

Part I

Introduction

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The Evolution of Financial Analysis

The financial industry is from an analytical viewpoint in a bad state, dominated by analytical silos and lack of a unified approach. How did this come about? Only up to a few decades ago, financial analysis was roughly synonymous with bookkeeping. This state of affairs has changed with the advent of modern finance, a change that was further accelerated by increasing regulation. In what follows we give a brief and eclectic history of financial analysis, explaining its evolution into its current state and focusing only on developments that are relevant to our purpose. The next chapter is an outline of what a solution to these problems should be.

1.1 BOOKKEEPING

Many of the early cuneiform clay tablets found in Mesopotamia were records linked to economic activity registering transactions, debts and so on, which suggests that the invention of writing is closely linked to bookkeeping.¹ Early bookkeeping systems were single-entry systems whose purpose was generally to keep records of transactions and of cash. The focus of such systems was realized cash flows and consequently there was no real notion of assets, liability, expense and revenue except in memorandum form. Any investment or even a loan had to be registered as a strain on cash, giving a negative impression of these activities.

Given the constant lack of cash before the advent of paper money, the preoccupation with cash flows is not astonishing. Even today many people think in terms of cash when thinking of wealth. Another reason for this fixation on cash is its tangibility, which is after all the only observable fact of finance.

In the banking area it first became apparent that simple recording of cash was not sufficient. The pure cash flow view made it impossible to account for value. Lending someone, for example, 1000 denars for two years led to a registration of an outflow of 1000 denars from the cash box. Against this outflow the banker had a paper at hand which reminded him of the fact that he was entitled to receive the 1000 denars back with possible periodic interest. This, however, was not recorded in the book.

By the same token, it was not possible to account for continuous income. If, for example, the 1000 denars had a rate of 12 % payable annually, then only after the first and second year would a cash payment have been registered of 120 denars. In the months in between, nothing was visible.

The breakthrough took place sometime in the 13th or 14th century in Florence when the double-entry bookkeeping system was invented, probably by the Medici family. The system was formalized by the monk Luca Pacioli, a collaborator of Leonardo da Vinci in 1494. Although Pacioli only formalized the system, he is generally regarded as the father of accounting. He described the use of journals and ledgers. His ledger had accounts for

¹ P. Watson, *Ideas: A History of Thought and Invention, from Fire to Freud*, Harper Perennial, 2006, p. 77.

assets (including receivables and inventories), liabilities, capital, income and expenses. Pacioli warned every person not to go to sleep at night until the debits equaled the credits.²

Following the above example, a credit entry of 1000 denars in the loans account could now be registered and balanced by a debit entry in the cash account without changing the equity position. However, the equity position would increase over time via the income statement. If subyearly income statements were made, it was now possible to attribute to each month an income of 10 denars reflecting the accrued interest income.

Thanks to Pacioli, accounting became a generally accepted and known art which spread through Europe and finally conquered the whole world. Accounting made it possible to think in terms of investments with delayed but very profitable revenue streams turning the focus to value and away from a pure cash register view. It has been convincingly argued that bookkeeping was one of the essential innovations leading to the European take-off.³ What was really new was the focus on value and income or expense that generates net value. As a side effect, the preoccupation with value meant that cash fell into disrepute. This state of affairs applies by and large to bookkeeping today. Most students of economics and finance are introduced to the profession via the balance sheet and the P&L statement. Even when mathematical finance is taught, it is purely centered on value concepts.

The focus on value has remained. The evolution of the position of cash flow within the system should be noticed with interest. This is especially striking given the importance of liquidity and liquidity risk in banks, especially for the early banks. After all, liquidity risk is the primal risk of banking after credit risk because the liabilities have to be much higher than available cash in order to be profitable.

Liquidity risk can only be properly managed if represented as a flow. However, instead of representing it in this way, liquidity was treated like a simple investment account and liquidity risk was approximated with liquidity ratios. Was it because fixation on cash flow was still viewed as primitive or because it is more difficult to register a flow than a stock? Whatever the case, liquidity ratios stayed state of the art for a long time. Early regulation demanded that the amount of cash could not be lower than a certain fraction of the short-term liabilities. So it was managed similarly to the credit risk – the second important risk faced by banks – where equity ratios were introduced. Equity ratios describe a relationship between loans of a certain type and the amount of available equity. For example, the largest single debtor to a bank cannot be bigger than x % of the bank's equity.

The next relevant attempt to improve cash flow measurement was the introduction of the cash flow statement. Bookkeepers – in line with the fixation on value and antipathy to cash – derived liquidity from the balance sheet. This was putting the cart before the horse! The remarkable fact here is that bookkeepers derived cash flow from the balance sheet and P&L, which itself is derived from cash flow, a classical tail biter! Is it this inherent contradiction that makes it so difficult to teach cash flow statements in finance classes? Who doesn't remember the bewildering classes where a despairing teacher tries to teach cash flow statements! Marx would have said that bookkeeping stood on its head from where it had to be put back on its feet.⁴ The cash flow statement had an additional disadvantage: it was past oriented.

² Luca Pacioli, *Wikipedia, The Free Encyclopedia*, http://en.wikipedia.org/wiki/Luca_Pacioli.

³ P. Watson, *Ideas: A History of Thought and Invention, from Fire to Freud*, Harper Perennial, 2006, p. 392.

⁴ One of Karl Marx's famous statements was "Vom Kopf auf die Füße stellen" which we quote a bit out of context here. Although applied to Hegel's philosophy it can be suitably applied here.

This was roughly the state of financial analysis regulation before the FASB 133⁵ and the Basel II regulations and before the advent of modern finance. The change came with the US savings and loans crises in the 1970s and 1980s. These institutions have been tightly regulated since the 1930s: they could offer long-term mortgages (up to 30 years) and were financed by short-term deposits (about six months). As a joke goes, a manager of a savings and loans only had to know the 3-6-3 rule: pay 3 % for the deposits, receive 6 % for the mortgages and be at the golf course at 3 o'clock.

During the 1970s the 3-6-3 rule broke down. The US government had to finance the unpopular Vietnam war with the money press. The ensuing inflation could first be exported to other countries via the Bretton Woods system. The international strain brought Bretton Woods down, and the inflation hit at home frontally. To curb inflation short-term rates had to be raised to 20 % and more. In such an environment nobody would save in deposits paying a 3 % rate, and the savings and loans lost their liabilities, causing a dire liquidity crisis. The crisis had to be overcome by a law allowing the savings and loans to refinance themselves on the money market. At the same time – because the situation of the savings and loans was already known to the public – the governmental guarantees for the savings and loans had to be raised. Although the refinancing was now settled, the income perspectives were disastrous. The liabilities were towering somewhere near 20 %, and the assets only very slowly could be adjusted from the 6 % level to the higher environment due to the long-term and fixed rate character of the existing business. Many banks went bankrupt. The government was finally left with uncovered guarantees of \$500 billion, an incredible sum which had negative effects on the economy for years.

This incident brought market risk, more specifically interest rate risk, into the picture. The notion of interest rate risk for a bank did not exist before. The focus had been on liquidity and credit risk as mentioned above. The tremendous cost to the US tax payer triggered regulation, and *Thrift Bulletin 13*⁶ was the first reaction.

Thrift Bulletin 13 required an interest rate gap analysis representing the repricing mismatches between assets and liabilities. As we will see, interest rate risk arises due to a mismatch of the interest rate adjustment cycles. In the savings and loans industry, this mismatch arose from the 30-year fixed mortgages financed by short-term deposits which became a problem during the interest rate hikes in the 1980s. The short-term liabilities adjusted rapidly to the higher rate environment, increasing the expense, whereas the fixed long-term mortgages on the asset side did not allow significant adjustments.

Gap analysis introduced the future time line into the daily bank management. Introducing the time line also brought a renewed interest in the “flow nature” of the business. The new techniques allowed not only a correct representation of interest rate risk but also of liquidity risk. However, the time line was not easy to introduce into bookkeeping. The notion of “value” is almost the opposite of the time line. Value means combining all future cash flows to one point in time. Valuation was invented to overcome the time aspect of finance. The notion of net present value, for example, was introduced to overcome the difficulties with cash flows which are irregularly spread over time. It allowed comparing two entirely different cash flow

⁵ Statements of Financial Accounting Standards No. 133, *Accounting for Derivative Instruments and Hedging Activities*, issued in January 2001 by the Financial Accounting Standards Board (FASB). This allows measuring all assets and liabilities on their balance sheet at “fair value”.

⁶ Office of the Thrift Supervision, *Thrift Bulletin 13*, 1989.

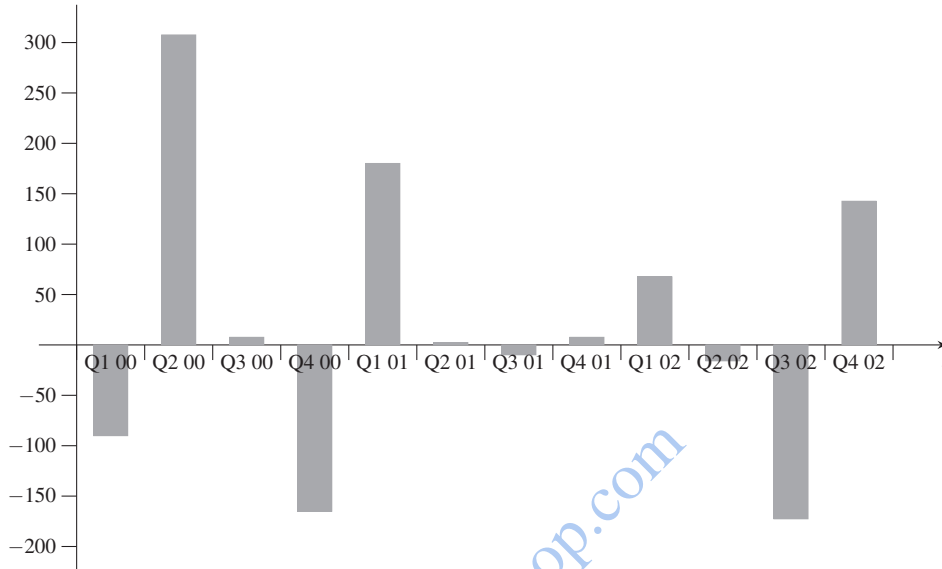


Figure 1.1 Cash flows projected along an investment horizon

patterns on a value basis. In other words, bookkeeping was not fit for the task. The neglect of cash and cash flow started to hurt.

Asset and liability management (ALM) was introduced to model the time line. Although ALM is not a well-defined term today, it meant at that time the management of the interest rate risk within the banking book.⁷ Why only the banking book? Because of the rising dichotomy between the “trading guys” who managed the trading book on mark to market terms and the “bookkeepers” who stayed with the more old-fashioned bookkeeping. We will hear more about this in the next section.

ALM meant in practice gap analysis and net interest income simulation (NII). Gap analysis was further split into interest rate gap and liquidity gap. A further development was the introduction of the duration concept for the management interest rate risk.

The methods will be explained in more detail later in the book. At this point we only intend to show the representation of an interest rate gap and a net interest income report because this introduced the time line. Figure 1.1 shows a classical representation of net cash flow with some outflow in the first period, a big inflow in the second period and so on. Net interest income demanded even dynamic simulation techniques. In short, it is possible to state expected future market scenarios and future planned strategies (what kind of business is planned) and to see the combined effect on value and income. Figure 1.2 shows, for example, the evolution of projected income under different scenario/strategy mixes.

Such reports are used to judge the riskiness of strategies and help choose an optimal strategy.

⁷ ALM today is in many cases defined in a much wider sense. It surely carries the notion of the control of the entire enterprise including trading. Besides interest rate risk it also includes exchange rate risk. In many banks International Financial Reporting Standards (IFRS) accounting is done in the ALM department. Funds Transfer Pricing (FTP) is another topic often treated inside ALM.

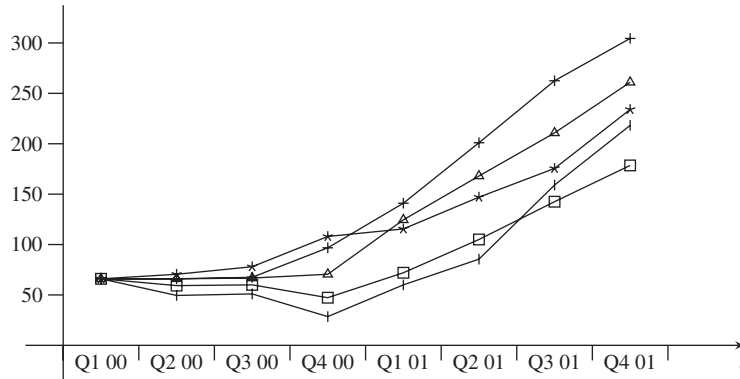


Figure 1.2 Income forecast scenarios along a natural time line

The introduction of the future time line into financial management was a huge step forward. The problem is not so much the time evolution, but that time in finance appears twice:

Natural time This is the passing of time we experience day by day.

Investment horizon This represents the terms of the contracts made day by day. For example, if investing in a 10-year bond, then we have a 10-year investment horizon. A life insurance, if insuring a young person, has an investment horizon up to 80 years.

Because financial contracts are a sequence of cash flow exchanged over time, a bank or insurance invests on the natural time line continuously into the investment horizon.⁸

Such information is not manageable by traditional bookkeeping. Bookkeeping can somehow manage natural time. It does so within the P&L statement but normally in a backward-looking perspective. The exception is during the budgeting process, of which Figure 1.2 is a sophisticated example, where a forward-looking view is taken. It is the investment horizon as represented by Figure 1.1 that creates troubles. It would demand subdividing each asset and liability account for every day in the future when there is business. This is done partially in reality where banks, for example, subdivide interbank accounts into three month, up to one year and above one year. This, however, is not sufficient for analytical needs. To make it even more complex, passing time (walking along natural time) shortens maturity continually, and every day new deals with new horizons may appear. This is definitely not manageable with a hand written general ledger but is even near impossible with the help of computers. Even if it were possible, it would be unsuitable for analysis since it would produce huge unmanageable and above all illegible balance sheets.

The appearance of the new ALM systems helped. ALM systems tried to improve the time line problem. But many of them were still too much “bookkeeping conditioned” and did not take this double existence of time into account properly. They focused more on natural time than on the investment horizon. Many systems were more or less Excel spreadsheets using the x axis as the natural time dimension and the y axis for the chart of accounts. In spreadsheets there is no real space for a third dimension that should reflect the investment horizon.

It was at this point that bookkeeping really got into trouble. Better solutions were needed.

⁸ See Section 2.6 for a more thorough treatment.

1.2 MODERN FINANCE

It is said that a banker in earlier days was able to add, subtract, multiply and divide. Bankers mastering percent calculation were considered geniuses. Multiplication and division were simplified, as can be seen in interest calculation under the 30/360 day count method. The calendar with its irregular months was considered too difficult. This difficulty was overcome by declaring that every month had 30 days and a year had 360 days.

With the advent of modern finance, this state of affairs changed dramatically. Banks became filled with scientists, mainly physicists and engineers. Top bankers who were usually not scientists often felt like sorcerers leading apprentices (or rather being led by them), or leading an uncontrollable bunch of rocket scientists constructing some financial bomb.

The rise of modern finance was partially due to the natural evolution of science. The first papers on the pricing of options by Merton, Black and Scholes were published in 1972. The Nobel Prize was awarded to Merton and Scholes (Black died earlier) in 1997. This coincided with the advent of exchange traded options in 1973. In this short time span finance was entirely revolutionized.

Scientific progress, however, was not the only factor at work. The savings and loans (S&L) crisis in the 1970s made it clear that traditional bookkeeping methods were not adequate. Bookkeeping with its smoothing techniques has a tendency to hide rather than to expose risk. The S&L crisis made it clear that new instruments such as swaps, options and futures were needed to manage risk, but these newly created contracts could not be valued with traditional bookkeeping methods. Moreover, with insufficient control these instruments could actually aggravate instead of reduce risk. This called for yet more theoretical progress and at the same time called for better regulation, such as the FASB 133.

Generally speaking, modern finance attempts to incorporate uncertainty in the valuation of financial instruments and does so in a theoretically sound way. The starting point to the valuation of an instrument is discounting its cash flows to the present date. However, accounting for uncertainty means that *expected* cash flows should be considered, which implies a probability distribution. The dominant approach in modern finance has been to calculate expected cash flows in a risk-neutral world.

The valuation of options, for example, is obtained by solving the Black–Scholes–Merton differential equation. The crucial assumption in the derivation of this equation is that investors are risk-neutral. In a risk-neutral world, only the expected return from a portfolio or an investment strategy is relevant to investors, not its relative risk. Risk neutrality could be constructed within the options pricing framework via the hedge argument.

The real world is full of risks and investors care about it; real people are risk-averse, a fact that is demonstrated in the St Petersburg paradox. In a game of fair coin tosses, a coin is tossed until a head appears. The payoff is 2^{n-1} if the first $n - 1$ tosses were tails. The expected payoff is therefore

$$\sum_{i=1}^{\infty} 2^{-i} 2^{i-1} = \sum_{i=1}^{\infty} \frac{1}{2},$$

which is infinite. The paradox lies in the fact that rational people would not be paying an infinite amount to participate in this game. In fact the price is much lower, in the range of a few ducats, depending on the utility that people assign to the return. In the real world people prefer lower and more certain returns over higher and uncertain returns even if the expected return is identical.

Returning to option pricing, the limitation of the risk neutrality assumption is manifested through the well-known volatility smile. The prices of far-out-of-the-money or riskier options are lower than the prices that would have been calculated using the observed volatility of the underlying. In effect, the expected cash flows from such options are modified into their risk-neutral values in order to account for the risk aversion of investors.

Under uncertain market conditions, there are two fundamental approaches to valuation. The first is to calculate risk-neutral cash flows and discount them with risk-free discount factors. The second involves calculating real world expected cash flows and discounting with deflators.⁹ Modern finance has generally taken the first approach with the necessary corrections, as in the case of volatility smiles. Traditional bookkeepers, with their going-concern view, would prefer the second approach. In most cases, where efficient markets are absent, only the second route is open.

The basic challenge to a unified analytical methodology is to incorporate the bookkeeper and the modern finance approaches. If one is interested only in valuation and value-related risk, as is the case with many quantitative analysts, all that is required are risk-neutral cash flows. Real world analytical needs, however, also encompass the analysis of liquidity and its associated risks. The expected cash flows, based on *economic* expectations, cannot be dismissed. This dichotomy will be present throughout the whole book. Theoretical approaches to this problem are only beginning to evolve.

Since the advent of modern finance, a gap opened up between its adherents and the more traditional bookkeepers. This was partly due to the fact that bookkeepers did not understand what the rocket scientists were doing. It is also true the other way around. The rocket scientists of modern finance refused – perhaps due to intellectual arrogance – to understand what bookkeepers were doing. Market value was declared the only relevant value, relegating other valuation methods to a mere number play. This approach overlooks the fact that market valuation is inherently based on a liquidation view of the world and ignores the going-concern reality. It also ignores the fact that the formulas of the rocket scientists only work in efficient markets whereas most markets are not efficient.

Moreover, little effort was taken to analyze a bank or insurance company in its entirety. The strong focus on the single transaction resulted in losing view of a financial institution as a closed cash flow system. Pacioli's advice, not to go to sleep before all accounts have balanced, went unheeded.

By the end of the 20th century we had on the one hand financial systems – the double-entry bookkeeping methods – with the entire institutions in mind but with weaknesses in analyzing uncertain cash flows. On the other hand, we had methods with powerful valuation capabilities but narrowly focused on the single financial transaction or portfolios of these, missing the total balance and overlooking the going-concern view. Finance, which is by nature a flow, was viewed even more strongly as a stock.

Modern finance got the upper hand because it had the power to explain risk – an important question that demanded an immediate solution. The result of this influence was a steady focus on subparts of an institution such as single portfolios or departments and a focus on the existing position only. Departmentalism is very common today. It is found in banks that treasurers and bookkeepers do not talk to each other. In insurances a similar split between actuaries and asset managers can be seen. Departmentalism has become a significant cost factor. To gain an overview of the whole institution is very difficult, and to answer new questions, especially at

⁹ The deflator approach, in the form of benchmark theory.

the top level, very costly. The problem is acknowledged but will take years to overcome. In order to do this, we need a clear view of the homogeneity of the underlying structure of all financial problems, which is the topic of this book.

1.3 DEPARTMENTS, SILOS AND ANALYSIS

As a consequence, the organizational structure of typical banks at the beginning of the 21st century follows a strict silo structure. The following departments are in need of and/or produce financial analysis:

Treasury The treasury is the department where all information flows together. Typical analysis within the treasury departments is gap analysis (mainly liquidity gap but also interest rate gap), cash management, sensitivity analysis duration, exchange rate sensitivity and risk (value at risk). Since all information must flow together at the treasury, the idea of building an integrated solution often finds fertile ground within treasury departments.

Controlling

Classical controlling This is the “watchdog” function. Are the numbers correct? Often the controlling is also responsible for the profit center, product and customer profitability. This needs on the one hand funds transfer pricing (FTP) analytics and on the other hand cost accounting. Also here all data have to come together, but controllers accept as a first stance the silo landscape. They just go to each silo, checking whether the calculations are done and reported correctly.

Risk controlling Driven by the regulators it became necessary by the mid 1990s to form independent risk controlling units. Risk controlling focused solely on the risk side of controlling, leaving the classical task to the classical controlling. Similar to the classical controlling usually no independent calculation is done but rather existing results are rechecked.

ALM ALM can have many meanings. In the most traditional definition it is the function to manage interest rate risk. Most of the analytical tools of the treasury are used but with a stronger view on interest rate instead of liquidity risk. Popular analysis tools are interest rate and liquidity gap and sensitivity. Sometimes even value at risk (VaR) is used in ALM. In addition to the treasury there is a strong focus on net interest income (NII) forecasting to model the going-concern (natural time) view. This relies strongly on simulation features. FTP is also important in order to separate the transformation income for which ALM is usually responsible from the margin, which usually belongs to the deal-making department.

Trading Trading is like a little bank inside a bank. The same analytics like the treasury and ALM are used, without however the NII forecast and FTP analysis.

Budgeting The budget department is responsible for the income planning of the bank. It has a strong overlap with the NII forecast of the ALM. However, in addition to the NII it takes the cost side into the picture. Whenever profit center results are forecasted then FTP plays a significant role.

Bookkeeping Traditional bookkeeping had little to do with the other functions mentioned here, since the book value has always been produced directly by the transaction systems. This, however, changed around 2004 with the arrival of the new IFRS rules IAS32/39. These rules are strongly market value oriented and demand a more adequate treatment of

impairment (expected credit loss). With this the methods strongly overlap with market and credit risk techniques. IFRS calculations are often done within the ALM department.

Risk departments Besides these departments we often also see risk departments, which are subdivided into three categories. Often they are under the same higher department level:

Market risk This is again a strong overlap with treasury/ALM/trading. The same analysis is done here as in these departments.

Credit risk With Basel II the need for more market risk analysis arose. From an analytical standpoint they add credit exposure analysis which strongly relies on results that are also used in market risk, such as net present value (NPV) (for the replacement value calculation).

Operational risk This can be seen to be quite independent from the other functions listed above, since operational risk (OR) centers more around physical activities than financial contracts. The methods applied are loss databases, risk assessment and Monte Carlo simulations on OR.

Other departments and other splittings of responsibilities may exist. The problem is not the existence of these departments. If not all then at least a good number of them has to exist for “checks and balances” reasons. The problem is that all of these departments – with the exception of operational risk and cost accounting – have heavy overlapping analytical needs with huge synergy gains between them. Although it seems very logical that departments would look for synergy in solving the problems, this has not happened in reality.

1.4 THE IT SYSTEM LANDSCAPE

The evolution of finance is paralleled in the evolution of IT systems used for financial analysis. Financial analysis cannot be divorced from the IT systems and supporting infrastructure. Much of finance – for example Monte Carlo techniques – depends entirely on powerful IT systems.

Early IT systems in the banking industry were transaction systems, general ledger (GL) and systems for storing market and counterparty data. Transaction systems are used to register saving and current accounts but also bonds, loans, swaps, futures, options and so on. Banks tend to have several such systems, usually four to eight, but in some cases up to 40 systems. In the following discussion we will focus exclusively on the transaction system data, leaving out market and counterparty data for the purpose of simplicity. This is justified on cost grounds since transaction data are the most expensive to maintain.

Before the savings and loans crisis up to the early 1980s most if not all analysis was based on general ledger data. With *Thrift Bulletin 13*, the increasing innovation leading to new financial instruments and the Basel initiatives increased the complexity. Partly due to the speed new requirements came in and partly due to the dichotomy between bookkeeping and modern finance, banks began to divide the analysis function into manageable pieces: treasury analysis, controlling, profitability, ALM, regulation (Basel II) and so on. The sub-functions could roughly be categorized into bookkeeping and market value oriented solutions.

What followed this structural change was the development of “customized” software solutions for the financial sector, developed to address specific analytical needs. In trying to accommodate specific needs, software vendors increased the technical segregation within financial institutions and strengthened the independence of departments. Banks now had a wide range of specialized departments or silos each with its own tools, created by different software

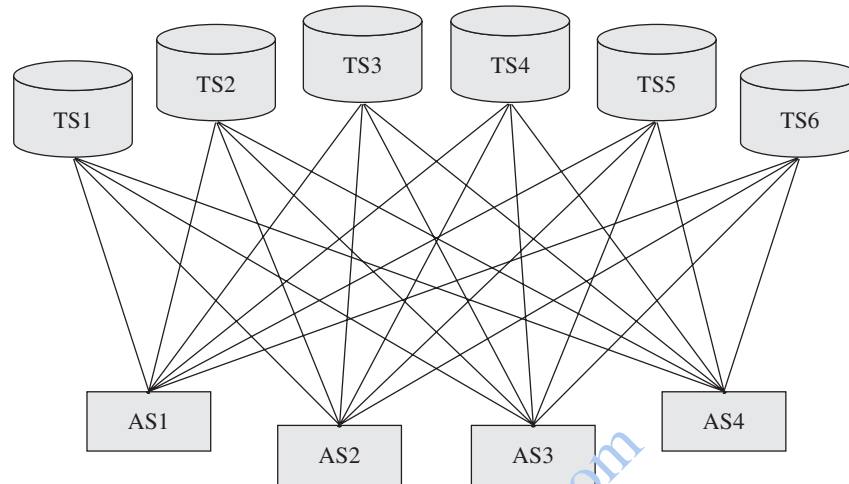


Figure 1.3 Interfacing transaction and analytical systems

houses, producing results that were often not comparable and difficult to reconcile. In addition, such systems were extremely expensive because of the interfacing involved. For example, say a bank's four discrete analytical systems drew data from six transaction systems. The bank's entire system would require 4×6 interfaces (see Figure 1.3).

Not only was segregation expensive and created more work through interfacing and the difficult reconciliation process, but it was also logically and functionally artificial since financial analysis uses the same core calculation tool set to derive the same basic results: cash flow, value and income.

In the end, although they set out to make the growing field of financial analysis more manageable by breaking it down into smaller, focused areas, banks and solution providers had actually created more complexity: now, analysts in different analytical areas were using customized systems, intricately interfaced to various data sources, to employ variations of the same calculation to derive essentially the same information.

The top management in the early 1990s realized the problems linked to this silo architecture. The problem was, however, perceived mainly as a data problem. The industry tried to overcome the problems through the use of "integrated" data warehouses, single locations where all financial data could be stored and shared by the various analytical departments.

This involved the transfer of data from multiple transaction systems into a single pool. The theory was that data consistency and accuracy of results would be improved and reconciliation would be easier when the various analytical functions had access to and worked on the same database. Most institutions rely on such data warehouses even today – but is this the optimal solution? The answer is no. We recognize two problems with this type of integration:

No real data integration Data warehousing as described above is essentially technical integration of data and does not integrate financial data from a logical perspective. Data are moved in bulk from their systems of origin into a segregated cell within the analytical data warehouse. This has been eloquently described within the industry as making just one huge data heap from a bunch of small heaps. Granted, there are fewer interfaces (using the example shown in Figure 1.4, six transaction systems and four

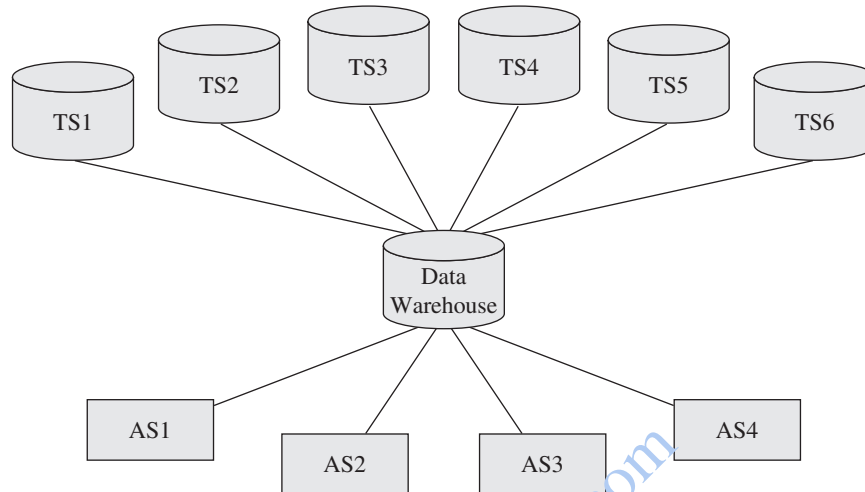


Figure 1.4 Interfacing transaction and analytical systems using a data warehouse

analysis systems make 10 interfaces necessary) and there is some cleansing of the data – processes that enhance data quality such as converting all dates to a common date format and using a unique code for each counterparty. While helpful, these adjustments are small and technical. In other words, they do not create true data integration from a financial analysis standpoint.

A simple illustration is provided by the concept of notional value. Although this basic notion exists in all transaction systems, it is often stored under different names such as “notional value”, “nominal value”, “current principal” or “balance”. When moved to a data warehouse, these data are in most cases not unified but instead stored in four different fields. Not only is the same logical information stored in multiple fields, the interpretation of the actual figure can depend on the source system from which it originates. For example, in one transaction system “notional value” might be positive for asset contracts and negative for liabilities, while in another transaction system “nominal value” may be defined with the opposite sign convention, as an absolute value or as a percentage of another value. Building an analysis or reporting engine on such a data warehouse means that a logical layer that interprets the data correctly according to the source system is required. Building and maintaining such logic is costly and prone to error. As a consequence, early data warehouses did not reduce the complexity of interfaces, were therefore cumbersome and expensive to maintain, and led to inconsistent results.

Multiple analytical engines lead to inconsistent results Let us assume a more ideal (but rarely observed) world where all financial data obtained from transaction systems are standardized and the complexity of interfaces is minimized within a data warehouse. To stay with the above example, the four mentioned fields above would map exactly into one field and all data would be defined in the same way. A query would be fairly simple now, but financial analysis cannot be handled with simple queries.

Why? In the “old days”, when finance was only accounting, it was indeed possible to create any report directly from a database. This worked since accounts and subaccounts

always “add up” save for the sign of assets and liabilities. As long as analysis was only grouping and summing, the basic idea of data warehousing is adequate. With the advent of modern finance, the “grouping and summing” hypothesis did not hold any more. We will see during the course of this book that the data stored in data warehouses are basic data about financial contracts (value date, maturity date, principal, interest rate, interest payment schedule and so on) and market conditions, from where the needed information can be calculated. Of course, there is also history that is first calculated and then stored only to be retrieved again. However, most of the interesting information needs frequent recalculation due to market changes, as can be seen from the fair value function described above.

For this reason it is not sufficient to have a central data warehouse where we could “plug-in” all the needed analytical systems or calculation engines that approach analysis from a variety of perspectives, such as NPV (net present value), VaR (value at risk), CAD (capital adequacy) FTP (funds transfer pricing) reports, as shown in Figure 1.5. There are many more in practice.

Each of the mentioned analyses relies upon the same elementary calculations to generate expected cash flows and derive income, sensitivity and risk from this value. However, customized systems, developed by different vendors, implement different forms of the core calculations. Especially the calculation of expected cash flows requires an elaborate process which is costly. The cost of programming can be reduced by making shortcut assumptions, especially regarding the generation of expected cash flows. In order to maintain such a variety of systems, simplifications are necessary and therefore often applied. Consequently results, even when based on integrated and consistent data, are quite different. Therefore, the data

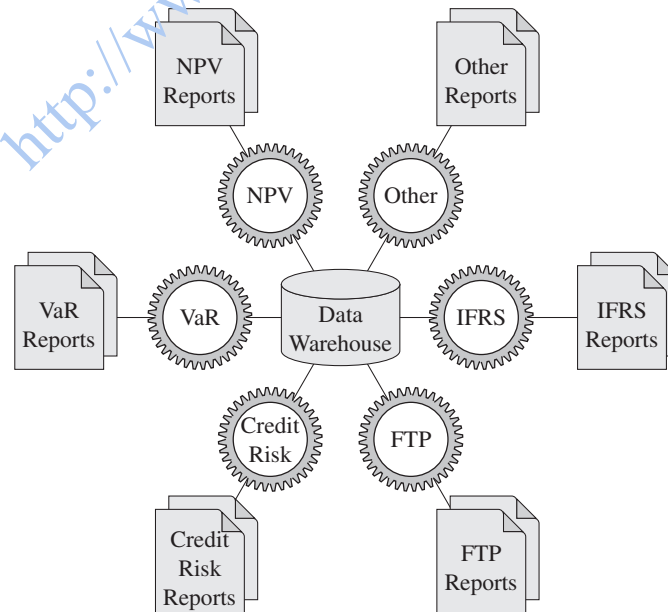


Figure 1.5 Using a variety of analysis specific tools leads to inconsistent results

warehouse solution suffers from a severe consistency problem and cannot overcome the barriers created by analytical segregation.

There was a movement in the 1990s to overcome the problem by calculating expected cash flows and storing them once and for all. Since all results are derived from these cash flows the way forward seemed to calculate, store this information centrally and make it available to all analytical tools of the different departments. After all it is cash flows that are most difficult to calculate and where most deviations between the applications are produced. Having the same cash flows for everyone will close most of the gap. There is only little additional calculation done after this stage. Many banks invested considerable sums to build what they called “the super cash flow”. The information was calculated once and then made available to all via a data warehouse.

As charming as the argument sounds, it was and still is wrong. The idea of the “super cash flow” overlooks the expectation aspect. The cash flow is only in very rare cases a fixed value that can be calculated in advance. It probably applies only to fixed noncallable government bonds of the highest rated governments (with probability of default zero). In all other cases cash flows are contingent on market conditions, behavior and the rating of the issuer. For example, the cash flows themselves depend, for example, on the actual yield curve and the curve can change any moment. Therefore the calculation of expected cash flows must be part of the analysis itself.¹⁰

1.5 NEW APPROACH

The answer to the silo and the consistency problems associated with a standard data warehouse turns out to be using a core calculation engine operating upon integrated and consistent data, as shown in Figure 1.6. This analytical engine generates expected cash flows independent of the department, from where the reporting elements cash flows, value, income, sensitivity and risk are derived. The engine has to be powerful enough to handle the double occurrence of time and to perform multiple valuation.

Creating reports for different analytical needs simply becomes a matter of selecting the appropriate reporting elements, filtering financial events with only minimal post-treatment and finally reporting the result according to the structure of the method of analysis. Because these building blocks are consistent, higher-order analytical results are consistent and comparable. As an example, market value reports rely strongly on market values and so does the replacement value of credit risk. The calculation of fair or market value is in both cases the same but the further treatments differ from case to case.

The new methodology of integrated financial analysis is a superior answer to the complexity created by segregation within financial analysis, as it is truly integrated and provides consistent and comparable results. Although the proposed methodology can handle more complexity, it is much simpler than the sum of the silo systems in place. The remainder of the book will talk about the ingredients to these data and calculation kernel, which will simplify financial analysis and increase consistency and information content drastically.

This concept was met with skepticism in the 1980s and also in the 1990s. The common wisdom seemed to be that an integrated system could only be built if its analytical capabilities were not sufficiently deep or broad. The resistance was overcome in the late 1990s as the

¹⁰ W. Brammertz, Die engen Grenzen des Super-Cash-Flows, *Die Bank*, 1998, 8, 496–499.

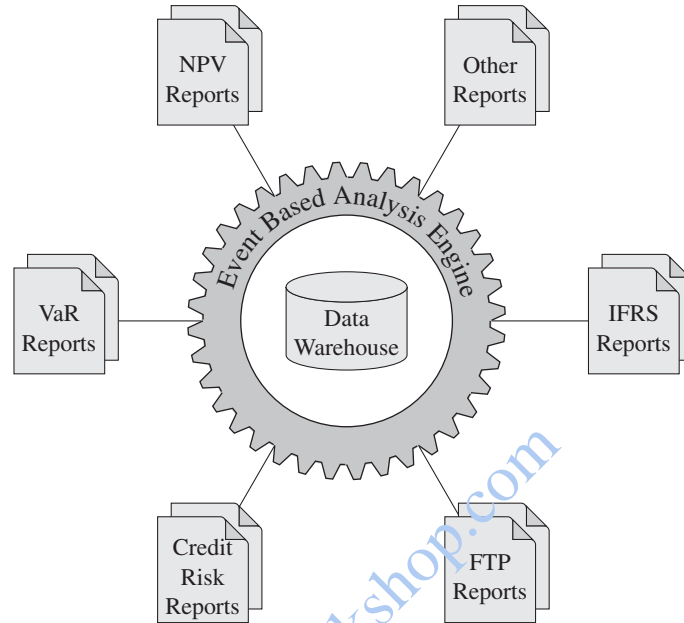


Figure 1.6 Using a unified analytical engine guarantees consistency of results

cost in complexity and in resources of using multiple analytical systems became increasingly excessive. The need for integration is, for example, strongly supported by Basel II and Solvency II regulation. It is now accepted that a system based on an integrated methodology makes sense. There is of course a huge gap between lip service and reality, but the possibility of a consistent methodology is an accepted fact, which is at least an important first step.

That it is possible to build simpler systems that can handle more complexity is best explained by an analogy with the development of writing. Early scripts were pictographic by nature. However, it is very difficult to move beyond a simple stage with pure pictograms and – as can be seen from Chinese – the system can become quite complex, absorbing a lot of intellectual energy. The script is very beautiful, but the main problem is the focus on words. Against this the invention of sound-related script, probably some time around 1400 BC, by scribes of the Mediterranean city of Ugarit was an intellectual breakthrough. Focusing not on objects and verbs but on the sound of objects and verbs simplified and improved the art of writing tremendously. A mere two dozen letters were sufficient to describe anything that could be spoken. From now on it was potentially possible for the vast majority of the population to be able to read and write without investing more than a few months or years during childhood. Such a system does not only apply to the words in existence when invented, but to all future words to come. Clearly, it might be necessary to add a few letters, especially when applied to new languages where new sounds are used, but the basic system is stable. Explaining at that time to a well-educated scribe, who had spent a good part of his life learning 10 000 or even 20 000 pictographic characters, that every reasonably intelligent child can easily learn to write the same amount of words in a much shorter time probably sounded arrogant if not foolish.

1.6 HAZARDS OF A SINGLE SOLUTION

Let us assume that a single system based on a consistent methodology which can generate all financial analysis results can be built. It is a valid question whether relying on a single system is a prudent way to build an analytical infrastructure. After all, a single system can not only produce wrong results, but can also do this consistently. Is it not better then to use multiple systems with overlapping coverage?

This concern should be taken seriously. In practise, however, there are mitigating factors:

1. Even with a single unified analytical system in place, feeder transaction systems are often able to produce a subset of analytical results. Most transaction systems record book values and some even generate gap reports. Trading systems can often produce sensitivity and risk figures. The overlapping analytical capabilities make it possible to reconcile calculation results and detect errors.
2. The calculation results of a single analytical system are used by different departments of a bank, whereas in the traditional setup calculation results are verified by the one or two departments that are using the specific system. As the analytical results are consumed and verified by a wider audience, software errors are more likely to be detected.
3. Data quality and consistency are often overlooked aspects of financial analysis. As with software quality, a larger user base means that problems will be found and corrected sooner rather than later.

If, however, it should turn out that all analytical functions are substituted by this one system, we would recommend building two systems independently. This is still far cheaper than having a myriad of parallel departmental systems.

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