The influence of rating philosophy on regulatory capital and procyclicality

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ABSTRACT
The aim of this research is twofold: first, to give insight in the rating philosophy concept, and second, to determine the influence of rating philosophy on the level, volatility and procyclicality of regulatory capital requirements.

The importance for banks to have a solid risk framework to predict credit risk is well reflected by the quality and the quantity of research on this subject. Moreover, a good risk framework is vital to become compliant with the new Basel II framework. The first step when developing a conceptually sound credit risk rating framework is to decide what the credit rating should indicate: the rating philosophy. It is very important for banks to decide whether they want their internal rating systems to grade borrowers according to their current condition (point-in-time, PIT), or their expected condition over a cycle (through-the-cycle, TTC), and unstressed or stressed, because the rating philosophy influences many aspects such as: credit approval, loan pricing, early warning of defaults, the level, volatility and procyclicality of regulatory and economic capital, and as a result the profitability of a bank and its competitive position.

Two datasets are used to determine the influence of rating philosophy on regulatory capital. The main conclusions are that capital requirements under a PIT rating method are on average lower than under a TTC rating approach, even if the average PD over the period is the same. However, PIT ratings lead to very volatile and procyclical capital requirements. The difference in average capital requirements between PIT and TTC stressed is 41.3% to 76.6%. This clearly shows the impact of the choice for a rating philosophy on the profitability of a bank. Banks need therefore to take a well grounded decision on which rating philosophy to adopt.

Keywords: credit ratings, rating philosophy, Basel II, regulatory capital requirements, procyclicality

JEL classification codes: E32, G20, G28, G33

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1 Introduction

The aim of this research is twofold: first, to give insight in the rating philosophy concept, and second, to determine the influence of rating philosophy on the level, volatility and procyclicality of regulatory capital requirements, based on two datasets.

One of the highest risks a bank faces is the risk that one of the bank's[1] counterparties goes into default, not repaying interest and/or principal. A solid framework for measuring credit risk is therefore of the utmost importance for a bank to manage and control its credit risks properly. Moreover, a good risk framework is vital to become compliant with the new Basel II framework. The Basel II IRB approaches require banks to have an internal measure of credit risk, to determine the probability of default (PD) of their obligors. Banks Basel II capital requirements are based on their own assessment of the PD of individual borrowers. However, most banks have difficulties in establishing credible and reliable estimates of their risk factors (Basel Committee on Banking Supervision, 2001).

The consequence of not having a solid risk framework is shown by the ongoing credit crisis in the sub-prime market in the US. Hundreds of thousands of borrowers have been forced to default and several major American sub-prime lenders have filed for bankruptcy. Lenders went from competing for customers on price to competing on easy terms by lowering lending standards, while not having enough focus on the default risk of the obligors.

The first step when developing an internal rating (PD) model is to decide what the rating should indicate, which is called the rating philosophy. The rating philosophy is the view of a financial institution on how rating assignments are affected by the bank's choice of the range of economic, business and industry conditions that are considered in the rating process (FED, 2006). Internal rating systems can be point-in-time oriented (PIT), through-the-cycle (TTC) oriented or follow a mixed approach. This choice can be combined with unstressed or stressed ratings with several levels of stress. In PIT ratings, risks are evaluated based on the current condition of a firm. TTC ratings look through temporary changes in credit risk, regardless of whether they are aggregate, industry or firm specific in nature. They indicate the ability of a firm to survive through the business and economic cycle.

The rating philosophy is of key importance as it affects o.a.:

- Loan pricing
- Early warning of defaults
- Level, volatility and procyclicality of regulatory and economic capital and the cost of capital
- Profitability and shareholder value

[1] The word 'bank' is used throughout the article and this includes all (financial) institutions that grant credit.

Although the rating philosophy is very important, the subject is often neglected by financial institutions, only few financial institutions seem to clearly have made a choice for a rating philosophy (Bank of Japan, 2005). Research by Treacy and Carey (2000) has shown that 25% of the banks rate borrowers risk over a one-year period, 25% over a longer period such as the life of a loan and the remaining 50% had no specific period in mind. Without knowing what the ratings should indicate, it is hard to develop a conceptually sound rating model: to decide which rating method and variables to use. When the model is developed, it is difficult either to interpret the results of backtesting, or to assess what will happen to the capital requirements during an economic cycle (Financial Services Authority, 2005). Banks often evaluate their ratings systems over one-year intervals. However, credit exposures often have maturities greater than one year and proper pricing and portfolio management usually involves analyses over longer periods. This makes it important to consider the possibility of distinct PIT and TTC ratings (Ong, 2005).

The choice for TTC versus PIT and unstressed versus stressed is a trade-off between:

- Quality; whether the ratings give a right indication of the probability of default
- Timeliness; whether the ratings are based on the current situation of the company
- Volatility; whether the ratings migrate often
- Level of PD; based on the level of stress and whether the ratings are PIT or TTC
- Procyclicality of the PD; the extend to which the PD is positively correlated to the economic cycle
- Costs; the higher the PD, the higher the capital requirements are and therefore the related costs

A TTC rating system can be defined by stable ratings and a stable PD level, however, the level of PD is in general higher than for PIT. PIT ratings give a good indication of the current situation of the company and are therefore a good predictor of the PD. However, the PD level is fluctuating and procyclical. The more stressed the ratings are, the higher the level of the PD is. Under the Basel II IRB approaches, the PD is one of the variables that determine the level of regulatory and economic capital needed. High PDs lead to higher capital requirements. High capital requirements are very costly for a bank; they lead to a higher cost of capital. These costs are incorporated in the interest rates charged and this influences profitability and the competitive position of the bank.

In this research, the influence of the different rating philosophies on regulatory capital requirements is determined. Two datasets with different risk profiles are used as indicators of PIT and TTC PDs: Global Corporate Default Study by Standard & Poor's (2007) and high-yield dollar denominated rate for corporate bonds in the U.S. and Canada (Altman, 2007).

The analyses, based on these two datasets, show that PIT ratings on average lead to lower regulatory capital requirements than TTC ratings, even when TTC is defined as the unstressed average of PIT ratings. In case the TTC ratings are stressed, the difference between PIT and TTC becomes larger; capital requirements for a stressed TTC approach can be up to 76.4% higher, depending on the level of stress. Capital requirements based on PIT ratings are very volatile. The capital requirements during a recession are 37% to 76% higher than average PIT capital requirements, depending on the risk profile of the portfolio. The cost of capital for an unstressed TTC rating method is about 9% higher than for PIT. For a stressed TTC rating method, the cost of capital can be up to 76% higher than PIT.

The results show that the level and procyclicality of regulatory capital differs significantly for PIT and TTC rating systems and for stressed and unstressed PDs. This indicates that banks need to take a well grounded decision on which rating philosophy to use because it has a significant influence on the bank's profitability and shareholder value.

The remainder of this paper is structured as follows. In the next section (2): regulatory capital for credit risk is described. In section three, the rating philosophy concept is worked out. Then, the methodology (4) and the results (5) are shown of the analysis of the capital requirements of different rating philosophies. The paper ends with a summary and some concluding remarks (6).

2 Basel II and credit risk

2.1 Pillar 1 regulatory capital for credit risk

The core activity of banks is to grant credit. A direct consequence is to recognize and control risks, especially credit risk. The Basel II Capital Accord requires banks to hold certain levels of capital, which is called regulatory capital (RC), based on their risk profile, in order to ensure that they remain solvent. Under both Basel II Internal Ratings-Based (IRB) approaches, banks' internal assessment of key risk drivers serves as primary input to the Pillar I RC calculation. The risk weights, and thus capital charges, are determined through the combination of quantitative inputs provided by banks, and formulas specified by the Basel Committee. There are three main components that determine the level of regulatory capital:

- Probability of default (PD): the probability of a default, during a given period of time (assessment period). Default means not receiving timely interest and principal as specified in the debt agreement
- Exposure at default (EAD): the outstanding obligation when the default occurs
- Loss given default (LGD): the fraction of the exposure that is lost in the event of a default

Under both IRB approaches, banks should provide own estimates of the PD which Basel II defines as follows: 'the probability that a borrower meets the default definition within one year, expressed as a percentage. A default is considered to have occurred with regard to a particular obligor when the obligor is 90 days past due on any material credit obligation and/or is unlikely to pay its credit obligations' (Basel Committee on Banking Supervision, 2006). To measure the PD on individual banks loans, most banks use rating models, also called credit scoring models. Rating is a process of classifying exposures into different grades that indicate the ability and willingness of counterparties to pay. These internal ratings must discriminate accurately between borrowers with greater and lesser chances of defaulting over the varying time frames, used in the analyses, so that the bank avoids adverse selection in competing for customers (Ong, 2005). Each grade matches with a corresponding PD (range). Under the Foundation IRB (F-IRB) approach, banks should use supervisory LGDs (between 35 and 45%, depending on level of collateralization) and EADs for the calculation of RC. Under the Advanced IRB (A-IRB) approach, banks should develop own methodologies for the determination of these two values. The higher the PD, and or LGD, and or EAD, the higher RC is.

2.2 Correlations between PDs and PD and LGD

So long as bank rating systems are responsive to changes in borrower default risk, capital requirements under the IRB approaches will tend to increase as an economy falls into a recession and fall as an economy enters an expansion (Gordy and Howells, 2006).

Both the probability of default and the loss given default, presented by the value of collateral, like the value of other assets, depend on economic conditions (Altman et al. 2003). The LGD rises just as the default rates tend to increase. Corporate defaults also cluster in time. If, in practice, defaults are more heavily clustered in time than envisioned in the default models, then significantly greater capital might be required in order to survive default losses, especially at high confidence levels (Das et al., 2007). This positive correlation between PDs and between PD and LGD has impact on the expected and unexpected losses and affects the procyclicality in the Basel II Accord for the IRB approaches, since the capital requirements are based on own estimates of PD and for advanced IRB also on own estimates of the LGD. During the last years, several researchers have investigated the relation between PD and LGD, including Jokivuolle and Peura (2003). Based on the found correlations, many have argued that Basel II will make it more difficult for policy makers to maintain macroeconomic stability (Gordy and Howells, 2006). Estrella (2004), among others, points to Pillar II of Basel II as a possible means of attenuating procyclicality. The purpose of Pillar II in the Basel framework is to ensure that the financial institution has sufficient capital available to meet the minimum capital requirements, even under stressed scenarios. However, the reduction of procyclicality will probably raise the average capital requirements.

3 Rating philosophy

3.1 Basel II requirement for rating models

Before a bank develops a rating methodology for the determination of PDs of their obligors, it should decide what it wants its rating models to predict.

The FED (2006) states it as follows: “A bank needs to specify its rating philosophy, that is, how the bank’s wholesale obligor rating assignments are affected by the bank’s choice of the range of economic, business, and industry conditions that are considered in the obligor rating process. The philosophical basis of a bank’s ratings system is important because, when combined with the credit quality of individual obligors, it will determine the frequency of obligor rating changes in a changing economic environment. Rating systems that rate obligors based on their ability to perform over a wide range of economic, business, and industry conditions, sometimes described as “through-the-cycle” systems, tend to have ratings that migrate more slowly as conditions change. Banks that rate obligors based on a more narrow range of likely expected conditions (primarily on recent conditions), sometimes called “point-in-time” systems, would tend to have ratings that migrate more frequently. Many banks will rate obligors using an approach that considers a combination of the current conditions and a wider range of other likely conditions. In any case, the bank would need to specify the rating philosophy used and establish a policy for the migration of obligors from one rating grade to another in response to economic cycles. A bank should understand the effects of ratings migration on its risk-based capital requirements and ensure that sufficient capital is maintained during all phases of the economic cycle”.

3.2 Rating Philosophy

The first step in the rating model development process is the determination of the rating philosophy. Financial institutions should first decide what they want their models to indicate before developing them. However only few financial institutions seem to clearly have made a choice which philosophy to use (Bank of Japan, 2005).

A rating philosophy is how the bank's obligor rating assignments are affected by the bank's choice of the range of economic, business, and industry conditions that are considered in the rating process (FED, 2006), in other words the kind of information the rating intends to summarize. Ratings can be stressed or unstressed with different stress levels. Rating system approaches may be characterized as being on a spectrum between:

- Point-in-time (PIT) approaches
- Through-the-cycle (TTC) approaches

3.3 Point-in-time

A Point-in-Time (PIT) rating system takes all cyclical and non-cyclical, systematic and obligor specific information into account. In a PIT rating process, the rating gives an indication of the borrower's current condition and/or most likely condition over the course of a chosen short time horizon, typically one year, or less (Basel Committee on Banking Supervision, 2001). PIT systems are defined by current PDs that reflect the current creditworthiness of the counterparty. Obligors are constantly assigned to new ratings who's PDs reflect the forward looking default likelihood, based on the best available information about the current credit quality. In case of perfect PIT models, defaults actually experienced should therefore match the predicted defaults in each and every year. The more PIT the PDs are the more forward looking and thus predictive they are.

Under a PIT system, changes in the economic environment surrounding are absorbed by rating migrations. The risk rating to the PD mapping is kept constant. A PIT system can be defined by volatile ratings, due to frequent rating migrations, but constant PDs per rating grade. Ex-post default rates per grade are stable regardless of the business cycle (Bank of Japan, 2005). PIT rating systems are cyclical and forward-looking. In general, PIT ratings tend to rise during economic upturns, as most obligors' creditworthiness improves and tend to fall during economic downturns (procyclicality).

3.4 Through-the-cycle

In literature, there is no consensus on what is precisely meant by TTC, especially on whether TTC ratings are stressed or not. What all definitions have in common is that a TTC estimate is based on a full business or economic cycle, to indicate the creditworthiness of an obligor.

A TTC rating system uses static and dynamic obligor characteristics, but tends not to adjust ratings in response to changes in macroeconomic conditions (Heitfield, 2005). TTC is defined as a measure of the ability of an obligor to remain solvent at the trough of a business or economic cycle or during severe stress events (Treacy and Carey, 2000). A through-the-cycle process requires assessment of the borrower's riskiness based on a worst-case, bottom of the cycle scenario. In this cased, a borrower's rating would tend to stay the same over the course of the credit/business cycle (Basel Committee on Banking Supervision, 2001). TTC ratings are based on a variety of longer-run considerations, financial and non-financial, quantitative and qualitative. The TTC rating methodology requires a separation of permanent and cyclical components in default risk. The essential feature of a TTC system is that it seeks to produce ratings that do not vary with cyclical movements (a cyclical), although the ratings of individual companies will fluctuate due to changes in their own position and prospects. TTC ratings only respond to permanent shocks to the firm, transitory shocks are ignored (Löffler, 2004).

In TTC rating, the rating grades of firms remain the same through the business cycle, but ex-post default rates within the same grade fluctuate reflecting the business cycle (Bank of Japan, 2005). A TTC system can be defined by stable ratings but realized PDs per rating grade vary over the cycle. A rating can therefore reflect different degrees of creditworthiness, depending on the state of the economy (Varsanyi, 2007). The more the deviation between the predicted and the realized PD is, the more difficult the validation of the rating models is. Under a TTC approach, a borrower's rating grade won't be fully sensitive to factors affecting the likelihood of the company defaulting in the next 12 months, such as whether the industry may be at or approaching a cyclical peak. Some risk sensitivity is rejected because transitory information is not used.

Trying to "look through the cycle" as a company's performance fluctuates is a challenge. It involves separating cyclical influences from those that are secular (i.e., longer-term trend) or seasonal, separating systematic (i.e., industry- or economy-wide) factors from those that are idiosyncratic (i.e., company specific) (Taylor, 2003). Under the TTC approach, a downsize or stress scenario is estimated for the borrower and the rating is assigned based on the borrowers projected condition in the event the scenario occurs. The stress scenario used in the TTC rating approach is a deviation from the normal condition which is of a cyclical nature and which occurs with a certain probability over a predefined horizon. Permanent and cyclical components of default risk are typically not directly observable, but have to be estimated (Löffler, 2004). This means that the determination of a TTC rating requires complex (statistical) analyses, which means that TTC grading entails greater expenses, and for many middle market credits the extra expense might render such lending unprofitable for banks (Treaty and Carey, 2000). Rating agencies, such as Moody’s and S&P, follow a TTC rating approach (Ong, 2005).

3.5 Hybrid

Few financial institutions seem to clearly have made a choice between PIT and TTC ratings. They seem to evaluate the creditworthiness of borrowers over some period, for example, three to five years, indicating that their choice is somewhere between the above two types of ratings (Bank of Japan, 2005). The ‘hybrid’ rating philosophy, the area between PIT and TTC is characterized by only partial responsiveness of ratings to changing external circumstances (Taylor, 2003). In a hybrid rating system, both the borrower’s current condition, outlook and cycle effects are included in the rating. Only substantial changes in the creditworthiness influence the rating. Short-term fluctuations, as included in the PIT rating are ignored. Ratings are not continuously reviewed, but on fixed moments in time. In a hybrid model, fluctuations in the economic or business cycles result in a combination of rating grade migration and changes in the level of default experienced in each grade (Financial Services Authority, 2005).

3.6 *Rating volatility*

The extend to which banks need to downgrade borrowers during a recession, depends for a large part on the way the PD is determined.

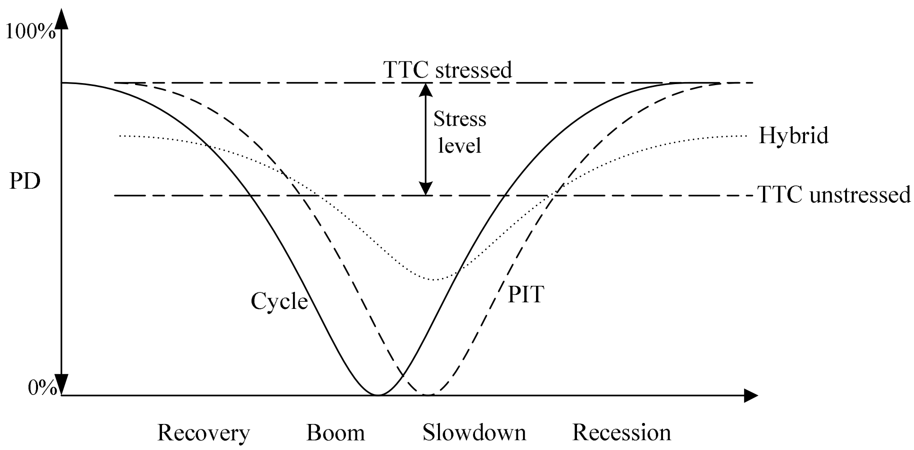

figure 3.1. The influence of the cycle on the ratings

The ratings arising from a TTC system will be stable and cyclically neutral. PIT rating systems that rate obligors on a more narrow range of expected conditions (both permanent and transitory shocks), tend to have ratings that migrate frequently and can be expected to move counter-cyclically, see figure 3.1.

3.7 *Rating horizon*

The rating horizon indicates on what time period the rating is based, see figure 3.2. Basel II uses a rating horizon of one year; “the PD is the probability that a borrower meets the default definition within one year” (Basel Committee on Banking Supervision, 2006).

PIT ratings are based on the expected developments of the creditworthiness of the client over a maximum of a year. A TTC rating looks forward through the cycle and takes the average (stressed) PD over a complete cycle, to estimate a one-year PD.

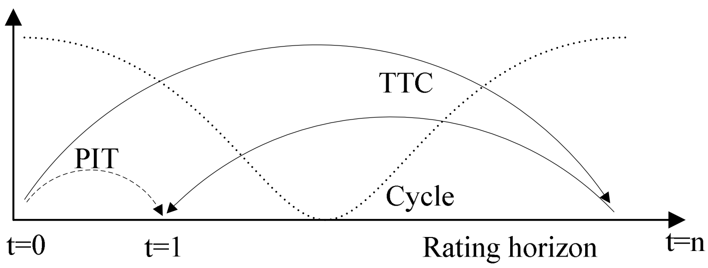

figure 3.2. The rating horizon

3.8 *The importance of rating philosophy*

The philosophical basis of a rating system is of key importance as it affects (o.a.):

- Rating volatility
- Internal rating model power and quality
- Early warning of defaults
- Pricing
- Level, volatility and procyclicality of regulatory and economic capital and the cost of capital
- Profitability, shareholder value and the competitive position of the bank

Figure 3.3 gives and overview of the rating process and shows in which processes the ratings are used. The use of ratings influences the level of efficiency and accuracy of a bank and in the end the profitability and shareholder value.

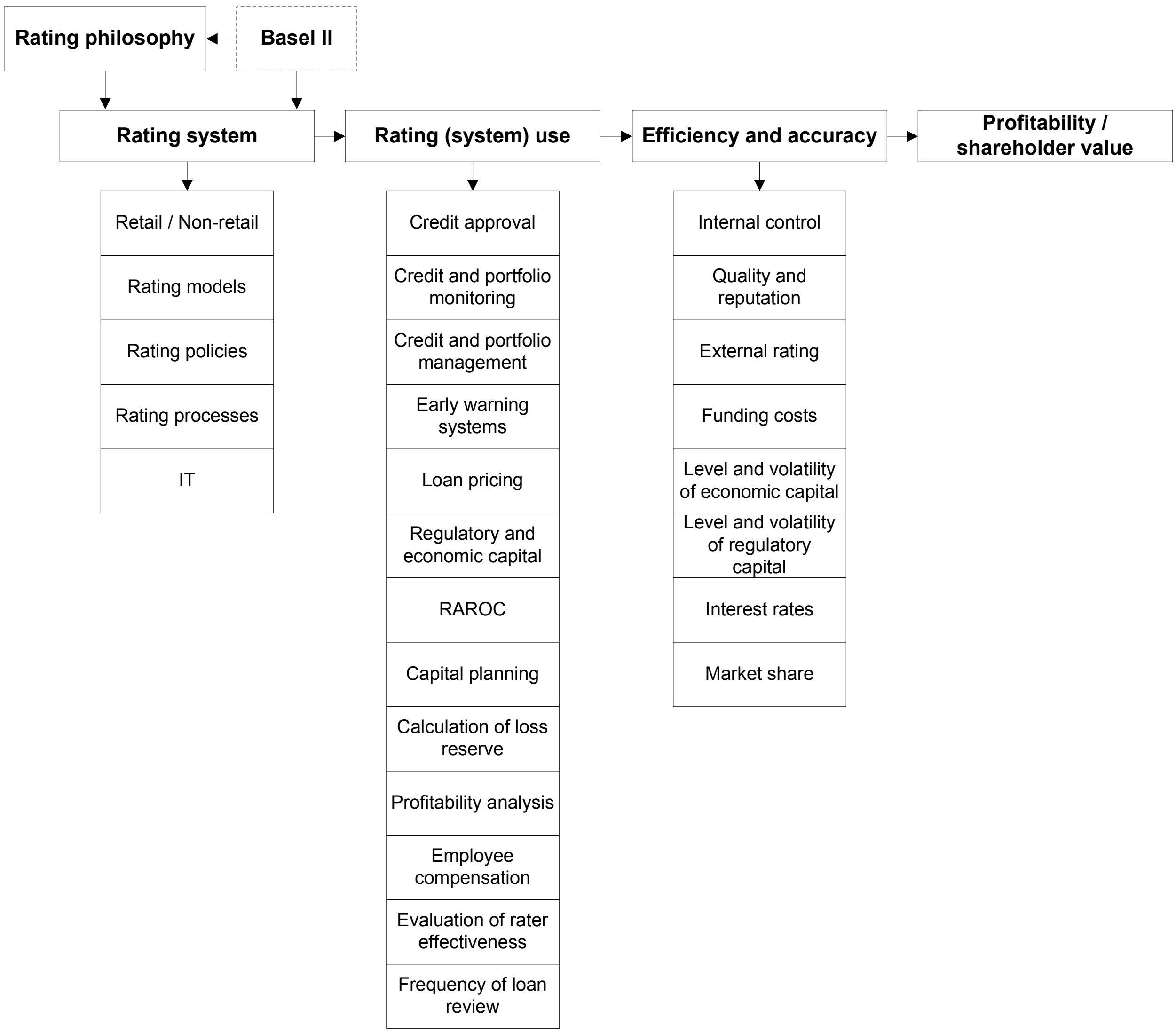

figure 3.3. Rating systems and rating (system) use

The rating philosophy has significant implications for the level and cyclicality of banks' regulatory and economic capital; see also the analysis in the sections 4 and 5. Procyclicality is derived entirely from migration between grades, and is thus based on the ratings system being used by the bank. Procyclicality refers to the tendency for regulatory capital requirements to rise with downswings in the economy and to fall with upswings (Financial Services Authority, 2005). Provided that credit risk components are correlated with macroeconomic conditions, capital requirements will tend to be high in recessions and low in expansions, possibly exacerbating the business cycle through the credit supply.

When using PIT ratings, the internal and regulatory capital requirements are becoming volatile and procyclical. PIT systems lead to higher capital requirements during recessions, which can lead to credit supply constraints as banks suffer capital shortages and they might perhaps even fail, which can worsen the economic situation. Substantial changes in capital requirements can increase the likelihood of a 'credit crunch'. In addition, during recessions, capital available to meet regulatory and economic capital requirements becomes scarcer as banks make more provisions and write-offs. There is also the possibility that actions taken by individual firms to reduce their risk, e.g. by cutting back on lending will magnify the downturn by causing a credit crunch (Financial Services Authority, 2005). On the other hand, during the recovery and peak phases of the cycle, the PIT rating methodology gives the opportunity to grant extra loans, because the capital requirements are lower, and therefore to stimulate the economy. Procyclical ratings can have macroeconomic consequences by encouraging overlending relative to risk in booms and reduction in lending during recessions (Catarineu-Rabell, Jackson and Tsomocos, 2003).

In order to avoid this undesirable side-effect, financial institutions might assign ratings in a "through-the-cycle logic" and estimate default probabilities (PDs) as long-run averages. The capital requirements under a TTC system are not influenced by the cycle, but since the ratings are stressed (according to the majority of definitions); the average capital requirements under a TTC system are expected to be higher than under a PIT system. Besides, this solution is somewhat in contrast with the Basel II purpose of making the capital requirements risk-sensitive. Since TTC ratings are very stable, capital requirements are stable and therefore, capital planning becomes easier.

Research by Catarineu-Rabell, Jackson and Tsomocos (2003) shows that ratings based on TTC rating approaches lead to little, if any, increase in capital requirements for non-defaulted assets in a recession, whereas ratings based on a PIT rating model lead to a 40% to 50% increase.

3.9 The choice for a rating philosophy

The choice for a specific rating philosophy is a trade-off between:

- Quality; whether the ratings give a right indication of the probability of default
- Timeliness; whether the ratings are based on the current situation of the company
- Volatility; whether the ratings migrate often
- Level of PD; based on the level of stress and whether the ratings are PIT or TTC
- Procyclicality of the PD; the extend to which the PD is positively correlated to the economic cycle
- Costs; the higher the PD, the higher the capital requirements are and therefore the related costs

Though we cannot judge a priori which rating method is better than the other for certain banks, it is still very important for financial institutions to understand whether their own internal rating systems are more PIT-oriented, TTC-oriented, or follow a hybrid approach. The optimal rating philosophy is determined by the rating objectives and the type of credit portfolio of the bank.

4 Data

4.1 Sample

The main goal of this research is to determine the influence of rating philosophy on regulatory capital requirements and on the cost of capital.

Since, in case of perfect PIT models the defaults actually experienced should match the predicted defaults in each and every year, historical annual default rates are used as an indicator of PIT PDs. TTC is defined as the long run average realized (PIT) PD. Because there is no consensus on the TTC rating definition, both unstressed and stressed average realized yearly ("PIT") PDs are used as an indicator of TTC PDs. Hybrid PDs are determined as in the middle of TTC and PIT PDs.

The following data are used: the Global Corporate Default Study by Standard & Poor's (2007), and the high-yield dollar denominated rate for corporate bonds in the U.S. and Canada (Altman, 2007), see appendix 1, tables 1 and 2. Table 1 shows the realized default rates over the years as presented by both sources. In table 2, the PIT, TTC and hybrid PDs are presented, where the PIT PDs are the same as the realized defaults over the year of table 1. TTC is defined as the average PD over the period (unstressed) and the average PD + 1, 2 and 3 standard deviations and the highest PD over the whole time period (stressed).

S&P's study analyzes the rating histories of 12,293 companies that were rated by Standard & Poor's as of Dec. 31, 1980, or that were first rated between that date and Dec. 31,

2006. These companies include industrials, utilities, financial institutions, and insurance companies around the world with long-term local currency ratings. A default is recorded on the first occurrence of a payment default on any financial obligation, rated or unrated, other than a financial obligation subject to a bona fide commercial dispute. The default rates are issuer-denominated rates.

The data in Altman's study are the authors' compilations of data of agency ratings from 1971 until 2006. In Altman's study, defaults are defined as bond issues that have missed a payment of interest and this delinquency is not cured within the "grace-period" (usually 30 days), or the firm has filed for bankruptcy under reorganization (Chapter 11) or liquidation (Chapter 7), or there is an announcement of a distressed-restructuring. The default rates are calculated in dollar-denominations.

In the analyses, regulatory capital is calculated according to the Basel II formulas for regulatory capital, for the assets classes corporate and retail (appendix 3). The following assumptions are made, the capital requirements are determined based on an LGD of 40%. There is a linear relationship between regulatory capital and LGD, when the LGD doubles and all other factors are kept constant, capital requirements doubles. The maturity factor used for regulatory capital is 2.5 years.

4.2 Descriptive statistics

The arithmetic-average PD of S&P's data is 1.44%, with a standard deviation of 0.984%. The annual default rate has varied from 0.14% in 1981 to 3.71% in 2001.

The arithmetic-average PD of Altman's data is 3.17% per year, with a standard deviation of 3.12%. The annual default rate has varied from as low as 0.158% in 1981 to as high as 12.80% in 2002. The rate has been about 10% or more (including 2001's 9.8%) in four out of the 36 years. Since 10% or greater is about two-standard-deviations above the mean, four observations with this amount is more than what one might expect in a 36-year time period if we assumed a normal distribution (Altman, 2007). The same holds for the S&P dataset. This indicates that the their might be a 'fat tail' issue, indicating that the chance of extremely high PDs is higher than can be expected based on a normal distribution.

The average PDs and standard deviations of both datasets show that the datasets have a different risk profile, see also figure 4.1. Altman's dataset has a higher average PD and a much higher standard deviation, compared to S&P. Figure 1 and 2 in appendix 1 show the PIT, TTC (unstressed and stressed) and hybrid PDs over the years of the datasets. Both datasets show the same pattern. In the early nineties and in 2001 - 2002, realized PDs were very high. In these years, there was a recession.

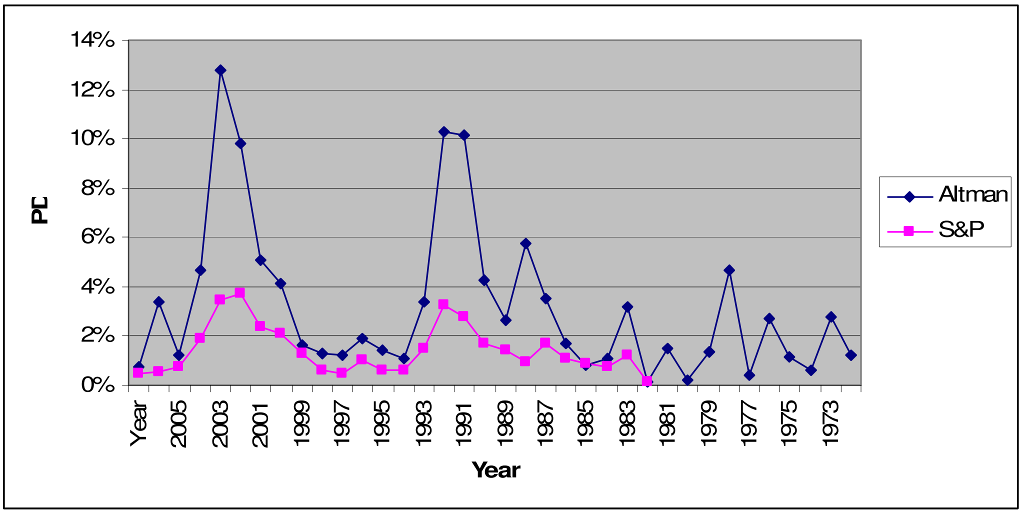

Figure 4.1. Historical realized PDs of Altman's and S&P's dataset

5 Results

5.1 PIT versus TTC on the rating scale

Table 3 of appendix 1 shows the average cumulative PDs over the years 1981 to 2006 of S&P (2007). PIT PDs are defined as the PDs over one year (column Y1). TTC PDs are the average PDs over a cycle, in this example 5, 10 and 15 year, as shown by the last three columns, see also table 5.1. The TTC PDs in this example are unstressed.

	PIT	TTC (average)		
Rating	**Y1**	**5 yr**	**10 yr**	**15 yr**
AAA	0.00	0.06	0.04	0.06
AA+	0.00	0.04	0.03	0.02
AA	0.00	0.04	0.03	0.08
AA-	0.02	0.10	0.07	0.12
A+	0.05	0.13	0.08	0.18
A	0.07	0.13	0.09	0.19
A-	0.06	0.16	0.11	0.20
BBB+	0.16	0.38	0.25	0.43
BBB	0.25	0.43	0.27	0.48
BBB-	0.33	0.81	0.50	0.73
BB+	0.57	1.19	0.74	0.94
BB	0.86	1.80	1.09	1.23
BB-	1.54	2.68	1.59	1.77
B+	2.70	3.75	2.09	2.17
B	7.10	5.15	2.80	2.48
B-	10.11	6.44	3.45	2.71
CCC/C	26.29	9.24	4.75	3.64

table 5.1. PIT and TTC PDs per rating S&P class

From AAA to BB-, the average PD over a longer time period (TTC) is higher than the 1 year PD (PIT), indicating that a TTC PD (which is the average (unstressed or stressed) PIT PD over a longer period), is higher than the PIT PD. This is due to the fact that over a longer time period, companies experience more uncertainty and there is a higher chance of facing problems, which leads to a higher PD percentage. A rating with a long horizon needs to account for all of the things that might occur over several years. A bank can't afford to ignore any of the events that seem likely or just possible over an extended period (Ong, 2006).

The average TTC PD in the range B+ to CCC/C is lower than the one year PIT PD, indicating that for a counterparty with a lower rating, a PIT PD is higher than TTC PD. One possible explanation is that when a company with a rating in the range B+ to CCC/C is able to survive one year, they are strong enough to survive for a longer period. The worst companies in the lower rating classes disappear in the first year because of a default situation; the somewhat stronger ones stay. This leads to a lower average PD over a longer time period.

5.2 Capital requirements PIT versus TTC unstressed

The tables below show a summary of the regulatory capital requirements (retail and non-retail), for a PIT, unstressed TTC and hybrid approach for S&P and Altman. They summarize the information as given in table 5 and 6 of appendix 2.

Non-retail	PIT	TTC	Hybrid
Avg PD	1.44%	1.44%	1.44%
Avg RC	7.28%	7.86%	7.72%
Max RC	10.29%	7.86%	9.28%
Min RC	2.71%	7.86%	6.37%
Stdev RC	1.81%	0.00%	0.78%

Retail	PIT	TTC	Hybrid
Avg PD	1.44%	1.44%	1.44%
Avg RC	3.56%	3.97%	3.87%
Max RC	4.86%	3.97%	4.61%
Min RC	1.07%	3.97%	3.10%
Stdev RC	0.94%	0.00%	0.41%

table 5.2. Regulatory capital requirements – S&P

Non-retail	PIT	TTC	Hybrid
Avg PD	3.17%	3.17%	3.17%
Avg RC	9.00%	9.83%	9.71%
Max RC	15.88%	9.83%	13.37%
Min RC	3.24%	9.83%	8.23%
Stdev RC	2.98%	0.00%	1.28%

Retail	PIT	TTC	Hybrid
Avg PD	3.17%	3.17%	3.17%
Avg RC	4.18%	4.77%	4.66%
Max RC	6.24%	4.77%	5.36%
Min RC	1.34%	4.77%	4.17%
Stdev RC	1.13%	0.00%	0.29%

table 5.3. Regulatory capital requirements – Altman

The row 'Avg PD' gives the average PD over the years and since TTC is defined as the unstressed average PD, the average PD is the same for PIT, TTC and hybrid. TTC has a standard deviation of 0, since each and every year, the same average default rate is used. Max RC gives the highest capital requirements percentage over the time period studied, Min RC the lowest. The time period being studied for the Altman sample is 10 years longer, which can give a bias compared to S&P.

The data show that PIT ratings, even if the average PD over the years is the same for PIT, TTC and hybrid (unstressed scenario), lead to the lowest average regulatory capital requirements, 7.28% for PIT and 7.86% for TTC. Since the relationship between PD and capital requirement is not linear, but has an upward slope, the capital requirements of the hybrid approach are closer to TTC than to PIT.

A PIT rating system has on average lower capital requirements, but the standard deviation is quite high, especially for Altman's dataset with a high default rate. This indicates that the capital requirements under a PIT rating system are volatile and procyclical. For Altman, in case of PIT, average RC is 9% (non-retail) with a standard deviation of almost 3%. The lowest RC was 3.24% versus the highest of 15.88%. The difference between lowest and highest RC is almost a factor 5. The following table gives an indication of PIT rating volatility.

	S&P		**Altman**	
	Non-retail	**Retail**	**Non-retail**	**Retail**
Average RC (table 2)	7.28%	3.56%	9.00%	4.18%
Highest RC (2001, table 5 appendix 2)	10.29%	4.86%	15.88%	6.24%
Lowest RC (2001, table 5 appendix 2)	2.71%	1.07%	3.24%	1.34%
% higher than average	**41.3%**	**36.5%**	**76.4%**	**49.3%**
% higher than lowest	**279.7%**	**354.2%**	**390.1%**	**365.7%**

table 5.4. PIT rating volatility

Table 5.4 shows that under a PIT rating system, the capital requirements for S&P's dataset are 36.5% (retail) to 41.3% (non-retail) higher during a recession, compared to the average capital requirements. For Altman, this is 49.3% (retail) to 76.4% (non-retail). Altman's dataset has on average a higher PD and more volatile PDs. The highest RC is 280% (non-retail) and 354% (retail) higher than the lowest RC for S&P and even 390% (non-retail) and 366% (retail) higher for Altman's dataset. It can be concluded that PIT ratings are very procyclical, since the highest capital requirements match with times of recession in history.

The results found match with research done by Catarineu-Rabell, Jackson and Tsomocos (2003). They found that ratings based on Moody's TTC approach lead to little, if any, increase in capital requirements for non-defaulted assets, whereas ratings based on a Merton-type model (PIT) lead to a 40% to 50% increase in a recession, compared to average.

5.3 Cost of capital PIT versus TTC unstressed

There is an ongoing debate on how to determine the Weighted Average Cost of Capital (WACC) for financial institutions. In this paper, we assume that the WACC equals 10% and use this percentage as a starting point for the analyses. The tables below give an indication of the cost of capital for the different approaches, PIT, TTC and hybrid of a credit portfolio; using a cost of capital of 10% (LGD is 40%). The cost of capital is calculated as: RC% * 10%. For example, RC of PIT non-retail of S&P is 7.28%, 10% of 7.28% equals 0.73%.

Having a credit portfolio of € 1 billion, the assumed cost of capital (non-retail) for one year is € 7.3 million for a PIT rating system and € 7.9 million for a TTC rating system.

		PIT Non-retail	TTC Non-retail	Hybrid Non-retail	PIT Retail	TTC Retail	Hybrid Retail
RC	S&P	0.73%	0.79%	0.77%	0.36%	0.40%	0.39%
	Altman	0.90%	0.98%	0.97%	0.42%	0.48%	0.47%

table 5.5. The cost of capital of RC

5.4 Capital requirements PIT versus TTC stressed

The tables below show the yearly RC requirements using a stressed TTC PD on S&P's and Altman's dataset, compared to unstressed TTC and PIT.

In literature, there is no consensus on what is precisely meant by TTC. Some of the definitions define TTC as the average PD over a cycle; others see TTC as a measure of the ability of an obligor to remain solvent at the trough of a business or economic cycle or during severe stress events (Treacy and Carey. 2000). In this research, 4 definitions of stressed are used: the average realized PD + 1, 2 and 3 standard deviations and the highest PD in the range, see appendix 1, table 1 and 2. Table 5.6 gives and indication of the average PDs and capital requirements of both datasets, for the different stress levels.

For the S&P dataset, the average PD over the time period is 1.436%. The standard deviation is 0.984%, so TTC + 1 st. dev. equals 2.42%, etc.. The highest PD over the time period is in 3.71% in 2001. The standard deviation of Altman's dataset is 3.116%.

	S&P			Altman		
Data	**PD**	**Non-retail**	**Retail**	**PD**	**Non-retail**	**Retail**
PIT	1.44%	7.28%	3.56%	3.17%	9.00%	4.18%
TTC unstressed	1.44%	7.86%	3.97%	3.17%	9.83%	4.77%
TTC + 1 st. dev.	2.42%	9.13%	4.56%	6.28%	12.23%	5.14%
TTC + 2 st. dev.	3.40%	10.03%	4.81%	9.40%	14.22%	5.59%
TTC + 3 st. dev.	4.39%	10.83%	4.94%	12.52%	15.76%	6.18%
TTC max	3.71%	10.29%	4.86%	12.80%	15.88%	6.24%

table 5.6. Regulatory capital requirements TTC stressed of S&P and Altman

The results show that for S&P, RC non-retail for TTC maximum stressed is 30.9% (41.3%) higher than TTC unstressed (PIT), for Altman, RC is 61.5% (76.4%) higher. The more stressed the PDs are, the higher RC, and the larger the difference between PIT and TTC unstressed and TTC stressed.

5.5 Cots of capital PIT versus TTC stressed

	S&P		Altman	
Data	**Non-retail**	**Retail**	**Non-retail**	**Retail**
PIT	0.73%	0.36%	0.90%	0.42%
TTC unstressed	0.79%	0.40%	0.98%	0.48%
TTC + 1 st. dev.	0.91%	0.46%	1.22%	0.51%
TTC + 2 st. dev.	1.00%	0.48%	1.42%	0.56%
TTC + 3 st. dev.	1.08%	0.49%	1.58%	0.62%
TTC max	1.03%	0.49%	1.59%	0.62%

table 5.7. The cost of capital of RC of S&P and Altman

The assumed yearly cost of capital of a non-retail credit portfolio of € 1 billion is € 7.28 million for PIT, € 7.86 million for an unstressed TTC system and € 10.29 million for a maximum stressed TTC rating system (S&P). For Altman, the difference is even larger, € 9.00 million (PIT) versus € 15.9 million (TTC stressed). When having a large credit portfolio as a bank, this difference is significant over the years and influences profitability and shareholder value.

5.6 Correlated PDs and LGDs

The examples above give an indication of RC and procyclicality using PIT and TTC PDs and an LGD of 40%. However, research by Altman et al (2003) and others has shown that PDs and LGDs are correlated. During economic downturns, both the PD and LGD go up. Under the advanced IRB approach (A-IRB), banks should use own estimates of both PD and LGD for the determination of regulatory capital. It can therefore be assumed that under A-IRB, regulatory capital becomes even more procyclical than the examples above indicate.

In the following example, the following relation between PDs and LGDs is assumed: when PD doubles, LGD doubles too. The RC is compared to RC with an LGD of 40%.

PD	LGD	RC non-retail	RC retail
1%	10%	1.74%	0.86%
2%	20%	4.33%	2.19%
4%	40%	10.52%	4.90%
6%	60%	18.05%	7.66%

PD	LGD	RC non-retail	RC retail
1%	40%	6.96%	3.45%
2%	40%	8.66%	4.37%
4%	40%	10.52%	4.90%
6%	40%	12.03%	5.11%

table 5.8 RC for a correlated PD and LGD, compared to no correlation

What the example above shows is that when LGDs and PDs show a positive correlation, the range of RC becomes much wider than with an LGD of 40%. RC under the A-IRB approach is probably more volatile and procyclical than RC under the F-IRB approach.

5.7 Analyses of the results

The main results can be summarized as follows:

- Capital requirements under a PIT rating system are the lowest in all cases, even when TTC is defined as the average PIT PD (unstressed). The only exception might be companies in the rating range B+ to CCC/C, since analyses has shown that a PIT PD is higher than an unstressed TTC PD (paragraph 5.1).
- The riskier a credit portfolio, the more volatile the PDs are, leading to extremely volatile and procyclical PIT capital requirements or very high TTC stressed capital requirements.
- The difference in average non-retail capital requirements and cost of capital between PIT and TTC maximum stressed is 41.3 (S&P) to 76.4% (Altman). This example clearly shows the impact of the choice for a rating philosophy on profitability of a bank. The

costs are incorporated in the interest rates charged, but this influences the competitive position of a bank and thus profitability and shareholders value.

- Since PDs and LGDs are correlated (during economic downturns, both the PD and LGD go up), it can be expected that RC under the Advanced IRB approach is even more procyclical than RC under the Foundation IRB approach, since A-IRB used own estimates for both PD and LGD, while F-IRB uses supervisory LGDs.

Capital requirements are significantly higher under a stressed TTC approach than under an unstressed TTC or PIT approach. In practice, it seems that a (fully) stressed TTC approach cannot be used because of competitive disadvantages. Higher capital requirements lead to a higher cost of capital; therefore the interest rates charged are higher. Besides, a fully stressed TTC approach is somewhat in contrast with the Basel II purpose of making the capital requirements more risk-sensitive.

An unstressed TTC approach leads on average only to slightly higher capital requirements than PIT; however, there are many years that the realized PD will be higher than the PD used for capital calculations. In those cases, regulatory and economic buffer capital available are lower than they should be based on the banks risk profile on that time, which leads to a higher risk of bank default. This conflicts with the main goals of Basel II which are to help protect the international financial system from the types of problems that might arise should a major bank or a series of banks collapse and to stimulate overall economic stability. According to Tayler (2003), since defaults are clustered during times of economic distress and LGDs are correlated with default rates, a time-weighted average may materially understate loss severity per occurrence. What Basel II proposes is that the LGDs assigned should be based not on its long run average, but rather on a bottom of the cycle level, to account for cyclical volatility and the resulting systematic risk.

A PIT PD leads on average to low capital requirements and the capital requirements represent the true risk profile of the credit portfolio. However, since the PD is very volatile, there is a risk of procyclicality, which has several unfavorable effects, see also paragraph 3.8. Since the PIT ratings are very volatile and the standard deviation is quite high, financial institutions are probably required by their supervisors to hold extra Pillar II capital to be able to manage the extremes.

6 Conclusion

The first step in the rating model development process is to decide what the ratings should indicate: the rating philosophy. It is very important for financial institutions to understand whether they want their internal rating systems to be point-in-time oriented (PIT), through-the-cycle (TTC) oriented, or follow a mixed approach, in other words the kind of information they want the rating to summarize. The rating philosophy is of key importance as it affects: pricing, early warning of defaults, the level, volatility and procyclicality of regulatory and economic capital requirements and as a result, the profitability of a bank and its competitive position.

The influence of rating philosophy on the level and procyclicality of regulatory capital requirements has been analyzed in this paper. The analyses, based on datasets of S&P and Altman with different risk profiles, show that PIT ratings on average lead to lower regulatory capital requirements than TTC ratings, even when TTC is defined as the unstressed average of PIT ratings. In case the TTC ratings are stressed, the difference between PIT and TTC becomes larger; capital requirements for a stressed TTC approach can be up to 76.4% higher, depending on the level of stress. Capital requirements based on PIT ratings are very volatile. The capital requirements during a recession are 37% to 76% higher than average PIT capital requirements, depending on the risk profile of the portfolio. The cost of capital for an unstressed TTC rating method is about 9% higher than for PIT. For a stressed TTC rating method, the cost of capital can be up to 75% higher, compared to PIT.

The results show that the level and procyclicality of regulatory capital differs significantly for PIT and TTC rating systems and for stressed and unstressed ratings. This indicates that banks need to take a well grounded decision on which rating philosophy to use since rating philosophy influences profitability and therefore the competitive position.

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Appendix 1 Descriptives

Year	Annual default rates	
	S & P[1]	Altman[2]
2006	0.44%	0.761%
2005	0.56%	3.375%
2004	0.77%	1.249%
2003	1.86%	4.661%
2002	3.48%	12.795%
2001	3.71%	9.801%
2000	2.40%	5.073%
1999	2.09%	4.147%
1998	1.27%	1.603%
1997	0.62%	1.252%
1996	0.50%	1.231%
1995	1.03%	1.896%
1994	0.62%	1.454%
1993	0.60%	1.105%
1992	1.49%	3.402%
1991	3.26%	10.273%
1990	2.74%	10.140%
1989	1.69%	4.285%
1988	1.43%	2.662%
1987	0.95%	5.778%
1986	1.72%	3.497%
1985	1.10%	1.708%
1984	0.91%	0.840%
1983	0.76%	1.095%
1982	1.19%	3.186%
1981	0.14%	0.158%
1980	-	1.500%
1979	-	0.193%
1978	-	1.330%
1977	-	4.671%
1976	-	0.388%
1975	-	2.731%
1974	-	1.129%
1973	-	0.626%
1972	-	2.786%
1971	-	1.242%
Average	**1.436%**	**3.167%**
St. dev.	**0.984%**	**3.116%**

Table 1. Annual default rates

Sources:
[1] Standard & Poor's Annual 2006 Global Corporate Default Study and Ratings Transitions. January 2007.
[2] E.I. Altman. About Corporate Default Rates. Chapter 15.

Year	S&P						
	Unstressed PD			Stressed PD TTC			
	PIT	TTC	hybrid	+1 st. dev.	+2 st. dev.	+3 st. dev.	Max.
2006	0.44%	1.44%	0.94%	2.42%	3.40%	4.39%	3.71%
2005	0.56%	1.44%	1.00%	2.42%	3.40%	4.39%	3.71%
2004	0.77%	1.44%	1.10%	2.42%	3.40%	4.39%	3.71%
2003	1.86%	1.44%	1.65%	2.42%	3.40%	4.39%	3.71%
2002	3.48%	1.44%	2.46%	2.42%	3.40%	4.39%	3.71%
2001	3.71%	1.44%	2.57%	2.42%	3.40%	4.39%	3.71%
2000	2.40%	1.44%	1.92%	2.42%	3.40%	4.39%	3.71%
1999	2.09%	1.44%	1.76%	2.42%	3.40%	4.39%	3.71%
1998	1.27%	1.44%	1.35%	2.42%	3.40%	4.39%	3.71%
1997	0.62%	1.44%	1.03%	2.42%	3.40%	4.39%	3.71%
1996	0.50%	1.44%	0.97%	2.42%	3.40%	4.39%	3.71%
1995	1.03%	1.44%	1.23%	2.42%	3.40%	4.39%	3.71%
1994	0.62%	1.44%	1.03%	2.42%	3.40%	4.39%	3.71%
1993	0.60%	1.44%	1.02%	2.42%	3.40%	4.39%	3.71%
1992	1.49%	1.44%	1.46%	2.42%	3.40%	4.39%	3.71%
1991	3.26%	1.44%	2.35%	2.42%	3.40%	4.39%	3.71%
1990	2.74%	1.44%	2.09%	2.42%	3.40%	4.39%	3.71%
1989	1.69%	1.44%	1.56%	2.42%	3.40%	4.39%	3.71%
1988	1.43%	1.44%	1.43%	2.42%	3.40%	4.39%	3.71%
1987	0.95%	1.44%	1.19%	2.42%	3.40%	4.39%	3.71%
1986	1.72%	1.44%	1.58%	2.42%	3.40%	4.39%	3.71%
1985	1.10%	1.44%	1.27%	2.42%	3.40%	4.39%	3.71%
1984	0.91%	1.44%	1.17%	2.42%	3.40%	4.39%	3.71%
1983	0.76%	1.44%	1.10%	2.42%	3.40%	4.39%	3.71%
1982	1.19%	1.44%	1.31%	2.42%	3.40%	4.39%	3.71%
1981	0.14%	1.44%	0.79%	2.42%	3.40%	4.39%	3.71%
Avg	**1.436%**	**1.436%**	**1.436%**	**2.42%**	**3.40%**	**4.39%**	**3.71%**
St. dev	**0.984%**	**0.000%**	**0.492%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Table 2. PIT, TTC and hybrid PDs, based on S&P's dataset

The unstressed PIT PD is the annual historical realized PD of table 1. Since in a perfect PIT rating system, predicted PDs perfectly match realized default percentages, it is assumed that the realized historical PDs match the PIT rating.

The unstressed TTC PD is the average of the PIT PDs over the whole period (1,436%). The hybrid PD is the average of the unstressed PIT PD of that year and unstressed TTC PD.

In literature, there is no consensus on what is precisely meant by TTC. Some of the definitions define TTC as a measure of the ability of an obligor to remain solvent at the trough of a business or economic cycle or during severe stress events (Treacy and Carey. 2000). In this research, 4 definitions of stressed are used: the average PD + 1, 2 and 3 standard deviations and the highest PD in the range (max.).

For the S&P dataset, the average PD over the time period is 1.436%. The standard deviation is 0.984%. TTC + 1 st. dev. equals 2.42%. The highest PD over the time period is in 3.71% in 2001.

Year	Altman						
	Unstressed PD			Stressed PD TTC			
	PIT	TTC	hybrid	+1 st. dev.	+2 st. dev.	+3 st. dev.	Max.
2006	0.761%	3.167%	1.964%	6.283%	9.399%	12.515%	12.795%
2005	3.375%	3.167%	3.271%	6.283%	9.399%	12.515%	12.795%
2004	1.249%	3.167%	2.208%	6.283%	9.399%	12.515%	12.795%
2003	4.661%	3.167%	3.914%	6.283%	9.399%	12.515%	12.795%
2002	12.795%	3.167%	7.981%	6.283%	9.399%	12.515%	12.795%
2001	9.801%	3.167%	6.484%	6.283%	9.399%	12.515%	12.795%
2000	5.073%	3.167%	4.120%	6.283%	9.399%	12.515%	12.795%
1999	4.147%	3.167%	3.657%	6.283%	9.399%	12.515%	12.795%
1998	1.603%	3.167%	2.385%	6.283%	9.399%	12.515%	12.795%
1997	1.252%	3.167%	2.210%	6.283%	9.399%	12.515%	12.795%
1996	1.231%	3.167%	2.199%	6.283%	9.399%	12.515%	12.795%
1995	1.896%	3.167%	2.532%	6.283%	9.399%	12.515%	12.795%
1994	1.454%	3.167%	2.311%	6.283%	9.399%	12.515%	12.795%
1993	1.105%	3.167%	2.136%	6.283%	9.399%	12.515%	12.795%
1992	3.402%	3.167%	3.285%	6.283%	9.399%	12.515%	12.795%
1991	10.273%	3.167%	6.720%	6.283%	9.399%	12.515%	12.795%
1990	10.140%	3.167%	6.654%	6.283%	9.399%	12.515%	12.795%
1989	4.285%	3.167%	3.726%	6.283%	9.399%	12.515%	12.795%
1988	2.662%	3.167%	2.915%	6.283%	9.399%	12.515%	12.795%
1987	5.778%	3.167%	4.473%	6.283%	9.399%	12.515%	12.795%
1986	3.497%	3.167%	3.332%	6.283%	9.399%	12.515%	12.795%
1985	1.708%	3.167%	2.438%	6.283%	9.399%	12.515%	12.795%
1984	0.840%	3.167%	2.004%	6.283%	9.399%	12.515%	12.795%
1983	1.095%	3.167%	2.131%	6.283%	9.399%	12.515%	12.795%
1982	3.186%	3.167%	3.177%	6.283%	9.399%	12.515%	12.795%
1981	0.158%	3.167%	1.663%	6.283%	9.399%	12.515%	12.795%
1980	1.500%	3.167%	2.334%	6.283%	9.399%	12.515%	12.795%
1979	0.193%	3.167%	1.680%	6.283%	9.399%	12.515%	12.795%
1978	1.330%	3.167%	2.249%	6.283%	9.399%	12.515%	12.795%
1977	4.671%	3.167%	3.919%	6.283%	9.399%	12.515%	12.795%
1976	0.388%	3.167%	1.778%	6.283%	9.399%	12.515%	12.795%
1975	2.731%	3.167%	2.949%	6.283%	9.399%	12.515%	12.795%
1974	1.129%	3.167%	2.148%	6.283%	9.399%	12.515%	12.795%
1973	0.626%	3.167%	1.897%	6.283%	9.399%	12.515%	12.795%
1972	2.786%	3.167%	2.977%	6.283%	9.399%	12.515%	12.795%
1971	1.242%	3.167%	2.205%	6.283%	9.399%	12.515%	12.795%
Avg	**3.167%**	**3.167%**	**3.167%**	**6.283%**	**9.399%**	**12.515%**	**12.795%**
St. dev	**3.116%**	**0.000%**	**1.558%**	**0.000%**	**0.000%**	**0.000%**	**0.000%**

Table 3. PIT, TTC and hybrid PDs. based on Altman's dataset

For Altman's dataset, the average PD over the time period is 3.167%. The standard deviation is 3.116%. TTC + 1 st. dev. equals 9.399%. The highest PD over the time period is in 12.795% in 2002.

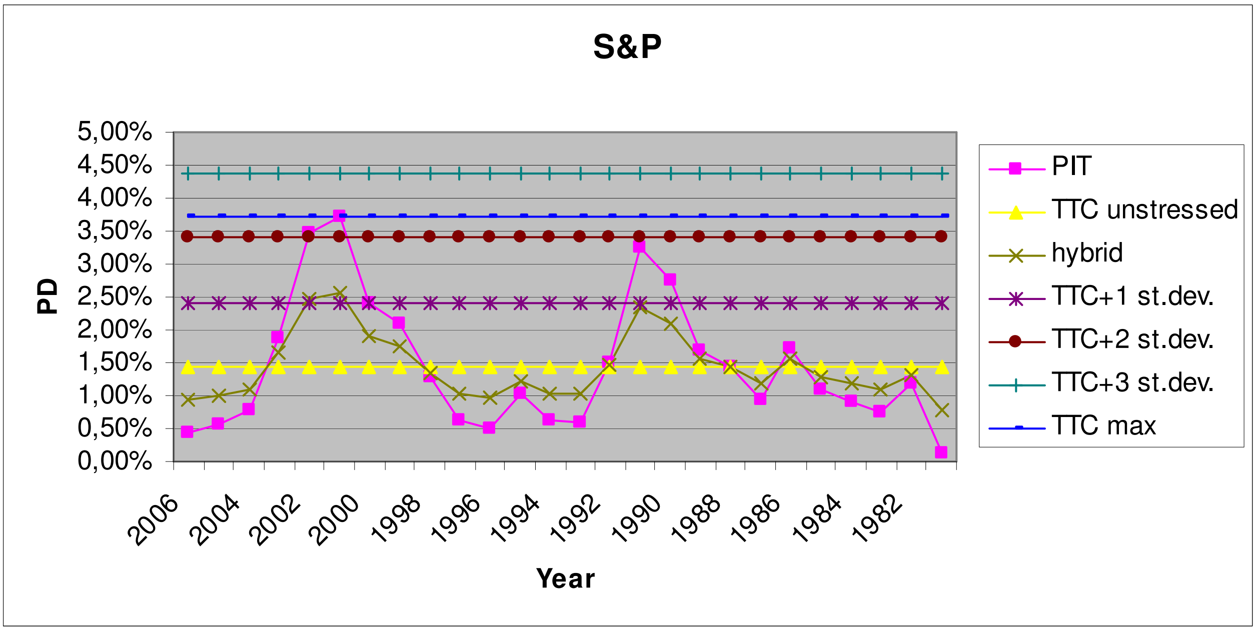

Fig. 1. PIT, TTC and hybrid PDs of S&P

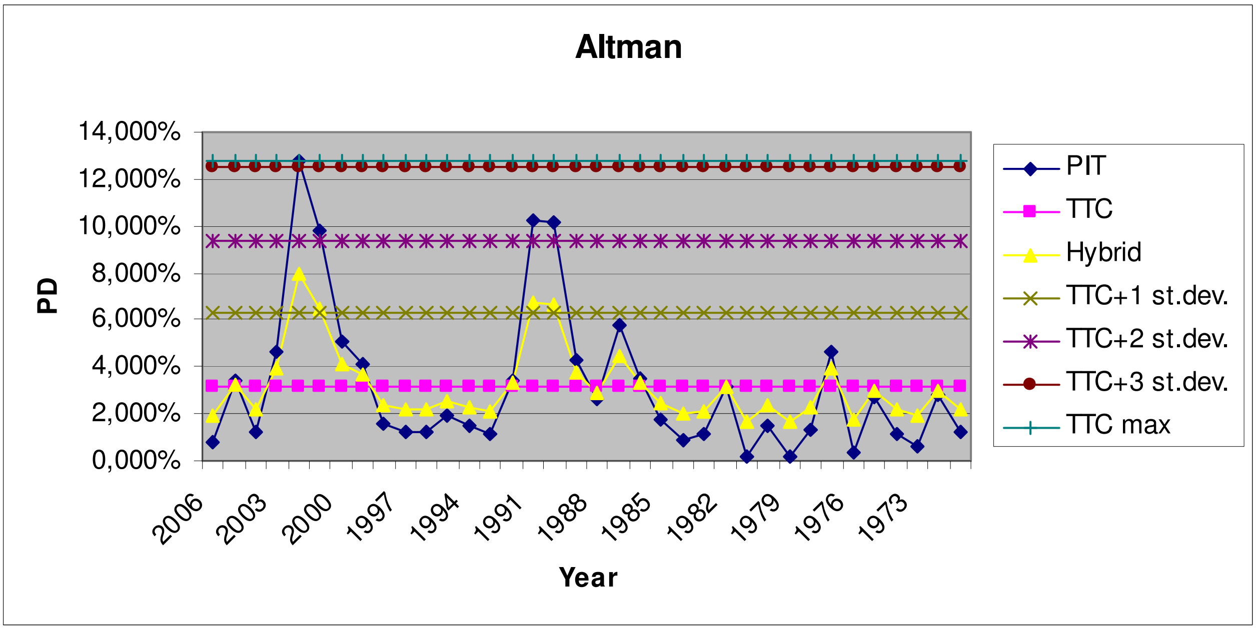

Fig. 2. PIT, TTC and hybrid PDs of Altman

The figures above show the PIT, TTC (unstressed and stressed) and hybrid PDs over the years of both datasets.
Both datasets show the same pattern. In the early nineties and in 2001 - 2002, realized PDs were very high. During these years, there was a recession.

																Average		
Rating	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**	**Y11**	**Y12**	**Y13**	**Y14**	**Y15**	**5 yr**	**10 yr**	**15 yr**
AAA	0.00	0.00	0.09	0.19	0.29	0.43	0.50	0.62	0.66	0.70	0.70	0.70	0.70	0.76	0.83	0.06	0.04	0.06
AA+	0.00	0.07	0.07	0.14	0.21	0.29	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.04	0.03	0.02
AA	0.00	0.00	0.00	0.09	0.21	0.29	0.39	0.53	0.65	0.78	0.88	0.96	1.11	1.19	1.24	0.04	0.03	0.08
AA-	0.02	0.09	0.21	0.34	0.48	0.65	0.81	0.95	1.07	1.20	1.34	1.51	1.57	1.71	1.79	0.10	0.07	0.12
A+	0.05	0.10	0.26	0.47	0.63	0.80	1.02	1.18	1.38	1.57	1.79	2.03	2.26	2.51	2.73	0.13	0.08	0.18
A	0.07	0.19	0.32	0.44	0.63	0.85	1.06	1.29	1.52	1.85	2.12	2.27	2.43	2.52	2.82	0.13	0.09	0.19
A-	0.06	0.22	0.35	0.53	0.79	1.11	1.57	1.87	2.14	2.33	2.42	2.56	2.67	2.80	2.93	0.16	0.11	0.20
BBB+	0.16	0.50	1.00	1.43	1.92	2.46	2.86	3.23	3.74	4.14	4.54	4.77	5.16	5.74	6.39	0.38	0.25	0.43
BBB	0.25	0.59	0.93	1.52	2.14	2.72	3.25	3.84	4.34	4.90	5.53	6.02	6.55	6.77	7.19	0.43	0.27	0.48
BBB-	0.33	1.11	1.94	3.04	4.07	5.04	5.77	6.47	7.00	7.67	8.26	8.84	9.42	10.26	10.90	0.81	0.50	0.73
BB+	0.57	1.54	3.12	4.62	5.94	7.36	8.65	9.25	10.32	11.18	11.76	12.31	12.80	13.37	14.17	1.19	0.74	0.94
BB	0.86	2.67	4.92	6.99	9.02	10.92	12.36	13.73	14.81	15.70	16.88	17.81	18.24	18.34	18.44	1.80	1.09	1.23
BB-	1.54	4.47	7.62	10.72	13.39	15.86	17.76	19.68	21.34	22.57	23.58	24.32	25.30	26.01	26.62	2.68	1.59	1.77
B+	2.70	7.46	12.04	15.91	18.75	20.87	22.86	24.53	25.95	27.41	28.62	29.59	30.64	31.71	32.59	3.75	2.09	2.17
B	7.10	14.23	19.47	23.21	25.77	28.03	29.45	30.56	31.48	32.48	33.42	34.45	35.58	36.39	37.26	5.15	2.80	2.48
B-	10.11	18.61	24.89	29.10	32.20	34.48	36.44	37.67	38.44	38.94	39.48	39.87	40.09	40.32	40.58	6.44	3.45	2.71
CCC/C	26.29	34.73	39.96	43.19	46.22	47.49	48.61	49.23	50.95	51.83	52.57	53.34	53.95	54.59	54.59	9.24	4.75	3.64

Table 4. S&P's Cumulative Average Default rates, 1981 to 2006 (%), Standard & Poor's Annual 2006 Global Corporate Default Study and Ratings Transitions, January 2007

This table shows the average cumulative PDs over the years 1981 to 2006 of Standard & Poor's. Cumulative default rates that average the experience of all static pools were derived by calculating marginal default rates, conditional on survival (survivors being non-defaulters) for each possible time horizon and for each static pool, weight averaging the conditional marginal default rates, and accumulating the average conditional marginal default rates.

The last columns show the average PD's calculated over a period of 5, 10 and 15 years (TTC PDs).

Appendix 2 Capital requirements PIT versus TTC unstressed

	PIT		TTC		Hybrid	
Year	**Non-retail**	**Retail**	**Non-retail**	**Retail**	**Non-retail**	**Retail**
2006	4.95%	2.27%	7.86%	3.97%	6.80%	3.36%
2005	5.52%	2.60%	7.86%	3.97%	6.96%	3.45%
2004	6.31%	3.06%	7.86%	3.97%	7.20%	3.59%
2003	8.48%	4.29%	7.86%	3.97%	8.19%	4.15%
2002	10.10%	4.83%	7.86%	3.97%	9.17%	4.58%
2001	10.29%	4.86%	7.86%	3.97%	9.28%	4.61%
2000	9.11%	4.55%	7.86%	3.97%	8.56%	4.33%
1999	8.76%	4.42%	7.86%	3.97%	8.35%	4.22%
1998	7.55%	3.80%	7.86%	3.97%	7.70%	3.88%
1997	5.77%	2.74%	7.86%	3.97%	7.03%	3.49%
1996	5.25%	2.44%	7.86%	3.97%	6.88%	3.41%
1995	7.03%	3.49%	7.86%	3.97%	7.47%	3.75%
1994	5.77%	2.74%	7.86%	3.97%	7.03%	3.49%
1993	5.69%	2.70%	7.86%	3.97%	7.01%	3.48%
1992	7.94%	4.01%	7.86%	3.97%	7.89%	3.99%
1991	9.91%	4.79%	7.86%	3.97%	9.05%	4.53%
1990	9.44%	4.67%	7.86%	3.97%	8.76%	4.42%
1989	8.25%	4.18%	7.86%	3.97%	8.05%	4.07%
1988	7.84%	3.96%	7.86%	3.97%	7.84%	3.96%
1987	6.83%	3.37%	7.86%	3.97%	7.39%	3.70%
1986	8.29%	4.20%	7.86%	3.97%	8.09%	4.09%
1985	7.20%	3.59%	7.86%	3.97%	7.55%	3.80%
1984	6.72%	3.31%	7.86%	3.97%	7.35%	3.68%
1983	6.27%	3.04%	7.86%	3.97%	7.20%	3.59%
1982	7.39%	3.70%	7.86%	3.97%	7.63%	3.84%
1981	2.71%	1.07%	7.86%	3.97%	6.37%	3.10%
Total %	**189.37%**	**92.68%**	**204.35%**	**103.19%**	**200.81%**	**100.56%**
Avg	7.28%	3.56%	7.86%	3.97%	7.72%	3.87%
Stdev	1.81%	0.94%	0.00%	0.00%	0.78%	0.41%

Table 5. Regulatory capital requirements – S&P

The table above shows the regulatory capital requirements for PIT, TTC and hybrid PDs (unstressed) on data of S&P (see table 2 for the PDs), using an LGD of 40%. The Basel II formulas as presented in appendix 3 for the calculation of regulatory capital for corporates and retail exposures are used.

	PIT		TTC		Hybrid	
Year	**Non-retail**	**Retail**	**Non-retail**	**Retail**	**Non-retail**	**Retail**
2006	6.28%	3.04%	9.83%	4.77%	8.61%	4.35%
2005	10.01%	4.81%	9.83%	4.77%	9.92%	4.79%
2004	7.51%	3.77%	9.83%	4.77%	8.90%	4.47%
2003	11.04%	4.97%	9.83%	4.77%	10.45%	4.89%
2002	15.88%	6.24%	9.83%	4.77%	13.37%	5.36%
2001	14.45%	5.66%	9.83%	4.77%	12.37%	5.16%
2000	11.35%	5.01%	9.83%	4.77%	10.62%	4.91%
1999	10.64%	4.92%	9.83%	4.77%	10.24%	4.85%
1998	8.12%	4.11%	9.83%	4.77%	9.09%	4.55%
1997	7.52%	3.78%	9.83%	4.77%	8.90%	4.47%
1996	7.47%	3.75%	9.83%	4.77%	8.89%	4.47%
1995	8.53%	4.31%	9.83%	4.77%	9.24%	4.60%
1994	7.88%	3.98%	9.83%	4.77%	9.01%	4.52%
1993	7.21%	3.60%	9.83%	4.77%	8.82%	4.44%
1992	10.03%	4.81%	9.83%	4.77%	9.93%	4.79%
1991	14.70%	5.75%	9.83%	4.77%	12.54%	5.19%
1990	14.63%	5.72%	9.83%	4.77%	12.49%	5.18%
1989	10.75%	4.93%	9.83%	4.77%	10.30%	4.86%
1988	9.37%	4.64%	9.83%	4.77%	9.60%	4.71%
1987	11.87%	5.08%	9.83%	4.77%	10.89%	4.95%
1986	10.11%	4.83%	9.83%	4.77%	9.97%	4.80%
1985	8.27%	4.19%	9.83%	4.77%	9.14%	4.57%
1984	6.52%	3.19%	9.83%	4.77%	8.66%	4.37%
1983	7.18%	3.58%	9.83%	4.77%	8.81%	4.44%
1982	9.85%	4.77%	9.83%	4.77%	9.84%	4.77%
1981	2.90%	1.17%	9.83%	4.77%	8.21%	4.15%
1980	7.96%	4.02%	9.83%	4.77%	9.04%	4.53%
1979	3.24%	1.34%	9.83%	4.77%	8.23%	4.17%
1978	7.67%	3.86%	9.83%	4.77%	8.94%	4.49%
1977	11.05%	4.97%	9.83%	4.77%	10.46%	4.89%
1976	4.66%	2.10%	9.83%	4.77%	8.37%	4.24%
1975	9.43%	4.66%	9.83%	4.77%	9.64%	4.72%
1974	7.26%	3.63%	9.83%	4.77%	8.83%	4.45%
1973	5.79%	2.76%	9.83%	4.77%	8.53%	4.31%
1972	9.49%	4.68%	9.83%	4.77%	9.66%	4.73%
1971	7.50%	3.76%	9.83%	4.77%	8.90%	4.47%
Total	**324.11%**	**150.42%**	**353.86%**	**171.70%**	**349.43%**	**167.63%**
Avg	9.00%	4.18%	9.83%	4.77%	9.71%	4.66%
st dev	2.98%	1.13%	0.00%	0.00%	1.28%	0.29%

Table 6. Regulatory capital requirements – Altman

The table above shows the regulatory capital requirements for PIT, TTC and hybrid (unstressed) PDs on data of Altman (see table 3 for the PDs), using an LGD of 40%. The Basel II formulas as presented in appendix 3 for the calculation of regulatory capital for corporates and retail exposures are used.

Appendix 3 Regulatory capital formula

Under the first pillar of Basel II, the regulatory capital (RC) is calculated.

Basel II IRB regulatory capital requirements for sovereigns, corporates, and banks:

R = $$0.12\left[\frac{1-e^{-50\cdot PD}}{1-e^{-50}}\right]+0.24\left[1-\frac{1-e^{-50\cdot PD}}{1-e^{-50}}\right] \quad (1)$$

b = $$\left(0.11852-0.05478\cdot\ln(PD)\right)^2 \quad (2)$$

K = $$\left(LGD\cdot N\left[(1-R)^{-0.5}\cdot G(PD)+(R/(1-R))^{0.5}\cdot G(0.999)\right]-PD\cdot LGD\right)\cdot (1-1.5\cdot b)^{-1}\cdot\left(1+(M-2.5)\cdot b\right)\cdot 12.5\cdot 1.06 \quad (3)$$

For corporates with annual sales below € 50 mln:

R = $$0.12\left[\frac{1-e^{-50\cdot PD}}{1-e^{-50}}\right]+0.24\left[1-\frac{1-e^{-50\cdot PD}}{1-e^{-50}}\right]-0.04\cdot(1-(S-5)/45) \quad (4)$$

Basel II IRB regulatory capital requirements for retail:

R = $$0.03\left[\frac{1-e^{-35\cdot PD}}{1-e^{-35}}\right]+0.16\left[1-\frac{1-e^{-35\cdot PD}}{1-e^{-35}}\right] \quad (5)$$

K = $$\left(LGD\cdot N\left[(1-R)^{-0.5}\cdot G(PD)+(R/(1-R)^{0.5}\cdot G(0.999)\right]-PD\cdot LGD\right)\cdot 12.5\cdot 1.06 \quad (6)$$

R: Correlation factor
b: Maturity adjustment
K: Capital requirement
N(x): Cumulative distribution function for a standard normal random variable
G(x): Inverse cumulative distribution function for a standard normal random variable
S: Annual sales in millions of euros