379
F(3, 95)		394,6756	P-value of F test	1,75e-53
log-likelihood		−812,0459	Akaike information criterion	1632,092
Schwarz Bayesian Criterion		1642,472	Hannan-Quinn Criterion	1636,292
Autocorrelation of residues – rho1		0,304099	Durbin-Watson status	1,216367

*** variable statistically significant at the significance level of 0.01;
** variable statistically significant at the 0.05 level of significance;
* variable statistically significant at a significance level of 0.1.

Source: on the basis of the program GRETL.

The significance level for the three explanatory variables was 1%. It shows that as well as the GDP at current prices, internal expenditure on R&D incurred in the unit, and investment in enterprises are very strong factors influencing the expenditures incurred by the companies for innovative activity.

The coefficient of determination R-square indicates the extent to which the tested factor explains the specified dependent variable (Kufel, 2013). In this study, it operates at a level equal to 0.548287.

The test statistic: TR^2 = 54.280426, the value of p = P (Chi-square (9) > 54.280426) = 0.000000

Table 4. The frequency distribution

Intervals	mean	number	frequency	cumulative	
< -2614,8	-3106,7	1	1,01%	1,01%	
-2614,8 - -1631,0	-2122,9	1	1,01%	2,02%	
-1631,0 - -647,25	-1139,1	17	17,17%	19,19%	******
-647,25 - 336,52	-155,36	55	17,17%	74,75%	**********
336,52 - 1320,3	828,41	22	22,22%	96,97%	*******
1320,3 - 2304,1	1812,2	1	1,01%	97,98%	
2304,1 - 3287,9	2796,0	1	1,01%	98,99%	
3287,9 - 4271,6	3779,7	0	0,00%	98,99%	
≥ 4271,6	4763,5	1	1,01%	100,00%	

Source: based on the program GRETL.

Missing observations are at a level of 11.61%. Empirical cumulative distribution has a normal distribution for null hypothesis.

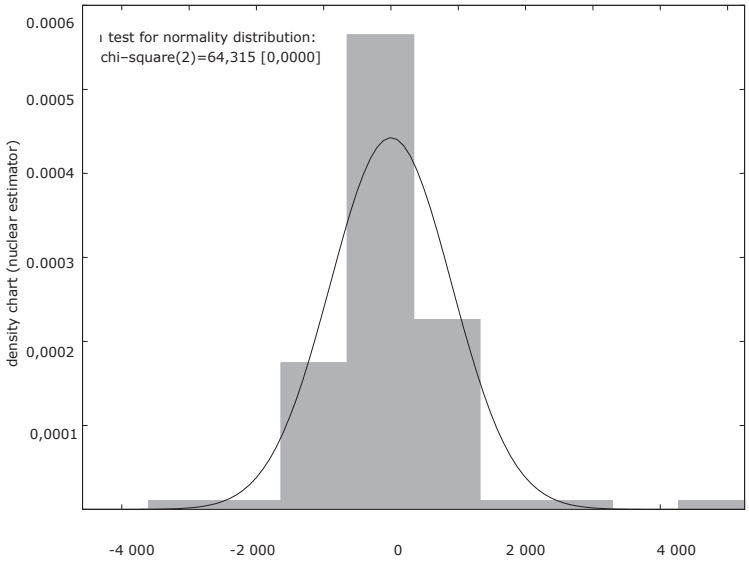

Figure 1. Test for normality distribution

Source: on the basis of the program GRETL.

The frequency distribution for uhat1, observations 1-112
the number of intervals = 9, mean = -3,9044e-013, standard deviation = 901.596

Collinearity rating VIF (j) - variance inflation factor
VIF (Variance Inflation Factors) - the minimum possible value = 1.0
Values > 10.0 may indicate a problem of collinearity - inflation of the variance
GDP_i_t 31,801
R+D_i_t 7,104
Inv_i_t 22,157

VIF(j) = 1/(1 - R(j)^2), where R(j) is the coefficient of multiple correlation between the variable 'j' and the other independent variables of the model.
To give a better sense of the problem, we also presented the results of panel estimation (least squares method) supplemented with additional variables 0-1 units of time.

Table 5. Panel OLS estimation using 99 observations
16 units of cross-sectional data were included
Time series length: minimum 4, maximum 7
The dependent variable (Y): I_i_t
Added variables: 0-1 units of time

	Factor	Standard error	Student's t-	p-value	
const	−921,502	268,403	−3,4333	0,0009	***
GDP_i_t	−0,0195573	0,00736414	−2,6558	0,0094	***
R+D_i_t	1,57842	0,201987	7,8145	<0,0001	***
Inv_i_t	0,402275	0,0702708	5,7246	<0,0001	***
dt_1	560,56	329,235	1,7026	0,0921	*
dt_2	592,359	331,874	1,7849	0,0777	*
dt_3	922,618	329,342	2,8014	0,0062	***
dt_4	382,219	314,388	1,2158	0,2273	
dt_5	687,067	344,611	1,9937	0,0492	**
dt_6	189,315	342,396	0,5529	0,5817	

The arithmetic mean of the dependent variable	2252,061	The standard deviation of the dependent variable	3257,159
The sum of squared residuals	68993696	The standard error of the residues	880,4601
Coefficient of determination R-square	0,933640	Adjusted R-squared	0,926930
F(9, 89)	139,1302	P-value of F test	1,78e-48
log-likelihood	−806,4680	Akaike information criterion	1632,936
Schwarz Bayesian Criterion	1658,887	Hannan-Quinn Criterion	1643,436
Autocorrelation of residues – rho1	0,305794	Durbin-Watson status	1,209672

Source: on the basis of the program GRETL.

Adding additional variables 0-1 units of time caused that the coefficient of determination R-square increased to a value of 0.959951.
The test statistic: TR ^ 2 = 95.035100, with a value of p = P (Chi-square (33) > 95.035100) = 0.000000

Table 6. The frequency distribution for uhat 4, observations 1-112
the number of intervals = 9, mean = 1,98665e-013, standard deviation = 880.46
Added variables: 0-1 units of time

Intervals	mean	number	frequency	cumulative	
< -2344,3	-2801,3	1	1,01%	1,01%	
-2344,3 - -1430,5	-1887,4	0	0,00%	1,01%	
-1430,5 - -516,60	-973,54	18	18,18%	19,19%	******
-516,60 - 397,27	-59,667	56	56,57%	75,76%	**********
516,60 - 1311,1	854,20	21	21,21%	96,97%	*******
1311,1 - 2225,0	1768,1	1	1,01%	97,98%	
2225,0 - 3138,9	2681,9	1	1,01%	98,99%	
3138,9 - 4052,7	3595,8	0	0,00%	98,99%	
≥ 4052,7	4509,7	1	1,01%	100,00%	

Source: on the basis of the program GRETL.

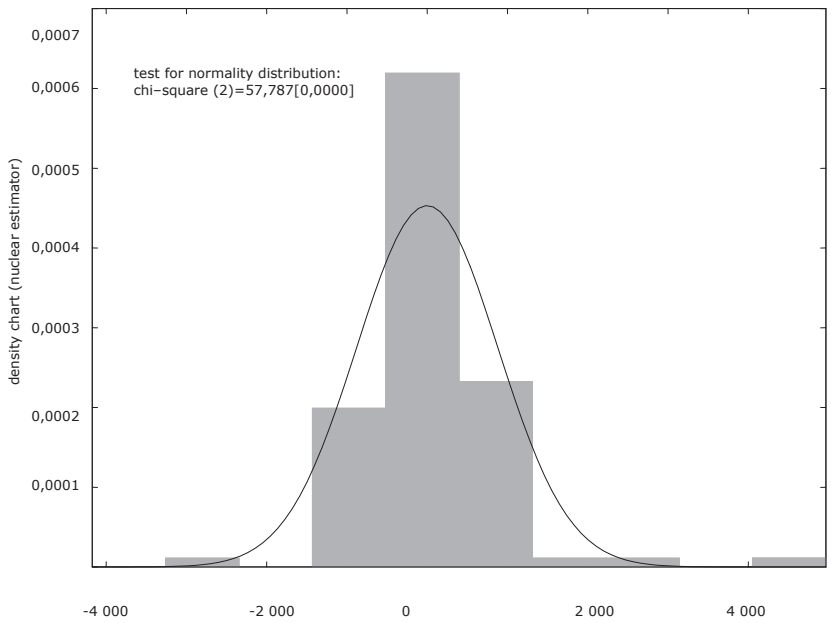

Figure 2. Test for normality distribution (with additional variables)
Source: on the basis of the program GRETL.

Collinearity rating VIF (j) - variance inflation factor
VIF (Variance Inflation Factors) - the minimum possible value = 1.0
Values > 10.0 may indicate a problem of collinearity - inflation of the variance
GDP_i_t 39,634
R+D_i_t 7,222
Inv_i_t 29,358
dt_1 1,889
dt_2 1,738
dt_3 1,778
dt_4 1,746
dt_5 1,776
dt_6 1,759
VIF(j) = 1/(1 - R(j)^2), where R(j) is the coefficient of multiple correlation between the variable 'j' and the other independent variables of the model.

The test results indicate that, the explanatory variables such as GDP and investment expenditure are correlated, and this indicates the presence of collinearity. Among the additional variables 0-1 units of time and in expenditure on research and development the phenomenon of collinearity does not appear , as specified numerical values are less than 10.

Table 7. Estimation Random effects (GLS), using 99 observations
16 units of cross-sectional data were included
Time series length: minimum 4, maximum 7
The dependent variable (Y): I_i_t
Added variables: 0-1 units of time

	Factor	Standard error	Student's t-	p-value	
const	732,665	251,474	2,9135	0,0045	***
GDP_i_t	0,0030833	0,00699776	0,4406	0,6605	
R+D_i_t	0,927435	0,262255	3,5364	0,0006	***
Inv_i_t	0,303809	0,059623	5,0955	<0,0001	***

Arithm. mean of depend. variable	2252,061	Stand. deviation of depend. variable	3257,159
The sum of squared residuals	85421398	The standard error of the residues	943,2954
log-likelihood	817,0403	Akaike information criterion	1642,081
Schwarz Bayesian Criterion	1652,461	Hannan-Quinn Criterion	1646,281

Source: on the basis of the program GRETL.

variance within' = 330317
variance between' = 132065

Breusch-Pagan Test on:
The null hypothesis: The variance of the error in the unit = 0
Asymptotic test statistic: Chi-square (1) = 5.17037 with a value of p = 0.0229754
Hausman test shows that for the null hypothesis UMNK estimator (GLS) is compatible. Asymptotic test statistic: Chi-square (3) is equal to 98.984 with a p value = 2,57006e-021.

Conclusions and recommendations

To sum up, the aim of the research was to analyze the relationship between changes in GDP, expenditures on R&D and capital expenditures and changes in the size of expenditure on innovation activities in 2008-2014. The panel model was built, annual data from the sixteen Polish provinces were used. Model estimation was made by classical least squares method using the program GRETL.

Results of the analysis presented in the work allow us to formulate the following conclusions:

- analysis of the panel is useful for solving problems related to exploration of determinants influencing the size of innovative activity in the surveyed provinces;
- the determinants of innovative activity should include all three examined factors. Increased level of these variables has a positive impact on changing the size of the innovative activity in Polish enterprises;
- the variability of the size of the innovative activity of Polish companies is affected, in a statistically significant way, by level of GDP and the level of expenditure on R&D (so the hypothesis 1 and 2 are confirmed);
- Hypothesis 3 was confirmed, since the value of investment is a direct factor increasing the size of outlays for innovative activity in the analyzed provinces in 2008-2014.

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