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Subject:

"Cross-industry analysis of companies' incentives to working capital targeting"

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Content

Abstract (Резюме)

Целью работы является сравнение отраслей с точки зрения склонности таргетировать рабочий капитал, а так же проверка устойчивости отраслей к рыночным колебаниям цены и шокам спроса с точки зрения прибыльности и ликвидности.

В работе проверялись следующие гипотезы:

1) Отрасли отличаются набором внешних факторов: параметрами волатильности рынка и издержками управления рабочим капиталом.
2) Отрасли, направленные на конечное потребление и обладающие диверсифицированным продуктовым портфелем являются наиболее устойчивыми к рыночным колебаниям с точки зрения прибыльности и ликвидности.
3) Наиболее устойчивые отрасли более других склонны таргетировать уровень рабочего капитала.

Модель имитации выбора оптимального рабочего капитала включала в себя 5 основных экзогенных факторов: два индикатора рыночной волатильности (волатильность уровня инфляции и волатильность непредвиденного шока спроса) и три коэффициента издержек управления рабочим капиталом (для запасов, кредиторской и дебиторской задолженностей). При этом индикаторы рыночной волатильности затем использовались для оценки устойчивости, а коэффициенты издержек служили оценкой необходимых денежных запасов для предотвращения возможных негативных последствий неэффективного управления рабочим капиталом.

Оценка данного внешнего набора параметров проводилась во время калибровки модели методом out-of-sample: на данных 2011 года моделировались показатели 2012 и приближались за счет изменения факторов к реальным показателям 2012 года. Так было выяснено, что факторы практически не отличаются между отраслями. Это является опровержением первой гипотезы работы и может быть объяснено недостаточной чувствительностью модели или тем, что указанные издержки являются неявными и не учитываются в отчетности.

Следующим шагом была оценка волатильности коэффициента прибыльности (дохода на акционерный капитал) и ликвидности (показатель цикла оборачиваемости денежных средств) в ответ на изменения указанных индикаторов волатильности рынка. Результатом стала карта стабильности по двум параметрам – ликвидности и прибыльности, где наиболее устойчивыми оказались отрасли, нацеленные на

потребительские сегменты, а наименее устойчивыми, отрасли первоначальной переработки и добычи сырья. При этом энергетический сектор оказался близок к наиболее устойчивому сектору, что может быть объяснено исключительной важностью рынка и неэластичным спросом. Эти результаты подтвердили вторую гипотезу об устойчивости отраслей, нацеленных на конечное потребление и с диверсифицированным продуктовым портфелем.

Наконец, на основе базового набора внешних параметров были смоделированы ряды оптимальных балансов рабочего капитала для каждой из 8 отраслей. Исследование заключалось в оценке их волатильности, следуя следующей логике: при незначительных колебаниях оптимального уровня рабочего капитала таргетирование не приведет к слишком большому отклонению от оптимума и, значит, является более предпочтительным, чем когда колебания оптимальных балансов рабочего капитала велико. С точки зрения данного подхода, наиболее склонными к таргетированию оказались отрасли, нацеленные на потребительские предпочтения и отрасль коммунальных услуг, в то время как наименее склонными оказались индустриальный сектор и сектор добычи и материалов.

В дальнейшем была попытка оценить оптимальные политики таргетирования, однако данный вопрос требует дополнительного исследования и приводился только в качестве примера. Однако результаты последнего блока подтвердили последнюю гипотезу о склонности устойчивых компаний к таргетированию рабочего капитала.

Таким образом, практический смысл работы заключается в получившемся рейтинге краткосрочной стабильности отраслей к рыночным колебаниям, а так же оценка их относительной склонности к таргетированию рабочего капитала.

Introduction

Contemporary life is frequently concerned with different business processes and corporate behavior: either in terms of ownership or in terms of management. Corporate processes are related to broad list of sciences and subjects. This work was developed to enlighten one of these subjects.

Most common question under investigation in corporate finance is capital structure and its optimization. There are numerous works on the topic and this problem refers to choice of financing of strategic development, but often misses ongoing operations and management of working capital. However, it should be noted that working capital management is also important for corporate financial health, because, with bad or absent working capital management, company faces risk of current liquidity shortfall and can be unable to finance its continuous operations.

The broad aim of this work is to consider, analyze and understand the process of working capital management: why it is important in firm's day-to-day behavior, how the process of management happens and what results it generates. To be more specific, this work will analyze the response of firm's management to continuous market fluctuations, compare these responses among different industries and try to work out industrial incentive towards working capital targeting. This work will try to complete three main tasks to better achieve goal. First, differences in industry-specific factors will be analyzed (factors such as corresponding market volatility and specific costs of managing working capital). Second, industrial sensitivity to market volatility will be compared from the point of view of stability of profitability and liquidity ratios. Finally, incentive to target working capital will be compared among industries and industrial ranking formed.

Among expected results are industrial ranking in their stability to market volatility, industrial ranking in their incentive to target or manage discretionary working capital balances and, finally, investigation of possible policies in working capital management.

The notion of importance of this work appeals to recent studies of corporate management attitude towards day-to-day decision-making. It becomes more and more noticed that corporate management policies tend to change their focus from long-term strategic decisions towards management of tactical behavior. It is reflected in the work of Lamberson (1995), who showed, that more and more top managers accept the importance of explicit management of working capital. When this tendency found, the next question to arise is why short-run process becomes so important. And at this step it can be seen that there aren't quite so many works on the topic, as there are on the process of capital structure management.

The broad scope of topics covered includes, in general, questions of working capital management importance, its influence on company's parameters of profitability and liquidity[1]. Then these questions have become to evolve and there appeared works that analyzed working capital management policies: their instability in time in general, their consistent similarity between companies of one industry and consistent differences between companies of different industries[2]. Some distinguishing characteristics of policies were developed, and thus the influence of policies of different types on profitability and liquidity was analyzed. Also, there are several works that consider the notion of efficiency of working capital management[3].

However, some topics were not sufficiently covered: though there were mentioned aims of working capital management, there were few works on what factors determine the optimal working capital. The process of decision-making while choosing optimal working capital was not deeply studied. And what is more important, there were no sufficient studies on evolution of optimal working capital requirements in response on external factors, though many mentioned that the aim of working capital management is day-to-day response to market behavior.

These factors determine the relevance and importance of main targets of this work: the process of decision-making while managing working capital will be explicitly modeled, and its response on external market fluctuations will be studied.

The structure of the thesis is the following: literature review and theoretical basis of the model, hypotheses, methodological description of the model of working capital management, including data collection process, model calibration and analysis of external industrial environmental conditions, cross-industry profitability and liquidity stability analysis and industrial stability ranking, cross-industry comparison of incentives to working capital targeting and incentive ranking and, finally, possible approach to evaluation of ability to target working capital (as example).

[1] Shin & Soenen (1998), Deloof (2003), Raheman & Nasr (2007)
[2] Weinraub & Visscher (1998), Afza & Nazir (2007)
[3] Shin & Soenen (1998), Ganesan (2007)

Chapter 1. Theoretical Basis and Literature Review

Literature Review

Working capital is considered as the amount of funds needed to finance ongoing operations and is known as important account in company's valuation. This was mentioned by Robert Moore (2012) in his descriptive paper. Moore gave its classification by types and basic accounting formulas for calculation. More importantly, Moore made several examples of practical importance of working capital, starting with notion of working capital as implicit account in determination of company's value. He therefore mentioned that working capital is the measure, which is important in mergers and acquisitions. However, this paper did not give any specific idea of why there can be any need in working capital adjustments.

Importance of working capital was further proved by the work by Raheman, Afza, Qayyum and Bodla (2010) on the sample of Pakistan firms. They emphasized the overall importance on working capital management:

> *"Working capital is known as life giving force for any economic unit and its management is considered among the most important function of corporate management. Every organization, whether profit oriented or not, irrespective of size and nature of business, requires necessary amount of working capital. Working capital is the most crucial factor for maintaining liquidity, survival, solvency and profitability of business"*
>
> *Raheman et al. (2010)*

Working capital management is known to influence corporate profitability, which makes it so important. The influence of working capital management on profitability was widely studied. Shin and Soenen (1998) ones of the first tried to analyze the correlation between working capital management efficiency and profitability. They conducted rather extended analysis on the measures of working capital management efficiency by comparing different approaches to cash conversion estimation.

Cash Cycle concept was introduced by Gitman (1974), who named it as crucial element of working capital management. Total Cash Cycle was defined as number of days from the time the firm pays for its purchases to the time of collections for finished goods sales. This was changed in the concept of Cash Conversion Cycle (CCC) by the work of Richards and Laughlin (1980) with definition as net interval between cash expenditures on raw materials and cash receipts from sales. In accounting it was represented as an additive measure funds

are committed to inventories and receivables less the number of days sales are deferred from suppliers. Later this concept was again modified by Gentry, Vaidyanathan and Lee (1990) into concept of weighted cash conversion cycle (WCCC), where weights on timing were calculated from actual values of corresponding transactions. Shin and Soenen indicated that WCCC measure is really complex for evaluation, while total cash cycle is unobservable. So CCC becomes most optimal measure. Further works also used cash conversion cycle as the measure of working capital management efficiency.

Mark Deloof (2003) tried to find out whether there is any influence of working capital management on corporate profitability at all. The study was conducted for Belgian firms. Working capital management efficiency, as was said, essentially was measured by the cash conversion cycle measure (CCC) – "the time lag between the expenditures for the purchases of raw materials and the collection of sales of finished goods" [Deloof, 2003]. Empirical analysis of 2000 Belgian firms showed strong negative relationship between gross operating income and CCC, indicating that managers can create value for their shareholders by reducing the working capital requirements.

Shin & Soenen (1998) indicated the similar patterns for sample of American firms. But they also gave explanation of the obtained results, which allowed better understanding of why working capital has to be managed. This subject is crucial for the current work, as it is important to understand indicators of working capital optimality.

First mentioned by Smith, Keith (1980), the importance of working capital management lies in the trade-off between dual goals: liquidity and profitability. It was said in the work that decisions, made to maximize profitability, tend to minimize liquidity and vice versa, but this was not specified. Raheman and Nasr (2007) studied Pakistan firms and gave clearer explanation why the subject of optimization of the working capital is important. They stated that the ultimate objective of any commercial firm is to maximize its profit. But increasing profits at the cost of liquidity can bring serious problems. Therefore, there must be trade-off between these two objectives: if company does not care about profitability, it cannot survive for a long period, on the other hand, if company does not care about liquidity it may face problem of insolvency and bankruptcy.

Mentioned tradeoff was further specified by Ganesan (2007). His work on analysis of working capital management efficiency gave additional understanding of the underlying reasons for working capital management. First, definition was proposed as following: optimization of working capital balance means minimizing the working capital requirements

and realizing maximum possible revenues. Also the work appeals back to Smith (1980) and the tradeoff between liquidity and profitability goals:

> *"Lesser requirement of working capital leads to less need for financing and less cost of capital and hence availability of more cash for shareholders. However the lesser working capital may lead to lost sales and thus may affect profitability"*
>
> *Ganesan, 2007*

These reasons were given in more details in the work – specifically for each of three components of working capital balance. It was said that accounts receivable, representing firm's trading policy as its convenience for customers, influence sales in positive way, which means that contraction of receivables may lead to lost clients and thus reduction of revenues. On the other hand, accounts payable reflect strictness of purchasing policy and Ganesan mentioned, that higher accounts payable indicate longer trade credits for suppliers and may affect the quality of raw materials in bad way, ultimately affecting production effectiveness and profitability. Finally, inventory accounts are important to cover shortfalls in production, but higher inventories imply higher storage costs and thus also affect profitability.

Raheman and Nasr (2007) gave very similar considerations on the topic: large inventories, not considering the cost of holding, may reduce the risk of stock-out and increase sales; trade credit may stimulate sales because it allows customers to assess product quality before paying, but can increase probability of bad debt; delaying payments to suppliers, similarly, allows company to assess quality of raw materials and can be a flexible and cheap source of financing, but late payments on invoices may be costly when discounts for early payments are offered. So, there is the same profitability/liquidity tradeoff for each component of working capital.

Though all works agreed on the negative relation between liquidity and profitability and thus stated that optimal working capital must be chosen to maximize both, Deloof (2003) indicated statistically large amounts of cash, invested in working capital for studied firms, which clearly contradicts to optimal behavior from the point of view of profitability.

From the review above the importance of working capital management is clearly proved, but except studies on reasons for balancing working capital there were no works that specified tradeoff parameters and explicitly determined factors of working capital optimality. So the topic of actual optimization of working capital balances held by firms was chosen for this work as the least studied.

To approach the topic more specific considerations on liquidity and profitability indicators were needed. In all mentioned empirical studies different indices were used for measuring profitability and liquidity. Profitability most often was measured by indicators of returns on different bases: return on assets and return on equity were common, but also classical indices of profitability were used, such as gross income margin, operating income margin, net income margin. All these indicators were also presented in the work of Nassirzadeh (2011). There he gave brief summary of traditional measures of profitability and more comprehensive ones. All measures mentioned above are traditional measures. In this work they will be of priority for their simplicity and transparency.

Among indicators of liquidity were mentioned traditional ratios such as quick ratio and current ratio, different comprehensive indices, which required specific kinds of adjustments for existing accounts and again difficult in implementation. Also there were flow measures, which estimated liquidity as possibility of cash generation (which is exactly the primary definition of it). Among them – Cash Conversion Efficiency indicator, presented by Ganesan (2007), which will be further specified in theoretical summary.

Important notion is, though, that simple optimal working capital modeling is not of practical importance, because it is still very firm-specific and generalized approach may give diluted results. To check this, the hypothesis of stability of working capital management patterns was studied. This question was much less highlighted in the existing studies, but there was work by Afza and Nazir (2007), who developed complex approach by analyzing working capital policies and their effect on company's welfare. They claimed that companies in general may adopt two types of policies: aggressive working capital management policy and conservative one. The main idea behind this choice is the same as for balancing working capital: an optimal level of working capital (and optimal policy of its management) should be the one that balances risk and efficiency. The degree of aggressiveness is measured by the relative value of investment in current accounts as opposed to fixed accounts. This is split into two policies: investment policy and financing policy. Aggressiveness of investment policy is measured by the ratio of current assets to fixed assets, indicating company's focus on ongoing operations. Similarly, financing policy aggressiveness is measured by the ratio of current to non-current liabilities – again indicating concentration on short-term financing and, consequently, frequent payments. The main result of the study was that correlation between policies aggressiveness and profitability of the firm is negative – more aggressive companies in terms of working capital management tend to be less profitable. Though this result does not

refer to the general notion of working capital optimal balance, but it gives raise to the idea of specific attitudes toward managing working capital.

Notion of working capital management policies is not too frequent. There were several studies on whether there is at all such concept as policy of management of working capital. One of the attitudes is that there is no significant stability in working capital management and thus the concept of working capital management policy is rather vague. Study of Filbeck and Krueger (2005) found that working capital practices were significantly different over time. Moreover, those practices changed significantly over time within industry. Main conclusion made was that working capital management is important and requires constant attention and dynamic adjustments. Similar studies were conducted by Gombola and Ketz (1983), Soenen (1993), Maxwell at al. (1998), Long at al. (1993). Another attitude is presented in the work of Pandey and Parera (1997) who found through questionnaires and interviews that most companies from their sample have informal working capital management policies and that company size has an influence on overall working capital policy.

Above studies showed controversial results about stability in working capital management patterns. However, obtained results are difficult to compare as they had different bases for analysis: some were conducted on corporate level, some compared intra-industry patterns. One work gave more general approach. This is the study of Weinraub and Visscher (1998), in which the main finding was that working capital management policies are statistically different between industries. There was also specification of different policies: high risk, high return working capital management policies were classified as aggressive. Lower risk and return policies were called moderate or matching, still lower risk and return working capital management policies were referred to as conservative. Aggressiveness in investing policy was measured as proportion of funds in current assets opposed to that of fixed assets: firm, that invest less in current accounts can get higher profitability, but it faces risk of liquidity shortfall and thus higher risk. As for aggressiveness of financing policy, consideration of payments is primary: financing more through short-term obligations company can enjoy lower cost of capital, but it risks shortfalls on frequent payments, while using long-term debt means higher costs of its servicing, but more safe payments. So, aggressive financing refers to higher rate of short-term debt. Important finding was also negative correlation between aggressiveness of investing and financing policies, i.e. company that invest more in fixed assets tend to finance it through non-current liabilities. At the same time, if company employs short-term financing, it uses more funds in current assets. This situation indirectly refers to balance between profitability and risk.

When policies were defined, there appeared considerations on cross-company differences in working capital. The basis of consideration was taken from paper by Nunn (1981), who investigated the question why different companies have different levels of working capital. The resulting regression model of working capital balances contained 19 variables pertaining to production, sales, accounting, competitive position and industry factors. His model was used to explain why working capital levels differ between firms both within and across industries.

Weinraub and Visscher followed the idea and found that industries do follow significantly different aggressive/conservative working capital policies and they remain stable relative to each other over extended period. 10 industries were analyzed, with 22 companies on average taken from each industry.

This scope of works narrowed the choice of possible investigation topics: there were found stable patterns of working capital policies but not across companies, but on the industrial level. These works again did not specify the determinants of optimal choice of working capital. The idea of cross-industry study is not only interesting for further investigation, but also has broad practical value in industrial valuation and allows getting some consistent and valid results. However, cross industrial analysis is reasonable only in the case, when industrial grouping based on financial data can be made. Otherwise, if there are no statistical differences in financial accounts across industries, model based on sole financials won't be able to distinguish among industries either.

One of important considerations was that financial ratios do not have statistically proven predictive power and better serve as descriptive tools. This notion was made by Gupta & Huefner (1972). Many studies attempted to assess usefulness of financial ratios at the level of individual firm, but in the paper of Gupta and Huefner (1972) macro level was of main concern. The hypothesis was that certain industries have higher values of a given ratio in comparison with others. But this restriction did not change the scope of analysis since the role of ratios in the current work is exactly descriptive or, to be more specific, comparative.

The main findings on the statistical differences in financial ratios across industries were that there actually exist systematic distinctions. Studies of Gupta (1969), Gupta & Huefner (1972) and Pinches, Mingo & Caruthers (1973) agree on these results in general. In the pioneer study Gupta sought to analyze the financial ratios with respect to three exogenous variables – industry, size, growth. One of the focuses of study was exploring and explaining industry effect on financial structural relationship of American manufacturing enterprises. Specifically, the study was design to determine if there are patterns in the cross-industrial

variations of financial ratios in indicators of liquidity and profitability in particular (among others). The data set included 173 000 corporations from 21 manufacturing industries (2-digit classification). One of the findings was that industries of primary manufacturing have lower indicators of profitability. One of the specific features of primary manufacturing corporations was said to be fixed asset composition – more specifically, reason to hold assets unrelated to manufacturing operations (excess fixed assets). Another important finding was that such indicators as average collection period and cash velocity were lower for primary processing industries. Implications for this work from the paper of Gupta (1969) are that there are industry specific financial accounts and ratios that can affect working capital.

Gupta & Huefner (1972) continued the study and stated that differences across industries are statistically significant only for some specific accounts and are rather similar for general accounts. Below given the summary of statistics for general financial ratios considered by Gupta & Huefner (Table 1):

Table 1. Summary of Statistics (Gupta, Huefner) on cross-industrial financial ratios

	Mean	St. Dev	Maximum	Minimum
Cash Velocity	16.96	5.85	30.05	8.82
Inventory turnover	6.65	2.5	12.35	2.18
Average collection period	53.43	16.7	100.27	18.90
Current Assets turnover	2.72	0.63	4.74	1.84
Fixed assets turnover	3.29	2.2	9.95	1.07
Total assets turnover	1.48	0.42	2.41	0.87

Another important result of the study was: ratio data corresponds highly with both the judgmental classification of economists and with numerous quantitatively expressed economic characteristics of the industries involved.

However, Gupta & Huefner covered only narrow scope of ratios. More broad analysis was given by Pinches, Mingo and Caruthers (1973). The study was interested in the development of empirically based classification of financial ratios and the analysis of long-term stability of these classifications over the period of 18 years. Based on multivariate procedures employed, there were distinguished 7 financial ratio groups:

- Returns on Investment
- Capital Intensiveness
- Inventory Intensiveness
- Financial Leverage

- Receivables Intensiveness
- Short-term Liquidity
- Cash Position

The composition of these groups was found to be stable over time. The implication for this work is that ratios related to short-term management are also stable and, given results of work of Gupta, Huefner (1972), working capital management policies may also be stable and depend on some industry-specific financial characteristics.

Working capital management is aimed to respond to ongoing market challenges. Study by Lamberson (1995) summarized previous arguments and conducted more general investigation of working capital determinants. The aim of the work was to show how the working capital position of the small firms responds to changes in the level of economic activity. There was one more confirmation of topic relevance for recent times, as it was found that financial managers devote approximately 60 percent of their time on short-term activities. The dynamic and highly volatile nature for short-term markets, the constant need to replace current assets and to pay current liabilities, and the fact that long-term funds are raised infrequently helps to explain the larger time allocation to short-term activities (reference to Gitman and Maxwell, 1985).

Lamberson found, that there is relation between the stage of economic cycle and the ratio of company's liquidity – liquidity position of the 50 small firms slightly increased during economic expansion with no noticeable change during economic slowdown. Though this research does not directly refer to the main idea of current work, it gave the important idea of analysis – there were too many studies on market influence, and still less works on continuous market fluctuations. Moreover, in his study, Lamberson indicated that liquidity results are statistically different between small and large firms. Primary reasons stated were:

1) Large firms can devote more resources and expertise to manage current assets,
2) Large firms have an advantage in economy of scale,
3) Large firms become more capital intensive

All these reasons were considered as underlying for the fact of greater liquidity of large firms; however their response on market conditions was not analyzed.

The format of the current study was chosen because of one work with format absolutely different from that of previous studies: there was no historical data analysis, instead simulation method was used. The main idea behind the work was that capital investment project is not easy to evaluate, because generated cash flows are subject to short-term

fluctuations due to working capital management. New structural project creates the need for additional investments in inventories, receivables, cash throughout the life of new equipment/plant (it is also assumed, that investment in working capital assets also causes a comparable expansion in current liabilities). In general, the objectives of the work were stated as: to create a model that simulates the dynamic and uncertainty in the working capital processes and integrate these parameters into the investment decision making process; to capture the effect of forecasting errors and inflationary conditions on working capital components and cash flows; to measure the cost and benefits of short-run investment and financing variables on the cash flow and investment. For the model of this work basis from model of Gentry on working capital was taken. However, there were several implications that made it impossible to implement the model directly: first of all, the model is based on randomly generated parameters and has no real value as separate working capital management model; second, the model for working capital management was developed as a part of capital structure model and process of optimal working capital choice was not directly described – only volatility was subject to consideration. However, there were described underlying decisions that were very helpful in developing real-data based model of working capital management process simulation.

Theoretical Summary

The importance of topic proved by literature review, it is important to summarize all theoretical implications before moving to methodology and model description.

So, Working Capital balance is the amount of funds needed to support ongoing operations and is given by:

$$WC = Acc.Receivable + Inventories - Acc.Payable \quad (1)$$

Working capital management process is needed to ensure that company has enough funds to avoid shortfalls (liquidity concern) and at the same time to fulfill basic reason for company existence – maximize profits. Working capital management process is essentially presented by the choice of optimal values for all three key accounts.

Account Receivable includes trade credits that company allowed to its customers. So, this account shows funds that were accounted as sales, but for which actual cash inflow did not happen. This account is part of current assets of the company. There are two different trends in managing this account: lower accounts receivable imply that more cash can be received immediately at the moment of sales and fewer sales would be lost as bad debt expenses;

higher receivables imply milder trading police of the company, allow better product evaluation for customers and can ensure customer's loyalty (Raheman and Nasr, 2007).

Accounts Payable are similar to Accounts Receivable, except the fact that now the company under consideration performs as customer. So, increase of Accounts Payable implies that cash outflow can be deferred and supplies better evaluated before payments. However, demand for trade credit and late payments may happen at a cost of loss of discount on earlier payments (Raheman and Nasr, 2007) or at a cost of worse shipments and decrease of production as a result – reference to moral hazard problem, when suppliers that have to work on non-preferable terms tend to apply less effort on better shipments (Ganesan, 2007).

Inventories account for goods produced, but not yet sold. This account helps to avoid production shortfall when demand unexpectedly rises. Also this account is inevitable for big-scale production, as it accounts for unfinished production also. Increase of this account is important in terms of liquidity; however it is costly to maintain inventories as they require storage facilities. So, in terms of profitability, decrease of inventories is optimal (Gentry, 1979).

Overall process of working capital management is acquiring the balance between profitability and liquidity by maximizing both measures simultaneously, as it was mentioned in previous works that neither account is to be neglected, and both accounts must receive equal attention of management.

As for measures of liquidity and profitability, there were considerations about the choice of ones named as standard (Nassirzaden, 2011).

As profitability account classical margin profitability was used from the point of view of simplicity: return on assets implies the effectiveness of asset management and optimality of capital investments (return generated by dollar invested in assets), return on equity is for shareholders consideration only, while profitability margins are broad and not attached to specific part of business. Net profit margin was chosen, because, due to model specifications, costs of working capital management are accounted separately and affect PAT and PBT accounts. So, profitability measure is the following:

$$PM_t = \frac{PAT_t}{Sales_t} \qquad (2)$$

To ensure compatibility of measures (as referred to flows accounts), liquidity measure is represented as Cash Conversion Efficiency indicator (Ganesan, 2007), given by:

$$LM_t = \frac{Cash\ Flow_t}{Sales_t} \quad (3)$$

To account costs of working capital management, approach of "provisions for possible loss" was used (Gentry, 1979). It stated that, instead of direct inclusion of future possibility of shortfall or client loss, estimate of possible costs and explicit accounting for them may be reasonable. Indeed, direct probabilistic accounting requires too complicated calculations and modeling, while effect is still not determined. Direct estimation of costs bears similar uncertainty, but is easier for calculations.

Chapter 2. Methodology of Working Capital Choice Modeling

Hypotheses

There are several hypotheses about cross-industrial patterns of corporate behavior in the short-run period:

1) Model will include external factors – market volatility indicators and estimators of costs of working capital management. These factors will represent external industrial environment and the first hypothesis is that there are statistical differences in these environmental conditions. That may be found at the stage of model calibration and estimation of these parameters.
2) Second hypothesis states that there exist cross industry differences in sensitivity of measures of profitability and liquidity to market volatility in prices and demand. Companies operating in industries with more diversified and more customer-oriented product portfolios tend to be less sensitive to change of market volatility parameters.
3) There are two possible approaches toward working capital management: through policy implementation (which will be called targeting, as working capital balances in this case are simply function from some base account) and through discretionary actions. The hypothesis is that only sectors with high stability of profitability and liquidity measures (as stated in the above hypothesis) will be able to obtain effective policy rules of working capital management, because for the others instability will cause the need in too many discrete adjustments

To confirm or reject these hypotheses, the model that simulates choice of optimal working capital balances was developed and employed on the base of real financial data.

Data Set & Sample

As industrial classification one of the most widely used systems was taken: Global Industry Classification Standard (GICS) currently used as Bloomberg industry classification system. In general, it consists from 4 levels of classification: sector, industry group, industry and sub-industry. The broadest level was taken as basic work industrial classification for several reasons: first, it gives reasonable industrial scope of 8-10 sectors; second, international classifications differ on the lower levels, so it is rather difficult to find reasonable match to form good sample of companies.

Industrial sectors as given by GICS are the following:

- ✓ Energy (oil & gas and related services)
- ✓ Materials (chemicals, construction materials, metal and mining etc.)
- ✓ Industrials (capital goods, commercial services and supplies, transportation)
- ✓ Consumer Discretionary (automobiles and components, consumer durables and apparel etc.)
- ✓ Consumer Staples (food and drug retail, food manufacture, household and personal products)
- ✓ Health Care (health care equipment, pharmaceuticals and biotechnology)
- ✓ IT (software and services, technology hardware and equipment)
- ✓ Utilities (electric, gas and water utilities)
- ✗ Financials (banks and insurance)
- ✗ Telecommunication Services

The last two sectors were excluded from analysis for the reasons of validity of comparison: companies in compared industries must have compatible reasons and methods for development and similar implied values under all financial accounts. From that point of view financial sector and telecom companies can be outliers in their attitude toward working capital due radically different asset structure. This shortened the list of industries to 8.

Companies in each sector had to have broad scope of operations to maximally exclude country-specific factors from the comparison. So as the source of primary company list the Forbes ranking of global companies was taken. This source allowed filtering on industry group level and helped to form list of 20-25 companies for each industrial sector.

As the source of specific financial data (accounts such as short-term investments were needed) Factiva was chosen. From the data available annual accounts for financial years 2012 and 2011 were taken, and for year 2012 interim (quarterly) data also was collected. The absence of part of financial was common problem, as companies located in Europe often provided only semiannual accounts, reduced list of companies for each industry, however 10 full financial reports for each industry were collected. That gave the sample of 80 companies and financials for 5 periods for each company (2011 full year accounts and 4 quarterly accounts of 2012). Raw financials were given in different currencies and US GAAP report forms. The data was collected in the following form, with yellow cells reserved for manual filling and white cells containing formulas, balancing accounts from given data to simplify collection process (Picture 1).

	4Q	3Q	2Q	1Q	2year	1year
Balance sheet						
Total Assets						
Total FA						
Production						
Investments						
Other						
Total CA						
Receivables						
Inventories						
Cash & STI						
Cash & Equivalents						
STI						
Other						
Total Liabilities						
Total NCL						
LTD						
Other						
Total CL						
STD						
Payables						
Other						
Total Equity						

Income Statement						
Revenue						
COGS						
Gross Profit						
SG&A						
R&D						
Dep'n						
Operating Income						
Financial Income						
Financial Expenses						
Other						
PBT						
Taxes						
PAT						

Picture 1. Form for financial data inputs

Note: account "Cash & STI" doubled sum of accounts "Cash & Equivalents" and "STI", this was necessary due to absence of explicit data on short-term investments (STI), this also was remembered and accounted when balancing financials.

Supposedly, there were mistakes in the source financials and, possibly, mistakes during collection. All accounts were checked on balancing; sometimes quarterly data was proportionally corrected in the way to sum up in annual values.

80 companies' accounts were presented in 15 different currencies:

1. USD (United States)
2. EUR (Eurozone)
3. GBP (United Kingdom)
4. RUB (Russian Federation)
5. NOK (Norway)
6. HKD (Hong Kong)

7. SAR (Saudi Arabia)
8. CHF (Switzerland)
9. JPY (Japan)
10. DKK (Denmark)
11. CNY (China)
12. SGD (Singapore)
13. KRW (South Korea)
14. TWD (Taiwan)
15. SEK (Sweden)

US Dollar was chosen as basic currency (accounted for most companies in the sample), so for correct recalculation several exchange rates for each currency were needed: exchange rates as at the end of each period: 31.12.2011, 31.03.2012, 30.06.2012, 30.09.2012, 31.12.2012 – for recalculation of balance sheet accounts. Average exchange rates for periods: 2011 full year, I – IV Quarters 2012 – for recalculation of income statement accounts. As the source of data online currency converter OANDA was used, because it supports options of calculations of averages for customized periods and contains reliable historical information on daily exchange rates for all existing currencies.

Adjusted for exchange rate data was aggregated for each industry sector. This approach was used in several works, one of which is that of Weinraub, Visscher (1998). In their cros-industrial analysis they averaged companies' financials and assumed resulted artificial accounts to be industrial. By doing this, as was stated, they removed effects of seasonality. So, in this work the same method was used: each industry's accounts are averaged for 10 included companies. There were also formed aggregate general balances as sum of all industrial accounts to check some model assumptions.

List of companies in all industries considered is given in Attachment 1.

Financials of all industries considered is given in Attachment 2.

Description of Working Capital Choice Model

Broad Description

The model is designed to imitate the process of day-to-day choice of optimal level of working capital for a corporation. The main aim is to achieve series of optimal working capital balances and test them on stability to check the correctness of stated above hypotheses. Moreover, the dependence of mean and variance measures of working capital series on market parameters will also be tested to check stability of each industry. Overall conclusion,

made from achieved series, will be relative industrial degree of incentive on managing versus targeting working capital.

General Assumptions

Since working capital management is the ongoing day-to-day process, 3 major assumptions are to be made:

- Short-run period (1 year)
- No structural investments during the period
- No long-term debt issues or repayments, share issues or buyouts

Period

In this work, tactical firm's behavior is under considerations, so the period has to be short-run: this is reasonable from microeconomic point of view to assume that during short-run period absence of significant structural changes is tolerated, which allows to concentrate only on ongoing operations. There is no explicit statement on how long short-run period has to last. The period of one year was chosen for 2 reasons: first, this period is short enough to allow excluding structural investments (even from bureaucratic point of view) and long enough to get reasonable amount of data for series analysis; second, data readily available includes one year only specification of financial accounts at quarterly level.

Investments

Taking into account short-run considerations, since no structural changes are allowed, there can be no large investment projects by microeconomic foundations of short-run. Structural investments are usually made to significantly change either production technology or capacity. In either way, this will disrupt short-term operations and, as was said in the work of Gentry (1979), new structural project creates the need for additional investments in inventories, receivables, cash throughout the life of new equipment/plant. This means change of working capital management policy not from the point of view of current optimality, but of structural necessity. So, while tactical behavior and short-run decisions are under consideration of this work, structural investment is to be neglected.

However, physical deterioration of assets must be taken under consideration, so day-to-day maintenance investment will be approximated by the amount of depreciation.

Capital structure

Without large structural investments there is no need in significant financing operations. Also, the argument about short-term operations is again in place. So, capital structure is expected to be conditionally constant: no explicit actions will be undertaken to change the level of long-term debt or number of shares outstanding. However, since no dividends payments are assumed either (Gentry, 1979), equity is subject to change by values of retained profits.

Model-specific Assumptions

Main decision periods

Primary input of the model is the number of days in the year. This is variable parameter; however it was chosen to be 360 for the following reasons: first, companies from different industries and different countries have different amounts of working days, so legal working days number is not a reasonable measure; for simplicity of calculations (with insignificant loss of precision) 360 days were chosen, when year is easily divided by 4 quarters, 90 days in quarter is also convenient number.

Working capital management is the process of support of ongoing operations, so day-to-day behavior was chosen to model and thus main operational period is 1 day. Hence, all flow variables are modeled as the series of data for 360 days. All stock variables are modeled as series of data for 4 quarters.

However, there are other specific periods of the model:

1) Days Sales Outstanding (DSO) – is a measure of the average number of days that a company takes to collect revenue after a sale has been made (4). This period is used for adjusting Receivables Account – assuming strict collection policy and no bad debt considerations (are implicitly included into costs of working capital management, will be specified later), receivables, allowed today, will be subject to collection in exactly DSO days from today.

$$DSO = \frac{Av.Receivables}{Sales} * N_{days} \quad (4)$$

2) Days Inventory Outstanding (DIO) – is a measure of the average number of days that a company takes to turn its inventory (including goods that are work in progress) into

sales (5). This period is used for adjusting Inventories Account. Strict inventories turnover assumption also holds.

$$DIO = \frac{Av.Inventories}{Sales} * N_{days} \quad (5)$$

3) Days Payable Outstanding (DPO) – is a measure of the average number of days that a company takes to pay its trade creditors (6). This period is used for adjusting Payables Account. Strict trade debt payout policy assumption also holds.

$$DPO = \frac{Av.Payables}{COGS} * N_{days} \quad (6)$$

4) Short-term Debt payout is assumed to happen strictly one year after debt was taken.

Choice of components of WC

Another model-simplifying development is that choice of all accounts would happen not in natural terms (money), but as a percentage of corresponding income/cost account as given in period calculations formulas. So, a company would choose the amount of trade credit allowed at given period to be a percent of sales, amount of debt to suppliers as percent of COGS. Inventories will be slight exception and considered as a percentage of production.

External Market Conditions Modeling

Inflation

Inflationary processes are assumed in the model. There are two uncertainty factors about inflation: average value and volatility of inflation levels. To model these uncertainties random normal process (appealing to Gentry, 1979) is assumed for inflation:

$$Inflation_t = \left[(1+\pi_t)^{1/NDays}\right] - 1, \qquad \pi_t \sim N(\pi^e, \sigma_\pi^2) \quad (7)$$

Expected inflation is estimated from the data existing for each industry[4] (8):

$$\pi^e = \frac{Revenue_{2012}}{Revenue_{2011}} - 1 \quad (8)$$

So, from this processes, market price fluctuations are presented by inflation level volatility measure.

[4] All data used in the model is averaged industrial data

Demand

Demand is subject to external shocks. Considering value of demand as product of quantity demanded and price of good (9):

$$Demand_t = Q_t * P_t \tag{9}$$

It would be impossible to directly model its fluctuations for different industries and different countries in one model. However, this can be approached as following (10):

$$\Delta Demand_t^{\%} = \Delta Q_t^{\%} + Inflation_t \tag{10}$$

This approximation is possible due to daily low rates of change.

Assume normal random processes (to be consistent with assumed inflationary processes) for structural demand change also: $\Delta Q_t^{\%} \sim N(0, \sigma_q^2)$

Zero expectation is explain by the following: any expected structural demand change will be already incorporated into expected inflation rate, so only unexpected structural demand changes are considered.

Hence, demand function will be (11):

$$Demand_t = Demand_{t-1} * (1 + \Delta Q_t^{\%} + Inflation_t) \tag{11}$$

Initial value of demand is determined from empirical data and is assumed to be equal to sales.

So, from this process, another source of market fluctuations is demand structural fluctuations, measured by demand unexpected shock volatility.

Internal Operations Modeling

Production

Due to the assumption of absence of structural investments and thus absence of any productivity or capacity changes, value of production is subject to inflationary growth only (12):

$$Production_t = Production_{t-1} * (1 + Inflation_t) \tag{12}$$

Initial value of production is determined from empirical data and is assumed to be equal to sales.

Inventories

To account for day-to-day inventories change two additional accounts are introduced: Inventories Flow (referred to as $Inventories_t$) and periodical change of inventories account (referred to as ΔInv_t). So, daily inventories are supposed to be part of current production (13):

$$Inventories_t = CI * Production_t \quad (13)$$

, where *CI* is policy management decision factor and is thus parameter of maximization problem.

$$\Delta Inv_t = Inventories_t - Inventories_{t-DIO} \quad (14)$$

Sales

Sales are formed from demand on company's product and actual production. Also, past inventories can be sold. In each period *t* the following happens:

<table>
<tr><td colspan="2">Demand is realized, value of production is realized, inventories due for sell are known</td></tr>
<tr><td>$Demand_t > Production_t - \Delta Inv_t$
There is excess demand and sales are not as big as they were able to be. We will refer to this situation as production shortfall
$Shortfall_t = Demand_t - Production_t + \Delta Inv_t$
This situation was caused by either too high inventories or too low production. In either way, it may decrease profitability. However, explicitly this situation won't be managed, because this process is subject to choice of optimal inventories</td><td>$Demand_t < Production_t - \Delta Inv_t$
There is excess supply and overproduction. We will still refer to this situation as production shortfall , but it'll have negative sigh
$Shortfall_t = Demand_t - Production_t + \Delta Inv_t$
Situation appeals to incorrect choice of inventories. Though desired level may be of one value, actual adjustment must happen, as all excess production will be saved as inventories:
$Inventories_t = Production_t + Inventories_{t-DIO} - Demand_t$</td></tr>
</table>

Then, sales for period are realized (15):

$$Sales_t = \begin{cases} Demand_t \mid Shortfall_t \leq 0 \\ Production_t + Inventories_{t-DIO} - Invenories_t \mid Shortfall_t > 0 \end{cases} \quad (15)$$

Receivables

To account for day-to-day receivables change two additional accounts are introduced: Receivables Flow (referred to as $Receivables_t$) and periodical change of receivables account (referred to as ΔRec_t). So, daily receivables are supposed to be part of current sales (16):

$$Receivables_t = CR * Sales_t \quad (16)$$

, where *CR* is policy management decision factor and is thus parameter of maximization problem.

$$\Delta Rec_t = Receivables_t - Receivables_{t-DSO} \quad (17)$$

COGS

COGS are assumed to be linear function of production value. Without any structural changes in technological processes, gross margin of production is assumed to be constant. Since initial production level is the same as sales level, COGS per period may be calculated as (18):

$$COGS_t = Production_t * \frac{COGS_0}{Sales_0} \quad (18)$$

Payables

To account for day-to-day payables change two additional accounts are introduced: Payables Flow (referred to as $Payables_t$) and periodical change of payables account (referred to as ΔPay_t). So, daily payables are supposed to be part of current COGS (19):

$$Payables_t = CP * COGS_t \quad (19)$$

, where *CP* is policy management decision factor and is thus parameter of maximization problem.

$$\Delta Pay_t = Payables_t - Payables_{t-DPO} \quad (20)$$

Costs of working capital management

As was already said, there exist costs of decrease of receivables, costs of decrease of inventories and costs of increase of payables. All of these costs are not explicit and refer to probabilities of events in the future. However, Gentry (1979) proposed the solution: account possible reduction of demand, possible production shortfall and possible loss from late shipments as provision for possible future costs in today's appraisal. One way to do it is made by the reference to Titman & Tsyplakov (2007), where they proposed to estimate costs of distress as some proportion of corresponding shortfall. However, in the context of current model, this concept was change as following. Since base account for receivables is sales account, then decrease of receivables must affect it. The relation proposed for costs of decrease of receivables is (21):

$$Cost_{rec} = \gamma_{rec} * \frac{Rec.Acc_0 - Rec.Acc_t}{Rec.Acc_0} * Sales_t \,, \quad if\ Rec.Acc_0 - Rec.Acc_t > 0 \tag{21}$$

, where γ_{rec} is coefficient of provision for possible future sales loss.

Similar for costs of inventories (22):

$$Cost_{inv} = \gamma_{inv} * \frac{Inv.Acc_0 - Inv.Acc_t}{Inv.Acc_0} * Production_t \,, \quad if\ Inv.Acc_0 - Inv.Acc_t > 0 \tag{22}$$

, where γ_{inv} is coefficient of provision for possible production shortfall.

Similar, with consideration of sign, for costs of payables (23):

$$Cost_{pay} = \gamma_{pay} * \frac{Pay.Acc_t - Pay.Acc_0}{Pay.Acc_0} * COGS_t \,, \quad if\ Pay.Acc_t - Pay.Acc_0 > 0 \tag{23}$$

, where γ_{pay} is coefficient of provision for possible future late shipments

Financial income / Financial expenses

Returns on financial assets (if exist) are determined on pre-modeling basis, using existing financial data. This also refers to debt interests as well. So, rates for short and long term investments and borrowings are assumed to be constant. No additional long-term investments/borrowings assumed, these payments do not change. Financial income also

accounts for income on market securities (short-term investment) and financial expenses also account for interest payments on short-term debt.

Rates were calculated as following: short-term deposit annualized rates for corporations were given in the open source bankrate.com, indicating best possible cash investments. Average rate was given as 0.24% and was assumed to be rate on STI. Annualized interest rate on long-term investment was calculated as remaining sum of financial income divided by the value of financial assets.

Short-term borrowing rate was taken as averaged rate for countries under consideration from World Bank database. Rate was calculated to be 4.4%.

All long-term rates were calculated as remaining interest payments / expenses divided by value of long-term investment / debt.

Other P&L accounts

SG&A account includes salaries, other non-production expenses, R&D expenses etc. In the short-run this account is reasonably fixed costs account, so it is not subject to real value change and simply grows with inflation.

Depreciation is incorporated in income statement and serves as tax shield (not added at CF calculations). In cash flow calculations it is not presented, as it is assumed that company undertakes maintenance measures at the expense approximated by depreciation value.

Effective tax rate is calculated basing on existing financial data and is assumed to be constant for a given industry.

The resulting value of P&L accounting is PAT_t

Cash Flows

First, for approximation of periodic cash flow current changes of short-term debt are assumed to be 0 (no borrowings were made in the current period) (24):

$$\Delta STD_t = -STBorrowings_{t-year} \quad (24)$$

Then, preliminary cash flow is calculated as (25):

$$CF_t = PAT_t - \Delta Rec_t - \Delta Inv_t + \Delta Pay_t + \Delta STD_t \quad (25)$$

Then cash account is revaluated (26):

$$Cash.Acc_{current\ season} = CF_t + Cash.Acc_{current\ season} \quad (26)$$

If estimated cash account is negative, then required amount to clear the cash shortfall is borrowed (27):

$$STBorrowing_t = Cash.Acc_{current\ season}, if\ Cash.Acc_{current\ season} < 0 \quad (27)$$

If new cash balances are greater, then their required maximum (as % of initial cash holdings), then excess cash is invested in market securities (28):

$$STInvestment_t = CF_t + Cash.Acc_{current\ season} - Max.Cash, \quad if\ CF_t + Cash.Acc_{current\ season} > Max.Cash \quad (28)$$

Change of short-term debt account is recalculated (29):

$$\Delta STD = STBorrowings_t - STBorrowings_{t-year} \quad (29)$$

Then cash flow is recalculated, to incorporate new decisions (30):

$$CF_t = PAT_t - \Delta Rec_t - \Delta Inv_t + \Delta Pay_t + \Delta STD_t - STInvestment_t \quad (30)$$

Choice of Working Capital

As was already said, working capital management is the process, conducted for maximization of both liquidity and profitability. It was also mentioned, that both parameters have to receive equal treatment. So, naturally, the function under maximization and choice will be:

$$F = PM + LM = \frac{PAT}{Sales} + \frac{CF}{Sales} \quad (31)$$

Since all costs of working capital management were explicitly included into calculations of optimal working capital balances, there is no need to evaluate future periods when making a decision.

Essentially, the process of choice of working capital policy is the process of choosing optimal coefficients *CI*, *CP* and *CR*, with which value of F is maximal at each period.

Evaluating External Conditions Parameters

There are several parameters in the model, for which there are no known or readily available base value to simulate working capital management decisions. These parameters are:

1) σ_{π}^{2} – volatility of price level
2) σ_{q}^{2} – volatility of unexpected demand shock
3) γ_{rec} – coefficient of provision for possible client loss
4) γ_{inv} – coefficient of provision for possible production shortfall
5) γ_{pay} – coefficient of provision for possible bad shipment

To evaluate these indicators in their base value, the method of out-of-sample forecasting was used. As base inputs for the model accounts of 2011 full year were employed. Basing on these accounts 5-dimantional maximization was started – under each possible set of inputs set of modeled accounts were calculated. The goal of this maximization is to get the set of inputs such that modeled accounts are the most similar to real accounts for year 2012.

For comparison not all accounts were chosen – only that related to estimated parameters:

1) Receivables Account
2) Inventories Account
3) Cash & STI account
4) Short-term Debt Account
5) Payables Account
6) Sales
7) COGS

From evaluation were excluded all fixed under model accounts of balance sheet, Cash and STI accounts were summed up to exclude problem of maximum cash from consideration, for similar reasons Financial Income P&L account was excluded, and all flows, that may incorporate explicitly modeled working capital management costs were also excluded.

Resulted quarterly values were compared to existing ones using chi-square goodness-of-fit test (32):

$$\chi^{2} = \sum_{Q=1}^{4} \sum_{accounts} \frac{(Actual\ Value - Modeled\ Value)^{2}}{Actual\ Value} \qquad (32)$$

The set of parameters, resulting in the lowest chi-square test value, is supposed to be base industry-specific parameter set.

Evaluating Optimal Internal Inputs

Remaining input parameters are minimum and maximum cash coefficients. To evaluate them, similar approach as for external factors was used, but, instead of chi-square goodness-of-fit test value, cumulative cash flow measure was used as target value. For all industries maximization problem is run using already evaluated set of base external parameters. From this maximization optimal industry-specific choices for maximum and minimum allowable cash are estimated.

Expected Model Output

When both external and internal sets of factors evaluated, series of optimal working capital balances will be generated for each industry in base scenario (exactly calculated factor sets). Moreover, since model allows generating series for almost all accounts, there will be series also for several different liquidity and profitability measures, to evaluate overall health of modeled industry.

Then, there will be conducted stability analysis that will generate specified series for different values of outside factors under consideration: volatility of inflation level and volatility of unexpected demand shock – two specified parameters of market fluctuations. Stability will be evaluated as the volatility of series means in response to change of external factors.

However, main output from the analysis will be relative stability of working capital balances with the following implication: with stable level of working capital with low volatility around the trend line, company may want to adopt targeting of working capital. When volatility is high – explicit management is better decision with respect to optimality of working capital balances. Also there will be conducted several regression analysis of series of working capital components change on their bases changes – this will be the evaluation of possible targeting methods for each component of working capital.

The results will be made for each industry separately and will, finally, allow constructing the aggregate ranking of industries from the perspective of their relative incentive towards targeting working capital.

Model VBA code can be found in Attachment 3.

Chapter 3. Analysis of Outputs of Working Capital Choice Model

Below the aggregate table of factor sets for all analyzed industries is presented (Table 2):

Table 2. Aggregate Statistics on Factor Sets

	Energy	Materials	Industrial	Consumer Discretionary	Consumer Staples	Health Care	IT	Utilities
External Factor Set								
σ_π	25%	25%	25%	25%	25%	25%	25%	25%
σ_q	25%	25%	25%	25%	25%	25%	25%	25%
γ_{inv}	25%	25%	25%	25%	25%	25%	25%	25%
γ_{rec}	50%	25%	25%	25%	25%	25%	25%	25%
γ_{pay}	25%	25%	25%	25%	25%	25%	25%	25%
Internal Factor Set*								
$MAXCash_{coef}$	0%							
$MINCash_{coef}$	0%							

**Note: Internal Factor Set is presented by coefficients of minimum and maximum cash balances. For maximum cash balances the formula is the following (33):*

$$MAXCash_{balances} = Cash.Acc_0 * (1 + MAXCash_{coef}) \quad (33)$$

For minimum cash balances the following formula is used (34):

$$MINCash_{balances} = Cash.Acc_0 * MINCash_{coef} \quad (34)$$

Theoretical meaning of coefficients of volatility is clear, while with cost coefficients it is more complicated: costs are considered as provisions for future losses. Higher costs should have implied that there is high risk in managing each particular account of working capital and that risk requires high provision. On the other hand low coefficient implies low provision and thus low estimate in probability of shortfall.

Looking on the table with factor sets it is clear, that model does not distinguish these parameters between industries. The process of calibration of model to real data, though, was useful in setting base parameters. Explanation for possible absence of distinction can be that these costs of working capital management, as well as provisions for them, are not explicit in

accounts. Moreover, the problem can be in that one year data only was considered. These questions can be the cases for further analysis and model improvement.

The only outlier is Energy sector with higher risk associated with receivables management. This can be intuitively explained by demand and sales structure – this sector operates with largest volumes of sales per client, so the probability of losing one, which is reflected in coefficient of costs, will have the greatest consequences for this sector, thus the higher coefficient.

Coefficients of cash can be rather simply explained: there are low requirements of necessary balances of cash due to low costs of short-term borrowings. Alternative to holding cash is short-term investment, which is profitable though not highly. In any case, it makes profitable hot to hold excess cash balances. Again, these results depend on rates of borrowing and lending in short period and may vary significantly with them. This analysis can be another way of further study improvement.

This part of analysis leads to rejection of first hypothesis: there were found no statistical differences in environmental conditions, in which each industry operates.

Analysis of Stability to Market Fluctuations

Stability will be measured with respect to base parameters of optimal working capital choice – liquidity and profitability. However, to distance analysis from model specifications and make it more valid, other indicators than in model will be used. So, three indicators for each industry will be tested:

1) Alternative measure for profitability – return on equity – Afza & Nasir, 2007 (35):

$$ROE_t = \frac{PAT_t}{Equity_t} \tag{35}$$

2) Alternative measure for liquidity - cash conversion cycle – Eljelly, 2004 and Raheman & Nasr, 2007 (36):

$$CCC = DSO + DIO - DPO \tag{36}$$

3) Working capital balances (37):

$$WC_t = Acc.Receivables_t + Acc.Inventories_t - Acc.Payables_t \tag{37}$$

Volatility factors are, as was already stated, standard deviations of inflation level and demand shocks. Analysis of stability will measure the degree of dependence of three stated above ratios to changes in volatility factors. Since model calibration showed equal base values

of both variances for each industry, explanatory variables will be the same – let it be range of deviations from 0% to 50%. For every value of explanatory variable the corresponding series of stated above accounts will be generated. As primary stability measure the dependence of mean of accounts on changes in explanatory variable will be tested. As secondary stability measure the dependence of standard deviation of series on changes in explanatory variable will be tested. Results will be framed as follows (Table 3):

Table 3. Frame for output on industrial stability

	a	b	t-stat	p-value	volatility
Volatility in level of inflation					
ROE					
Mean					
Standard deviation					
CCC					
Mean					
Standard deviation					
WC					
Mean					
Standard deviation					
Volatility of unexpected production shock					
ROE					
Mean					
Standard deviation					
CCC					
Mean					
Standard deviation					
WC					
Mean					
Standard					

deviation					

Note: table is divided into two major blocks: analysis of price volatility and analysis of demand volatility. In each block behavior of tree stated ratios is analyzed. For each ratio primary and secondary stabilities are evaluated. Evaluation is essentially regressing mean or standard deviation of series on explanatory variable. Coefficient b shows by how much response variable changes with unit change of explanatory variable. Stability implies zero dependence, to test this t-statistics of zero coefficient b is calculated with corresponding p-value, where:

H0: $\beta = 0$

HA: $\beta \neq 0$

Additional measure (for cross-industrial comparison) is total volatility of response variable.

Intra-industry analysis

Energy

ENERGY	a	b	t-stat	p-value	volatility
Volatility in level of inflation					
ROE					
Mean	-0.01	0.02	0.595	0.55	0.029
Standard deviation	0.30	-0.64	-3.688	0.00	
CCC					
Mean	0.18	-0.12	-4.114	0.00	0.036
Standard deviation	0.56	0.20	0.326	0.75	
WC					
Mean	16959	-11369	-7.258	0.00	2336
Standard deviation	-713	9294	2.498	0.02	
Volatility of unexpected production shock					
ROE					
Mean	0.00	-0.01	-0.784	0.44	0.016
Standard	0.28	-0.69	-4.732	0.00	

deviation					
CCC					
Mean	0.62	-2.91	-2.394	0.02	1.325
Standard deviation	-8.96	60.90	5.469	0.00	
WC					
Mean	21601	-49072	-6.856	0.00	10371.292
Standard deviation	-8590	68895	3.391	0.00	

This industrial sector is characterized by low mean sensitivity of profitability; however it is still highly variance sensitive. Liquidity ratio is highly mean sensitive to increase of market volatility – increase in volatility causes the decrease in liquidity ratio – of 0.64 for price volatility and much higher – for demand shocks.

Materials

MATERIALS	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	0.00	0.03	0.668	0.51	0.049
Standard deviation	0.07	0.45	2.336	0.02	
CCC					
Mean	0.53	0.03	0.125	0.90	0.273
Standard deviation	1.66	1.99	0.923	0.36	
WC					
Mean	4342	-2735	-4.445	0.00	753
Standard deviation	-24	2073	1.981	0.05	
Volatility of unexpected production shock					
ROE					
Mean	-0.03	-0.27	-0.401	0.69	0.694
Standard deviation	0.66	5.01	2.352	0.02	

CCC					
Mean	2.62	-15.07	-1.291	0.20	12.226
Standard deviation	-31.92	243.02	5.042	0.00	
WC					
Mean	4766	-5511	-6.802	0.00	1170
Standard deviation	-301	3901	2.276	0.03	

Materials sector is much more stable to market fluctuations than Energy sector: both liquidity and profitability ratios are mean insensitive, though both increase variance in ratios with increase of market volatility. Looking on indicator of total volatility of working capital balances, it can be noted that they are more stable than in Energy sector.

Industrials

INDUSTRIALS	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	0.00	0.00	-0.447	0.66	0.010
Standard deviation	0.14	-0.21	-2.195	0.03	
CCC					
Mean	0.71	0.91	2.269	0.03	0.433
Standard deviation	3.24	0.37	0.112	0.91	
WC					
Mean	10059	-6077	-7.068	0.00	1265
Standard deviation	-5	4902	2.265	0.03	
Volatility of unexpected production shock					
ROE					
Mean	0.01	-0.02	-0.743	0.46	0.023
Standard deviation	0.12	0.14	0.916	0.36	
CCC					

	Mean	-0.18	6.58	2.660	0.01	2.728
	Standard deviation	-0.33	24.52	3.647	0.00	
WC						
	Mean	10124	-9424	-5.674	0.00	2211
	Standard deviation	-38	7305	2.139	0.04	

Again industry is mean insensitive from the perspective of profitability, but shows positive correlation between liquidity ratio and volatility of market. Possible explanation for this is that industry partially specializes on large defense contracts, which have great portion of R&D and often have combined contrast type: fixed-price with cost+ part in it, which allows better compensating costs with guaranteed payments.

Consumer Discretionary

CONSUMER DISCRET.	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	0.00	0.00	0.771	0.44	0.003
Standard deviation	0.05	-0.03	-0.606	0.55	
CCC					
Mean	0.09	-0.33	-2.116	0.04	0.170
Standard deviation	0.11	0.33	1.272	0.21	
WC					
Mean	15693	-7715	-5.120	0.00	1930
Standard deviation	-694	6457	2.395	0.02	
Volatility of unexpected production shock					
ROE					
Mean	0.00	0.00	0.262	0.79	0.005
Standard deviation	0.05	-0.03	-0.786	0.44	

CCC					
Mean	-0.19	1.50	2.287	0.03	0.714
Standard deviation	-3.92	28.92	5.608	0.00	
WC					
Mean	17400	-21417	-6.452	0.00	4672
Standard deviation	-1801	14777	2.287	0.03	

Relatively profitability stable sector, market shocks show different impact on liquidity: price volatility decreases liquidity, while demand shocks tend to have positive impact. Overall volatility of liquidity ratio shows that both shocks have relatively low impact

Consumer Staples

CONSUMER STAPLES	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	-0.01	0.02	1.412	0.16	0.018
Standard deviation	0.28	-0.60	-3.802	0.00	
CCC					
Mean	0.25	-0.25	-3.615	0.00	0.080
Standard deviation	0.76	0.21	0.259	0.80	
WC					
Mean	5468	-4241	-7.039	0.00	885
Standard deviation	-350	3300	2.485	0.02	
Volatility of unexpected production shock					
ROE					
Mean	0.00	0.02	1.234	0.22	0.013
Standard deviation	0.11	0.18	1.180	0.24	

CCC					
Mean	0.07	0.80	2.059	0.04	0.416
Standard deviation	-0.47	8.81	4.217	0.00	
WC					
Mean	5745	-7032	-6.370	0.00	1544
Standard deviation	-612	5553	2.460	0.02	

Sector is comparatively less stable to market fluctuations than others. Liquidity index shows strong correlation with market volatility factors, but overall volatility in liquidity is comparatively low and indicates sector stability.

Health Care

HEALTH CARE	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	0.00	0.02	1.518	0.14	0.011
Standard deviation	0.18	-0.40	-4.025	0.00	
CCC					
Mean	-0.85	-1.77	-2.438	0.02	0.791
Standard deviation	4.69	-1.06	-0.240	0.81	
WC					
Mean	5349	-2512	-4.258	0.00	713
Standard deviation	-46	2273	2.180	0.03	
Volatility of unexpected production shock					
ROE					
Mean	0.00	-0.01	-1.899	0.06	0.004
Standard deviation	0.10	-0.16	-2.669	0.01	
CCC					

Mean	-1.78	3.74	1.863	0.07	2.140
Standard deviation	-0.37	32.83	3.653	0.00	
WC					
Mean	6278	-9082	-7.184	0.00	1876
Standard deviation	-554	5374	2.100	0.04	

Health Care is relatively unstable sector from the points of view of both profitability and liquidity. Sector is characterized by large corporations who make revenues on new development and patents, and large number of smaller manufacturers of more cheap generic drugs. Increase in market volatility causes large fluctuations in financial welfare of big companies.

IT

IT	a	b	t-stat	p-value	volatility
Volatility in level of inflation					
ROE					
Mean	-0.12	0.35	1.707	0.09	0.217
Standard deviation	2.30	-6.70	-5.546	0.00	
CCC					
Mean	-0.74	-0.94	-2.686	0.01	0.387
Standard deviation	3.31	-0.18	-0.055	0.96	
WC					
Mean	3140	-1286	-1.888	0.07	727
Standard deviation	208	1031	1.165	0.25	
Volatility of unexpected production shock					
ROE					
Mean	-0.12	-0.14	-0.133	0.89	1.078
Standard deviation	2.33	2.33	0.762	0.45	
CCC					

Mean	-0.98	0.58	1.663	0.10	0.368
Standard deviation	2.36	7.20	1.712	0.09	
WC					
Mean	4542	-11151	-5.263	0.00	2740
Standard deviation	-2479	19639	3.590	0.00	

IT sector is relatively stable to demand shocks, which may serve as indicator of inelastic demand. However its profitability and liquidity depend on the price fluctuations – profitability depends positively and fluctuates comparatively with large magnitude, while there is strong negative relation in price volatility and liquidity.

Utilities

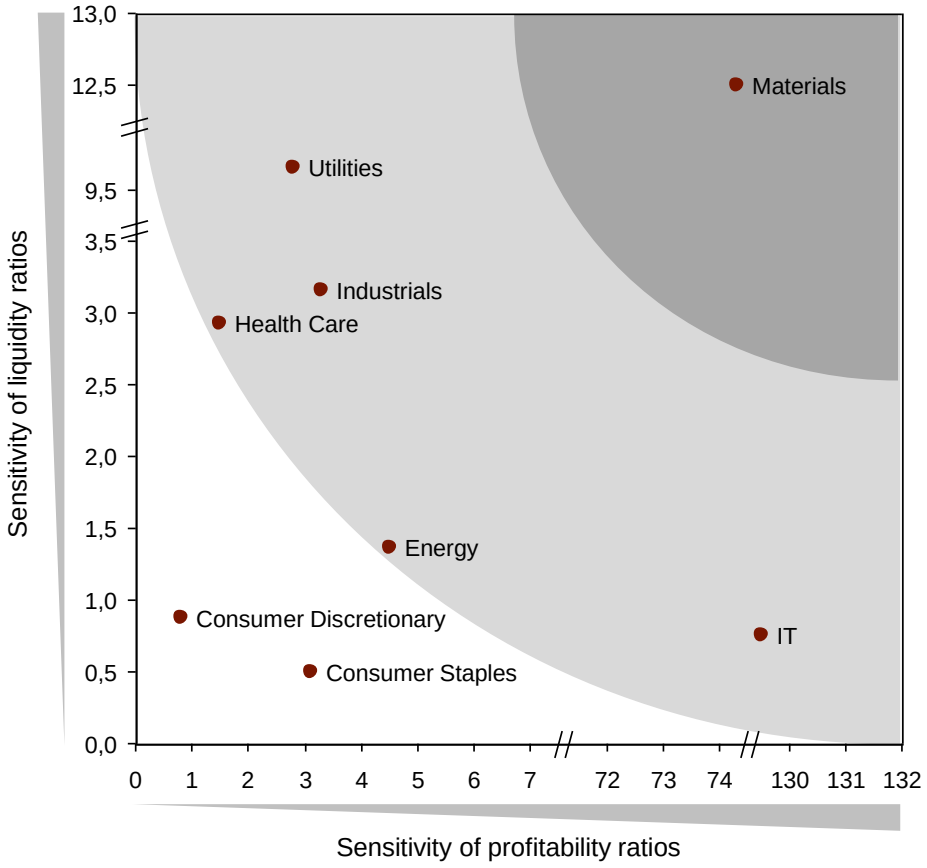
UTILITIES	**a**	**b**	**t-stat**	**p-value**	**volatility**
Volatility in level of inflation					
ROE					
Mean	0.00	0.02	1.703	0.10	0.010
Standard deviation	0.08	0.11	0.989	0.33	
CCC					
Mean	0.03	-0.57	-3.341	0.00	0.196
Standard deviation	0.22	0.14	0.436	0.66	
WC					
Mean	3087.09	-2274.26	-6.593	0.00	490
Standard deviation	-207.38	1856.18	2.531	0.01	
Volatility of unexpected production shock					
ROE					
Mean	0.00	0.01	0.623	0.54	0.018
Standard deviation	0.07	0.20	1.640	0.11	
CCC					

	Mean	-2.70	16.34	1.840	0.07	9.464
	Standard deviation	-34.84	218.17	6.049	0.00	
WC						
	Mean	4666	-13862	-6.130	0.00	3110
	Standard deviation	-3958	28330	3.944	0.00	

Utilities sector is closer to manufacturing industries than to retail or services. This creates similar tendencies – stability of profitability ratios and rather strong dependence of liquidity ratios on both demand and price fluctuations.

Cross-industrial comparison

Previous results were summarized from the following perspective: sensitivity of profitability indicator was measured as its volatility in response to change in market conditions. Similarly, profitability sensitivity was measured as volatility of ROE measure in response to change in market conditions. These measures allowed getting map of relative industrial stability (Picture 2):



Picture 2. Ranking of sectors (from the stability perspective)

Note: stability of profitability and liquidity ratios was measured using stated above indicators for liquidity and profitability, and is presented by volatilities of corresponding values in response to market conditions change.

Picture above summarizes previous analysis and allows ranking the sectors from the perspective of their stability to market fluctuations – both in price level and demand shocks. White zone indicates the most stable industries with lowest volatility of profitability and liquidity ratios in conditions of market fluctuations. Dark grey area, on the contrary, indicates the most unstable sector, in other words most sensitive to market fluctuations sector.

Consumer Discretionary and Consumer Staples sectors are clearly in the white zone. This reflects that both shocks: in price level and unexpected demand shocks – do not alter their ROE and CCC measures significantly. At the same time, Consumer Discretionary sector is relatively more stable in terms of profitability than Consumer Staples, while for liquidity stability the opposite is true. These results can be explained intuitively – consumption goods have the most stable demand, appealing to smooth consumption patterns, and the broadest range of products, i.e. diversified product portfolio. However Consumer Discretionary, operating mostly with cars and household electronics, has higher values of trade credits and thus faces liquidity problems more closely, than consumer Staples, which explains their lesser liquidity stability.

The least stable sector is that of raw materials supplier. It is characterized by very volatile ROE and CCC indicators in response to market conditions change. Intuition also applies – this industry is the most dependent on the welfare of other ones, and the crisis of 2008 showed this clearly: metal & mining and construction materials industries faced the greatest recession, chemicals also significantly slowed development.

Light-grey zone showed sectors with different instability parameters: IT is situated near the right side, showing good liquidity stability due to rather inelastic demand and low production costs (easy to meet demand), but low profitability stability, which can be explained by different factors, one of which is piracy in software and comparatively luxury classification of hardware (lesser smoothing). The group in top left corner, on the other hand, has stable profitability patterns, but lacks liquidity stability. Utilities sector, as the representative, has the following problem, leading it so far towards liquidity sensitivity: this sector is responsible for supply of power, gas and heat to households. This activity is associated with the greatest levels of trade debt in almost all countries due to late payments. This sector is profitable because of other activities with industrial corporations, but large receivables accounts often cause liquidity shortfalls. Industrials and Health Care sectors are

very close in liquidity stability, but the former has worse profitability stability – demand for industrial products is less elastic, than for drugs, which can be one of the reasons.

Energy sector is very close to the stable zone, because combines medium values for both ROE and CCC volatilities. It lies on the ray with consumption products and materials: industrial orientation makes both liquidity and profitability measures less stable than for consumption goods sectors, but at the same time economic significance of industry all over the world makes its demand far less elastic than for Materials sector and moves it near white zone.

This diagram confirms the second hypothesis of the work – there are indeed clearly distinguishable sectors: for ones both risks of liquidity and profitability shortfall are small under conditions of market parameters change (due to low volatility of corresponding parameters), for others – the contrary is true. And there is group of industries for which market volatility affects only one side of stability.

Analysis of Incentives to Target Working Capital

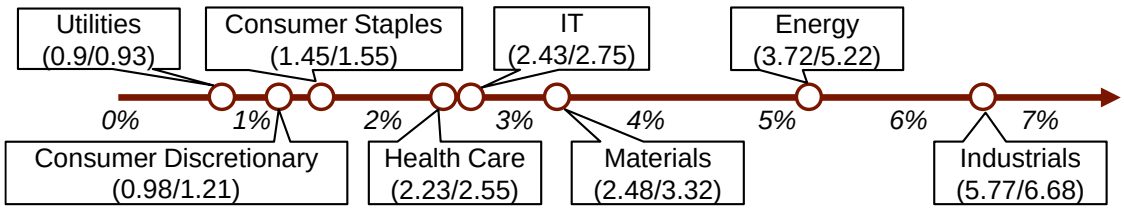
Analysis of Volatility of Working Capital Balances

This analysis is central for this work as it is designed to answer the question about incentive towards working capital management. Two alternatives are under consideration. First, working capital can be managed through targeting, or policy implementation. This would imply existence of constant policy rule and absence of explicit adjustments. The other alternative is discretionary management actions to choose optimal working capital balances every period. The essence of analysis is in following: if working capital management decisions are not very different through time (i.e. volatility of optimal working capital balances through time is comparatively low), then policy method can be applied, i.e. working capital balances can be set as fixed share of base accounts. If working capital balances vary significantly, it is indicator that discretionary approach will be better while managing ongoing operations and it is not reasonable to create any rules. This method is designed for comparative analysis of incentives and should not be a rule for management design.

Volatility will be measured by standard deviation around mean and trend values. Moreover, to account for overall business scale, which is different for different industries, the applied indicator will be:

$$VI = \frac{St.Deviation}{Mean} \ (\%) \qquad (38)$$

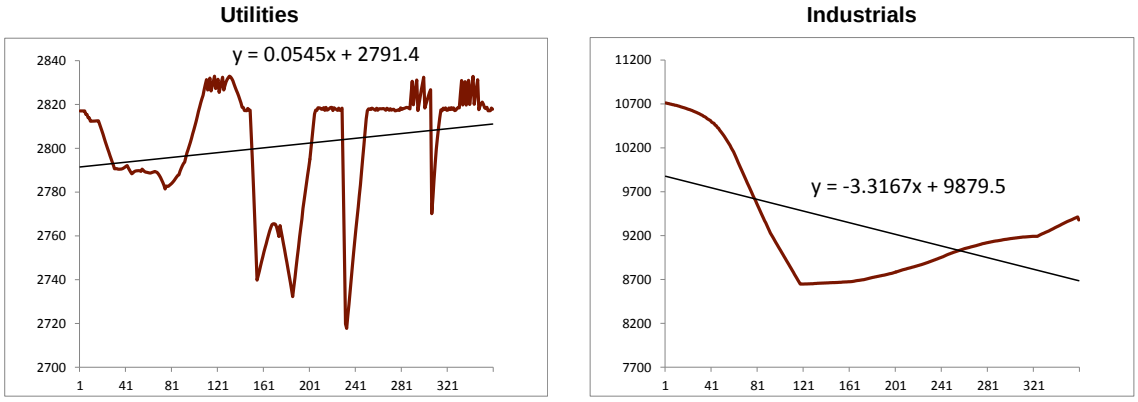
When calculated, these indicators resulted in the following ranking (Picture 3):



Picture 3. Industrial incentive to manage working capital (ranking)

There is a group of industries, for which incentive to actively manage working capital (using discretionary policy) is comparatively low: Utilities sector, Consumer Discretionary and Consumer Staples sectors. On the contrary, such industrial sectors as Energy and Industrials have the highest incentive to implement discretionary working capital policy.

Another important result from this part of analysis is in the tendency of working capital changes. There are industries, for which working capital is gradually decreasing, indicating their incentive to concentrate on liquidity rather than profitability. On the other hand, some companies show increasing trend in working capital, which may indicate the incentive to increase profitability at the cost of liquidity (examples: Picture 4). All graphs are presented in Attachment 4.



Picture 4. Trends in working capital balances

Testing for Possible Working Capital Management Policies

Working capital targeting sometimes referred to as setting working capital as fixed percent of sales, for example. This section will analyze in more detail the possibility of targeting: each component of working capital will be tested on statistical correlation with its base account. Existence of such correlation will imply that policy rule can be developed. So, possibility to engage in policy management of working capital was estimated by regressing corresponding working capital components on their base accounts.

$$Receivables_t = \alpha_{rec} + \beta_{rec} * Sales_t \quad (39)$$

Inventories:

$$Inventories_t = \alpha_{inv} + \beta_{inv} * Production_t \quad (40)$$

Payables:

$$Payables_t = \alpha_{pay} + \beta_{pay} * COGS_t \quad (41)$$

These regressions are not necessarily exact working capital management policies, rather they indicate whether there is strong relation between policy instrument and its base account to further develop optimal strategy. So, simultaneous rejection of hypothesis of no correlation will indicate possible existence of policy rules:

$$\begin{cases} H_0: \beta_{rec} = 0;\ H_a: \beta_{rec} \neq 0 \\ H_0: \beta_{inv} = 0;\ H_a: \beta_{inv} \neq 0 \\ H_0: \beta_{pay} = 0;\ H_a: \beta_{pay} \neq 0 \end{cases} \quad (42)$$

Considering the group with incentive to target, the reasonable step is to try to figure out optimal targeting policy: regressing policy instruments on their base may help to understand the policy rule for targeting working capital components.

Utilities

UTILITIES	a	b	t-stat	p-value
Receivables	1793	-11.26	-2.055	0.04
Inventories	-1422	9.03	12.917	0.00
Payables	637	-5.14	-5.387	0.00

All coefficients are significantly non-zero, which means that companies in Utilities sector can, using stated above rules, effectively target all components of working capital.

CONSUMER DISCRET.	a	b	t-stat	p-value
Receivables	809	-1.72	-1.022	0.31
Inventories	-928	2.41	5.366	0.00
Payables	2460	-7.88	-10.28	0.00

Consumer Discretionary sector allows targeting only part of working capital components, so it is not clear whether partial targeting is needed or better to engage in fully discretionary policy. This must be subject to further analysis.

CONSUMER STAPLES	a	b	t-stat	p-value

Receivables	-144	1.10	0.664	0.51
Inventories	-565	4.03	5.722	0.00
Payables	1586	-18.57	-14.23	0.00

Similar results are found for Consumer Staples sector.

This section and above analysis were presented as examples of testing for ability of company to target working capital. Though only Utilities sector appeared to have ability to create policy rules for working capital management because of high correlation of all components to their base accounts, it may be the case that simple linear regression is not the optimal model.

So, there is reasonable correlation between incentive and ability to target working capital, as given in this section. But more investigation must be directed towards finding more specific and more applicable policy rules.

Third hypothesis is confirmed partially: it is confirmed in the current policy specification frame, but this can change with further policy investigation.

Summary and Conclusions

One of the targets of the work was to conduct cross-industrial comparison of stability of companies to ongoing short-term market fluctuations while engaging in optimal management, where indicators of market fluctuations were assumed to be price volatility and volatility of unexpected demand shock.

Industrial choice and data collection resulted in the sample of 8 industries with 10 firms in each and total of 80 firms.

Model used discussed in many papers liquidity / profitability tradeoff of ongoing operations and thus the maximization of both parameters simultaneously became the essence of optimization process.

Calibration of model on out-of-sample of real data showed almost identical external factor sets for all industries and didn't allow additional industrial distinction. This is the rejection of first hypothesis of the work that industries operate in statistically different environment. After that direct simulation allowed ranking industries with respect to their stability – from perspective of profitability and liquidity. Ranking showed that industries with mostly end-customer client base (Consumer Discretionary and Consumer Staples) are the most stable, while primary manufacturers and raw-materials suppliers (Materials sector) appeared to be the least stable to market fluctuations. This was the confirmation of the second hypothesis of the work about three stability groups of industrial sectors: fully stable, fully sensitive and partially sensitive.

Another aim of the work was to model the choice of optimal working capital balances and using these optimal decisions evaluate the industrial incentive to manage working capital through policy or discretionary in different industries.

Analysis of incentives to manage versus target working capital showed the relation with industrial stability: it appeared that most stable industries have higher incentive to target working capital than least stable. However, further analysis of possible targeting policies showed that only one industry is actually able to easily create policy rules for working capital targeting, and it was Utilities sector. Intuition there may be in that Utilities sector is often regulated and also there is significant part of revenues coming from tariffs, which ensures some stability, but this was not proved by the model. This is partial but not complete confirmation of the last hypothesis that stability of sector ensures the possibility to engage in working capital management through policy rules.

The model and further analysis had some limitations, which may become the fields for further work. First, the data sample was not large enough to effectively approximate

industries, so all reasoning on intuition was based on that fact and on position of largest companies. More general data may bring some new results into the work. Second, function, on which choice of optimal working capital balances was based, is not general enough and can miss some profitability / liquidity considerations. Moreover, appealing to the work of Afza and Nasir (2007) on working capital management policies, introduction of function that may distinguish the degree of aggressiveness through giving more weight to either liquidity or profitability could possibly better simulate optimal choices for different industries. Third, calibration of model did not reveal any industry-specific characteristics of data set, which could result from little sensitivity of model in the part of optimal choice of working capital, which again leads to the problem of choice of function for maximization. The last but not the least, further analysis of simulated accounts and flows could possibly show some patterns of policies of working capital management, which could result in better practical implementation.

Working in these directions can improve model and make it more practical, but even in current specification it was able to evaluate stability of industries and show on broad level whether management should implement working capital management policies or engage discretionary in working capital balances choice.

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Attachments

Attachment 1. List of analyzed companies

Energy:

1. Exxon mobil
2. Royal dutch shell
3. Chevron
4. BP
5. OJSC Gazprom
6. Statoil ASA
7. Total SA
8. ConocoPhillips
9. PetroChina Co
10. Rosneft Oil

Consumer Staples:

1. Anheuser-Busch InBer
2. The Coca-Cola
3. PepsiCo
4. CVS Caremark
5. Philip Morris International
6. Mondelez International
7. Japan Tobacco
8. Seven & I Holdings
9. Altria Group
10. Wilmar International

Materials:

1. Saudi Basic Industries
2. DuPont
3. Dow Chemicals
4. Linde
5. Holcim
6. International Paper
7. Lafarge
8. Shin-Etsu Chemicals
9. HeidelbergCement
10. Freeport-McMoRan Copper

Health Care:

1. Pfizer
2. Novartis
3. Sanofi
4. Merck & Co
5. Johnson & Johnson
6. GlaxoSmithKline
7. Abbott Laboratories
8. Express Script
9. Amgen
10. Eli Lilly & Co

Industrials:

1. Boeing
2. EADS
3. Caterpillar
4. Moller-Moersk
5. Canon
6. Union Pacific
7. Lockheed Martin
8. East Japan Railway
9. Mitsubishi Electric
10. Eaton

IT:

1. Samsung Electronics
2. IBM
3. Google
4. Intel
5. Dell
6. SAP
7. Taiwan Semiconductor Manufacturing
8. EMC
9. eBay
10. LM Ericsson Telephone AB

Consumer discretionary:

1. Volkswagen Group
2. Toyota Motor
3. Daimler
4. Ford Motor
5. General Motors
6. Nissan Motor
7. Honda Motor
8. Saic Motor
9. Continental
10. BridgeStone

Utilities:

1. E.On
2. Iberdrola
3. Enel
4. RWE Group
5. Duke Energy
6. Southern Co
7. Gas Natural
8. Exelon
9. NextEra Energy
10. American Electric Power

Attachment 2. Financial inputs (industrial averaged), USD mn

Energy

		Aggregate					
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		250 784	253 014	241 629	256 440	250 784	248 550
Total FA		187 902	185 732	177 670	185 480	187 902	183 064
	Production	145 735	142 726	136 319	139 976	145 735	138 446
	Investments	22 274	22 364	23 198	25 205	22 274	25 511
	Other FA	19 892	20 643	18 153	20 300	19 892	19 107
Total CA		62 883	67 282	63 959	70 960	62 883	65 486
	Receivables	27 195	30 298	26 362	31 783	27 195	31 431
	Inventories	15 759	16 493	15 459	17 304	15 759	15 827
		14 538	16 299	15 619	16 731	14 538	13 817
	Cash	8 281	12 484	11 618	12 349	8 281	7 675
	STI	6 257	3 815	4 001	4 381	6 257	6 142
	Other CA	5 391	4 191	6 519	5 143	5 391	4 411
Total Liabilities		117 604	120 136	115 396	123 232	117 604	120 452
Total NCL		65 269	65 086	62 318	64 178	65 269	63 345
	LTD	26 170	26 825	25 181	24 678	26 170	24 574
	Other NCL	39 100	38 261	37 136	39 500	39 100	38 770
Total CL		52 335	55 050	53 079	59 055	52 335	57 108
	STD	7 908	7 933	8 007	8 897	7 908	8 246
	Payables	23 029	32 205	31 354	35 263	23 029	23 690
	Other CL	21 398	14 912	13 718	14 894	21 398	25 171
Total Equity	Equity	133 180	132 878	126 232	133 208	133 180	128 097

Income Statement							
	Sales	63 060	59 872	60 494	67 339	250 764	244 078
	COGS	47 643	43 812	45 568	49 472	186 496	171 901
	Gross Profit	15 417	16 059	14 926	17 866	64 268	72 177
	SGA	2 369	2 406	2 239	2 175	9 190	8 461
	Depn	3 374	3 307	3 078	3 091	12 849	11 299
	Operating Income	9 674	10 346	9 609	12 600	42 230	52 417
	Financial Income	75	73	75	76	299	319
	Financial Expenses	262	231	244	280	1 018	706
	Other	1 200	1 603	2 026	2 303	7 131	14 669
	PBT	8 287	8 586	7 414	10 093	34 380	37 360
	Taxes	3 388	3 675	3 160	4 186	14 409	14 032
	PAT	4 899	4 912	4 253	5 907	19 971	23 328

Materials

		4Q	3Q	2Q	1Q	Aggregate 2year	1year
Balance sheet							
Total Assets		47 679	47 881	47 062	47 670	47 679	46 350
Total FA		32 685	32 784	32 226	32 733	32 685	31 857
	Production	18 835	18 753	18 579	18 909	18 835	18 497
	Investments	1 900	1 602	1 807	1 521	1 900	1 844
	Other FA	11 951	12 429	11 840	12 303	11 951	11 517
Total CA		14 994	15 097	14 836	14 937	14 994	14 493
	Receivables	4 531	4 745	5 063	5 011	4 531	4 468
	Inventories	4 373	4 309	4 090	4 201	4 373	4 014
		4 892	4 492	4 386	4 368	4 892	5 256
	Cash	2 031	3 587	3 672	3 706	2 031	2 153
	STI	2 861	905	714	662	2 861	3 103
	Other CA	1 198	1 550	1 297	1 357	1 198	755
Total Liabilities		26 330	26 361	26 105	26 495	26 330	25 813
Total NCL		18 177	18 028	17 776	18 283	18 177	17 843
	LTD	11 100	11 310	11 049	11 493	11 100	11 395
	Other NCL	7 077	6 719	6 727	6 790	7 077	6 448
Total CL		8 153	8 333	8 329	8 212	8 153	7 971
	STD	1 810	2 295	2 592	2 294	1 810	2 025
	Payables	3 078	2 996	2 917	3 190	3 078	2 967
	Other CL	3 265	3 042	2 819	2 729	3 265	2 979
Total Equity	Equity	21 349	21 520	20 957	21 174	21 349	20 537

Income Statement							
	Sales	6 977	6 875	7 406	7 110	28 368	28 524
	COGS	4 723	4 577	4 925	4 741	18 966	18 837
	Gross Profit	2 255	2 298	2 481	2 368	9 402	9 687
	SGA	1 009	948	984	933	3 873	3 529
	Depn	519	447	438	432	1 836	1 679
	Operating Income	727	902	1 059	1 004	3 692	4 479
	Financial Income	24	23	24	24	94	88
	Financial Expenses	167	173	166	172	678	672
	Other	114	- 38	15	18	110	123
	PBT	469	791	901	837	2 998	3 772
	Taxes	221	286	349	318	1 175	1 456
	PAT	248	505	553	519	1 824	2 315

Industrials

					Aggregate		
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		68 067	65 368	63 968	63 010	68 067	61 785
Total FA		41 902	39 456	38 519	38 568	41 902	37 716
	Production	24 236	23 690	23 150	22 883	24 236	22 305
	Investments	3 357	2 398	2 786	3 087	3 357	3 408
	Other FA	14 309	13 368	12 582	12 598	14 309	12 004
Total CA		26 164	25 912	25 449	24 442	26 164	24 069
	Receivables	8 201	7 954	7 529	7 222	8 201	7 410
	Inventories	10 715	11 311	10 676	10 466	10 715	9 652
		5 606	5 051	5 108	4 860	5 606	5 316
	Cash	4 667	4 119	4 098	3 692	4 667	4 234
	STI	939	932	1 010	1 168	939	1 082
	Other CA	1 642	1 597	2 136	1 894	1 642	1 691
Total Liabilities		48 276	47 265	46 888	45 907	48 276	45 795
Total NCL		26 667	25 732	25 758	25 312	26 667	25 256
	LTD	12 572	11 884	11 931	11 526	12 572	11 472
	Other NCL	14 095	13 847	13 827	13 786	14 095	13 784
Total CL		21 609	21 533	21 130	20 595	21 609	20 539
	STD	2 672	3 234	2 956	2 619	2 672	2 348
	Payables	5 332	5 590	5 698	5 750	5 332	5 362
	Other CL	13 605	12 710	12 476	12 225	13 605	12 829
Total Equity	Equity	19 046	18 103	17 079	17 103	19 046	15 990

Income Statement							
	Sales	13 273	11 678	12 243	11 344	48 538	45 150
	COGS	9 889	8 231	8 590	8 015	34 725	30 299
	Gross Profit	3 383	3 448	3 653	3 330	13 813	14 851
	SGA	1 741	1 572	1 621	1 545	6 479	6 207
	Depn	693	636	604	592	2 525	2 375
	Operating Income	949	1 240	1 428	1 193	4 809	6 269
	Financial Income	17	16	16	17	66	95
	Financial Expenses	140	141	142	142	564	526
	Other	- 81	14	31	- 48	- 85	1 522
	PBT	907	1 102	1 272	1 116	4 397	4 316
	Taxes	337	347	479	365	1 528	1 710
	PAT	570	755	793	751	2 869	2 606

		Aggregate					
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		187 552	179 544	166 417	165 566	187 552	159 104
Total FA		103 580	98 384	88 945	87 628	103 580	85 533
	Production	41 122	39 443	36 612	33 031	41 122	36 069
	Investments	16 465	18 643	18 847	18 067	16 465	14 959
	Other FA	45 993	40 299	33 487	36 531	45 993	34 505
Total CA		83 971	81 159	77 472	77 937	83 971	73 571
	Receivables	42 397	38 807	36 698	36 815	42 397	36 444
	Inventories	14 901	15 840	14 784	14 929	14 901	13 650
		20 924	20 221	20 182	20 205	20 924	19 225
	Cash	13 518	13 186	13 811	13 640	13 518	12 749
	STI	7 406	7 035	6 370	6 564	7 406	6 476
	Other CA	5 749	6 292	5 808	5 988	5 749	4 251
Total Liabilities		131 939	126 851	117 677	117 300	131 939	113 250
Total NCL		66 896	60 896	56 060	55 199	66 896	52 897
	LTD	41 386	37 071	34 303	33 414	41 386	31 495
	Other NCL	25 510	23 824	21 758	21 785	25 510	21 402
Total CL		65 044	65 955	61 617	62 101	65 044	60 353
	STD	28 769	30 264	27 038	26 508	28 769	25 667
	Payables	15 085	15 113	15 089	15 687	15 085	14 521
	Other CL	21 190	20 578	19 490	19 905	21 190	20 165
Total Equity	Equity	55 554	52 652	48 674	48 223	55 554	45 794

Income Statement							
	Sales	35 884	33 087	33 310	33 385	135 666	122 217
	COGS	24 726	25 387	25 860	25 661	101 634	93 174
	Gross Profit	11 158	7 700	7 450	7 724	34 032	29 044
	SGA	4 363	4 346	3 979	4 135	16 823	16 257
	Depn	5 057	1 654	1 489	1 499	9 699	6 669
	Operating Income	1 737	1 700	1 982	2 090	7 509	6 117
	Financial Income	58	57	57	58	230	452
	Financial Expenses	435	204	96	92	826	513
	Other	3 048	129	- 341	- 153	2 684	- 1 034
	PBT	- 1 688	1 423	2 284	2 210	4 230	7 090
	Taxes	- 3 253	- 924	380	551	- 3 246	- 54
	PAT	1 565	2 348	1 904	1 659	7 476	7 145

Consumer Staples

					Aggregate		
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		63 975	65 779	63 634	64 967	63 975	62 782
Total FA		45 320	46 442	46 046	47 129	45 320	45 825
	Production	11 521	11 724	11 510	11 800	11 521	11 407
	Investments	4 158	3 961	3 831	3 407	4 158	3 753
	Other FA	29 640	30 756	30 705	31 923	29 640	30 665
Total CA		18 656	19 337	17 589	17 839	18 656	16 957
	Receivables	4 578	5 033	4 837	5 084	4 578	4 412
	Inventories	5 018	5 208	5 115	5 181	5 018	5 038
		7 042	7 197	5 357	5 739	7 042	5 590
	Cash	4 957	5 133	4 133	4 305	4 957	4 586
	STI	2 085	2 064	1 225	1 434	2 085	1 004
	Other CA	2 017	1 899	2 279	1 834	2 017	1 916
Total Liabilities		40 367	41 780	40 227	40 864	40 367	39 769
Total NCL		23 049	24 827	23 476	23 581	23 049	22 945
	LTD	14 607	16 031	14 880	14 721	14 607	14 139
	Other NCL	8 442	8 796	8 596	8 861	8 442	8 807
Total CL		17 318	16 953	16 751	17 283	17 318	16 824
	STD	6 090	5 534	5 957	6 199	6 090	6 095
	Payables	4 215	5 234	5 359	4 338	4 215	3 642
	Other CL	7 012	6 184	5 435	6 746	7 012	7 087
Total Equity	Equity	23 604	26 612	25 751	26 662	23 604	23 007

Income Statement							
	Sales	12 933	12 971	12 951	12 038	50 892	47 026
	COGS	7 486	7 538	7 556	7 093	29 674	27 340
	Gross Profit	5 446	5 433	5 395	4 945	21 219	19 686
	SGA	2 662	2 532	2 515	2 274	9 984	10 830
	Depn	792	798	782	748	3 121	1 536
	Operating Income	1 992	2 102	2 097	1 922	8 114	7 320
	Financial Income	36	35	35	36	142	141
	Financial Expenses	201	223	204	199	826	896
	Other	100	76	15	93	284	65
	PBT	1 728	1 840	1 913	1 666	7 146	6 501
	Taxes	516	582	576	535	2 209	2 019
	PAT	1 212	1 258	1 337	1 131	4 938	4 481

Health Care

					Aggregate		
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		94 245	93 392	91 974	89 135	94 245	88 490
Total FA		63 577	63 515	62 612	58 753	63 577	58 774
	Production	11 313	11 269	11 136	11 275	11 313	11 379
	Investments	4 558	4 907	4 192	4 158	4 558	3 390
	Other FA	47 705	47 339	47 284	43 320	47 705	44 005
Total CA		30 668	29 877	29 362	30 382	30 668	29 715
	Receivables	8 320	8 289	8 360	8 404	8 320	8 424
	Inventories	5 290	5 433	5 163	5 084	5 290	4 908
		14 115	12 635	12 228	13 786	14 115	13 578
	Cash	5 541	6 801	7 127	8 649	5 541	5 280
	STI	8 574	5 834	5 101	5 136	8 574	8 298
	Other CA	2 942	3 520	3 611	3 108	2 942	2 805
Total Liabilities		50 416	49 155	49 472	47 325	50 416	47 242
Total NCL		32 728	31 724	30 960	29 902	32 728	30 379
	LTD	17 138	16 897	16 097	15 539	17 138	15 977
	Other NCL	15 590	14 827	14 863	14 363	15 590	14 402
Total CL		17 688	17 431	18 512	17 423	17 688	16 863
	STD	3 759	3 953	5 004	4 602	3 759	3 342
	Payables	3 979	3 718	4 236	3 566	3 979	3 278
	Other CL	9 950	9 760	9 272	9 255	9 950	10 243
Total Equity	Equity	43 829	44 236	42 502	41 810	43 829	41 248

Income Statement							
	Sales	12 944	12 471	12 740	10 984	49 140	44 729
	COGS	4 914	4 759	4 751	3 330	17 755	13 160
	Gross Profit	8 030	7 712	7 990	7 653	31 385	31 569
	SGA	4 914	4 423	4 455	4 215	18 007	17 793
	Depn	943	887	900	888	3 618	3 865
	Operating Income	2 173	2 402	2 635	2 550	9 760	9 912
	Financial Income	38	38	38	38	153	163
	Financial Expenses	193	206	204	199	801	747
	Other	461	15	308	86	870	1 539
	PBT	1 558	2 219	2 161	2 303	8 242	7 789
	Taxes	346	345	494	511	1 695	1 495
	PAT	1 212	1 874	1 667	1 793	6 547	6 294

IT

					Aggregate		
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		68 918	65 628	62 897	61 867	68 918	60 674
Total FA		36 307	35 391	33 929	32 116	36 307	30 807
	Production	14 749	14 585	14 196	13 644	14 749	13 047
	Investments	4 271	3 785	3 402	3 304	4 271	3 145
	Other FA	17 288	17 021	16 332	15 168	17 288	14 614
Total CA		32 611	30 237	28 968	29 751	32 611	29 867
	Receivables	11 080	10 258	10 087	9 626	11 080	10 956
	Inventories	3 175	3 464	3 379	3 032	3 175	2 922
		15 924	14 171	13 383	14 878	15 924	13 780
	Cash	5 446	7 302	6 873	7 702	5 446	4 754
	STI	10 478	6 869	6 510	7 176	10 478	9 026
	Other CA	2 431	2 344	2 119	2 215	2 431	2 209
Total Liabilities		32 046	29 725	28 715	28 237	32 046	28 314
Total NCL		13 526	12 269	11 738	11 651	13 526	11 386
	LTD	6 646	5 833	5 387	5 624	6 646	5 357
	Other NCL	6 880	6 436	6 351	6 027	6 880	6 029
Total CL		18 520	17 456	16 978	16 586	18 520	16 928
	STD	2 933	3 108	2 743	2 695	2 933	2 938
	Payables	3 916	3 925	4 433	3 884	3 916	3 961
	Other CL	11 671	10 423	9 801	10 006	11 671	10 029
Total Equity	Equity	36 872	35 903	34 182	33 630	36 872	32 359

Income Statement							
	Sales	15 311	13 932	13 471	12 721	55 435	50 748
	COGS	7 356	6 746	6 511	6 337	26 950	25 577
	Gross Profit	7 955	7 186	6 960	6 384	28 485	25 171
	SGA	3 890	3 708	3 617	3 377	14 591	12 856
	Depn	1 064	1 035	989	920	4 007	3 418
	Operating Income	3 001	2 443	2 354	2 088	9 886	8 897
	Financial Income	61	61	60	61	242	246
	Financial Expenses	58	52	62	48	220	210
	Other	95	- 6	- 50	- 142	- 104	- 286
	PBT	2 909	2 458	2 403	2 242	10 012	9 218
	Taxes	850	614	610	510	2 584	2 327
	PAT	2 059	1 844	1 793	1 732	7 428	6 891

Utilities

					Aggregate		
		4Q	3Q	2Q	1Q	2year	1year
Balance sheet							
Total Assets		107 883	107 986	101 724	106 268	107 883	102 478
	Total FA	86 839	87 259	80 975	83 813	86 839	80 988
	Production	57 280	59 449	52 958	50 414	57 280	52 545
	Investments	4 727	4 977	5 070	5 107	4 727	5 950
	Other FA	24 832	22 833	22 947	28 292	24 832	22 493
	Total CA	21 044	20 727	20 749	22 456	21 044	21 490
	Receivables	10 513	11 989	11 440	13 033	10 513	12 442
	Inventories	2 817	2 966	2 600	2 483	2 817	2 643
		5 386	4 905	4 973	6 025	5 386	5 139
	Cash	2 449	2 481	1 667	3 029	2 449	1 515
	STI	2 937	2 424	3 306	2 996	2 937	3 625
	Other CA	2 328	867	1 737	915	2 328	1 266
Total Liabilities		75 829	72 024	68 309	70 857	75 829	72 471
	Total NCL	56 457	52 819	48 788	49 321	56 457	50 903
	LTD	29 520	29 383	27 171	27 305	29 520	26 639
	Other NCL	26 937	23 437	21 616	22 016	26 937	24 264
	Total CL	19 372	19 204	19 521	21 536	19 372	21 567
	STD	4 687	5 124	5 592	5 682	4 687	5 554
	Payables	5 649	7 664	7 511	8 761	5 649	5 331
	Other CL	9 037	6 416	6 418	7 093	9 037	10 682
Total Equity	Equity	31 734	32 131	29 670	31 360	31 734	29 547

Income Statement							
	Sales	14 069	11 984	11 559	13 338	50 950	45 623
	COGS	10 782	9 018	8 658	10 041	38 499	32 732
	Gross Profit	3 287	2 966	2 901	3 297	12 451	12 891
	SGA	919	599	765	675	2 957	4 140
	Depn	1 544	874	800	774	3 992	3 169
	Operating Income	824	1 494	1 336	1 848	5 501	5 582
	Financial Income	88	85	87	88	348	312
	Financial Expenses	509	531	519	572	2 131	1 443
	Other	279	156	15	50	500	1 302
	PBT	124	892	888	1 314	3 218	3 148
	Taxes	257	359	240	407	1 263	1 150
	PAT	- 133	533	648	907	1 955	1 999

Attachment 3. Model VBA Code

Period Process

Sub Period(Day As Integer, Year As Integer, Season As Integer, CI As Double, CP As Double, CR As Double)

```
Dim Past_Period, Shortfall, test As Integer
Dim Change As Double

Change = 0

'block for beginnings of periods, when Day-CCC is less than 0
If Day - CCC < 0 Then Past_Period = 0 Else Past_Period = Day - CCC

If Day Mod (NDays / 4) = 0 Then
   Inventories_Acc(Year, Day \ (NDays / 4)) = Inventories_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Receivables_Acc(Year, Day \ (NDays / 4)) = Receivables_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Payables_Acc(Year, Day \ (NDays / 4)) = Payables_Acc(Year, Past_Period \ (NDays / 4) + 1)
   STD(Year, Day \ (NDays / 4)) = STD(Year, Past_Period \ (NDays / 4) + 1)
   Market_Sec(Year, Day \ (NDays / 4)) = Market_Sec(Year, Past_Period \ (NDays / 4) + 1)
   Prod_FA(Year, Day \ (NDays / 4)) = Prod_FA(Year, Past_Period \ (NDays / 4) + 1)
   Other_FA(Year, Day \ (NDays / 4)) = Other_FA(Year, Past_Period \ (NDays / 4) + 1)
   Cash_Acc(Year, Day \ (NDays / 4)) = Cash_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Other_CA(Year, Day \ (NDays / 4)) = Other_CA(Year, Past_Period \ (NDays / 4) + 1)
   LTD(Year, Day \ (NDays / 4)) = LTD(Year, Past_Period \ (NDays / 4) + 1)
   Other_NCL(Year, Day \ (NDays / 4)) = Other_NCL(Year, Past_Period \ (NDays / 4) + 1)
   Other_CL(Year, Day \ (NDays / 4)) = Other_CL(Year, Past_Period \ (NDays / 4) + 1)
   Equity(Year, Day \ (NDays / 4)) = Equity(Year, Past_Period \ (NDays / 4) + 1)
ElseIf Past_Period Mod (NDays / 4) = 0 Then
   Inventories_Acc(Year, Day \ (NDays / 4) + 1) = Inventories_Acc(Year, Past_Period \ (NDays / 4))
   Receivables_Acc(Year, Day \ (NDays / 4) + 1) = Receivables_Acc(Year, Past_Period \ (NDays / 4))
   Payables_Acc(Year, Day \ (NDays / 4) + 1) = Payables_Acc(Year, Past_Period \ (NDays / 4))
   STD(Year, Day \ (NDays / 4) + 1) = STD(Year, Past_Period \ (NDays / 4))
   Market_Sec(Year, Day \ (NDays / 4) + 1) = Market_Sec(Year, Past_Period \ (NDays / 4))
   Prod_FA(Year, Day \ (NDays / 4) + 1) = Prod_FA(Year, Past_Period \ (NDays / 4))
   Other_FA(Year, Day \ (NDays / 4) + 1) = Other_FA(Year, Past_Period \ (NDays / 4))
   Cash_Acc(Year, Day \ (NDays / 4) + 1) = Cash_Acc(Year, Past_Period \ (NDays / 4))
   Other_CA(Year, Day \ (NDays / 4) + 1) = Other_CA(Year, Past_Period \ (NDays / 4))
   LTD(Year, Day \ (NDays / 4) + 1) = LTD(Year, Past_Period \ (NDays / 4))
   Other_NCL(Year, Day \ (NDays / 4) + 1) = Other_NCL(Year, Past_Period \ (NDays / 4))
   Other_CL(Year, Day \ (NDays / 4) + 1) = Other_CL(Year, Past_Period \ (NDays / 4))
   Equity(Year, Day \ (NDays / 4) + 1) = Equity(Year, Past_Period \ (NDays / 4))
Else
   Inventories_Acc(Year, Day \ (NDays / 4) + 1) = Inventories_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Receivables_Acc(Year, Day \ (NDays / 4) + 1) = Receivables_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Payables_Acc(Year, Day \ (NDays / 4) + 1) = Payables_Acc(Year, Past_Period \ (NDays / 4) + 1)
   STD(Year, Day \ (NDays / 4) + 1) = STD(Year, Past_Period \ (NDays / 4) + 1)
   Market_Sec(Year, Day \ (NDays / 4) + 1) = Market_Sec(Year, Past_Period \ (NDays / 4) + 1)
   Prod_FA(Year, Day \ (NDays / 4) + 1) = Prod_FA(Year, Past_Period \ (NDays / 4) + 1)
   Other_FA(Year, Day \ (NDays / 4) + 1) = Other_FA(Year, Past_Period \ (NDays / 4) + 1)
   Cash_Acc(Year, Day \ (NDays / 4) + 1) = Cash_Acc(Year, Past_Period \ (NDays / 4) + 1)
   Other_CA(Year, Day \ (NDays / 4) + 1) = Other_CA(Year, Past_Period \ (NDays / 4) + 1)
   LTD(Year, Day \ (NDays / 4) + 1) = LTD(Year, Past_Period \ (NDays / 4) + 1)
   Other_NCL(Year, Day \ (NDays / 4) + 1) = Other_NCL(Year, Past_Period \ (NDays / 4) + 1)
   Other_CL(Year, Day \ (NDays / 4) + 1) = Other_CL(Year, Past_Period \ (NDays / 4) + 1)
   Equity(Year, Day \ (NDays / 4) + 1) = Equity(Year, Past_Period \ (NDays / 4) + 1)
End If

dInv(Year, Day) = 0
dRec(Year, Day) = 0
dPay(Year, Day) = 0
```

```
dSTD(Year, Day) = 0
STB(Year, Day) = 0
STI(Year, Day) = 0
CashFlow(Year, Day) = 0

'realization of actual value of production
Production(Year, Day) = Production(Year, Past_Period) * (1 + Inflation(Year, Day))
Inventories(Year, Day) = CI * Production(Year, Day)
If Day - DIO * CCC < 0 Then
   If Inventories_Acc(Year, Season) + dInv(Year, Day) < 0 Then Inventories(Year, Day) =
Inventories(Year - 1, NDays + Day - DIO * CCC) - Inventories_Acc(Year, Season)
Else
   If Inventories_Acc(Year, Season) + dInv(Year, Day) < 0 Then Inventories(Year, Day) =
Inventories(Year, Day - DIO * CCC) - Inventories_Acc(Year, Season)
End If

'change of inventories
If Day - DIO * CCC < 0 Then
   dInv(Year, Day) = Inventories(Year, Day) - Inventories(Year - 1, NDays + Day - DIO * CCC)
   If Demand(Year, Day) < (Production(Year, Day) - dInv(Year, Day)) Then
      Sales(Year, Day) = Demand(Year, Day)
      If (Production(Year, Day) + Inventories(Year - 1, NDays + Day - DIO * CCC) - Demand(Year, Day))
> Inventories(Year, Day) Then
         Inventories(Year, Day) = Production(Year, Day) + Inventories(Year - 1, NDays + Day - DIO *
CCC) - Demand(Year, Day)
      End If
   Else
      Sales(Year, Day) = Production(Year, Day) - dInv(Year, Day)
   End If
Else
   dInv(Year, Day) = Inventories(Year, Day) - Inventories(Year, Day - DIO * CCC)
   If Demand(Year, Day) < (Production(Year, Day) - dInv(Year, Day)) Then
      Sales(Year, Day) = Demand(Year, Day)
      If (Production(Year, Day) + Inventories(Year, Day - DIO * CCC) - Demand(Year, Day)) >
Inventories(Year, Day) Then
         Inventories(Year, Day) = Production(Year, Day) + Inventories(Year, Day - DIO * CCC) -
Demand(Year, Day)
      End If
   Else
      Sales(Year, Day) = Production(Year, Day) - dInv(Year, Day)
   End If
End If

‘Realization of costs of inventories
If Inventories_Acc(0, 0) > (Inventories_Acc(Year, Season) + dInv(Year, Day)) Then
   Cost_Inv(Year, Day) = Coeff_Cost_Inv * (Inventories_Acc(0, 0) - Inventories_Acc(Year, Season) -
dInv(Year, Day)) / Inventories_Acc(0, 0) * Sales(Year, Day)
Else
   Cost_Inv(Year, Day) = 0
End If

'realization of VC
COGS(Year, Day) = (1 - Gross_Margin) * Production(Year, Day)

'choice of reeivables
Receivables(Year, Day) = CR * Sales(Year, Day)
If Day - DSO * CCC < 0 Then
   dRec(Year, Day) = Receivables(Year, Day) - Receivables(Year - 1, NDays + Day - DSO * CCC)
Else
   dRec(Year, Day) = Receivables(Year, Day) - Receivables(Year, Day - DSO * CCC)
End If
```

```
        'realization of costs of receivables
        If Receivables_Acc(0, 0) > (Receivables_Acc(Year, Season) + dRec(Year, Day)) Then
            Cost_Rec(Year, Day) = Coeff_Cost_Rec * (Receivables_Acc(0, 0) - Receivables_Acc(Year, Season) -
dRec(Year, Day)) / Receivables_Acc(0, 0) * Sales(Year, Day)
        Else
            Cost_Rec(Year, Day) = 0
        End If

        'choice of payables
        Payables(Year, Day) = CP * COGS(Year, Day)
        If Day - DPO * CCC < 0 Then
            dPay(Year, Day) = Payables(Year, Day) - Payables(Year - 1, NDays + Day - DPO * CCC)
        Else
            dPay(Year, Day) = Payables(Year, Day) - Payables(Year, Day - DPO * CCC)
        End If

        'realization of costs of payables
        If (Payables_Acc(Year, Season) + dPay(Year, Day)) > Payables_Acc(0, 0) Then
            Cost_Pay(Year, Day) = Coeff_Cost_Pay * (Payables_Acc(Year, Season) + dPay(Year, Day) -
Payables_Acc(0, 0)) / Payables_Acc(0, 0) * COGS(Year, Day)
        Else
            Cost_Pay(Year, Day) = 0
        End If

        'realization of FC
        SGA(Year, Day) = SGA(Year, Past_Period) * (1 + Inflation(Year, Day)) + Cost_Inv(Year, Day) +
Cost_Rec(Year, Day) + Cost_Pay(Year, Day) + Abs(Cost_Prod_Change(Year, Day))
        RnnD(Year, Day) = RnnD(Year, Past_Period) * (1 + Inflation(Year, Day))
        Depn(Year, Day) = Depn(Year, Past_Period) * (1 + Inflation(Year, Day))

        'repayment of std
        dSTD(Year, Day) = 0 - STB(Year - 1, Day)

        'Realization of independent accounts of balance sheet and income statement
        Oper_Income(Year, Day) = Sales(Year, Day) - COGS(Year, Day) - SGA(Year, Day) - RnnD(Year, Day) -
Depn(Year, Day)
        Fin_Income(Year, Day) = Other_FA(Year, Season) * ((1 + r_LTI) ^ (CCC / NDays) - 1) +
Market_Sec(Year, Season) * ((1 + r_STI) ^ (CCC / NDays) - 1)
        Fin_Exp(Year, Day) = LTD(Year, Season) * ((1 + r_LTD) ^ (CCC / NDays) - 1) + STD(Year, Season) *
((1 + r_STD) ^ (CCC / NDays) - 1) - dSTD(Year, Day)

        'accounts of income statement
        EBT(Year, Day) = Oper_Income(Year, Day) + Fin_Income(Year, Day) - Fin_Exp(Year, Day)
        PAT(Year, Day) = (1 - Tax) * EBT(Year, Day)

        'calculating cash-flow
        CashFlow(Year, Day) = PAT(Year, Day) - dInv(Year, Day) - dRec(Year, Day) + dPay(Year, Day) +
dSTD(Year, Day)

        If Cash_Acc(Year, Season) + CashFlow(Year, Day) < MINCash Then
            STB(Year, Day) = MINCash - Cash_Acc(Year, Season) - CashFlow(Year, Day)
            dSTD(Year, Day) = STB(Year, Day) - STB(Year - 1, Day)
            CashFlow(Year, Day) = PAT(Year, Day) - dInv(Year, Day) - dRec(Year, Day) + dPay(Year, Day) +
dSTD(Year, Day)
        ElseIf Cash_Acc(Year, Season) + CashFlow(Year, Day) > MAXCash Then
            STI(Year, Day) = Cash_Acc(Year, Season) + CashFlow(Year, Day) - MAXCash
            CashFlow(Year, Day) = PAT(Year, Day) - dInv(Year, Day) - dRec(Year, Day) + dPay(Year, Day) +
dSTD(Year, Day) - STI(Year, Day)
        End If

        'If dSTD(Year, Day) > 0 Then PAT(Year, Day) = PAT(Year, Day) - dSTD(Year, Day) * ((1 + r_STD) ^
(CCC / NDays) - 1)
```

```
End Sub
```

Main Module

```
Sub Genr_Market()
Dim i, j As Integer
Dim Dem As Double, Inf As Double
For i = 1 To NYears
   For j = 0 To NDays Step CCC
      If j <> 0 Then
         Inf = 1 + Application.WorksheetFunction.Norm_Inv(RnD(), CPI(i), OutPVolatility + 0.00001)
         If Inf < 0 Then
            Inflation(i, j) = -1
         Else
            Inflation(i, j) = (Abs(Inf)) ^ (CCC / NDays) - 1
         End If
         Dem = 1 + Application.WorksheetFunction.Norm_Inv(RnD(), 0, DVolatility + 0.00001)
         If Dem < 0 Then
            Demand(i, j) = 0
         ElseIf (Inflation(i, j) + (Abs(Dem)) ^ (CCC / NDays)) < 0 Then
            Demand(i, j) = 0
         Else
            Demand(i, j) = Demand(i, j - CCC) * (Inflation(i, j) + (Abs(Dem)) ^ (CCC / NDays))
         End If
      Else
         Demand(i, 0) = Demand(i - 1, NDays)
      End If
   Next j
Next i
End Sub
```

Sub Daily_Process(Day As Integer, Year As Integer, Season As Integer)

```
Dim CI_c, CP_c, CR_c As Integer
Dim BValue, BMAXValue As Double
Dim NextSeason As Integer
Dim NCC As Double

BMAXValue = 0 - 10000000

'First stage of maximixation
For CI_c = 0 To 10
   For CP_c = 0 To 10
      For CR_c = 0 To 10
         Call Period(Day, Year, Season, CI_c * 0.1, CP_c * 0.1, CR_c * 0.1)

         If Sales(Year, Day) <> 0 Then BValue = (PAT(Year, Day) + CashFlow(Year, Day)) / Sales(Year, Day)
Else BValue = 0

         If BValue > BMAXValue Then
            BMAXValue = BValue
            CI(Year, Day) = CI_c * 0.1
            CP(Year, Day) = CP_c * 0.1
            CR(Year, Day) = CR_c * 0.1
         End If

      Next CR_c
   Next CP_c
Next CI_c
```

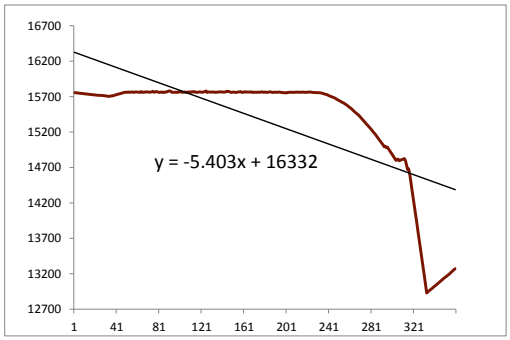
```
'preparation for second stage of maximization
If CI(Year, Day) = 0 Then CI(Year, Day) = 0.05
If CI(Year, Day) = 1 Then CI(Year, Day) = 0.95
If CP(Year, Day) = 0 Then CP(Year, Day) = 0.05
If CP(Year, Day) = 1 Then CP(Year, Day) = 0.95
If CR(Year, Day) = 0 Then CR(Year, Day) = 0.05
If CR(Year, Day) = 1 Then CR(Year, Day) = 0.95

'Second stage of maximization
For CI_c = CI(Year, Day) * 100 - 5 To CI(Year, Day) * 100 + 5
   For CP_c = CP(Year, Day) * 100 - 5 To CP(Year, Day) * 100 + 5
      For CR_c = CR(Year, Day) * 100 - 5 To CR(Year, Day) * 100 + 5
         Call Period(Day, Year, Season, CI_c * 0.01, CP_c * 0.01, CR_c * 0.01)

         If Sales(Year, Day) <> 0 Then BValue = (PAT(Year, Day) + CashFlow(Year, Day)) / Sales(Year, Day)
Else BValue = 0

         If BValue > BMAXValue Then
            BMAXValue = BValue
            CI(Year, Day) = CI_c * 0.01
            CP(Year, Day) = CP_c * 0.01
            CR(Year, Day) = CR_c * 0.01
         End If

      Next CR_c
   Next CP_c
Next CI_c

Call Period(Day, Year, Season, CI(Year, Day), CP(Year, Day), CR(Year, Day))

'Recalculating balance sheets accounts
Inventories_Acc(Year, Season) = Inventories_Acc(Year, Season) + dInv(Year, Day)
Receivables_Acc(Year, Season) = Receivables_Acc(Year, Season) + dRec(Year, Day)
Payables_Acc(Year, Season) = Payables_Acc(Year, Season) + dPay(Year, Day)
Cash_Acc(Year, Season) = Cash_Acc(Year, Season) + CashFlow(Year, Day)
STD(Year, Season) = STD(Year, Season) + dSTD(Year, Day)
Market_Sec(Year, Season) = Market_Sec(Year, Season) + STI(Year, Day)
Equity(Year, Season) = Equity(Year, Season) + PAT(Year, Day)

'Calculating required cumulative flows
CF_cum = CF_cum + CashFlow(Year, Day)
SC = SC + Sales(Year, Day)
COGSC = COGSC + COGS(Year, Day)

'Calculating control ratios
ROE(Year, Day) = Sales(Year, Day) / Equity(Year, Season)
WC(Year, Day) = Receivables_Acc(Year, Season) + Inventories_Acc(Year, Season) - Receivables_Acc(Year,
Season)
If (SC > 0) And (COGSC > 0) Then
CC(Year, Day) = Receivables_Acc(Year, Season) / SC + Inventories_Acc(Year, Season) / SC -
Receivables_Acc(Year, Season) / COGSC
Else
CC(Year, Day) = 0
End If
End Sub


Sub Annual_Process(Year As Integer)
Dim days_count As Integer
Dim Season As Integer
Dim future_season As Integer
Dim BV As Double
```

```
Sales(Year, 0) = Sales(Year - 1, NDays)
COGS(Year, 0) = COGS(Year - 1, NDays)
SGA(Year, 0) = SGA(Year - 1, NDays)
RnnD(Year, 0) = RnnD(Year - 1, NDays)
Depn(Year, 0) = Depn(Year - 1, NDays)
Oper_Income(Year, 0) = Oper_Income(Year - 1, NDays)
Fin_Income(Year, 0) = Fin_Income(Year - 1, NDays)
Fin_Exp(Year, 0) = Fin_Exp(Year - 1, NDays)
EBT(Year, 0) = EBT(Year - 1, NDays)
PAT(Year, 0) = PAT(Year - 1, NDays)

Prod_FA(Year, 0) = Prod_FA(Year - 1, 4)
Other_FA(Year, 0) = Other_FA(Year - 1, 4)
Inventories_Acc(Year, 0) = Inventories_Acc(Year - 1, 4)
Receivables_Acc(Year, 0) = Receivables_Acc(Year - 1, 4)
Cash_Acc(Year, 0) = Cash_Acc(Year - 1, 4)
Market_Sec(Year, 0) = Market_Sec(Year - 1, 4)
Other_CA(Year, 0) = Other_CA(Year - 1, 4)
LTD(Year, 0) = LTD(Year - 1, 4)
Other_NCL(Year, 0) = Other_NCL(Year - 1, 4)
STD(Year, 0) = STD(Year - 1, 4)
Payables_Acc(Year, 0) = Payables_Acc(Year - 1, 4)
Other_CL(Year, 0) = Other_CL(Year - 1, 4)
Equity(Year, 0) = Equity(Year - 1, 4)

Receivables(Year, 0) = Receivables(Year - 1, NDays)
Inventories(Year, 0) = Inventories(Year - 1, NDays)
Payables(Year, 0) = Payables(Year - 1, NDays)
Demand(Year, 0) = Demand(Year - 1, NDays)
Production(Year, 0) = Production(Year - 1, NDays)
STB(Year, 0) = STB(Year - 1, NDays)

'BV = Business_Value(1, Year)

Season = 1
future_season = 1
SC = 0
COGSC = 0

For days_count = CCC To NDays Step CCC
   If (days_count) Mod (NDays / 4) = 0 Then Season = (days_count) \ (NDays / 4) Else Season = (days_count) \
(NDays / 4) + 1
   If (days_count + CCC) Mod (NDays / 4) = 0 Then future_season = (days_count + CCC) \ (NDays / 4) Else
future_season = (days_count + CCC) \ (NDays / 4) + 1
   Call Daily_Process(days_count, Year, Season)

   'calculation of cumulative flows
   Sales_cum(Year, Season) = Sales_cum(Year, Season) + Sales(Year, days_count)
   COGS_cum(Year, Season) = COGS_cum(Year, Season) + COGS(Year, days_count)
   SGA_cum(Year, Season) = SGA_cum(Year, Season) + SGA(Year, days_count)
   RnnD_cum(Year, Season) = RnnD_cum(Year, Season) + RnnD(Year, days_count)
   Depn_cum(Year, Season) = Depn_cum(Year, Season) + Depn(Year, days_count)
   Oper_Income_cum(Year, Season) = Oper_Income_cum(Year, Season) + Oper_Income(Year, days_count)
   Fin_Income_cum(Year, Season) = Fin_Income_cum(Year, Season) + Fin_Income(Year, days_count)
   Fin_Exp_cum(Year, Season) = Fin_Exp_cum(Year, Season) + Fin_Exp(Year, days_count)
   EBT_cum(Year, Season) = EBT_cum(Year, Season) + EBT(Year, days_count)
   PAT_cum(Year, Season) = PAT_cum(Year, Season) + PAT(Year, days_count)
   Production_cum(Year, Season) = Production_cum(Year, Season) + Production(Year, days_count)

Next days_count
End Sub
```

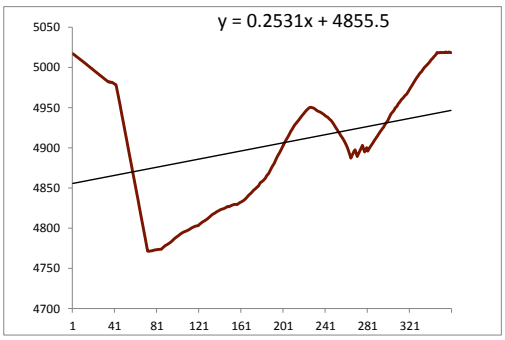
```
Function Chi_Square() As Double
Dim ObsPar(1 To 10, 1 To 4) As Double
Dim i As Integer, j As Integer

Chi_Square = 0

For i = 1 To NDays
   j = (i - 1) \ 90 + 1
   ObsPar(1, j) = ObsPar(1, j) + Sales(1, i)
   ObsPar(2, j) = ObsPar(2, j) + COGS(1, i)
   ObsPar(3, j) = ObsPar(5, j) + RnnD(1, i)
   ObsPar(4, j) = ObsPar(7, j) + Fin_Exp(1, i)
Next i

For j = 1 To 4
   ObsPar(5, j) = Inventories_Acc(1, j)
   ObsPar(6, j) = Receivables_Acc(1, j)
   ObsPar(7, j) = Cash_Acc(1, j) + Market_Sec(1, j)
   ObsPar(8, j) = STD(1, j)
   ObsPar(9, j) = Payables_Acc(1, j)
   ObsPar(10, j) = Equity(1, j)
Next j

For i = 1 To 4
   For j = 1 To 10
      Chi_Square = Chi_Square + ((ObsPar(j, i) - ExpPar(j, i)) ^ 2) / ExpPar(j, i)
   Next j
Next i

End Function
```

Attachment 4. Working capital simulated balances in base parameter set, USD mn

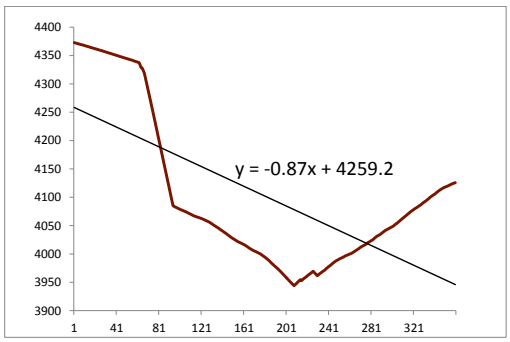
Energy



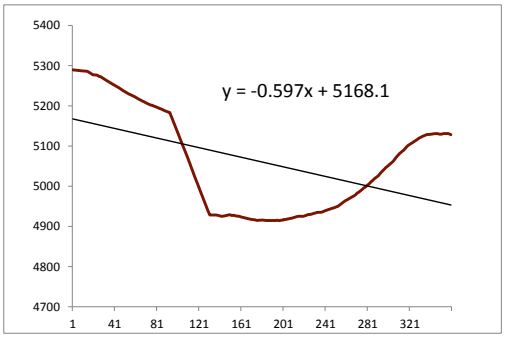
Consumer Staples



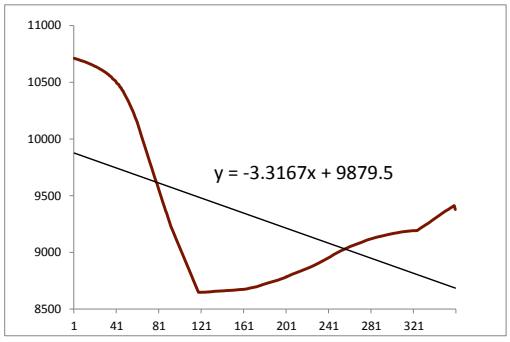
Materials



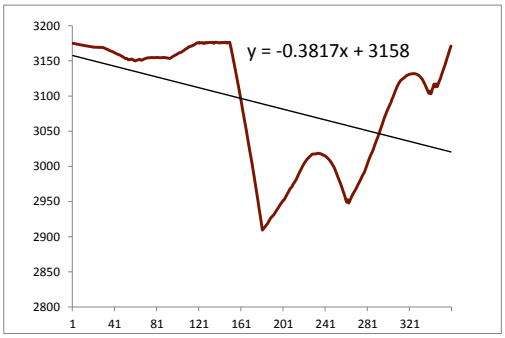
Health Care



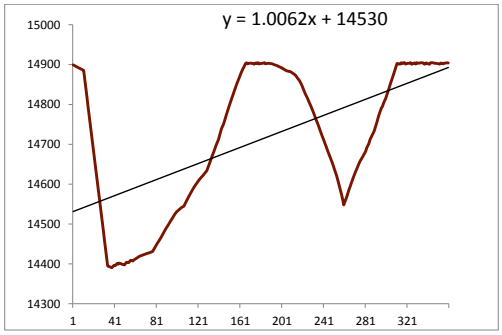
Industrials



IT



Consumer Discretionary



Utilities