

Dynamics of value-based management – does shareholder value cause short-termism?

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Paper presented at the 30th International Conference of the System Dynamics Society, St. Gallen, Switzerland, July 23rd – 26th, 2012

Abstract: Shareholder Value (SHV) and value-based management (VBM) are blamed for causing short-termism of investors and managerial myopia. Empirical evidence states decreased holding periods of stocks by investors, increased discount rates and widespread adoption of earnings management. While this supports the existence of short-termism and myopia, it does not clarify its causes. What is missing is: do shareholder value and value-based management cause short-termism in the behavior of investors and managers? The paper uses System Dynamics to model both concepts and to try to explain short-termism and myopia as endogenous outcome of these concepts. The contribution to the debate on short-termism is to better understand the role of SHV and VBM in explaining short-termism and to direct future empirical research as well as advancing modeling of SHV and VBM.

Keywords: *shareholder value; short-termism; system dynamics; simulation; value-based management*

Introduction

It is consensus in finance, accounting and management control to view the increase of shareholder value as the ultimate goal of a company (Rappaport, 1986). Implemented as value-based management (VBM) with appropriate corporate governance, incentive and decision structures, the intention is to guide managerial actions toward that goal (Stewart, 1999). With such instruments in place managers and investors alike should concentrate on the long-term value creation of a company.

Shareholder value as a concept and value-based management as a method came under attack from the beginning, yet, the momentum of critical views gained speed with the financial crisis of 2008. Empirical studies show a decrease in payback threshold and increase in hurdle rates (Dobbs, 2009). Both are seen as signs of devaluing the long-term. Additionally, earnings management is now a widespread phenomenon. It intends to keep up earnings even if that means sacrificing future benefits (Graham, Harvey, & Rajgopal, 2005). Such empirical evidence supports the notion of managers and investors focusing on the short-term instead of the long-term. That effect is also called “short-termism”.

However, blaming shareholder value and value-based management as causes for short-termism is not well grounded: there is also evidence contradicting the notion of “short-termism”. Bartov et.al. showed for example, that firms which manage earnings tend to show higher performance in the long run (Bartov, Givoly, & Hayn, 2002). Others see short-termism as outcome not of shareholder value per se but of a misguided application of it (Rappaport, 2011, p. 47).

What is missing is a deeper understanding of the effectiveness of value-based management on short-term and long-term profits and its induced managerial and investor behavior. Such an understanding is needed to decide about the relevance of short-termism critic on shareholder value and appropriate remedies as well.

This deeper understanding requires a model that captures the dynamics of value-based management in the short-term and long-term. Additionally, explaining induced behavior of value-based management from factors and relations within a model (endogenously) seems more useful and convincing than blaming factors

outside of it (exogenously) which, for example, Rappaport does. Here, a system dynamics model is build to capture the dynamics of value-based management. The main result is that short-termism can be explained in two situations: (a) profit targets beyond a certain threshold, so the firm is not able to meet these targets in the long run and, maybe more important and more widespread, (b) uncertainty of managerial actions and decisions on profitability given stretch targets. The latter is a typical feature of shareholder value in reality. From that, we conclude that short-termism seems to be not an aberration but an intrinsic and endogeneous feature of shareholder value.

The paper contributes to the literature on short-termism and shareholder value and offers new insights in the causes and circumstances of short-termism. Further research could build on the findings in discussing effective policies to reduce short-termism.

Shareholder Value, value-based management and short-termism

Shareholder value and value-based management

Shareholder Value is based on Modern Portfolio Theory in finance. Modern Portfolio Theory focuses on financing and investing decisions of rational actors on capital markets (Miller & Modigliani, 1961; Modigliani & Miller, 1958). These authors conclude basically that investors should consider risk and rewards of investments in the selection of a portfolio of investments. Investors can reduce their risk of a portfolio of investments compared to the individual investments alone if they select investments with not perfectly or even negatively correlated risks.

To make such a decision for investments in companies, investors need to consider required returns on debt and equity which both constitute the cost of capital. While required return on debt is basically a weighted average of interest rates of debt positions corrected with the risk of default, calculating required return on equity (or cost of equity) is not straightforward.

Sharpe, Lintner and Mossin developed in the 1960's the later so called Capital Asset Pricing Model (CAPM) to determine cost of capital (Lintner, 1965; Mossin, 1966; Sharpe, 1964). According to CAPM cost of capital is calculated as sum of

return from risk free investment plus a risk premium for investing in a riskier asset, like company shares. That premium is derived from the expected return of the portfolio of all assets (or in stock markets for all stocks) multiplied by the covariance of the returns for the asset under consideration compared to the covariance of returns for all assets.

According to CAPM expected returns have to be used in calculating cost of capital. That requires reliable long-term predictions on market returns as well as on returns of a specific investment under consideration. For lack of reliable (and stable) predictions in practice often historic data or extrapolations of historical data are used which poses additional problems (see for example (Fama & French, 1997; French & Fama, 1989).

In a seminal paper, Jensen and Meckling argued that it is not self-evident that managers will decide in line with return expectations from investors. Investors or owners face benefits and costs of agency, with agency meaning to mandate others to manage a company (Jensen & Meckling, 1976). One instrument to reduce agency costs is to align managerial and owners' goals through offering management a share of value created for the owners. That is the essence of value-based management.

While the creation of value is basically the outcome of an investment, managers and owners alike need a metric to measure and reward performance for a given period instead of rewarding at the end of lifetime of an investment far in the future. The metric used most commonly is Residual Income or Economic Value Added (EVA™) which is basically just another name for Residual Income.

Residual Income is defined as income earned minus income required. Required income or capital charge is calculated as cost of capital [%] multiplied by invested capital [€].(Brealey & Myers, 2003), p. 521-6).

The idea of shareholder value and value based management was especially popularized by Rappaport (1986) and the consulting firm Stern Stewart, the latter brought the idea of EVA™ into the public (Stewart, 1999).

A metric like EVA™ is part of value-based management, which is defined as “a mind-set where everyone in the organization learns to prioritize decisions based on their understanding of how those decisions contribute to corporate value” ((Young & O’Byrne, 2000), p. 18). Value-based management reaches out into strategic planning, capital allocation processes, operational budgeting,

performance measurement, management compensation and internal and external communication (ibid).

In theory, value-based management should lead to long-term value creation, yet some studies question that. It is regularly bemoaned in the literature, that instead of fostering long-term value creation, short-term orientation is dominant ((Bridle, 2010; Demirag, 1995; Lavery, 2004). Some argue that short-termism is a trait of Western style of management (Mamman & Saffu, 1998). If that notion were true, remedies would be hard to find and blaming shareholder value as cause would be completely misdirected. However, the majority of critics see shareholder value and its assumed focus on profits in the short-run as causal explanation. However, the role of shareholder value and value-based management is not clear. Is shareholder value a cause for short-termism or only a mediating factor among others or even the result of short-termism?

The debate and evidence of short-termism

Before we try to answer these questions via modeling we should understand more fully what short-termism means and which evidence exists that support or contradict it. Short-termism or myopia refers to decision making that ignores or downplays intertemporal aspects relevant for decisions. In other words, decision maker are concerned primarily with the short-term at the expense of the long-term effects of their decisions (Lavery, 1996). Short-termism is perceived as a symptom or a set of symptoms (syndrome) rather than a cause (ibid, p. 831). Evidence for this syndrome is sometimes anecdotal or rather superficial in that the decline of US manufacturing is assigned overall to short-termism (see for sources (Haldane & Davies, 2011). More reliable evidence is found in financial data of firms and markets.

Hurdle rates, used by managers for discounted cash flow valuation of investments, are according to several studies substantially higher than reasonable cost of capital estimates. Also managers apply relatively short payback thresholds of two to four years for projects. That seems challenging, given a typical time to construct a plant of around two years (see for references (Dobbs, 2009). While investment opportunities often lead to low or negative returns in the beginning, some argue, that managers may even prefer projects with higher returns at the beginning but lower net present value to avoid low earnings (Palley, 1997). This is supported by

evidence on career penalties for not meeting analyst forecasts (Mergenthaler, Rajgopal, & Srinivasan, 2011). It is then not surprising to find evidence of a widespread behavior to manage earnings; i.e. to smooth or to try at nearly all costs to meet or beat quarterly earnings forecasts (Graham et al., 2005).

A similar orientation toward the short-term is observed with investors. Haldane and Davies report on an increasing short-termism in pricing of US and UK stocks (Haldane & Davies, 2011).

However, there is some contradicting evidence. Bartov et. al. found evidence for firms that meet or beat quarterly earnings forecast to perform better in the future. Accounting earnings are seen as informative signal for future profitability (Bartov et al., 2002). Even if investors show myopic behavior and expectations, that may not lead necessarily to managerial myopia as indicated by the study of Samuel (Samuel, 2000).

In sum, there is evidence of short-termism; yet two caveats should be taken into account: first, it seems that short-term oriented decisions do not necessarily have to lead to long-term difficulties, second, the interaction of investor myopia and managerial myopia is not straightforward.

There is a stream of literature trying to explain short-termism (Laverty, 1996; Marginson & Mcaulay, 2008). We refer to the classification of Laverty, which seems still to be state of the art (Laverty, 1996). According to it short-termism may be caused by one or more of the following reasons (see also (Bhojraj & Libby, 2005; Demirag, 1995; Samuel, 2000)):

- a) Flawed management practice: this includes high discount rates or expecting performance effects happening too fast.
- b) Managerial opportunism: it is possible that managers prefer short-termism because of positive effects for them personally, for example higher bonuses before retirement.
- c) Stock market myopia: the classic argument about increasing pressure from stock markets to focus on quarterly earnings.
- d) Differences in financing of firms across countries: equity financed firms in US and UK are more under pressure to deliver short-term results than debt-financed firms in Germany or Japan where debt-holder are more oriented towards the long-term growth and ability to meet financial obligations.

- e) Information asymmetry: investors, lacking reliable information in long-term prospects of firms, may view short-term profits as the only reliable signal they have to evaluate long-term profitability.

All these categories can be linked to shareholder value and value based management. Hence, we explore them in the following discussion to build a model to explain short-termism from that perspective.

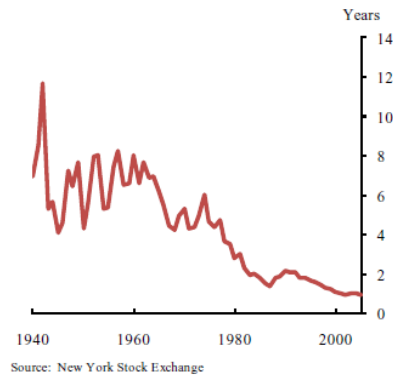
Modeling value-based management

Rationale for system dynamics and dynamic hypothesis

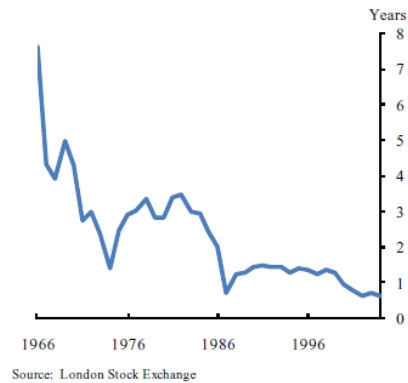
In this paper, system dynamics as modeling approach is used for two reasons. First, the effects under scrutiny develop over time so a method to understand dynamic processes is appropriate and a key feature of System Dynamics. Second, the perspective of System Dynamics is to explain behavior from the structure of systems, i.e. endogenously. It draws attention to self-induced effects and empowers to change undesired outcomes through one's own decisions instead of viewing a social situation as caused and sustained by circumstances beyond one's control (Richardson, 2011).

While System Dynamics modeling is seen as an iterative process, it should start with a clear articulation of the problem one wants to understand (Sterman, 2000), ch. 3). Here, we want to understand, if shareholder value and value-based management do cause short-termism in the behavior of investors and managers. Evidence of short-termism of investors are increases in discount rates and reduced holding periods of stocks as displayed in the following graph 1 and mentioned in the previous chapter.

NYSE average holding period,
1940-2005



FTSE average holding period,
1940-2005



Graph 1: Holding periods of stocks in the long run

Evidence of short-termism of managers comprises earnings management and discount rates well above reasonable cost of capital values.

The dynamic hypothesis is then, that a System Dynamic model should display the same behavior regarding discount rates, holding periods and earnings management over time. If model output shows similar behavior to empirical data, one can assume to see basically the same underlying forces at work which generate that behavior over time (Sterman, 2000), p. 116-7). From the decrease in holding periods one can derive some sort of goal seeking behavior of investors. The model consists of two basic building blocks: investors and management.

Causal-loop models for investors and management

Investors: from the perspective of corporate finance, potential investors and stockholders¹ are interested in earning a maximum return on capital which they provided to a firm given a certain level of risk. What counts at the time of investment is future return on capital not past returns; hence, what is important for investors in deciding to invest or divest is expected return and expected value. The latter calculated as net present value of future expected returns discounted with a specific discount rate. The discount rate investors use is often based on CAPM, as mentioned before. The specific discount rate combines risk free returns with a risk

¹ We will use the term investor for both, potential investors in stocks and actual stockholders, since it will be clear from the context which is meant. Also we assume no principal differences regarding interests and actions of both groups.

premium calculated as expected market return multiplied by covariance of the firm's returns with market returns.

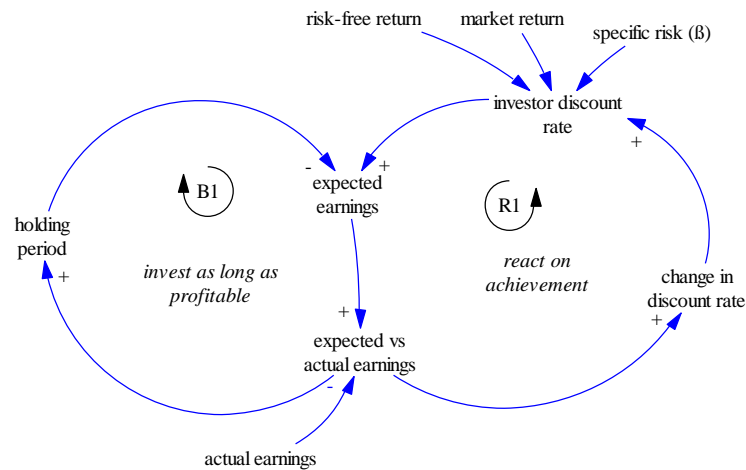
Consequently, investors will hold their investment as long as it meets or exceeds their return or value target. The average holding period will decrease if that does not happen and vice versa.

We assume equity-financed firms with no debt. In a basic model there is no need to include debt holders. Debt holders typically are entitled for fixed returns (interest on debt) and face lower risks through collaterals, except near bankruptcy of the firm. There seems no argument why debt positions should cause managerial myopia²; hence we omit debt and debt holders from our analysis.

In a causal loop diagram for investor behavior (see graph 2), two loops are apparent. The balancing loop B1 ("invest as long as profitable") is formed by a goal-seeking structure: the longer the holding period of investors the lesser the pressure on expected earnings and vice versa. The rationale is that investors with short holding periods would want to earn returns in this time frame as much as possible to ensure a maximum return on their investment. The second loop is a reinforcing process of expectation adaption (R1, "react on achievement"). Investor discount rate is first derived from CAPM with risk-free return, market return and specific risk but then adapted to the deviation of expectation to actual returns. Investors learn with higher experienced returns that they could increase their target and vice versa.³

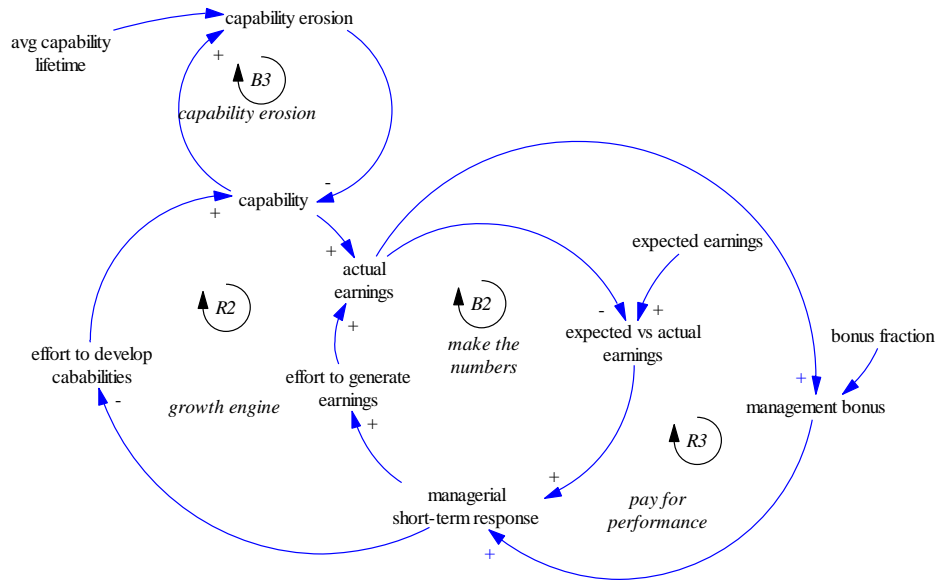
² However, if a firm had only short-term debt contracts short-termism could develop since the firm would have to redeem loans quite often which would require substantial liquidity and solvency. Yet, that seems not very likely.

³ That also allows for speculative bubbles in so far as investors overreact on beating their expectations by managers.



Graph 2: Causal-loop diagram for investor behavior

Firm and management: we assume that a single firm cannot influence market return significantly or its fixed specific risk. The first point is reasonable since stock market returns are averages of all firms' returns and a single firm is usually not large enough to influence it alone in the long run. The second point is clearly overstated since firms can and do diversify or even change the industry they are in. Yet, to keep the discussion simple we will proceed with it. To model the firm we build on an idea of Repenning and Henderson (Repenning & Henderson, 2010) which is grounded in the resource-based view of firms (Teece, 2007). According to that earnings are an outcome of exploiting capabilities (see graph 3). Capabilities grow through efforts to develop them and erode over time (loop B3, "capability erosion"). Since investing in capabilities lower earnings in the short run with the hope of higher earnings in the long run, management has to find a delicate balance in allocating resources and efforts. The pressure of earnings targets requires an adaptation to that target (loop B2, "make the numbers"). Yet, management must decide to share efforts between making the numbers and developing capabilities (loop R2, "growth engine"). Repenning and Henderson defined managerial response as a constant, exogeneous value which better suited their analysis. Here, we define managerial short-term response as a variable influenced by expected vs actual earnings. Thus, we can capture the pressure exerted by investors to meet or beat their targets. Also not included in their model is managerial compensation. Loop R3 ("pay for performance") increases the pressure on managerial short-term response further.



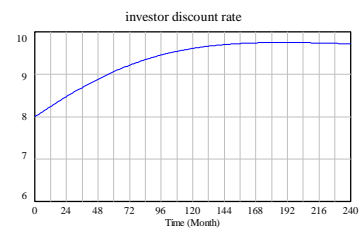
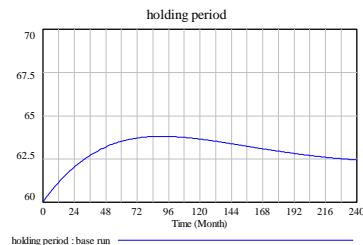
Graph 3: Causal-loop diagram for firm and management

Model simulation and results

Base run simulation of partial models

Investor model: The simulation of the partial model for investors should reveal adaptations of discount rate and holding periods over time depending on the ratio of expected versus actual earnings. Starting with constant actual earnings discount rate and holding period show the supposed behaviour over time as depicted in graph 4.

- Simulation of partial model for investors
- Constant actual earnings = 100 (similar to 10% given invested capital of 1000)
- Initial discount rate 8%
- Initial holding period 60 months

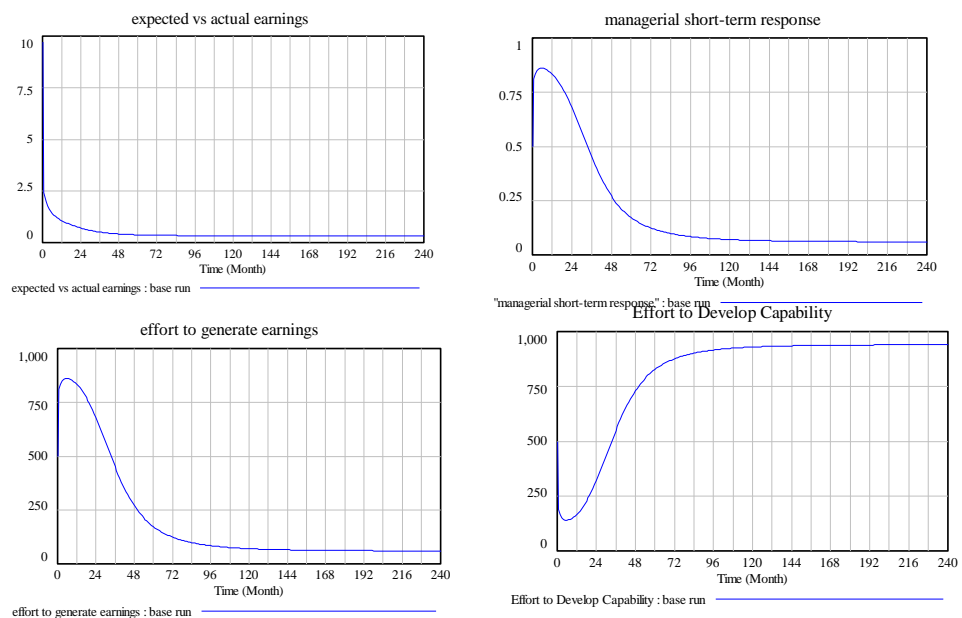


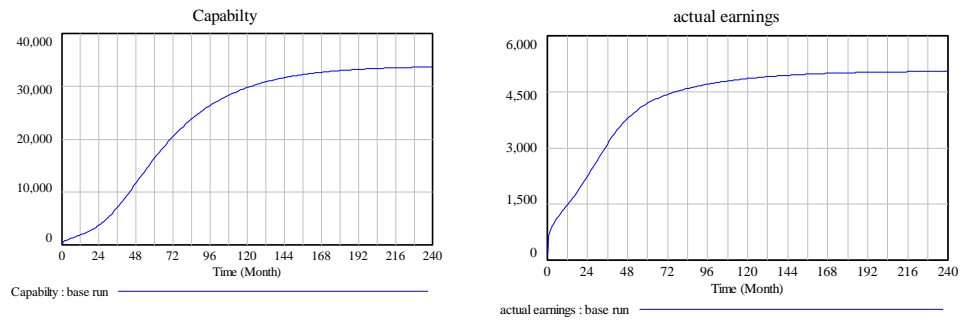
Graph 4: Base run simulation of partial model "investors"

Since in the beginning actual earnings are higher than expected, holding period increases as well as discount rate, yet holding period seems to overshoot. Given

constant actual earnings, expected earnings approaches actual earnings which reduces holding period in the following. Finally, holding period settles at around 62 months. The same principal behaviour of adaptation holds for actual earnings lower than expected. Earnings expectations level off to actual earnings over the course of time. Hence, based on the model structure and its goal-seeking behaviour we conclude that short-termism cannot be explained by investor behavior alone.

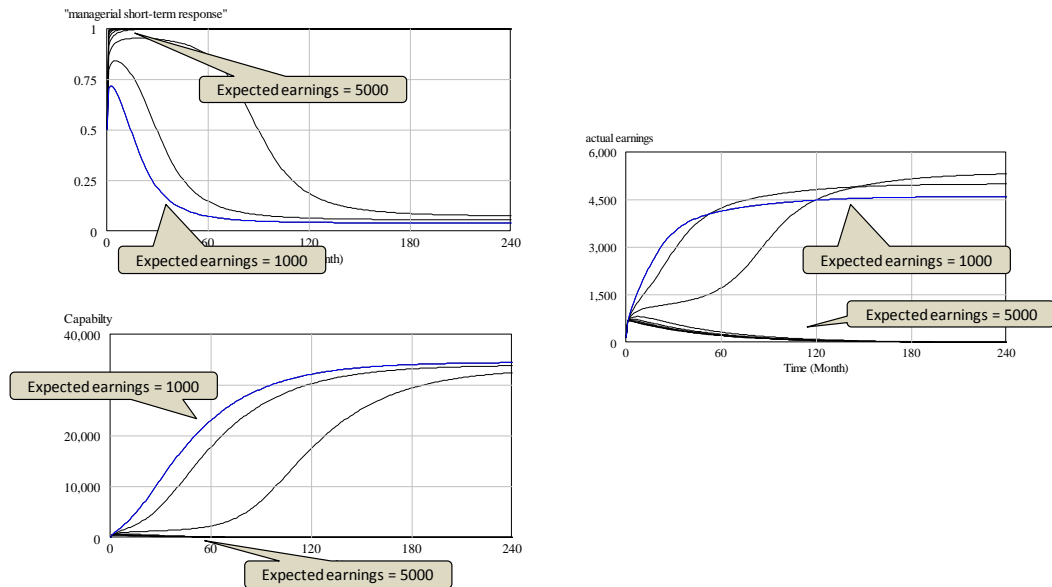
Firm and management model: the dynamic hypothesis for simulating the partial model of the firm and management is that managers respond to earnings targets by balancing short-term earnings generation and long-term capability development. The favored resulting behaviour is meeting or beating earnings targets due to large enough effort, capability development and productivity of the firm. Graph 5 shows such behaviour. After a short rise in managerial short-term response the firm is able to generate earnings that permanently beat the target (here 1000). Consequently, management focuses mainly on developing capabilities.





Graph 5: Base run simulation of partial model “firm and management”

If effort, capability development and productivity are too low such a performance plateau will not occur. To the contrary, when targets are several times higher than feasible for the firm, management will concentrate excessively on generating short-term earnings and at the same time and consequently neglect capability development. It is no surprise that this has to lead to reduced capability which in turn limits actual earnings on such a low level that the firm is not able to meet targets regardless of managerial effort. Graph 6 depicts sensitivity runs of different earnings targets. Earnings targets were increased from 1000 to 5000 in steps of 500. The previously virtuous cycle of managerial response and capability development to earnings reverses into a vicious cycle: despite much effort, the firm cannot and will not achieve targets due to lack of capability. Expected earnings function as threshold or tipping point of that result. Beyond a certain target level (here near 2050), the firm is doomed to fail. Yet, in reality neither management nor investors will know for sure where this point is (a similar result is derived by (Repenning & Henderson, 2010), but with a different model and context).



Graph 6: Effects of simulating expected earnings between 1000 and 5000

To sum up, the partial model of firm and management seems as first candidate to explain short-termism; if targets are fix and too high, a firm will be not only miss the target but also ruin its profitability and cease to exist in the long run through lack of developing capabilities. However, that does not explain the empirical facts fully, especially regarding investor behaviour. Also, it would mean that investors will not react on missed targets and adapt their expectations. Hence, the next step is to combine both partial models.

Combining both partial models

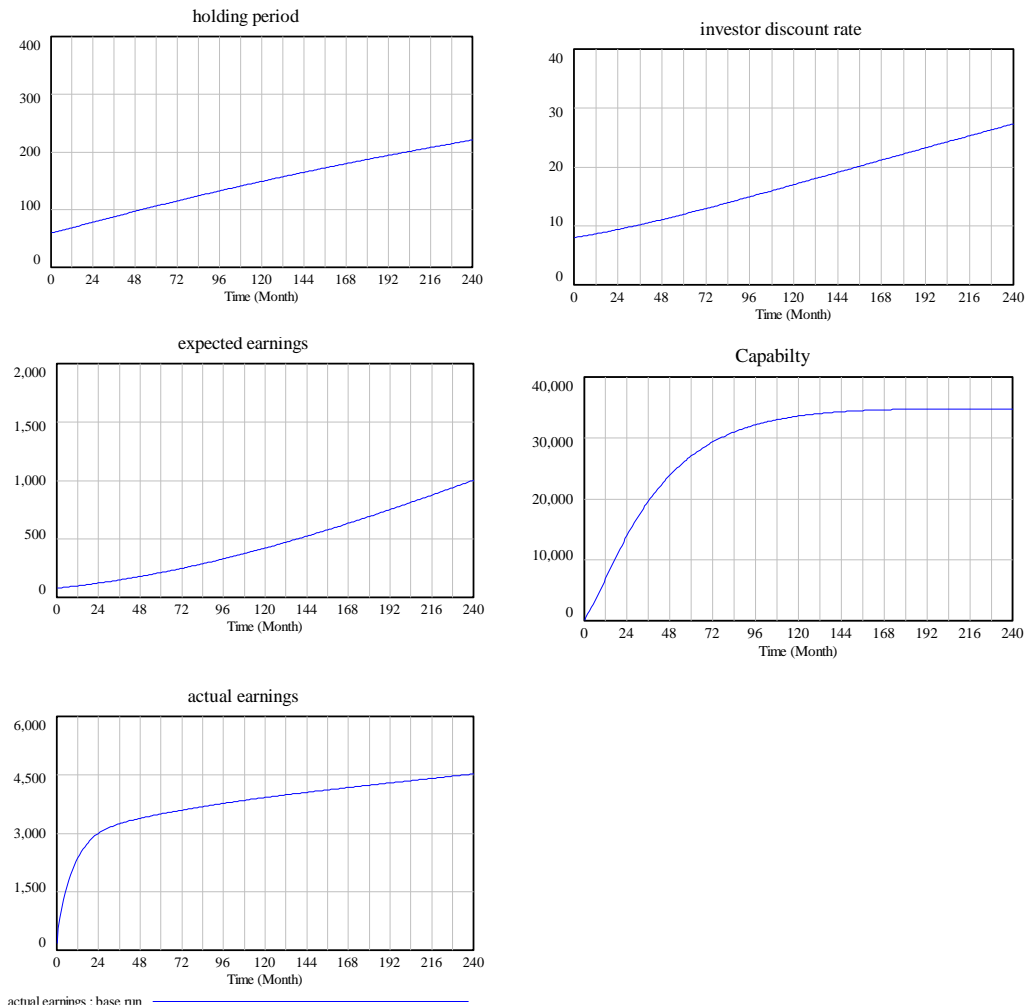
Simulating the combined partial models lets us confirm the notion of shareholder value as a long-term target: the firm's earnings increases, capability and profitability stay at such a level, that even increased earnings expectations cannot hinder the firm in delivering results (see graph 7).⁴

However, that holds only given two main assumptions:

- a) Firm specific attributes like total possible effort, productivity of capability and of earnings generation allow for generating earnings well above increasing expectations. Different values for these attributes in different firms will change that profoundly. We discussed that already for the firm and management partial model and it seems true also for the combined model.

⁴ See for the whole model as stock-flow-diagram appendix 1

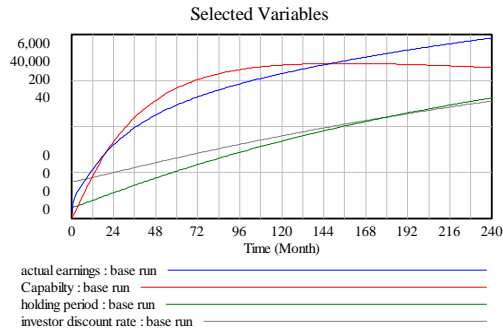
b) Investors are willing to wait for meeting or beating targets. In the base run the initial holding period as well as the time to form expectations on discount rates is 5 years; the time for smoothing target achievement is 2 years. While there is some evidence for such long time frames in the past (see graph 1), today investors will probably not wait that long, especially if they are institutional investors (Bushee, 2001; Connelly, Tihanyi, Certo, & Hitt, 2010).



Graph 7: Base run simulation of combined model

Surprisingly, changing the second assumption above to capture more short-term oriented investors does not change the overall behaviour of the system (see graph 8). Capability levels off earlier, but the other variables point in the same direction as before. So far, our model does not create short-termism.

variable	Previous value	Actual value
Initial holding period	60	12
Time to smooth expected earnings vs actual	24	3
Time to form change expectations for discount rate	60	3



Graph 8: changing variables towards assuming short-term investors

Effect of Uncertainty on Short-Termism

What we assumed above, is that management does not face uncertainty concerning profitable investments for the future or appropriate measures to increase profits in the short run. Under that assumption managers do know for sure critical parameters that drive capability and earnings, namely capability investment productivity and productivity of capability and effort to generate earnings. Obviously, that does not match with reality. Management does not know in advance how their effort to develop productivity transforms in capabilities; that is in assets and resources useful for future profit generation. Also efforts to generate earnings in the short-run do not necessarily work out in form of actual earnings. Managers face tremendous uncertainty while in the need to make decisions about the future (Beinhocker, 2007; Ormerod, 2005)

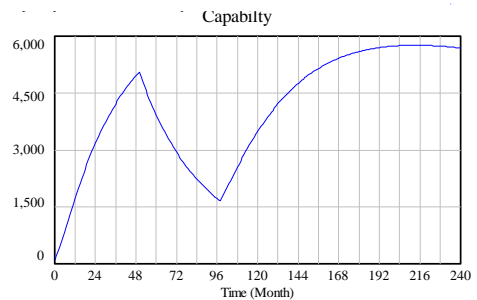
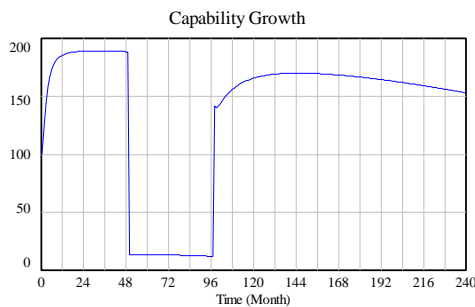
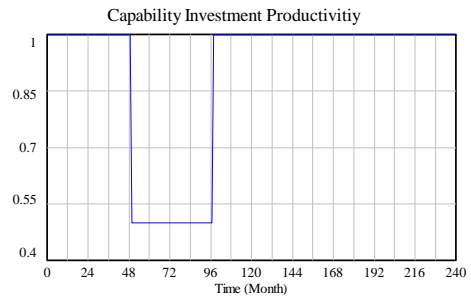
On the other side, shareholder value lets investors assume that managers know about profit generation and that setting stretch targets give managers the right incentive to do whatever they can to meet or beat these targets. To keep managerial effort high, investors will plausibly increase their expectations faster than reducing them in the face of lower profitability.

It seems self-evident what can happen if managers do not meet targets because of uncertainty and despite much effort: while expectations stay high or lower only reluctantly, pressure to deliver results increases. In the short-run only short-term measures can be undertaken to meet expectations of impatient investors. Short-termism in managerial reactions becomes apparent.

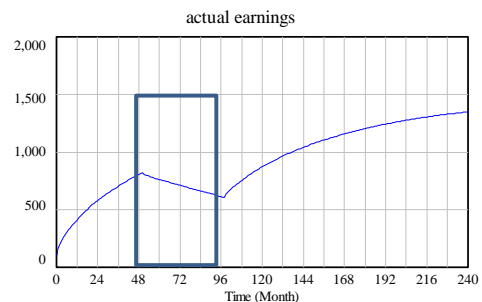
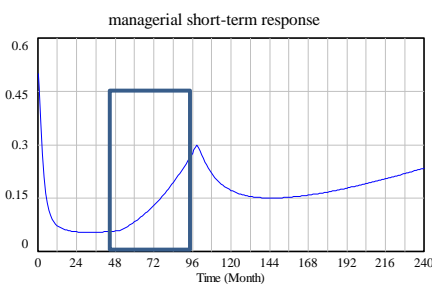
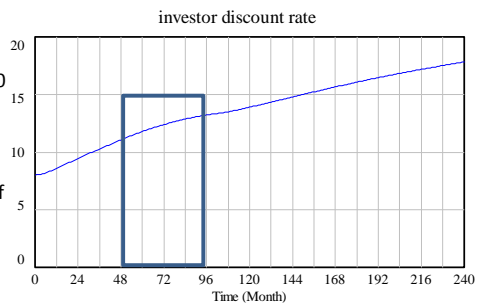
A simple simulation illustrates that case. We change capability investment productivity at time 50 for 48 months from unity to one half. With that we assume that, maybe by unforeseeable reasons, incompetence or plain bad luck, managerial effort for developing capability is less effective. We would expect an increase in

managerial short-term response because expectations stay high and adapt only slowly. And that is what happens (see graph 9).

- Changing capability investment productivity from unity to ½ between t = 50 and t = 98
- Effects on capability growth rate and capability



- Investor expectations react only slowly, seen at change in discount rate around t = 70 and t = 100
- Since expectations increase, managerial short-term response increases too. That can be interpreted as short-termism (see rectangle below)
- Actual earnings decrease despite that because of lack of capabilities



Graph 9: Effect of a reduction of capability productivity and short-termism

Uncertainty will intrude into managerial plans and actions more often than illustrated above. From a managerial perspective it seems reasonable to react on missing targets and increased investor pressure with short-term oriented decisions. What else could managers do to convince investors knowing that investors react on missing targets with dismissal of managers (Jenter & Kanaan, 2008)?

The conclusion is: short-termism seems to be the logical outcome in uncertain times with stretch profit targets as defined by shareholder value.

Discussion and Implications

Similar to Repenning and Henderson (2010), we do not find that focusing on short-term earnings or increasing expectations lead indispensably to failure of a firm in the long run. It does so in two situations:

Expectations beyond a certain threshold: In our model that threshold is a connection of firm-specific effort possible, capability development and productivity. It is plausible to guess, that the exact value of this critical threshold in reality will not be known. Yet, it is also plausible to guess, that shareholder value did not caused massive harm to the majority of firms. It is true, that since the advent of shareholder value in the 1980s many firms had to face takeovers with subsequent changes in management or even cessation of their very existence. On the other hand, new ventures were founded and led to success and a lot of firms grew stronger under the rule of shareholder value. Shorter holding periods of investors or increased discount rates set stretch targets which could be met by most of the firms over time, but not all.

Uncertainty of managerial actions and stretch targets: Since uncertainty is abounding for managers and firms and shareholder value increases the hurdle rate, that situation should be widespread. Again, that does not lead inevitably to failure of firms, but it can explain a more short-term focus of managers and investors alike. Increased pressure to deliver results could put more firms and management teams under stress what would lead to a higher “turnover” in management as well as in firms. For both, empirical evidence is available for a decrease in the tenure of CEOs (Kaplan & Minton, 2007) and the increase in merger & acquisitions since the late 1970's (Jansen, 2008).

The problems with shareholder value and short-termisms are often discussed against the background of corporate scandals like ENRON or excessive compensations of CEOs or investment bankers. Some argue that these should be seen as excesses that should not be attributed to the very idea of shareholder value (Rappaport, 2011). Our model suggests otherwise: short-termism and short-term

orientation seem to be outcomes that are caused by the concept of shareholder value itself, i.e. endogeneously.

Clearly, the model is restricted to the main factors and components of value-based management. It could be enhanced by incorporating factors like agency frictions (Stein, 1989), reporting frequency (Bhojraj & Libby, 2005), management turnover (Palley, 1997) or further not yet mentioned variables which are also possible candidates to explain short-termism.

Furthermore, what we have not discussed are remedies against short-termism, ranging from changing taxation, managerial compensation or firm cultures. But this or an enhanced model can provide the fundament for analysing effects of such remedies on short-termism.

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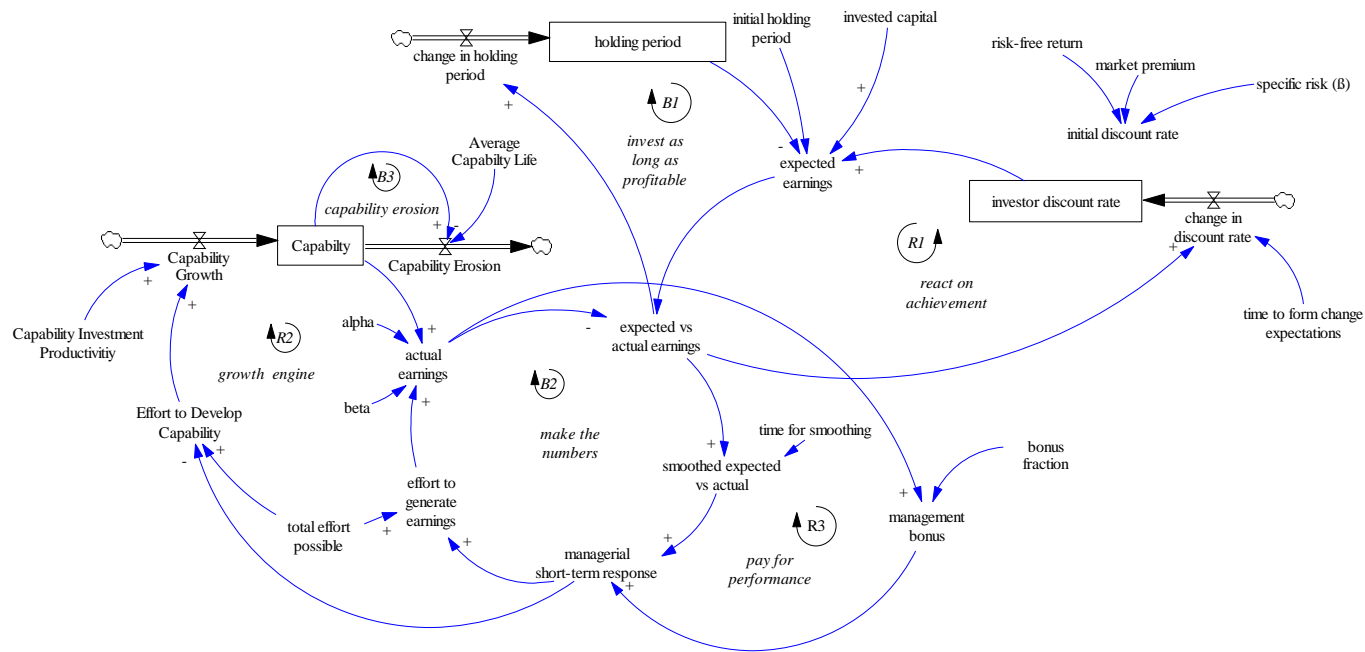
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Appendices

Appendix 1: Model as stock-flow diagram



Appendix 2: Model equations

- (01) actual earnings= Capabilty^{alpha}*(effort to generate earnings)^{beta} [EUR]
- (02) alpha= 0.7 [dimensionless]
- (03) Average Capabilty Life= 36 [months]
- (04) beta= 0.3 [dimensionless]
- (05) bonus fraction= 10 [percentage]
- (06) Capability Erosion= Capabilty/Average Capabilty Life [EUR/month]
- (07) Capability Growth= Effort to Develop Capability^{Capability Investment Productivitiy} [EUR/month]
- (08) Capability Investment Productivitiy= 1 [dimensionless]
- (09) Capabilty= INTEG (Capability Growth-Capability Erosion,100) [EUR]
- (10) change in discount rate= SMOOTH(1- (expected vs actual earnings), time to form change expectations) [percentage]
- (11) change in holding period=(1-SQRT(expected vs actual earnings)) [month/month]
- (12) Effort to Develop Capability= total effort possible * (1-"managerial short-term response") [dimensionless]
- (13) effort to generate earnings= total effort possible * "managerial short-term response" [dimensionless]
- (14) expected earnings= invested capital * (investor discount rate/100) * (holding period/initial holding period) [EUR/month]
- (15) expected vs actual earnings= (expected earnings)/(actual earnings) [dimensionless]
- (16) FINAL TIME = 240 [month]
- (17) holding period= INTEG (change in holding period, initial holding period) [months]
- (18) initial discount rate="risk-free return" + "specific risk (β)" * market premium [percentage]
- (19) initial holding period= 12 [month]
- (20) INITIAL TIME = 0 [month]
- (21) invested capital= 1000 [EUR]
- (22) investor discount rate= INTEG (change in discount rate/10,initial discount rate) [percentage]

- (23) management bonus= $\text{SMOOTH}(\text{actual earnings} * (\text{bonus fraction}/100), 1)$, [EUR]
- (24) "managerial short-term response"= $1/(1+\text{EXP}(\text{LN}(\text{management bonus})*(1-\text{smoothed expected vs actual})))$ [dimensionless]
- (25) market premium= 5 [percentage]
- (26) "risk-free return"= 3 [percentage]
- (27) $\text{SAVEPER} = \text{TIME STEP}$
- (28) smoothed expected vs actual= $\text{SMOOTH}(\text{expected vs actual earnings}, \text{time for smoothing}, 1)$ [dimensionless]
- (29) "specific risk (β)"= 1 [dimensionless]
- (30) time for smoothing= 3 [month]
- (31) $\text{TIME STEP} = 1$ [month]
- (32) time to form change expectations= 3 [month]
- (33) total effort possible= 200 [dimensionless]