ASSET MANAGEMENT IN VOLATILE MARKETS

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1. Introduction

The 27th SUERF Colloquium in Munich in June 2008: *New Trends in Asset Management: Exploring the Implications* was already topical in the Summer of 2008. The subsequent dramatic events in the Autumn of 2008 made the presentations in Munich even more relevant to investors and bankers that want to understand what happens in their investment universe. In the present SUERF Study, we have collected a sample of outstanding colloquium contributions under the fitting headline: *Asset Management in Volatile Markets.*

In the first paper, *Robert C. Merton*, Professor at the Harvard Business School and recipient of the 1997 Nobel Memorial Prize in Economic Sciences, points out some important recent challenges to the asset management industry. Financial innovation has facilitated decomposition of the asset management business into its component parts. Modern financial technology permits the separation of risk exposure selection and management from physical investment choices, capital expenditure plans, ownership and governance of assets. Thus, risk can be viewed as a separate dimension of asset management decisions. To illustrate this point, the author applies it to the risk management for a whole country. Modern financial technology allows a reconciliation of endeavours to exploit comparative advantage and efficient diversification.

The author distinguishes between "Alpha" and "Beta" investment strategies. An asset manager produces Alpha when he is able to add performance per unit of risk over and above the performance that the client could add without help. Beta strategies rely on well-diversified, efficient exposures. They are much cheaper to implement. The problem with so-called "Alternative investments" such as private equity and direct real estate is that these assets have stale prices and do not trade very often. This biases correlation calculations and causes mis-measurement of systematic risk.

Asset managers including hedge funds should be able to explain how they are making money. When returns reflect a risk premium, investors should know what kind of risk they are taking. Hedge funds are lightly regulated. This allows them to act as counterparties to heavily regulated financial institutions.

The trend away from defined-benefit pension plans towards defined-contribution plans means that savers are forced to manage their pension assets without

having the necessary qualifications for doing it. The author argues that financial institutions must intermediate and create user-friendly, easy-to-understand pension products.

The speaker then turned to sovereign wealth funds. An economic-risk balance sheet for a country makes it possible to examine how risks associated with all types of assets and liabilities interplay with each other. The uncertainty regarding the country's productive activities should be taken into consideration. You cannot come up with an optimal strategy for asset allocation for a sovereign wealth fund outside the context of the country's other assets and liabilities.

Professor Merton recommended that sovereign wealth funds with a mandate to invest outside the home country should hold a whole world market portfolio. One advantage of this strategy is that a broad index portfolio minimizes political concerns.

The benefits of aligning comparative advantage and portfolio risk diversification are illustrated by using the computer chip producer Taiwan as an example. In a swap contract, Taiwan can oblige itself to pay the return on the world chip market while the counterparty accepts the obligation to pay the return on a world portfolio. The swap contract just provides risk transfer.

In his concluding remarks, Professor Merton finds that the financial instruments described open wonderful opportunities. Financial innovation changes transfer mechanisms, control mechanisms and risk patterns. This must be understood by academics, practitioners and overseers. Supervisory authorities are no longer able to say: "We know where all the risks are, they are here and we control them, and the risks can not go anywhere else." Successful innovations run ahead of the infrastructure including regulation and oversight. The essential trade-off is between managing the mismatch structurally of innovation to infrastructure security, and trying to do it in an efficient way.

In the Second paper, *Otto Loistl* and *Stephan Zellner*, Vienna University of Economics and Business Administration, and *Martin Gartner* and *Christiane Zinner*, Siemens AG, Austria look at the asset management value generating chain. Inspired by Treynor, they characterize the investment process as a three-legged stool supported equally by securities research, portfolio management and securities trading. According to the authors, the paradigm of the efficient market has been abandoned and the superiority of active sophisticated portfolio management is beyond any doubt. Integrated active

asset management relies on three steps: Research, portfolio construction and strategy implementation. In the paper, they discuss the tasks that have to be performed at each step.

The relative value strategy is a quantitative trading strategy that aims to take advantage of short-term market inefficiencies. When pairs of assets tend to show a stationary pattern over a period of time but deviations occur, the asset manager should take a long position in the relatively undervalued asset and a short position in the relatively overvalued one. A sample of the largest stocks included in the DJ Stoxx 600 is pre-selected and suitable similar pairs of assets are determined. When a price ratio is starting to deviate from its "normal" behaviour, a trade should take place. The idea is that the price ratio follows a mean-reversion process. When the time of a portfolio adjustment has been identified, the next step is to determine how much to buy or sell. A comparison of the relative value portfolio and the DJ Stoxx 600 index shows superior performance of the former for the data period 2001 to 2005.

Implementation of a strategy implies transaction costs. Under a relative value strategy, the portfolio has to be rebalanced very often. Transaction costs are therefore a critical component. The authors go on to analyze the implementation shortfall which occurs between the time of a decision to revise the portfolio and the time when the revision is realized and the portfolio weights are adjusted. A study based on futures data documents that transmission via the FIX-protocol reduces the implementation shortfall.

By integrating the individual tasks in the asset management's chain of value generation there are many opportunities to generate value and increase a portfolio's return. In real markets, there are a lot of arbitrage opportunities and integrated active asset management generates returns by exploiting these arbitrage opportunities.

In the Third paper, *Krzysztof Rybinski*, Deputy Governor of the National Bank of Poland and *Urszula Sowa,* Economist, National Bank of Poland, analyse the management by central banks and sovereign wealth funds of global reserves. Foreign exchange reserves can be built up in order to hedge the country against sudden stops of trade and capital flows and against financial market volatility. Reserve accumulation may also reflect central bank interventions to prevent the currency from strengthening with implications for the international competitiveness of domestic firms. Since the Asian crisis of 1997, the precautionary motive of reserves accumulation seems to have dominated over other motives.

The authors define opportunity costs of holding ample reserves as a forgone growth of GDP amid too conservative central bank reserve management. They calculate hypothetical opportunity costs for different alternative investment strategies for a sample of 33 countries. The resulting opportunity costs are very high. Many central banks are consequently changing their reserve management strategies in order to enhance yield and improve risk management. There has been a slow but sure move towards more diversified portfolios (across currencies and instruments), while at the same time monetary policy goals and financial stability needs have remained binding constraints.

In the fourth paper, *Peter R. Haiss* and *Bernhard Sammer,* Vienna University of Economics and Business Administration, focus on the role of derivative markets in the financial landscape. The new financial instruments have opened new possibilities of risk sharing and risk diversification and uncovered interdependencies between the various sectors of the financial market in an unsuspected transparent way. Inspired by Merton and Bodie, the authors point out the three channels, through which derivatives may influence the integration of financial markets and the economic development: the volume channel, the efficiency channel and the risk channel. Using BIS data they document the impressive growth of exchange traded and OTC-traded derivatives. A look at the development of derivatives markets expressed in percentage of the GDP confirms that this financial sector has developed very rapidly. The rising importance of derivatives can foster a decoupling between monetary and financial liquidity via leveraging. Thus, there is little doubt that monetary policy has lost some influence on national liquidity conditions. Derivatives are used extensively to manage risks by companies as well as by asset managers. The LTCM case and the recent "Subprime-Securitization Crisis" have shown the sensitivity of the markets towards risk. The lesson for asset managers is that they have to draw more attention to risk controlling and transparency to better assess risks associated with derivatives. Derivatives have in fact a highly concentrated market structure which means that stress testing and analysis of counterparty risk are crucial for asset managers.

New financial instruments have undoubtedly increased the complexities of the international financial system. It is not evident to what extent financial innovation has contributed to the recent crisis. However, each of the papers in the present SUERF Study contributes to our understanding of what happens in the volatile global financial markets.

Morten Balling, Ernest Gnan and Catherine Lubochinsky

2. Future Trends in Asset Management: Challenges and Observations

Presidential Introduction of Professor Robert C. Merton by Catherine Lubochinsky

The time has come for the 2008 Marjolin Lecture and I have the privilege this year to introduce Robert Cox Merton, professor at Harvard Business School (since 1988), and not to be confused with Robert King Merton, the famous sociologist professor at Columbia University, his father. Not only was he thus introduced to the academic world in his early age but it was also his father who introduced him to poker and stock markets - a premonitory combination.

However, Robert C. Merton, more fond of cars than cards, decided to go to college at Columbia's engineering school. And even more surprising, he published his first paper on Gulliver's Travels in the Journal of History of Ideas. Fortunately for us, Robert Merton diverged into economics when he joined the MIT in 1967 to complete a PhD under the supervision of Paul Samuelson, and later became his assistant. At that time, Paul Samuelson was already investigating warrant pricing. One could say that's how it all began for Robert - the (market) timing was right!

He held his first position at MIT in the Sloan School of Management, where he became a Professor and stayed for 18 years, enjoying colleagues such as Modigliani, Cox, Black and Scholes. His first fields of research were dynamic models of optimal lifetime consumption, portfolio selection, equity asset pricing and contingent claim pricing. During that period, he published what are certainly the most-read papers in finance around the world:

- **Intertemporal Capital Asset Pricing Model** (Econometrica 1973)
- **Theory of Rational Option Pricing** (Bell Journal of Economics and Management 1973)
- **On the Pricing of Corporate Debt** (Journal of Finance 1974), which paper definitely contributed to the Nobel Prize he was co-awarded (with Scholes) in 1997.

Black and Scholes had published their paper on the Pricing of Corporate Liabilities in 1973 (Journal of Political Economy). Quasi-simultaneously, Robert Merton showed in this 1974 paper that the dynamic trading strategy prescribed by Black and Scholes to offset the risk exposure of an option would provide a perfect hedge in the limit of continuous trading. That is, if one could trade continuously without (transaction) cost, one could exactly replicate the option payoffs. This was thus an alternative proof of the pricing technology. This proof in finance is as important as the discovery of the structure of DNA in biochemistry.

But Robert Merton is a man of two lives: besides being an academic, he has always been a practitioner. Over the last 30 years he has been into finance practice. By the end of the 1970's, his research was about applications of his models to social security, pension funds, deposit insurance, corporate investment decisions etc. and he became, not surprisingly, consultant with the Chicago Board Option Exchange. In 1976, with Scholes, he set up the first mutual fund with downside protection (well before the put insurance products developed in the 1980's or floor products in the 1990's). He then spent some time as a top advisor to Salomon Brothers, where Scholes joined him, and where they met the co-founder of what was to be the famous hedge fund LTCM (1994). Robert C. Merton is currently Resident Scientist at Dimensional Fund Advisors.

One could go on for another couple of hours trying to summarize all of Robert's achievements, but I think the SUERF participants are more eager to listen to him. So, Robert, the "floor" is yours to tell us about the "Future Trends in Asset Management".

1. Introduction

Thank you very much for those remarks. If I was a truly Rational Man I would say 'Thank you!' and sit down because it can only go one way following that introduction. I would first of all like to thank SUERF for inviting me to deliver this year's Marjolin Lecture. I do not intend to discuss the current crisis and its immediate interplays with asset management, not because such a topic is not interesting, but because it would be too interesting, and we would not be able to cover any other topic. Fortunately this topic has been excellently

summarized this morning, having been thoroughly researched and discussed during this Colloquium. Instead, I will address the subject of "Future Trends in Asset Management: Challenges and Observations".

Over the last three decades the financial system has changed enormously, thanks in no small part to advances in computer technology, telecommunications and, indeed, finance science. In turn, the extraordinary financial innovation that practitioners have brought to bear over this period of time has been shaped greatly by academic financial research, with a considerable impact on all of us, as producers, users and overseers of the system. Nowhere has this been more apparent than in the development of derivative securities technologies, including futures contracts, options and more complex option contracts. I plan to divide my remarks today into three parts.

First, I wish to address the recent trends in the asset management industry for the manufacturing or production of asset management services. I will discuss the bifurcation that has taken place with the decomposition of the asset management business into component parts as well as touching upon the implications of this bifurcation for recombining this business for institutional and retail clients. Second, I will discuss sovereign-wealth funds with a brief case study of this large and rapidly growing sector, in particular the execution of sovereign wealth funds, reserves and debt management, which can all be decentralized. I will raise the issue of whether considering an objective function (from which the optimum policies for each are derived) reflects an integrated, generalized asset/liability-management perspective for overall country risk exposures forms an appropriate way to address this particular asset management activity. Third, I will examine risk transfers vs. capital needs and capital flows. Of course, risk allocation forms the essence of asset management. Modern financial technology permits the separation of risk exposure selection and management from physical investment choices, capital expenditure plans, ownership and governance of assets. It is possible to radically change risk exposures without affecting capital, trade or income flows or even the traditional balance sheet. Thus, risk can be viewed as a separate dimension of management decisions.

As we will see, the tools that are most efficient for risk transfers are not necessarily those that are used for managing capital flows, and to illustrate this point I will apply this to the risk management for a whole country with the explicit idea in mind of exploring the trade-off between pursuing the two well-known economic dictums: on the one hand we are instructed to pursue our comparative advantage - whether as an individual, a firm, an institution

or a whole country – whilst on the other hand we are told to diversify efficiently. These two dictums conflict with one another, since the pursuance of comparative advantage clearly means focusing on a few, typically highly-related, activities, whilst diversification advocates investing in many different asset classes, preferably ones that are unrelated to one another. I will illustrate how modern financial technology allows the reconciliation of those two dictums. From the perspective of potential gains as a result of efficient asset management for economic growth, in particular in developing economies, as well as the challenges we have to deal with, we are faced with complexities and increasing demands with regard to required knowledge. Overseers and senior managers of producers in particular find themselves having to address an ever more complex set of situations. In my title, I have deliberately chosen to use the word "observations", since any single topic of the three I will address could easily fill an entire lecture. As such it will only be possible to allude to certain aspects of points of each topic, so each section should be considered to be a taster menu, rather than forming any definitive discussion on such topics.

2. Recent trends in the asset management industry for the manufacturing or production of asset management services

Last night, we heard from the Senior Partner of Pioneer Investments about many of the issues of trends in asset management from a practitioner's perspective. If we examine how asset management has been changing, the principal change has been towards a "barbell" type of investment strategy. Two extremes have been responsible for the largest absolute growth within asset management. The first extreme is one of very efficient risk exposures - so-called "Beta" exposures. Such Beta exposures are good for efficient diversification, as is the case in such asset management vehicles as index funds, ETFs, and derivatives among others. It has proven to be a huge area of growth in producing Beta in a scalable and efficient low-cost form. This pure exposure is balanced out by another extreme at the other end of the barbell, which focuses on pure performance, – so-called "Alpha", where superior performance, beyond that

which can be obtained from core but passive strategies is sought. Typically vehicles for the production of Alpha are so-called alternative assets, such as private equity, hedge funds, direct real estate investments and almost any other kind of niche area, where it is possible to generate excess returns. Both of these extremes have proven to be substantial growth areas, at nil expense in relative terms.

Traditional long-only managers have combined Alpha and Beta together offering exposures to important assets classes, and promising superior performance in these classes. However, many of the star managers, who had hitherto been traditionally found in long-only shops, have now left that sector to become part of these alternatives. Pressure has therefore been place on this middle group, and in some ways this process is catching up with academic theory. It has always been postulated that one could logically and perhaps efficiently separate those functions and unbundle them and provide open architectures for implementing them, and this appears to the way that things are heading.

The question arises, therefore, as to the implications of such barbell investment strategies? Primarily, it has become apparent that institutions are moving more towards alternative investments that they were in the past. I would like to point out to you, however, that even if institutions were adopting the same portfolio as they had done in past, in order to achieve what they had achieved in the past, such a step would nevertheless be necessary. Why? Because, as I have already alluded to, since many of the successful managers that they were using before in the long-only shops have left to set up hedge funds and other alternatives. Effectively, to remain with these managers, they have therefore had to pursue alternative asset classes. Therefore, making that forecast does not necessarily suggest that changing towards the alternatives will imply really different patterns of returns for institutions, although I believe that this will be the case in practice.

Secondly, this bifurcation also creates much greater transparencies of strategies and sources of value added. Producers of pure Alpha, and by this I mean the abstract extreme, have no place to hide and are therefore only able to reply, “Here is my extra return and all the systematic risks expected have been taken out”. On the other hand, producers of pure Alpha can not proffer statements like, “We did well but the market was down, so what can I say?”

With regard to the aspect of fees, as you are all aware, long-only management fees are very different in terms of the percentage of assets than management

fees for alternative asset classes. For hedge funds, there is an apparent standard for fees of "2 and 20" - a management fee of 2% of net added value (NAV) per annum and a performance fee of 20% of the fund's up side or profit. However in an actively managed portfolio, the management fee is quoted in basis points, whether it is 75 or 100 or even more basis points; however the management fees are nothing like the percentages that apply for hedge funds.

However, the question then arises of which type of fund management produces the more costly Alpha? It is apparent that this can be measured very simply. For example, for a fund with a "2 and 20" fee structure, it is possible to express the value of the fees as a traditional annual percentage of assets beforehand. This is possible because the performance part of the fee is nothing more complex than a call option, and call options can be valued, so this when added to the 2% management fee gives us a composite simple percentage of assets as an annual management fee. If this is applied for a typical fund, e.g. one that has a similar variance or volatility to the market as a whole, the figure that emerged with "2 and 20" management fees, for pure alpha, i.e. for a provider who is giving 100% of every Dollar or Euro invested in the fund to alpha, then it corresponds to about 2.8% per year of annual management fee. If, however, the manager is producing alpha on only half your invested capital, with the other half producing beta, which costs almost nothing to produce - e.g. an amount of practically zero – say as low as 2–4 b.p. the difference is very apparent. In some instances people actually have a negative management fee, i.e. the fund manager actually pays the investor 2 b.p. to let them index for you, although this again is an extreme. In the event that the split between alpha and beta is 50:50, then the 2.8% you are paying for the alpha becomes 5.6%. It can be compared easily to buying liquid detergent for your washing machine from the supermarket and having two choices – either the large bottle, which is mostly water, or the small one, which is concentrated. If you buy the large bottle, which appears to be the better bargain, you are mostly paying for water, which most of the time costs practically nothing. This is also the case in investment management. The only way that you can compare is to decompose, even with a traditional manager. In a more extreme case, if 20% of the portfolio is dedicated to producing pure alpha and 80% of the portfolio is dedicated to producing beta or "passives", the effective rate that you are paying for alpha is a management fee of almost 15%. Therefore, the fee structure can be comparatively quite different depending on the actual mix of alpha and beta. The barbell structure makes this transparent – and much more transparent than in the past, and this has clear implications for the industry.

The second result of separating alpha from beta that occurs is that there is an acceleration of the ongoing process of alpha being "turned into" beta. What does that mean? Before answering this question, I wish to define what exactly I mean by alpha in my remarks. By alpha, I mean that any time you can add performance over and above the performance that the client could add without you, you are adding alpha. This may be a little different from some definitions but I think it is the practical definition of alpha. Put in other terms, if I can show you that I can do something better for you than you can do at the moment then there is an added value of performance. But, if the way that I do that is something that could be done systematically and at low cost, then as soon as this is recognized, even though the entity that is getting the alpha is getting the benefit, the fund manager will no longer be able to earn fees of a similar magnitude of "2 and 20", but will earn fees that are much closer to fees for providing beta. To give you a couple of concrete examples of what I mean by this, there is some evidence that small cap stocks have an incremental risk premium over large cap stocks and that so-called value stocks have an incremental risk premium over growth stocks. If that is true and one tilts the portfolio relative to a base portfolio in the passive market towards holding more small cap stocks and more value stocks, then if this is the case, you should be able to realize a higher performance per unit risk than you would with the passive strategy – and that would be alpha. Some well-known hedge funds follow precisely that strategy. However, once this approach becomes understood in the market place, then the other part of the business - the Beta business - will be able to create small cap vs. large cap, value vs. growth, and they would be able to do this at a very low cost. At that point, the cost structure will then change away from the high management fees for delivering alpha, and that is the sense in which it migrates to beta. The speed at which this is happening is accelerating. Like many other businesses it has become much more competitive, and is much more difficult now to sustain a margin in that environment.

Third, you will witness expansion on the beta side in the following sense: new asset classes, among these asset classes are climate, longevity risk being traded, liquidity, pre-programmed liquidity, and owner-occupied real estate. The concept of owner-occupied real estate as an investor asset class sounds strange – after all, how can you get investment exposure, if there are other people who live in and own such real estate? It is possible though. As these classes expand, we see the Beta side does too. So what is the implication of this bifurcation in terms of what the institutions now have a greater need for – namely the assembler function.

Chart 1: Stages of Investment Production Process for Given Objective Function

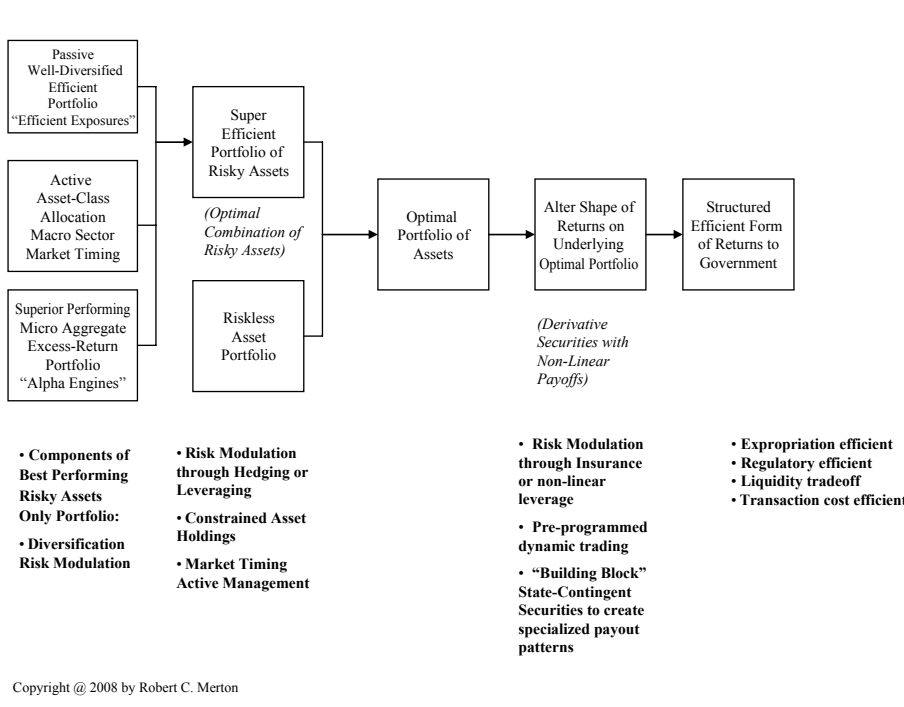


Figure 1 shows a schematic of money or asset management. It can be broken into three pieces. On the far left hand side is the starting point – the well-diversified, efficient, so-called Beta exposures, passive assets. There may also be macro-market timing across those classes. This forms the first part of the activity. Additionally, as shown in the bottom box on the left hand side, there is the so-called Alpha, from all the specialized areas from which you can pick stocks or other misvalued assets. These three components then have to be optimally mixed together to come up with the optimal combination of risky assets, which is then mixed with the risk-free asset in order to modulate risk. Finally, you come up with your optimal portfolio, and then if you choose to, you can actually bend and twist and shake that portfolio into different types of payoffs. One of the fastest growing areas is floor products, where a minimum return is placed on the optimal portfolio, but where upside is retained. Finally you end up with the efficient form of the product. In the traditional version of this process, everything that is listed in the three boxes on the left hand side of the figure is done by one entity (or by a small group of entities), and the client does not really have to do very much, other than to indicate the exposures it wants. However, it has now become a specialized process with

many different portfolio-component providers and someone has to assemble all these parts for this institution. One of the implications for this, in terms of efficiency, is ensuring that you have integrated and consistent risk measures between alternatives and traditional asset classes. Over the last 25 or 30 years there has been a lot learned and developed in performance measurement for equities, debt, small caps, and large caps – the traditional asset classes. While risk measures for these asset classes are hardly perfect, a lot of experience has been gained about that kind of performance measurement.

The problem with alternatives emerges if you take those same performance tools and attempt to simply apply them to alternatives – you are going to get a mess as they can not be applied well. For example, in any private equity or direct real estate, a feature of those assets, even though they quote their assets once a month or once a quarter, is that they have stale prices, and do not trade very often. Companies in a private equity portfolio sometimes do not get re-priced for years. Now the effect of that is that if you put the historical returns into a standard optimizer, then they look less far less correlated with traditional assets than they actually are. That biases the results to make it look like that segment is outperforming and is a much better diversifier than in reality. It is possible to correct this bias, but to do so of course requires you to actually make the correction. If you just use the traditional measurement tools, you will get a very large, order-one effects that could be as much as a 1000 b.p. of apparent alpha originating solely from the mismeasurement of the systematic risk from stale pricing. In hedge funds, even ones with liquid assets which do not have this problem, the hedge funds have dynamic strategies which systematically change their risks through time, unlike the traditional classes which have reasonably stable risk characteristics. So for example, relative-value funds tend to have the feature of increasing their risk when they go down, thus acting like contrarians. So, if this non-linearity arising from these changes is not accounted for, once again there is a biased measure of the risk and there is then an overstatement of the performance followed of course by a correction.

Another issue that was raised in a different context earlier this morning, was that one ought to know where the extra returns are coming from. If a risk manager is making lots of money, it is also a good thing for the risk manager to be able to say how they are making money.

So part of this assembler process that has been forced onto the institutions as a result of the bifurcation is to understand where their returns are coming from. For example, in hedge funds, there are three systematic sources from

where I think returns could be coming from - whether they actually do or not is of course an empirical issue. One source is that they are just taking systematic market risk, and that they aren't pure performance players, and they are exposed to the same risks that equities are, regardless of whether they are trying to be exposed to them or not. This may seem rather prosaic but it is true.

Second, as a well-done study by a colleague of mine showed, in which there was an analysis of returns for every hedge fund asset class from convertible bonds, long and short equity, through to wealth, there is the systematic factor for at least since 1994 to 2004–5 that seems to explain a large part of the excess returns as usually measured, known as liquidity-event risk. A single variable needs to be placed in the returns which identifies when a liquidity event, such as the one we experienced in Summer 2007, occurs. I do not refer to what has happened subsequently during the credit crisis, as that is a different matter, but when you have a seizing-up in the markets regardless of size, then that risk seems to be one that all classes of hedge funds are exposed to, and all these classes take that risk. Now to a certain extent there is a risk premium paid for taking that risk, but you do not realize it, and that could be a systematic source of return.

The last one, which might be very important for overseers to recognize, is that I believe hedge funds, even if managers do not think of it this way, perform a very important role in dealing with the global institutional rigidities that we see. We have a global financial system and yet as we all know we have individual nation-state systems that do not match up in regulatory terms, which on the whole act a bit like a speed limit sign, in that they are designed to approximate the best conditions, but clearly at times they create an unintended negative kind of restriction for various types of institutions. This is more likely to occur, the more global and more complex the system becomes. The role here of hedge funds is that they can intermediate for the intermediaries. However, they do not intermediate the way a banker intermediates - i.e. on a one-on-one basis, facing the clients. They intermediate through markets. The common factor for all hedge funds, as far as I know, since they do everything in investing, is that they are lightly regulated. That is the only common factor I can really come up with. If you have someone who is regulated in the same way as the institutions who are up against institutional rigidities, they cannot be an intermediary, as they face exactly the same rigidity. So it becomes necessary for there to be an alternative way, so that that there are some institutions that are not regulated in the same way, thereby allowing them to be on the other side of the transaction, not with the intention of superseding or circumventing policy, but to play the

role of service shock absorbers for the complex realities of all the systems that are interacting and are writing a fixed set of rules. This is not meant to be seen as a criticism of the system, it is just a structural description that when fixed rules are written, they do not work well all the time, and sometimes there can be unintended consequences. If you able to have an unregulated entity that can form the other side of the transaction, then it is possible and they can help you. One of the key reasons why hedge funds are making money is not because they are smarter, faster, or have better models, but is in fact because they are providing a service, an intermediation service, a risk transfer service, particularly in the environment I have mentioned, which would be one way of trying to understand where these extra returns, if any, are coming from.

I have hitherto described the implications of the bifurcation for institutions, but there are also implications on households, as has been alluded to by the practitioner's view of asset management. One of the big visible trends around focuses on the retirement part of the life cycle and the oft-quoted metaphor is of a three-legged stool approach for retirement, with the respective legs of the stool being personal savings, the government/social security type schemes, and an employer or equivalent institutional accounts. For the most part, the corporate or institutional provisions of the three-legged stool have taken the form of defined-benefit plans, or at least this has historically been the case. As you are all aware that has changed radically. In the US and the UK and many other parts of the world, such defined-benefit plans are disappearing, although they still contain approximately USD 3 trillion as well as asset tools, so managers of such funds are unlikely to go out of business for a while. For people worried about their retirement provision, however, such defined-benefit plans are no longer a viable prospect. What has happened is that by substitution the defined-contribution plans have come in, which I happen to think they are not the answer, but I would have to save any further elaboration for another day's discussion. A next generation does exist, but I do not wish to comment upon this. But what is the consequence of this trend? Suddenly professors, brain surgeons or auto assembly line workers are now confronted with the task of having to figure out how to allocate their assets in order to be able to enjoy an adequate standard of living in retirement, which is often decades into the future, and which often lasts for decades after retirement, and which is a very daunting complex problem - even for professors - to try to address. The idea that brain surgeons and professors or auto assembly line workers can do that in an effective way, even with the benefit of all their education, is about as likely as me being able to make my own decisions on surgery. Imagine how I would feel as I was being wheeled into the operating theatre, as I am about

to go under from the anesthetic and my surgeon asks me whether I would like 12 or 17 sutures. I would not know.

However, this dilemma is one with which we are confronted with the defined-contribution plan. In this instance, the bifurcation confronts households with decisions they have never had to make in the past, ones which they are unable to make in the present, and ones which, even with education, I do not think they will be able to make in the future. The answer to that is going to be a recombination coming back, we are going to have to use intermediation again and create user-friendly, easy-to-understand products. To have millions of people go through their retirement being poor can not be viewed as an acceptable long-term equilibrium. It is one matter if you lose money and are unable to afford to have a second home or second car or whatever, but for the general population's retirement that does not make sense. This is currently a very big trend which I foresee happening in asset management and we have that reversal going through that.

3. Sovereign Wealth Funds

The second main topic that I wish to address is that of sovereign wealth funds. With regard to sovereign wealth funds, I really wish to make three points. I think we are all aware that sovereign wealth funds are an expanding area. Currently sovereign wealth funds are worth about USD 3 trillion and are growing fast.

Firstly I would like to address the objective function of sovereign wealth funds. In this morning’s plenary session it was mentioned that depending on which country you are in, there exist sovereign wealth funds, pension funds, stabilization funds, savings funds or sector funds. Rather than focusing upon all these definitions, I would prefer to look at the balance sheet for the government, representing a particular country.

Table 1: Government Economic Risk Balance Sheet (For China in this instance)

Assets	
	RMB bn
Present Value of Incomes from:	
TAXES	3325.7
Excise	188.6
VAT	1278.5
Sales	512.9
Customs	112.8
Income	949.3
Motor Vehicles	68.8
Dividends	86.8
Land	128.1
Others	TBD
FEES	0.0
Administration	TBD
Penalty and Confiscatory	TBD
SEIGNORAGE	TBD
Balances of:	
INVESTMENTS	1500.0
Sovereign Wealth Fund	TBD
Industry and Transportation Fund	TBD
Culture and Education Fund	TBD
Social Security Fund	TBD
Agriculture Fund	TBD
Housing Accumulation Fund	TBD
INFRASTRUCTURE	TBD
CASH	1.7
SPECIAL DRAWING RIGHTS	TBD
CURRENCY RESERVES	7775.8
MONETARY GOLD	33.7
STATE-OWNED BANKS	TBD
NON-BANK STATE-OWNED ENTERPRISES	TBD
DEPOSITS	1021.1
OTHER ASSETS	TBD
TOTAL	13657.9+TBD

Liabilities	
	RMB bn
Present Value of Non Discretionary Expenses on:	
ECONOMIC DEVELOPMENT	901.9
SECURITY & EXTERNAL RELATIONS	377.9
SOCIAL DEVELOPMENT	1500.5
GOVERNMENT ADMINISTRATION	335.6
BENEFITS	
Industry and Transportation	TBD
Culture and Education	TBD
Social Security	TBD
Agriculture	TBD
Housing Accumulation	TBD
Commerce and Trade	TBD
SUBSIDY TO STATE-OWNED ENTERPRISES	18.0
Balances of:	
MONETARY BASE	TBD
GOVERNMENT DEBT OUTSTANDING	
Local Currency	285.6
Foreign Currency	TBD
CENTRAL BANK BILLS	TBD
BANK RESERVES	651.7
Contingent Claims (Implicit Guarantees)	
GUARANTEES TO BANKS AND NON-BANKS	TBD
GUARANTEES ON RETIREMENT INCOME	TBD
GUARANTEES ON SOCIAL WELFARE	TBD
General Balance (Economic Assets in excess of Economic Liabilities)	9586.7 +TBD
TOTAL	13657.9+TBD

Sources: State Administration of Taxation, Tax Income Statistics; The People's Bank of China, Balance Sheet of Monetary Authority; Ministry of Finance, 2006 State Fiscal Income/Expense Final Account

What we are trying to achieve, and this could be applied to any country, is to draw up a balance sheet where all the assets of the government are listed.

This is also done for other reasons, e.g. for fiscal policy we try to assess the valuation for the various taxes and present value of those tax assets, as well as values for cash and currency reserves, monetary gold, state-owned banks, etc. Additionally we also include investments, like sovereign wealth funds, the industry and transportation fund, culture and education fund, social security fund, - i.e. all the funds that a country might have. The right hand column of the table shows the present value of non-discretionary expenditures, the ones that you will not skip even if you cannot pay your debts. Then you have the various monetary bases. Here I have lumped the Central Bank balance sheet together with the government balance sheet including Bank Reserves, as well as aggregating accounts and the various contingent claims, (i.e., guarantees to banks and non-banks, retirement and social welfare). At the bottom of the table there is then a general balance that is available, which is like the equity of that sector of the economy. If you are trying to manage the risk in any meaningful way, and that is certainly a key role of sovereign wealth funds, which whilst being a source of savings it should be remembered that asset management, when applied, largely revolves about how you allocate the resources you save across different risks. It therefore, does not make sense to treat the sovereign wealth fund as if it is a stand-alone entity, when you are trying to decide what the optimal objective function is. The only thing that makes sense, in that instance, is to do a sort of asset/liability management for that whole balance sheet, and to then examine how do these risks interplay with all the other risks and the liabilities, and then decided upon what is optimal for the sovereign wealth fund in terms of its objective function, given all these characteristics. This can be done, or is certainly as doable as the naïve approach of treating the sovereign wealth fund as a stand-alone, and it really defines risk in an appropriate manner. It also allows currency reserves to be run by the monetary authority separately, which also happens to be very practical, and debt management can also be handled separately, although it is essential that there is a rationalization of the risks somewhere along the line, not to act as a constraint on the behavior of the individual players, but rather to ensure ultimately, that there is the right risk return characterization for what matters to the government.

I would submit to you, that one of the advantages to this approach is that it does not matter what the sovereign wealth fund is defined to do. It falls into its characteristics when put together with all the other assets - a point I will return to - when talking about it in a different context. Certainly one of the roles that the fund can serve, besides simply saving intergenerationally, which in a certain world it will, e.g., by putting money in bonds, where it does not matter what you invest in and is typically used for diversification outside the

country. In China, for example, China Investment Corporation (CIC) was specifically set up for that purpose, and the reason for doing so can be seen on the risk list – as the tax revenues listed are risky. And what is the risk related to? One thing that is however certain, is what the country's productive activities are. So clearly if you know from diversification that if you have a very heavy domestic investment, and let us understand that computer chips in Taiwan form a large part of your industry, then you do not want to be investing in computer chips in your sovereign wealth fund, since you already have exposure to this, whereas if you are, for example's sake, Chile and have thriving copper and forestry industries, but no computer chips, you will want to. That is just a simple illustration that you cannot come up with an optimal strategy for asset allocation within a sovereign wealth fund without the context of other government assets and liabilities. In China's case it is trying to address the asset bubble, which has been addressed at least in part in the last six months with the halving of the stock market, but these things still come and go, and there are ways to deal with them. Now, as a case in point of policy, not wishing to be critical, as an outsider I would have to say that I am very confused by the policy pursued by CIC. I understand its mandate is to invest outside the country and what it is doing is supposed to be representative of the proof-of-concept to the ruling powers. Why then, when starting out, did CIC begin by investing in individual deals. I quote the example of its investment in Blackstone Group, which, whilst it happens to have gone down by 30%. Had it gone up by 30% it was still not the correct thing to do. My recommendation, for all sovereign wealth funds, but particularly for the ones that are getting started, would be, if their mandate is to invest outside the country, their core position, right to begin with, should be to hold a whole world market portfolio ex their own country's securities, which consists of a highly diversified passive set of assets. I say this not because I do not believe in active management, but because one starts with the core.

Returning to figure 1, every optimal actively managed portfolio strategy always involves significant allocations to passive assets. It is never based purely on alpha assets. So you are going to need to have passive assets. Second, it is possible to put trillions of dollars to work very quickly with almost no market impact, let alone needing to enter into individual deals. You are then not under the pressure that China has found itself under, of having to go out and try to find outside partners in a rush and to then put this money to work without a coherent strategy – the results of which, I am sure you can imagine will be to overpay – not that I mean this disrespectfully to those people involved in the industry – I, too, am a part of it. However, when someone with a huge amount of resources is in a hurry to invest a lot

of money, and they admit that they do not know what they are doing outside the country, then they are unlikely to end up in deals that really are the best deal for them. There are other benefits for investing in a whole world market portfolio. Such an investment is scalable and, reversible, to a far greater extent than pursuing any of the active strategies, and from a political point of view it is a non-entity in terms of attracting political attention. I realize that I have barely touched upon the negative political aspects that have been going on in relation to sovereign wealth funds and their exercising too much power. Such aspects disappear with a broad index strategy. Once they have also established that they can take resources out at their pleasure to do the active parts. For this reason, I am, therefore, very confounded why this advice has neither been given and nor been followed, but there remains plenty to be done of order-one importance to help to ensure that development and to move forward.

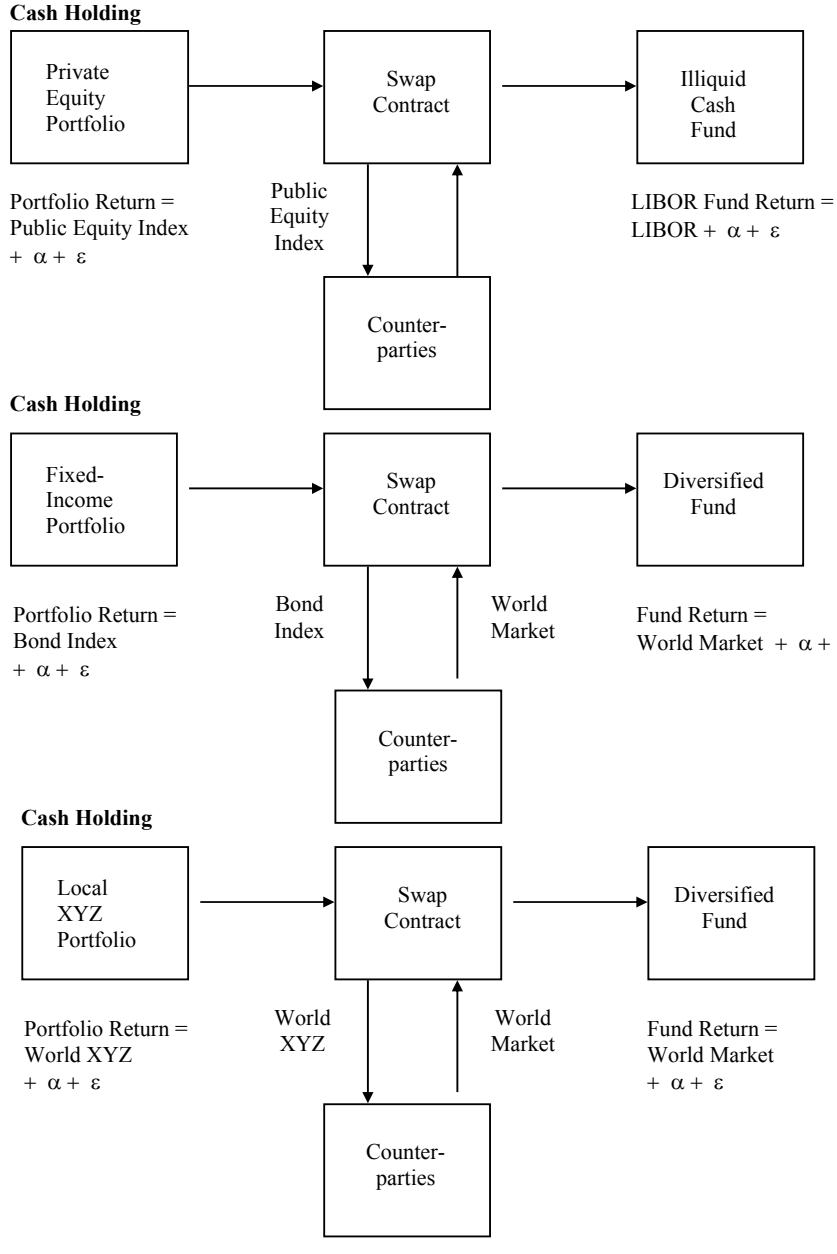
4. The Difference between Risk Transfer and Capital Flow

Continuing on from my previous example, I would once again like to use Taiwan as an example. Suppose that you represent Taiwan and suppose that, to make it simple, its sole industry were computer chips, which is a comparative advantage for Taiwan. One of the consequences of this being the case, is that if you have normal investments in Taiwan and you do nothing about it, you are exposed to a very, very concentrated risk, namely an exposure to the world chip market, which Taiwan does not control, and which anyone is able to invest in, and yet as a result of this it has a very undiversified risk exposure as a country. Now it is clear, that while computer chips form a comparative advantage for Taiwan, bearing the world's chip risk does not form part of the positive value creation from Taiwan's exposure, because it is possible for anyone to do that. It is what we call a zero net present value type risk, with a fair return which anybody can get. It is certainly not necessary or desirable for Taiwan to take the whole world chip risk.

The question, therefore, arises as to what Taiwan can do to diversify, while still maintaining its comparative advantage? In the old days, the country would have had an industrial policy that would start to develop another industry - such as a forestry industry or an oil-based industry or an industry which reflected just what is needed in the world. But what could a country like Taiwan do instead today?

I would suggest that Taiwan does the following thing, as shown in figure 2 above. Taiwan enters into a swap contract in the form of a total-return swap contract. The swap contract has two parties and basically based on a certain notional amount of the size of the actual investment, they swap returns with each other on two different asset classes. This can be done with any two assets and since the returns of any two assets are being swapped, and you are just exchanging returns applied to the same investment base, there is no investment cost involved for the swap in question – even for the transaction, as it is a pure exchange of returns and such contracts have initial zero value. No cash flow or investment are required, it is just an exchange. Every futures contract is effectively also the same, as there is no investment in a futures contract either.

Figure 2: Separating Risk Exposures from Cash Investments, Governance and Liquidity: Pursuing Comparative Advantage vs Efficient Diversification



In this instance, suppose that Taiwan put a notional USD 10 billion into a contract which states that it will pay the return on the world chip market,

which will be measured by putting a portfolio together of stocks in Intel, AMD and all the other companies in the chip industry, something which is done all the time, and that portfolio is monitored and its total return-including dividends and capital gains or losses – is examined. Whatever that total return is, is multiplied by USD 10 billion each year. This would be what Taiwan must pay to the other party. What does Taiwan get in return for that? Suppose Taiwan gets back the return on a world portfolio, i.e. one based on all industries, which in theory is the best diversified portfolio, at least until we are able to go to Venus, or Mars. So, Taiwan in this instance would get back the return on the world portfolio, multiplied by USD 10 billion. In other words, we see a swap on return, the world chip returns in exchange for world diversified portfolio returns.

The economics of this swap contract for Taiwan would be as follows. Previously, Taiwan's returns from the chip returns were made up of two parts. Part of Taiwan's chip returns, which includes the world market, meaning that when chips are doing well for the world, then it is also good for Taiwan's chip industry. In contrast, when chips are not doing well in the world, it is also bad for Taiwan. In addition, because Taiwan has its own industry, it has an additional return, which is Taiwan-specific, which is its alpha. We hope that this additional expected return is positive so that Taiwan has a comparative advantage, as well as there being another error term, which relates to events like there being a strike in Taiwan, which affects Taiwanese chip manufacturing, but not chip manufacturing in the rest of the world. So Taiwan is getting world chip returns plus alpha for comparative advantage, plus the residual for the local risk. World chip represents a big part of the total risk. This swap has kept the alpha, and the local risk with Taiwan, but has removed world chip risk by instead putting the risk in world diversified risk.

With a single contract, we have transformed the core risk of Taiwan, or in this case, at least USD 10 billion of risk, with this risk changing from being concentrated in one industry to diversifying it into the best diversified performance in the world, while retaining the comparative advantage and the local issues that the country controls, 100% for Taiwanese. This has been achieved with a single contract, which it is possible to execute in large size at a low cost and which can be also reversed if you don't like it. The swap contract is very non-invasive and offers a whole range of other features too, although the feature I am particularly trying to highlight in this instance is that of the risk transfer. No money has been taken, there have been no capital flows or trade, just a pure risk exchange. Some people might believe that there is an investment flow going in and an investment flow going out, but if all you want to do is a simple risk transfer,

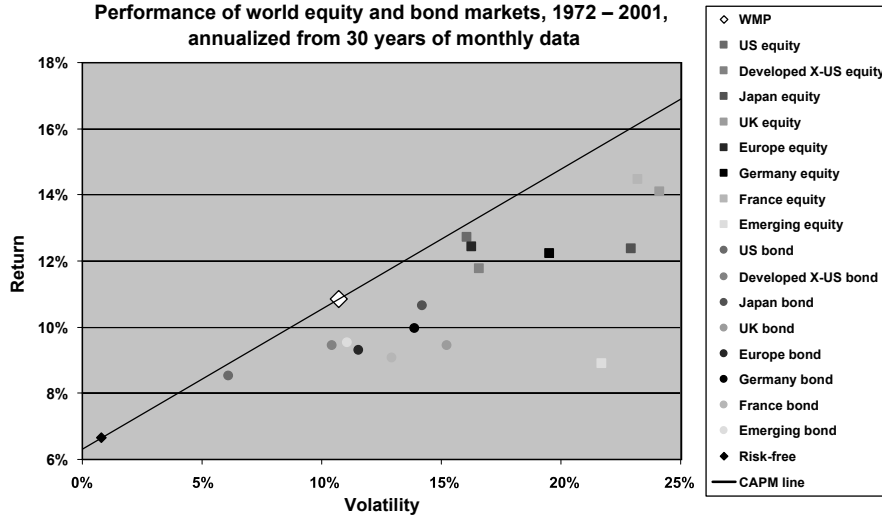
then it would be very inefficient to have Taiwanese sell shares in Taiwanese companies to foreigners, and then have foreigners and the Taiwanese go and buy foreign shares and to have the investment flow come back. Anyone trying to develop smaller countries will know that there is no coordination of those two capital flows at a later stage, whereby one country's activities start to take off, while the other country's do not. At that point you get the kind of disruption which leads to people calling for capital controls. By doing it using the swap contract instead, you have married the two investments as an exchange, so you never have a mismatch of the capital flows involved and that is why there are no capital flows. Simple risk transfer does not, therefore, provide any core investment for Taiwan, but instead just provides risk transfer or risk reallocation. In this way, derivatives are very much more efficient than the cash market in terms of risk reallocation - both from an overseer's point of view, as well as in terms of efficiency of costs and everything else. There is a built-in coordination between the implied flows and the two directions. Of course, if capital needs to flow in a country, this won't directly give you any new capital, so it is necessary to use the right tool.

Box 1: Relative Advantages of Country Swaps for Diversifying Risk

- ***Minimizes Moral Hazard*** of Expropriation or Repudiation
- ***Locals perform*** industrial governance, trading in shares in local market, receive benefits/losses of local-country-specific component of industry returns, thus avoids political risk of "selling off the crown jewels of the country"
- ***Credit Risk:*** no principal amounts at risk; set frequency of payments (0.25, 0.5, 1 years); "right-way" contract [pay when the country is better able]; potential for credit guarantee and/or two-way-market-to-market collateral
- ***Policy is non-invasive:*** doesn't require change in employment patterns and behavior, changes in industrial structure or changes in financial system design
- ***Policy is reversible*** by simply entering into an off-setting swap
- ***Robust*** with respect to local financial system design: works well with capital controls, pay-as-you-go pension system, or no local stock market at all
- ***How to measure country risk:*** Patterned after BIS model for banks
- ***Potential Gains:*** From 1972–2001, a gain of 600+ b.p. in average return for same risk level by efficient diversification
- ***Global political question:*** In the future if all countries had economic risks that were nearly perfectly correlated with the World Market Portfolio, then how might that affect global political behavior?

The above box shows the advantages of this method, although it is not the only way of going about matters. Let us, however, consider what this simple contract has achieved. It has moved Taiwan in principal from having a concentrated risk in one industry to a world-diversified risk while retaining its comparative advantage, and its workers still do exactly the same thing,

it is non-disruptive and that's considering all kinds of activity related to it. Furthermore, this size of feature also allows you to separate governance, liquidity and things like zero net value present risk. Some people may wonder why I mention governance. Rightly, or wrongly, many countries are worried about having foreign ownership of their shares and their industries. Some countries even place in some restrictions in what their pension and other funds invest in. This is done, not because they want to force concentrated investment, but because they want to ensure that governance also remains within the country. They also may want the cash that is raised by local industries for the pension fund to go into local industries as investment for the workers – which are both reasonable policies, and this also happens to be the case of Taiwan in this instance. All Taiwan shares can be 100% owned by Taiwanese, and they could also be in pension funds in Taiwan - as the pension funds bought the shares, and thus the local risk is being borne locally. What has also been done is to strip out the part of the risk which Taiwan has no control over and to substitute a much better risk for term pattern. The potential benefits for countries are clear, particularly for smaller countries, which by their nature have to be more concentrated with their pursued comparative advantages, as well as for developing countries. This technical risk-transfer tool could really contribute substantially to economic development.



Source: André F. Perold, Joshua N. Musher (2002), "The World Market Portfolio"

The above graph, by a colleague of mine, covers the last 30 years of the 20th century, plotting the average returns in percent on one axis, against the

volatility measured on those returns on the other axis, covering a period of 30 years from 1972–2001 for a number of large equity and bond asset classes, putting weight on their average returns and standard deviation. In addition the CAPM line passes through a point, which is the World Market Portfolio. All these asset classes have been taken and put together, weighted by the size of their market value.

In theory, the World Market Portfolio should be the most efficient investment as a risk return trade-off, and this graph proofs this to be the case, even though realizations can sometimes be different to expectations. Moreover, the CAPM line, which goes through the risk-free asset and through the WMP's point, gives you a higher slope, or a higher return to the unit risk than were it to go through any of the individual boxes. And that's solely a consequence exposed due to diversification. If we then turn to look at emerging market equities - not for one emerging market country, but the whole portfolio of emerging markets, which has diversification relative to a single country. It has an average return of about 9%, with 22% standard deviation. Some degree of diversification is already apparently due to having banded and put together all the emerging markets. Now, if we were to suppose that those emerging market countries had been able to follow the strategy we just laid out, whether they proceed using a single industry or whatever their best option is, and were able to enter into contracts for all the risk exposure, not for a total of USD 10 billion but for their entire risk exposure, and to do so fully, even though in practice this is not possible – however the point here is to illustrate the size of the numbers involved. For taking the same risk as they actually took, of 22%, and heading straight up until the CAPM line is hit, it would be at this point that you would be on for the same risk if you invested in the market portfolio and the risk reacted to the same level of risk as if just concentrating on emerging markets. That difference to this point is approximately 600 basis points.

Put simply, and after all this is hypothetical although it does demonstrate the magnitude involved, if you apply the rule of 72 to calculate how many years it takes to double your money at a specific interest rate of 6% it would take 12 years (i.e. 72/6) to double your money. Therefore, in 30 years, which is two and a half times 12 years, had they followed this risk rule completely, they would have had 5 or 6 times more accumulated wealth in their country at the end of 30 years – which is a big, big number. However, in reality it would not be possible for this doubling to be done perfectly, and after all, it is also not certain that the future will be the same as the past has proven to be. All I am trying to convey to you is that while fancy stuff using derivatives may sound very technical and kind of nice it can not be applied as a big important policy.

In this case we can see how large the magnitude of efficient risk transfer can be, particularly for developing and small countries. So the effects on welfare in terms of economic growth and wealth creation are substantial, even if they are not as big as in this hypothetical situation. Furthermore, this is not achieved by unearthing the next Warren Buffett and getting that person to run the country's assets, but is a result of pure diversification and is the result of improving the efficiency of risk transfer.

5. Conclusion

To sum up, I would like to say that I think that there are wonderful opportunities coming out of all of this – some of which I have tried to allude to, with the last one being in the benefits potentially of risk transfer at a very large level. But there are also big challenges. These kinds of things are easy to describe and could even be implemented tomorrow, since they are not like having GDP bonds or some other assets that no one knows how to trade. We can do this, in this size, tomorrow morning - in fact we could even start today, since everything I have described to you is doable with market proven technologies today. This is not a purely experimental thing, but something that could be done instead, even though it is more complex than my illustrations. And the challenge, particularly for overseers and for management, is knowing what the investments are in. Taiwan, for example, would be doing business in this way with all these different countries. And in fact it has transferred a huge amount of risk the other way, and is actually not exposed largely to the world chip market but is instead exposed to something very different. And that's what's engaged here in this process and that's the challenge. There are challenges for all the three groups that SUERF represents, with a need for a better understanding of modeling and factors that change institutions. We need to understand how to design better institutions, to understand how risk characteristics are changed, and how flows work. For the academic economists, particularly the monetary and macro people, there is a need to return to the risk balance sheet in order to understand these markets, and to understand that when you create these markets you change the transfer mechanism, you change the control mechanism, you change the risk patterns, and you can't get away from it. They are first-order. You can't use those models and have any degree of comfort with them without a thorough

understanding of their limitations and capabilities. For the practitioners, the excitement and challenges are clearly going to be: how is it going to be possible to produce all these products and how can we keep control over these standard risks which are changing across geopolitical borders? We are also going to need ex ante and ex post a better understanding of risk characteristics. Finally for the overseers, life is going to be much more complex, as there will no longer be a single challenge that can be watched. The overseers will no longer be able to say: "We know where all the risks are, there are right here and we control them, and the risks can not go anywhere else!" This will not be the case, and certainly isn't currently the case, nor will it be in the future, which will make overseers jobs more complex. Central Banks will have to approach all these markets and risks in a far more sophisticated manner – and they already approach them in a more sophisticated manner than they did, say, a decade ago. It will be necessary to know more about that the markets, be more engaged towards them and aware of what is going on in them.

Finally, with regard to the role of innovation, we have to recognize the risk-benefit trade-off in innovation: it is structural that successful innovations will run ahead of the infrastructure, I use the term infrastructure to cover regulation and oversight. And the reason for that is very simply that most innovations are not successful. It makes no sense, nor is it practical, if you have 100 ideas for innovations for you first to build 100 infrastructures to support all of them and then see what's going to work – if you were to try that, you never get anything done. What happens is inevitably that most of them fail with some amount of support put in, but the successful ones, whether it is sub prime mortgages, which I think has some positive aspects to it although it may have been poorly done in its current form. We will have to wait to see that - at least in the US. But these innovations are going to run ahead. If you focus solely on the innovations in ensuring that you do not have a crisis, and avoid having one, then there will be no innovation. It is a little bit like a high-speed train. If a high speed train can go 250 km/h, but the track (i.e. the infrastructure) is only capable of handling 100 km/h, if you say, "Fine, we will never let you go over 100", you won't have a problem with the track but you won't have the benefit of the 250 km/h innovation. At the other extreme if you just let it go at the 250 km/h with an infrastructure that can only handle speeds of 100 km/h, then I need not have to tell you what is going to be the outcome. So the essential trade off is between managing the mismatch structurally of innovation to infrastructure security, and trying to do it in an efficient way. I wish that there was a golden rule for this, but there isn't one, in my judgment, except for judgment and understanding of what it is that you're analyzing.

INTEGRATED ACTIVE ASSET MANAGEMENT[1]

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Abstract

In our work we mainly focus on two recent developments concerning asset management. First, asset management has become more actively and second, high sophisticated investment strategies have been developed. By analysing the involvement of a sophisticated investment strategy in an active asset management we distinguish three different tasks into which asset management might be separated: Research, Portfolio Selection/Revision and Trading. We propose the integration of these separate tasks into the active management process as a new trend in active asset management. Therefore, the value added chain of each part of the asset management is under revision. Discovering the value generating opportunities of the entire process we analyse each single step of the integrated active asset management and look for possibilities of exploitation. One part of our analysis will focus on the issue of trading or, in terms of the Markets in Financial Instruments Directive

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(MiFID), on “Best Execution”. Considering the question, if the price received or charged is fair regarding the actual market situation, MiFID only refers to traditional securities like stocks. At the moment the Committee of European Securities Regulators (CESR) lists 6,983 shares (as of 26 May 2008) being admitted to trading on EU regulated markets.

Concerning alternative investments the European Undertakings for Collective Investment in Transferable Securities (UCITS) already provide the legal framework for mutual funds and (alternative) investment companies. The aim of the UCITS is to achieve an effective single market for instruments that are consistent to the UCITS directive. Measures planned to achieve this goal are the standardization of UCITS notification procedures and the clarification which assets are consistent with the UCITS and hence eligible for investment. Being compliant with the UCITS directive will be a major aspect of quality and might also be a major aspect of marketing. We suppose that finding a (fair) market price will also affect the so-called “alternative” investments in the future. Indeed, as indicated by the problems of Structured Investment Vehicles finding an adequate price (when no market price exists) is an important issue. It becomes obvious that in the near future CESR will have to tackle the pricing and trading issues for alternative investments and to identify those (structured) investment vehicles that are qualified as being consistent to the UCITS directive. This might have an important impact on the liquidity of alternative investments.

In particular by handling individual shares, individual prices and single orders the trend towards an integrated active asset management will become observable. Therefore, we will focus on individual events, data and detailed procedures applied by practitioners and asset managers. Of course the proposed integration might be a difficult task. Nevertheless, we want to point out the implications of the new trend in a descriptive way. The integration of research and portfolio revision will be illustrated by means of the Relative Value Strategy. However, the integration of the portfolio revision and the trading process is not yet fully realised for the regarded Relative Value Strategy. As we do not want to disregard the integration of the trading, we will descriptively illustrate new developments in trading by discussing the current increase of trading opportunities, quite commonly designated as dark pools. In the course of the analysis we will briefly discuss Electronic Communication Networks (ECNs) and Automated Trading Systems (ATSs) and the recent increase of software tools, designated as order management or execution management systems. The new developments in trading involve a mixture of cooperation and competition among exchanges and investment

banks as each player tries to exploit the inefficiencies of the trading process. This issue is barely discussed among academic researchers. Nevertheless, the appearance of the alternative trading venues provides opportunities to exploit market inefficiencies as the implementation shortfall, which might be estimated up to 6.00 % p.a. Transaction costs might be mentioned as a further example for inefficiencies that might be exploited. Hence it is not surprising that the regulatory activities as MiFID in Europe and the National Market System Regulation (Reg NMS) in the US try to handle this issue.

Thereby MiFID originates the term “Best Execution”. However, the question arises how to measure this term. In the past the available data was limited to prices and the measurement of trading efficiency had to rely on proxies like “mid prices”, “spreads” or “half spreads”. But for measuring “best execution” more than only prices are needed. Due to the developments in information technology the whole order book data is available nowadays, i.e. prices, numbers, partial fills, etc. These data provide the opportunity to measure the trading efficiency by the order “eating up the order book”. With respect to Xetra order book data we will show that the trading efficiency is surprisingly high. However, the available data provide the opportunity to investigate the important step “from orders to prices”, i.e. instead of predicting prices the probability distribution of the order placement is estimated. Thereby professionals and financial practitioners succeed in exploiting the detailed information of the order book and the novel high speed communication facilities by implementing procedures that go beyond the methods applied by academic researchers: Professionals surpass the researchers in developing adequate models and methods.

The methods of the professionals profit from the “organized complexity” that was addressed by Weaver (1948) sixty years ago, reaffirmed by Hayek (1974) in his Nobel lecture 1974 and has been quite recently addressed again by Klir (2006). Real economic problems are controlled by individual actions and interactions. While statistical methods help to detect the moving forces in the capital markets the modelling of the events generated by individual signals is the challenge of recently developed methods as “event stream processing” or “complex event processing”. As indicated by recently proposed models these methods might provide the tools to integrate portfolio revision and trading. As mentioned above, such an exploiting systematic investment approach might be structured into the three stages Research or Forecasting, Portfolio Construction and Strategy Implementation. In our work we describe the difficulties implicated with each stage.

A Relative Value Strategy will be developed and the Forecasting and Portfolio Construction will be explained with reference to the Relative Value Strategy. But in a systematic investment strategy these three stages have to be integrated into the active asset management. This becomes obvious by an empirical study showing the embarrassments implicated with the third stage, namely the Strategy Implementation. Deriving from the idea of exploiting the inefficiencies resulting from a nonintegrated active asset management some possibilities for exploitation will be figured out as conclusion. Regarding trading inefficiencies we differentiate between implementation shortfall and slippage. The first analyses the price change between the point in time when the asset manager decides to initiate an order and the point in time of the execution of the order. The second refers to the transaction prices when the execution walks up the order book. Slippage will be discussed by analysing tick-by-tick order book data of the German stock index DAX.

1. Introduction

Jack Treynor, one of the great masters, once stated that Portfolio Management equals a three legged stool resting on Securities Research, Portfolio Management and Securities Trading (Treynor and Wagner (1990)). The importance of these three parts has been remaining during the last decades. But the connection among these three parts has become much closer: The Improvement in IT, the communication tools, the deregulation of the capital markets and last but not least, the introduction of a huge number of so-called derivative products lead to a fundamental change in asset management. New investment instruments have been developed and investors are not restricted to concentrate on long-only equity and fixed income investments or to trade on the local market only. The recent regulation initiatives to further investor protection both in US and EU will increase importance of trading issues, e.g. best execution and multilateral trading facilities. The philosophy of buying a market portfolio at only one exchange available and holding it till maturity is no longer the guideline, neither from the regulatory nor from the portfolio management point of view. The development of the active portfolio management strategy (Grinold and Kahn (2000)) break fresh ground to portfolio management techniques and terms: Long/short equity, market neutral, managed futures and much more sophisticated strategies have been

made available to a great variety of investors. The impressive developments of information and communication technology enable investors to trade globally nearly all these instruments. They obtain information about all these investments nearly without any time delay.

The paradigm of the efficient market has been abandoned, at least in modern portfolio management. Active portfolio management has shown the superiority of portfolio selection and revision. The rise of hedge funds regarding both the number of funds and money invested is a convincing proof that inefficiencies which can be exploited by sophisticated strategies exist on the market. Even if the recent crises in hedge fund business underlines that there is of course risk in the hedge fund business, the overall superiority of active sophisticated portfolio management is beyond any doubt. However, exploiting these opportunities requires very sophisticated tools in all three stages of portfolio management, either research, either portfolio construction or trading. At the moment the major challenge seems to be that these three sectors have to be treated together to exploit the opportunities. We will designate this combined approach Integrated Active Asset Management (IAAM). The real challenge we have to cope with is to take advantage of the opportunities offered by the recently available techniques. The advantage of a systematic investment strategy is the possibility of using complex quantitative approaches on every stage of the Integrated Active Asset Management Process. We will explain the individual steps firstly and discuss the issue of integration afterwards.

1.1 Research

The quantitative research strategy assumes that the future returns of an investment instrument can be modelled by a certain return generation process, e.g. if the future asset returns are significantly influenced by the lagged relationship between various factors, the patterns of these indicators could be used to accurately predict the future returns (Mitev (2003)). Hence a combination of a systematic investment strategy and an accurate prediction of short-term future returns of financial assets embedded in an integrated active asset management is a convincing approach to exploit market opportunities.

To develop a reliable financial forecasting system the target process has to be defined and indicators influencing the target process have to be found. Dependencies between indicators and the target process have to be modelled mathematically and short-term forecasts predicting the future price

movements have to be generated. The target process in the Relative Value Trading Strategy, presented in this paper, consists of the identification of the assets, pairs of which tend to show a stationary pattern over a certain period of time, but which are experiencing deviations from their equilibrium in a short run. Based upon the assumption, that the past behaviour will repeat in the future, a short term forecast for each combination of the assets is created.

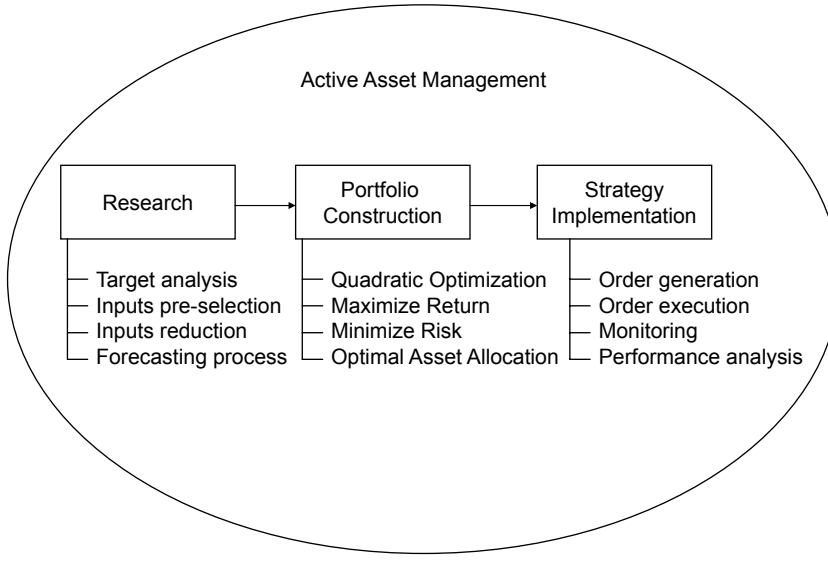
1.2 Portfolio Construction

In the second step a portfolio based on the predicted future price movements has to be constructed. The optimal asset allocation is a subject to linear constraints such as lower and upper limits for single assets or asset classes according to the requirements contracted in the management mandate. The objective function is to maximize the expected portfolio return while minimizing the expected portfolio risk and the expected transaction costs. The resulting portfolio is cash neutral and consists of a basket of long and short positions, where the sum of all long positions equals the sum of all short positions.

1.3 Trading

At the third stage a consistent trading strategy has to be implemented. The amount of shares/securities determined in the portfolio construction stage has to be realized by buying/selling the appropriate number of shares. Trading implies firstly determining the market place, secondly the timing and thirdly slicing of the entire amount into several tranches; i.e. where, when and how to trade. The execution has to be monitored regarding both trading procedure and transaction costs, thus enabling an integrated performance analysis as well as an efficiency analysis at each stage of the entire process. Figure 1 exhibits the entire process.

Figure 1: The three stages of an integrated active asset management



The paper will discuss the tasks that have to be performed at the individual stages of the integrated process and the possibilities resulting from integrating the steps. Firstly we will discuss the complexities of forecasting and the portfolio construction process. Secondly we will discuss new trends in trading by a detailed analysis of the trading landscape and the implementation process. Due to the short-term forecasts a portfolio based on a systematic investment strategy has to be rebalanced very often. Hence, transaction costs are a critical component for active asset management. Various factors impact transaction costs, e.g. commissions, brokerage fees, price impact costs, slippage, implementation shortfall, etc. While some of the costs can be measured quite exactly (explicit costs), others cannot be quantified as easily (implicit costs). The big issue is that the implicit costs are becoming more and more important. Therefore we focus on analyzing the implicit costs. We may differentiate three different forms of implicit transaction costs: Round trip costs, slippage and implementation shortfall. We will concentrate on discussing implementation shortfall and slippage. While round trip costs are a common measure of a trading venue's overall attractiveness, we believe that for measuring the implicit transaction cost of a single transaction, slippage and implementation shortfall are far more important. We will not question the importance of roundtrip considerations. However we believe that the investigation of a single transaction's implicit costs has been neglected so far but deserve adequate investigation.

1.4 Implementation shortfall

Implementation shortfall is due to the discrepancy between the prices at which the portfolio manager decides to change the portfolio composition (decision price) and the actual trading price (Perold (1988), Treynor (1994)). According to our research results, this implementation shortfall may be considerably large for non-integrated strategies. It is therefore important to analyze the impact on the performance and to discuss how to handle it.

Perold (1988) defines implementation shortfall as the difference of the performance of a "real" portfolio and a paper traded strategy. He firstly calculated the "paper" price as the midpoint of the current Bid-and Ask-Quotes at the time point the trader decides to trade. As the portfolios investigated in our analysis consist of the most liquid FX, Stock Indices, Fixed Income and Commodity future contracts, we sharpen the definition and use the price of the last transaction executed immediately before the portfolio construction decision as "paper" price. The "real" price is the effective price of the transaction. The implementation shortfall is the difference in performance of the "paper" portfolio and the real portfolio.

Analyzing the implementation shortfall we focus on two major factors that significantly influence the price difference between paper price and transaction price. First, we examine the impact of the amount invested in a portfolio. As the order size of highvolume portfolios can be very high, brokers are not capable to fulfill all the orders immediately. They slice big orders into individual packages that are traded separately. Consequently the difference between decision price and trading price might be higher for high-volume portfolios.

Then, in a second step we analyze the possibilities to use computerized trading, commonly designated as algorithmic trading (Algo-Trading). In Algo-Trading computer programs determine the point in time and the volume of the orders submitted to the market, i.e. the electronic order book (Prix et al. (2007a)). Algo-Trading requires fast and accurate communication between the order book and the trader as order submitter. The speed can be improved considerably by XML based protocols. One open standard is the Financial Information Exchange (FIX) Protocol. Using a FIX Protocol allows order placement nearly without delay, so the time delay between initiation and execution of an order can be minimized. We compare the implementation shortfall between brokers using a FIX Protocol and brokers who have to

initiate the orders manually. The big advantage of FIX protocol is the speed of the order submission and the general acceptance among many market participants.

We will also show that the factors influencing implementation shortfall depend on the asset class; while implementation shortfall regarding commodity futures is influenced by the notional of the portfolio, the time delay between initiation and execution of an order is responsible for implementation shortfall of stock indices and FX futures. We consider differences between decision/paper and execution prices as inefficiency that might be exploited.

The paper is organized as follows: Section 2 will give a short overview of the key aspects and difficulties regarding the stages "Research" and "Portfolio Construction" and the resulting new challenges for a modern active asset management as shown in Figure 1. In section 3 we want to focus on the "Strategy Implementation". First, we analyze post-order slippage and implementation shortfall with respect to the volume invested in a portfolio and the use of Algo-Trading systems. Second we try to figure out possibilities for exploiting these inefficiencies.

2. Integration of Forecasting and Portfolio Revision

In the following we try to give an example of each stage, research, portfolio construction and strategy implementation. In this section we will describe one possibility that might picture the forecasting (research) process. Therefore, we want to introduce a strategy designated as **Relative Value Strategy**.

Relative Value Strategy is a quantitative trading strategy that aims to take advantage of short-term market inefficiencies. Although not necessarily cash-neutral, in most of the cases it is designed as a self-financing strategy, and in its common form it is very simple. Relative Value Strategy involves the identification of the assets, pairs of which tend to show a stationary pattern over a certain period of time, but which are experiencing deviations from their equilibrium in a short run. By taking a long position in the relatively undervalued asset and the short position in the relatively overvalued one at the moment of their divergence, the profit will be made if the history repeats

itself and the prices converge again. More details about the Relative Value trading (or pairs trading) can be found in the following works: Gatev et al. (1999), Vidyamurthy (2004) and Elliott et al. (2005).

Here we present the Relative Value Strategy applied on the subset of the DJ Stoxx 600 stocks. We want to discuss each single step which has to be considered at the research stage. We will try to describe the preselection of the inputs which are needed to generate the forecasts. We want to figure out the target analysis and the final choice of the inputs. And finally, we will give a short description how the forecasts can be generated when following the Relative Value Strategy within an Integrated Active Asset Management.

2.1 Inputs preselection and reduction

The data employed in this paper consist of the daily closing and opening prices, market capitalisation, volume and turnover data for DJ Stoxx 600 shares over the period from January 2000 to December 2005. In order to make sure that the proposed transactions can be executed, a preselection of the assets according to technical and market criteria is a necessary first step. The technical criteria include a check for data availability, times-series errors and detecting the outliers regarding the open-close spreads. All assets that do not satisfy technical criteria are excluded from the analysis. Further pre-selection is done based on the following market criteria:

- Market capitalisation has to be larger than EUR 3 billion.
- Volume has to be larger than 10,000.
- Lend costs have to be less than 0.4% p.a. of the deployed capital.

In this preselection phase, the number of assets can be reduced to 260 by filtering out those that do not meet the above criteria. The assets are distributed among ten industries, where each of the industries consists of 6 to 41 assets, which consequently results in a relatively high number of potential pairs within one industry. Therefore, the selection of the most suitable pairs of assets represents the key step in the relative value trading process. First, it reduces the number of pairs we can trade, and second, it takes into account only the pairs that make good candidates for the relative value trading.

2.2 Target Analysis

After the initial data screening, where the number of assets has been reduced by more than a half, the most important step in the relative value trading process - the selection of the most suitable pairs of assets - can begin. The idea is to form the pairs of similar assets, i.e. assets from the same industry with a stable historical relationship.

Figure 2 shows such a pair of assets. The rescaled price time series of Daimler and Fiat show a longterm stable relationship, i.e. they are moving together in the long run. Also, the figure below shows the spread between those prices. Generally, we look at the historical spread (ratio) between the prices of the two assets to see if there is a consistent long term relationship between them. Also, the assets that make good candidates for the relative value trade should have a measurable relationship.

In order to find an adequate measure or selection criterion, we examine different statistical tests. The first measure that we examine is the correlation coefficient that we calculate for the pairs' prices as well as for the daily returns of the prices. Beside the correlation coefficient, three unit-root (or stationarity) tests are examined as potential measures of the assets similarity. The unit-root tests are examined in two different ways. First, as applied on the price ratios and second, as applied on the residuals of the linear regression in which the price of one asset is the independent variable and the price of the other is the dependent variable.

First, we create all the possible pairs out of our 260 assets. Then we create two-asset portfolios, with both assets equally weighted and calculate the performance of all such two-asset portfolios. Further, we calculate the Sharpe ratio[2] for each of the two-asset portfolios. On the other side, we apply each of the potential similarity measures (mentioned in the previous paragraphs) on the pairs of assets, and as a result we get the test-statistics for each pair and for each similarity measure or a potential selection criterion. Finally, we regress the previously calculated two-asset portfolios' Sharpe ratios on the test statistics of the corresponding pairs of assets. Figure 3 depicts a relationship between the Sharpe ratios of all two-asset portfolios and the test statistics of the pairs of assets comprising these portfolios.

[2] Sharpe Ratio = (Portfolio return – Risk free rate) / Volatility; Risk free rate = 2.5 % p.a.

Figure 2: Rescaled Prices of Daimler and Fiat and their Spread

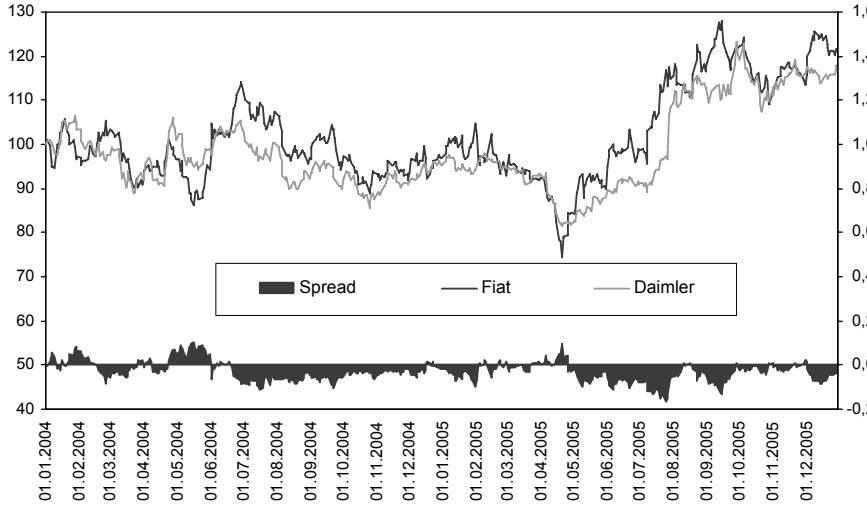


Table 1 shows the coefficients of correlation (the R-square) between each selection criterion and the Sharpe ratio.

According to the results in table 1, the Phillips-Perron (PP) unit-root test (see Phillips (1987) and Phillips and Perron (1988)) has been chosen as selection criterion, and, it is the only criterion that is significantly related to the Sharpe ratio of the relative value portfolio. The assets considered as good candidates for relative value trading are those for which the sum of all the PP-values for all the pairs that asset appears in, optimises our selection criterion. In our work, the selection of pairs, using the Phillips-Perron unit-root test, is done at the beginning of each year based on the price movements in the previous year. We create a similarity matrix for each industry, containing the PP-statistics for all asset pairs in that industry. However, the selection of pairs might be done more frequently than once a year, but for reasons of simplicity we choose this period. Nevertheless, a more frequent selection process might improve the results.

Figure 3: Relation between the Selection Criterion and the Sharpe Ratio of the Two-Asset Portfolios

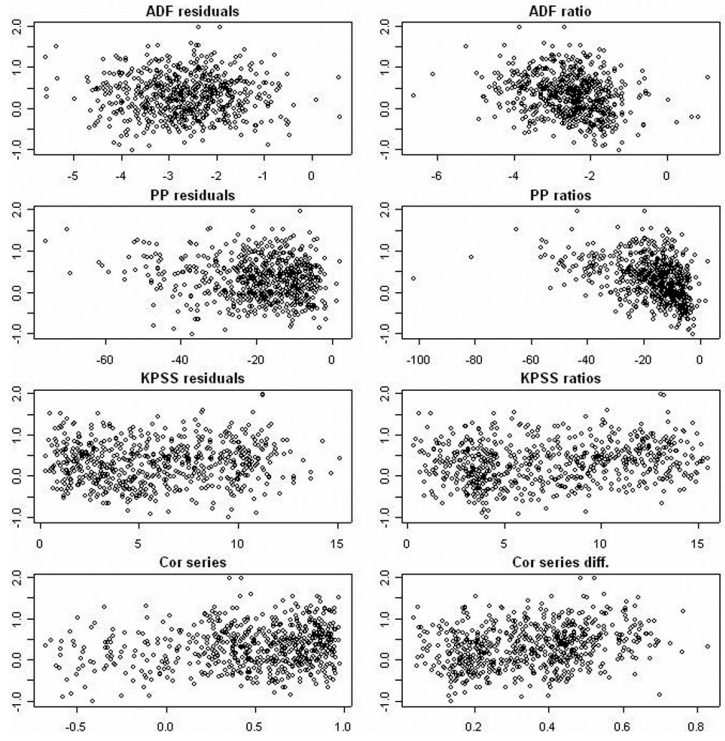


Table 1: Overview of different criteria

Criterion (test statistics) – R^2	00–05	2000	2001	2002	2003	2004	2005
ADF (Residuals)	0.0000	0.0019	0.0012	0.0003	0.0036	0.0195	0.0536
ADF (Ratio)	0.0599	0.0336	0.0117	0.0220	0.0158	0.0692	0.0551
PP (Residuals)	0.0172	0.0860	0.0721	0.0485	0.0694	0.0800	0.1284
PP (Ratio)	0.1493	0.1991	0.1194	0.1875	0.2153	0.1421	0.1618
KPSS (Residuals)	0.0046	0.0004	0.0005	0.0000	0.0548	0.0009	0.0164
KPSS (Ratio)	0.0374	0.0646	0.0140	0.0236	0.0161	0.0072	0.0002
Correlation of the prices	0.0288	0.1779	0.0830	0.0029	0.0161	0.0433	0.0393
Correlation of the daily price returns	0.0651	0.0104	0.0742	0.0018	0.1102	0.0003	0.0097

2.3 Forecasting Process

After the selection of suitable pairs has been done, we are going a step further and trying to predict the future price ratios movements, as well as the forecasts for each of the assets. Here, we are examining a price ratio of a pair of assets.

The point at which our price ratio is starting to deviate from its "normal" behaviour is the point at which the trade should occur. We consider a deviation from a normal behaviour to be a significant change in the range of the oscillation around the mean. Based on the fact that each price ratio follows a zig-zag pattern, we search for the alternate local minima and maxima of the ratio. If the price ratio has changed by a certain amount (distance d) compared to the last local extreme value, then we can expect the mean-reversion to occur and accordingly, we can determine in which direction the price ratio will move at the next time point, i.e. we can determine one step ahead direction forecast for that ratio.

Assuming that the current point of the price ratio is X_t and that the last identified extreme value was a minimum (at the point t_0), in the interval between the last extreme value and the current point (maximum length of the interval equals $m = [\max(t-m, t_0+1), t-1]$) we will search for a local minimum.

- X_j is a local maximum if the following conditions are fulfilled:
- $Xj = \max(X_i | i \text{ in } [\max(t-m, t_0+1])$
- $X_t(1-d) \geq X_j, 0 < d < 1$ and
- X_j is the last point in the observed interval that fulfils the first two conditions.

For a minimum, the following should hold:

- $X_j = \min(X_i | i \text{ in } [\max(t-m, t_0+1), t-1|)$ and
- $\dfrac{X_j}{(1-d)} \leq X_t$

That means that a point is an extreme point if it is a minimum or a maximum of the observed interval and if the price ratio has changed by d.

Again, following the idea of the mean-reversion, the direction forecast for the time point $t + 1$ would be:

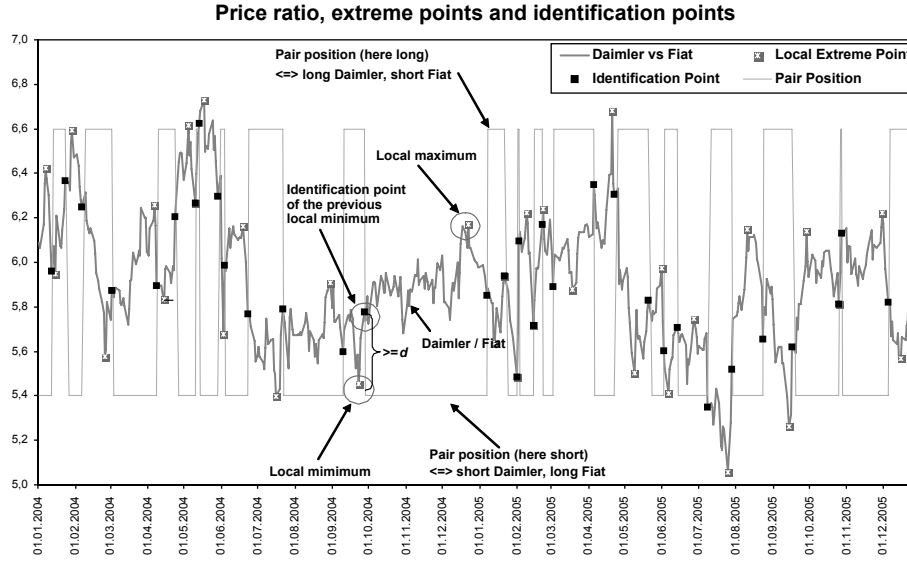
- 1, if at the point t in the interval $[max(t-m, t_0+1), t-1]$, a maximum was identified, meaning that the price ratio has fallen by d,
- –1, if at the point t in the interval $[max(t-m, t_0+1), t-1]$, a minimum was identified, meaning that the price ratio has increased by d,
- the same as the previous forecast, otherwise.

The point at which the forecast definition occurs is called the identification point and the trade should occur one day after the identification.

Example:

Figure 4 shows a graph of a price ratio for two similar assets, as well as the local extreme points and the points at which the extreme points have been identified. In this example, the above mentioned parameter d equals 5%. At the moment of the identification of an extreme point, a new direction pair-forecast is defined. The blue line represents the pair positions. A pair position is later translated to a single asset position. For example, if a pair position is long then it means that the position of the asset in the numerator should be long and for the one in the denominator it should be short. However, it is important to note that relative forecasts shown here are only relative single asset forecasts based on the forecast of one pair. As one asset can appear in more than one pair, the final forecast for a single asset is equal to the sum of all the relative forecasts for that asset.

Figure 4: The forecasting process regarding the Relative Value Strategy



As can be seen from figure 4, at the moment of identification (solid points) of an extreme value (outlined points) the pair forecast is changed and it is kept constant until the next identification point.

Distance parameter *d* plays evidently an important role in this process. On one hand, it determines which and how many points will be identified as extreme points (the smaller the *d*, the more extreme points will be identified and therefore more often the forecast will change). On the other hand, parameter *d* determines after what time an extreme point will be detected and indirectly, in case of a strictly mean-reverting process, by what extent the price ratio will change before the next extreme value has been reached.

Therefore, finding a suitable *d* is of great importance for the successful relative value trading. Parameter *d* is in general not a constant. It is constructed so that it reflects the recent price ratio movements. Basically, it is a function of the ratio's volatility, and although it can remain constant for a certain period in time, it is periodically checked and automatically adjusted in order to catch potential volatility shifts or a beginning of a trend.

2.4 Optimal Asset allocation

Once the assets to be traded have been selected, and all possible pairs have been created as well as the forecasts for each of the pairs, we can go to the next stage, to wit, the portfolio construction. We calculate the portfolio weights for separate assets and answer the question "How much are we going to buy or sell and when?". In order to calculate the portfolio weights, it is necessary to determine the single asset forecasts.

Let us say that at the identification point, our pair forecast for the next day equals 1. In that case the relative single asset forecast equals:

- 1, for the asset in the numerator, and
- –1, for the asset in the denominator.

The opposite holds if the pair forecast equals –1. The forecast for a single asset is then the sum of all the relative forecasts calculated based on the pair forecasts for all pairs that particular asset appears in.

Here we should bear in mind that the same asset can appear in more than one pair and therefore it is possible that it is undervalued in one pair while it is overvalued in the other. In case of the contradictory relative forecasts (that sum up to 0), the final single asset forecast for that particular asset will be defined as neutral and the proposed weight for that asset will be zero.

The portfolio weight of stock j at the time t is calculated as

$$W_{j,t} = \frac{p_{i,t}}{\sum_{i \in I_k} \left| p_{i,t} \right|} \cdot \frac{(i \mid i \in I_k \text{ and } i \in \text{Selected})}{(i \mid i \in \text{Selected})}$$

I_k designates the industry to which the asset belongs, $p_{j,t}$ represents the sum of the relative forecasts for the period t for the asset x_j.

Since we are constructing a cash neutral (as well as market neutral) portfolio, we have $\sum_{j \in I_k} p_{j,t} = 0$, then it also holds $\sum_j W_{j,t} = 0$. Based on the previous two equations, it can be easily shown that $\sum_j \left| W_{j,t} \right| = 1$.

Finally, under the assumption that the whole disposable capital is invested in stocks, according to the previously calculated portfolio weights, and based on the assumption that the orders have been executed at the opening prices, the portfolio value at the time t equals

$$PF_t = PF_{t-1}\left(1+\sum_{j=1}^{k}(W_{j,t}r_{j,t} - c\,|\,W_{j,t} - W_{j,t-1}\,|)\right)$$

Where $x_{j,t}$ represents the opening price of a stock j at the time $t, r_{j,t} = \frac{x_{j,t}}{x_{j,t-1}} - 1$ (return of the j^{th} stock), and c represents transaction costs.

In practice, the calculation of the proposed weights is done every working day after the closing of the markets and the proposals are sent to the traders the following working day before the opening of the markets. The transactions are supposed to be executed at the opening prices on that day, but the execution strategy and the choice of the submission of the orders (whether market or limit orders) are left to be decided by the trader. In the proposal sent to the trader, there is no information on the time-distribution of the trading orders or the time distribution of the quantities to be sold or bought, but only the information on the portfolio weights for the assets to be traded.

Figure 5 shows the total relative value portfolio development (black line) over the period from January 2001 through December 2005, as well as the development of the industry portfolios (grey lines) in the same period. The portfolio rebalancing is done on a daily basis, while the selection of the pairs of assets is done once a year.

The performance of the total relative value portfolio, as well as the performances of the separate relative value industry portfolios shown in figure 5, is calculated using the opening prices with the transaction costs included in the calculation. In practice, the actual trading prices, which are not necessarily equal to the opening prices, should be used for the portfolio evaluation. However, this will be discussed in more detail in section 3.

Table 2 shows the relative value portfolio statistics for the years 2001 to 2005. For the purposes of this calculation, a risk free rate of 2.5% per annum was used.

Although some industry portfolios show a moderate performance, total portfolio performance has been relatively high in the whole period and shows an upward trend.

Figure 5: Performances of the portfolio and the industry portfolios

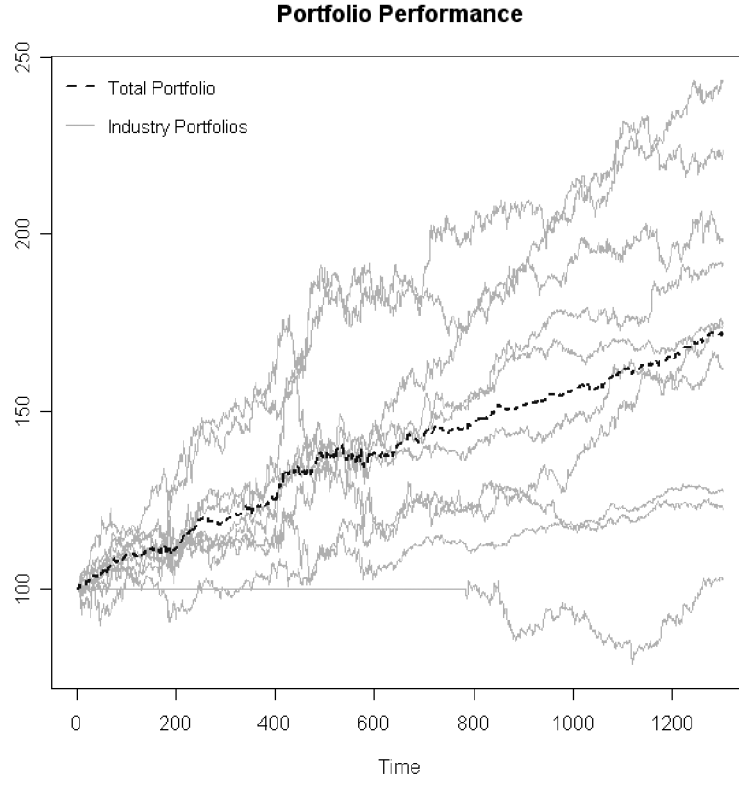


Table 2: Portfolio Statistics

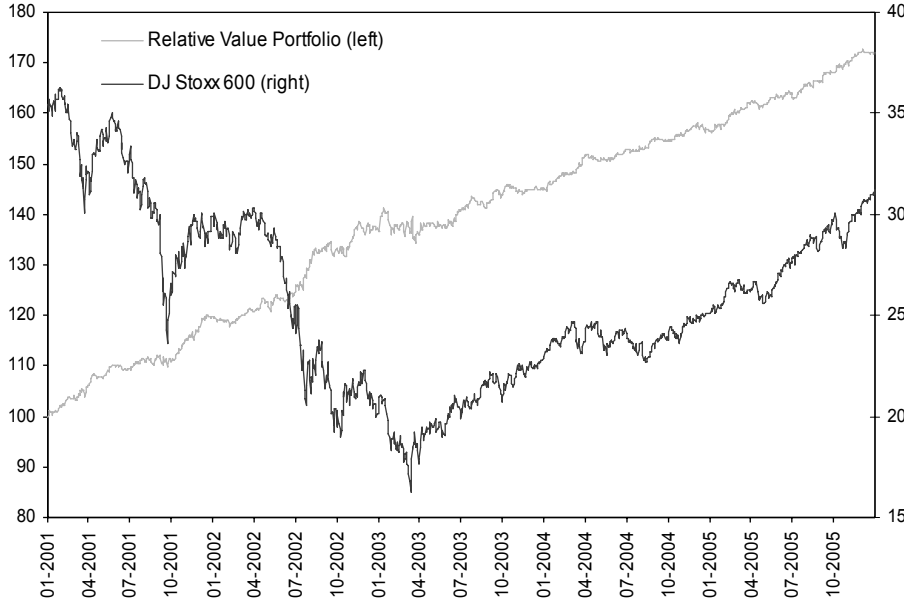
	Return	Vola (%)	Sharpe Ratio+	Correlation between Portfolio Value and DJ Stoxx 600
2001	19.2	5.8	2.9	–0.7
2002	8.0	6.4	0.9	–0.9
2003	9.2	5.4	1.2	0.9
2004	3.9	2.7	0.5	0.4
2005	6.1	2.0	1.8	0.9

+ Risk free rate = 2.5% p.a.

The total relative value portfolio in figure 5 (black line) is depicted again in figure 6, but this time together with the DJ Stoxx 600 Index. In comparison with the underlying index, total relative value portfolio performance shows less volatility than the Index and it is also evident that at the times where the

Index experienced a downward trend, there is a strong negative correlation between the two (see table 2).

Figure 6: Relative Value Portfolio vs. DJ Stoxx 600



The main conclusion of this section is that the Relative Value Strategy applied on the subset of the DJ Stoxx 600 shares shows a consistent and good performance. Also, the comovement of the Relative Value portfolio performance and the DJ Stoxx 600 Index is weakening in the "bad times" (i.e. in the year 2001 and 2002, where the Index experienced a downward trend) and where the correlation coefficient of the two series proves that there is a highly negative correlation. On the other hand, the correlation of the two is highly positive in the periods in which the underlying index shows a consistent upward trend (year 2003 and 2005).

3. Inefficiencies in Non-Integrated Trading Decisions

In chapter 2 we discussed the first two stages of an integrated active asset management, to wit, the generation of forecasts and the construction of a portfolio in reference to the Relative Value Strategy. Now we want to focus on the third stage, namely the strategy implementation. Firstly, we provide an empirical study concerning the difficulties when implementing a strategy based on futures contracts. Secondly, we analyse the microstructure of trading facilities with the aim to discover inefficiencies that might be exploited.

3.1 Implementation Shortfall and Slippage in Futures Trading

So far, when measuring the performance of the Relative Value portfolio, we assumed that the calculation of the weightings to be held in each position was based on the closing prices. Furthermore we made the assumption that the rebalancing of the portfolio's position was executed at the opening price of the corresponding rebalancing day. Such strategies, where a virtual price such as the opening price is considered as execution price, are designated as **paper-traded** strategies. The transactions are assumed to be executed at a **paper price** that might differ from the effectiveexecution price. Beside the opening price also the closing price or any intraday price could be considered as trading price for a paper-traded strategy.

However, while regarding a paper-traded strategy might be very helpful for the portfolio construction process, the strategy has to be implemented on the real market afterwards, i.e., the numbers of contracts to be traded have to be calculated, the orders have to be generated and executed, the price developments have to be monitored and the performance of the portfolio has to be analyzed. Trading implies also the determination of the market place, the timing and the slicing of the entire amount into several trade packages. Furthermore one has to decide how the submission of the orders should take place. The whole process of implementing the strategy on the market is the third stage of an integrated active asset management.

Of course the implementation of a strategy is not free of charge. When executing an order the portfolio manager has to think of the related transaction costs. Transaction costs might be split into explicit and implicit costs. While explicit transactions costs such as broker fees or exchange commissions

might be accurately measured, implicit costs such as round trip costs, slippage or implementation shortfall cannot be quantified quite exactly.

3.1.1. Data and Method

When following a systematic investment strategy such as the Relative Value Strategy the portfolio has to be rebalanced very often. As the Relative Value Strategy is rebalanced on a daily basis, transaction costs are a critical component for active asset management. Nevertheless, as they can be measured quite exactly, the explicit costs will be disregarded in our study. We want to focus on the implicit costs, especially we will provide an empirical study analyzing the implementation shortfall and slippage costs of a non-integrated asset management strategy. The magnitude of the derived measures will motivate for integrating also the implementation-stage in an active asset management.

Before continuing we want to specify some terms used in this chapter. When speaking of the execution price the price of an effective execution of an order is in mind of the authors. The decision price is the current real time price in the moment at which the portfolio manager decides to place an order, to be more specific: As the regarded portfolio consists of the most liquid future contracts we consider the last execution price prevailing at the moment the asset manager decides to trade as decision price.

Presenting an empirical study of a nonintegrated strategy we want to point out the inefficiencies that arise of the nonintegration. Therefore, we look at four (non-integrated) portfolios only invested in the most liquid FX, Commodity, Stock-Indices and Fixed Income future contracts. The four portfolios follow the same Global Macro long/short investment strategy. Nevertheless, the four analyzed portfolios differ in two important aspects. First, the notional of two of the portfolios is higher than EUR 150 million. Therefore they are defined as high volume portfolios. The notional of the others is less than EUR 50 million and we refer to them as low volume portfolios. Second, two brokers receive the market orders via electronic FIX connection.[3] The other two brokers have to initiate the trades manually. The advantage of using electronic FIX connectivity (Financial Information Exchange Protocol) is the very fast order execution. In both cases the objective is to execute the market

[3] See http://www.fixprotocol.org.

orders immediately after their transmission. So we have the following four portfolios for comparison:

- Low volume, i.e. less than 50 million invested; no FIX, i.e. submission of orders via email (in the following abbreviated as “Low, no FIX”)

- High volume, i.e. more than 150 million invested; no FIX, i.e. submission of orders via email (in the following abbreviated as “High, no FIX”)

- High volume, i.e. more than 150 million invested; FIX, i.e. submission of orders via FIX protocol (in the following abbreviated as “High, FIX”)

- Low volume, i.e. less than 50 million invested; FIX, i.e. submission of orders via FIX protocol (in the following abbreviated as “Low, FIX”)

The regarded portfolios are rebalanced every Monday at approximately 15:00 UTC based on the asset allocation proposal calculated by the fin4cast Technology. The fin4cast Technology has been developed by FSC Financial Soft Computing GmbH since 1995. The fin4cast Technology provides forecasts, e.g. weekly Monday-to-Monday predictions, which we use as input for a quadratic optimization of the four portfolios considered in this paper. Hence, the strategy considered integrates the first two stages, to wit, the generation of forecasts and the portfolio construction.

The result of the second stage of fin4cast Technology is a portfolio construction that delivers weekly weightings to be held in each asset over a certain period in relation to the notional of the portfolio. The performance of the strategy is calculated at a paperprice. When implementing the strategy in the real market the weightings to be held have to be transformed into numbers of contracts the brokers have to trade. Therefore fin4cast uses the real time (last execution) prices of the particular future contracts that arise directly before the numbers are submitted to the broker. These real time prices are considered as decision prices.

For our study fin4cast provides for all four portfolios the execution prices, the decision prices, the number of contracts traded and the weights proposed by the optimization process.

3.1.2 Post-Order Slippage

Market participants on financial markets have two main possibilities to submit their orders: They can place a market or a limit order. If a market order is placed the broker will execute the order at the current market price or at best efforts. Otherwise, a limit order is only fulfilled if the broker is in the position to execute the order at a preliminarily determined price (decision price) or at a better price. Hence submitting a limit order has the advantage that the current trading price will be the same as the expected trading price, but if the broker cannot execute the order to the decision price the order will not be fulfilled. Hence the disadvantage of a limit order is that there is no guarantee that the order will be fulfilled. Furthermore the broker usually will charge higher fees for limit orders. On the other side market orders will almost be fulfilled, but the execution price might substantially differ from the price at the time point of the order calculation. We will designate this price difference between the decision price and the effective execution price as post-order slippage (Gartner et al. (2007)).

There are many reasons for post-order slippage. Brown et al. (2006) mention the rapidly fluctuating prices due to heavy trading volume. Bessembinder and Seguin (1993) consider the dependence between price volatility, trading volume and market depth as a possible reason. Lee (1993) mentions the different prices at different exchanges or different prices at intermarket exchanges as possible reasons. Brown et al. (2006) also mention the multistage order process as a reason for the price differences. However, in this empirical study we do not want to search for reasons for the price differences, but we want to analyze the magnitude of post-order slippage costs and the consequences of other price differences occurring on financial markets. Furthermore, we want to analyze the factors influencing the slippage costs and to quantify their magnitude.

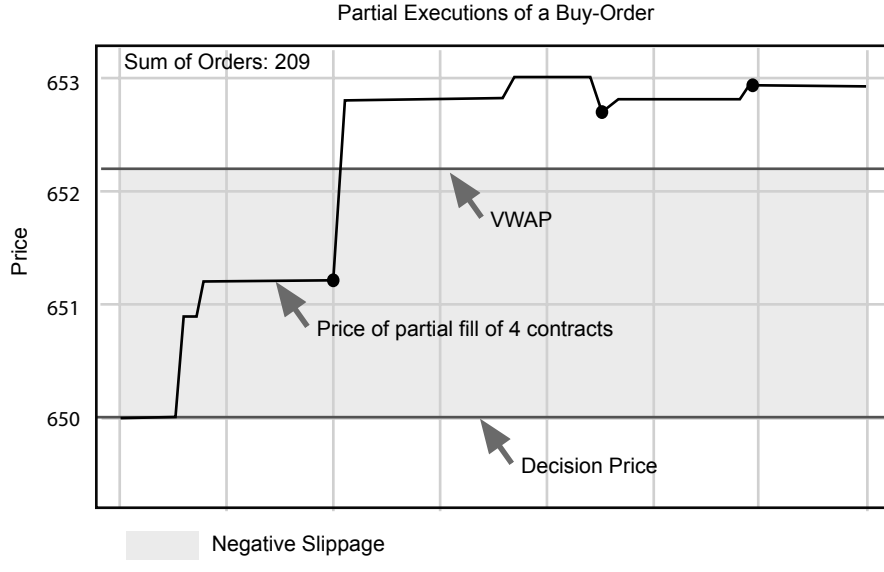
However, when comparing one strategy that is both traded on the paper and in the real market it becomes obviously that the performance of the paper portfolio and the one of the effective traded portfolio might differ in a considerable dimension. It is not surprising that the deviation between the paper price and the effective execution price is the reason for the difference in the portfolios performances. Hence we arrive at the third stage of a consistent trading strategy, to wit, the implementation of a strategy.

When regarding a papertraded strategy such as the Relative Value Strategy the paper price will equal to the decision price. Hence a paper-traded portfolio

takes no market impact effects into account, which might result from placing an order. Moreover, due to quickly changing prices, heavy trading volume and big order sizes that cannot be fulfilled immediately by a broker the effective execution price might substantially differ from the paper price.

The result of an optimization process such as the Relative Value Strategy is the percentage weight of an asset that should be held over a certain period of time after the portfolio rebalancing. But as the broker needs the number of contracts that have to be traded, the proposed weights must be converted to a whole number of contracts. This step of calculating the numbers to be traded is designated as order calculation. To transform the weightings into numbers of contracts a price is needed. Therefore the current real time price at the order calculation is used. This price can be regarded as decision price.

Figure 7:



Nevertheless, due to the market impact, the high liquidity in future markets and all the other reasons the decision price used for the order calculation might significantly deviate from the effective transaction price. Figure 7 clarifies the market impact and price effects that appear when an order is placed. The figure shows the partial executions of an order that was submitted on the 29th January 2007. The order was a buy order of 209 contracts of the Gold future contract (expiring in April 2007). As the broker could not fill all the orders at once because no counterpart was available due to the order size, the trades had to be split up into trade packages. E.g. the first trade package consisted

of one single contract, the second package consisted of three contracts, etc. In the picture the size of the packages is relative to the size of the black points.

The red line shows the decision price and the green line shows the price of the single trade packages that are represented by the black points. When looking at the picture one might think of a self fulfilling prophecy, because the placement of the buy order drifts the price up. However, the effective execution price (regardless of all costs) is the volumeweighted average price represented by the blue line and it obviously differs from the decision price. As the difference between decision and execution price has a negative sign also the post-order slippage is negative. Note that for estimating the post-order slippage of the whole order the price deviation has to be multiplied by the slot size of each traded contract and by the number of contracts that are traded. Considering a slot size of 100 for 209 contracts and a price deviation of –2.2 USD per slot it becomes obvious that the post-order slippage might be of significant magnitude.

For estimating the magnitude of the post-order slippage for the whole portfolio over the observation period $1,...,t$ we calculate the cumulated post-order slippage relative to the notional of the portfolio.

$$\text{Cumulated Slippage} = \sum_{t=1}^{T} \sum_{i=1}^{I} \frac{(p_{i,t,dec} - p_{i,t,exe}) \cdot n_i \cdot q_{i,t}}{\text{notional}_t}$$

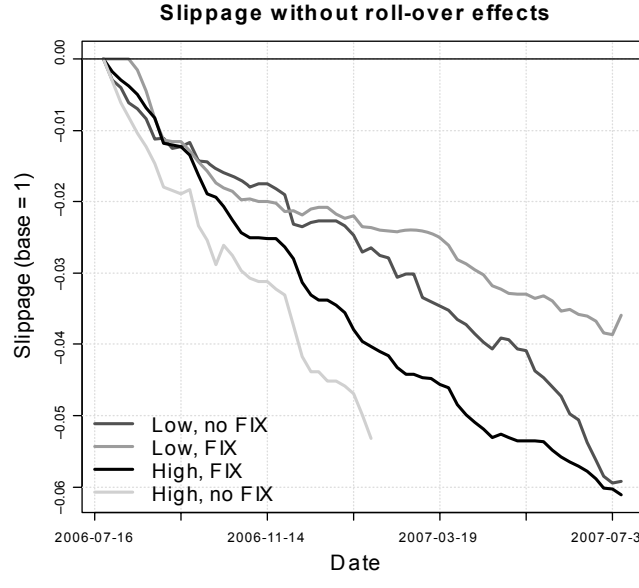
$p_{i,t,dec}$ is the decision price in t for the asset i and $p_{i,t,exe}$ is the effective execution price of the asset i. n_i is the slot size of one contract of asset i and $q_{i,t}$ is the number of contracts to be traded for asset i in t.

Figure 8 shows the cumulated slippage of the four portfolios. As the fourth portfolio (high, no FIX) was cleared in February 2007, the line ends there. As already mentioned above, the portfolios can be distinguished by two main aspects, namely the amount invested and the way of submitting the orders to the broker and to the exchange. The first message of the graph is that the cumulated post-order slippage is considerably large.

Nevertheless, figure 8 allows the following conclusions: The postorder slippage depends on the amount invested in the portfolio and on the way of submitting the orders. While the low volumed portfolio without using FIX connectivity shows a cumulated post-order slippage of nearly 7% over the observation period the value can be decreased by using a FIX protocol for orders' submission to approximately 4%. The same effect of using a FIX connectivity can be observed for the high volumed portfolios. If comparing

the two portfolios using (or not using) a FIX connectivity for orders' submission it becomes obvious that also the size of the trades negatively influences post-order slippage. The bigger the orders that are submitted, the more trade packages have to be built by the broker. This results in high deviations between the decision and the effective execution price.

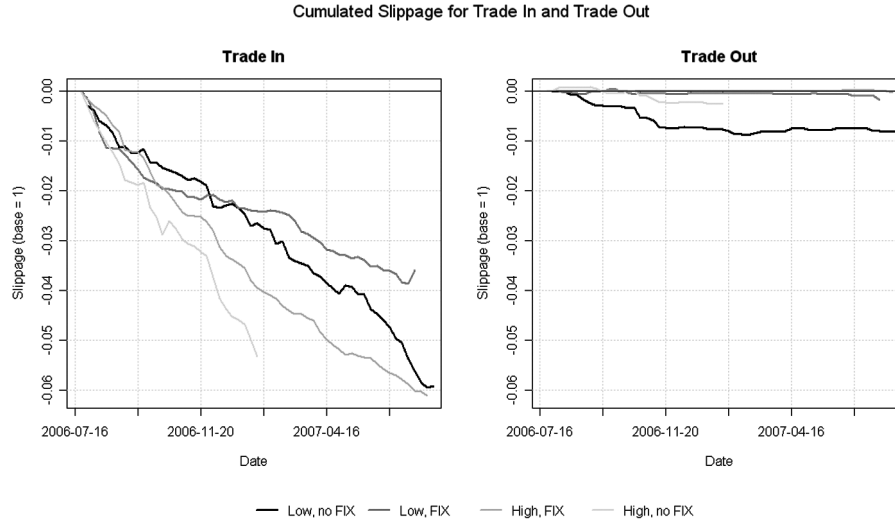
Figure 8: Cumulated Post-Order Slippage



However, the first upcoming question is "What is the reason for the large post-order slippage?". First, one might think of the rollover costs, i.e. the costs emerging due to the rollover from an expiring future contract into a more liquid contract, as a possible reason. Therefore, firstly we plot in figure 9 the cumulated post-order slippage of all orders excluding all the post-order slippage resulting from the contract rollovers (left picture) and compare it in a second step with the cumulated post-order slippage resulting only from the contract rollovers (right picture). However, figure 9 clarifies that the rollover costs are not responsible for the magnitude of the post-order slippage.

Now let us split up the cumulated post-order slippage into the four sectors, to wit, the Foreign Exchange futures, the Fixed Income futures, the Stock Indices futures and the Commodity futures. In figure 10 the cumulated post-order slippage separated for the four sectors can be seen.

Figure 9: Cumulated post-order slippage of the contract rollovers



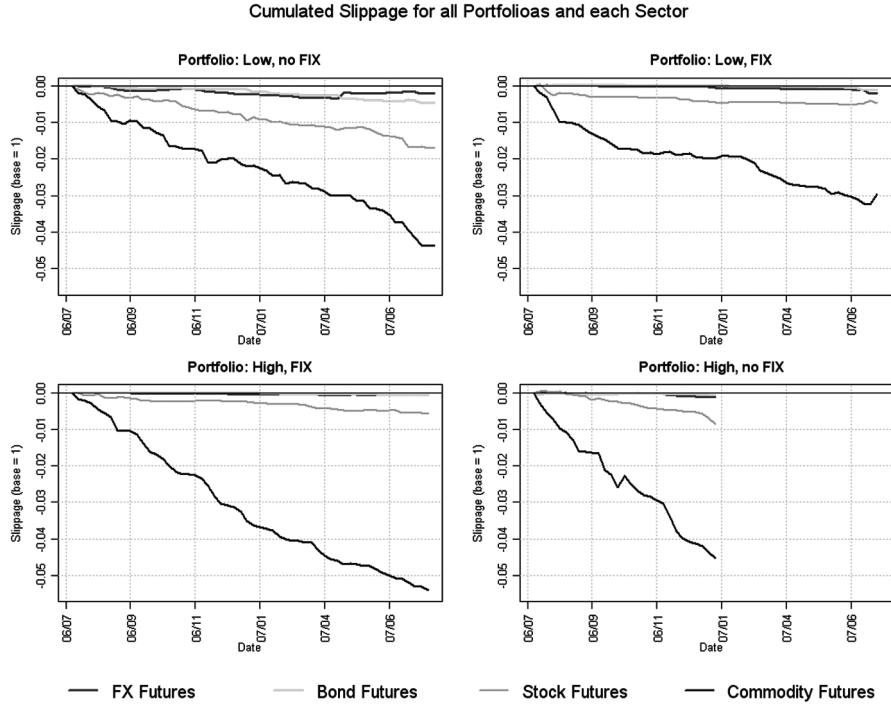
Now it becomes obvious that the biggest part of the post-order slippage is due to the trades regarding the Commodity future contracts. As the post-order slippage is lower for low volume portfolios the amount invested in the portfolio seems to be an influencing factor for the magnitude of the post-order slippage for the commodity futures. While the postorder slippage regarding the bond and FX futures is negligible, the stock indices futures show an influence, but not as much as the commodity futures.

The high post-order slippage in the commodity sector has several reasons: First the liquidity for commodity futures might not be given all the time, so submitting big-sized orders might result in high price deviations, because the broker has to split the order into trade packages. Furthermore filling all these packages might take some time. Second, the commodity futures regarded in this portfolio are not traded fully electronically. This means that the time span between submission and execution of the order might be considerably high. All the future contracts of the other sectors are traded fully electronically. That might be the reason why using a FIX connection might reduce the post-order slippage.

Nevertheless, post-order slippage must not be summed up with performance of a portfolio. Hence a concept for measuring the impact on the performance is needed. One possibility therefore is to measure the implementation shortfall that will be introduced in the following section. However, due to the equivalence of the results regarding the volume and the way of submitting

the orders we will just consider one of the four portfolios regarded in this section. To be more explicit, in the following section we will concentrate on the portfolio designated as "High, FIX" in this section.

Figure 10: Cumulated postorder slippage split up into the 4 sectors.



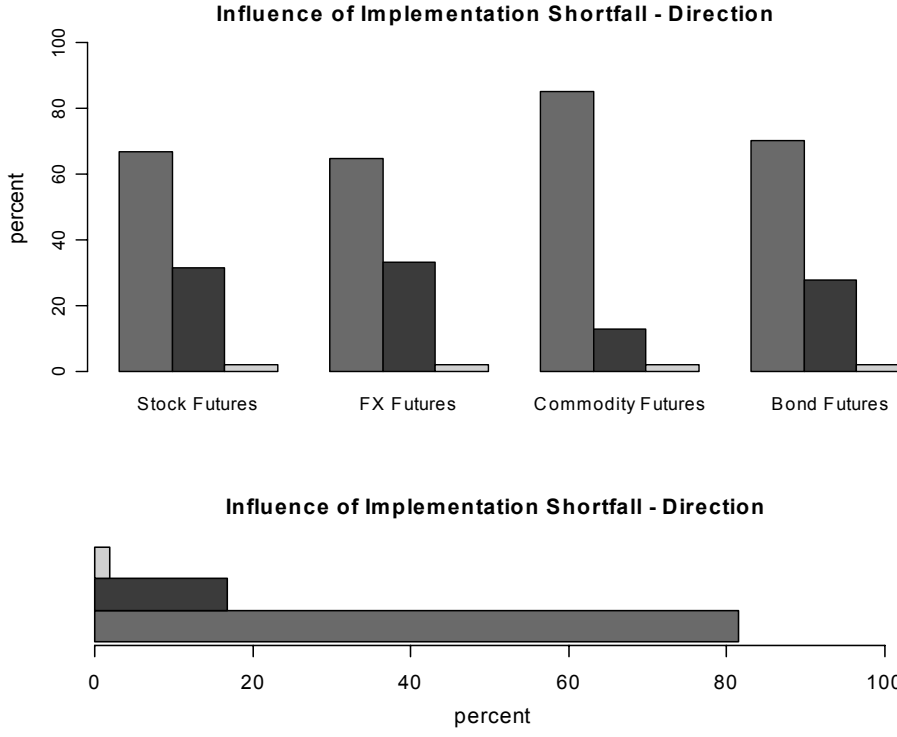
3.1.3. Implementation Shortfall

Perold (1988) compares both the performance of a paper-traded and an effective traded portfolio each following the same strategy. Consequently he defines implementation short fall as the difference between the performances of the two portfolios. All other costs are disregarded and the performance r_t for both portfolios is calculated as

$$r_t = \sum_i \left(\frac{p_{out,t+1}}{p_{in,t}} - 1 \right) \cdot w_{i,t}$$

where $p_{out,t+1}$ represents the price at the end of the holding period, $p_{in,t}$ the price at the beginning of the holding period and $w_{i,t}$ the weighting to be held over the holding period.

Figure 11: Influence of the Implementation Shortfall



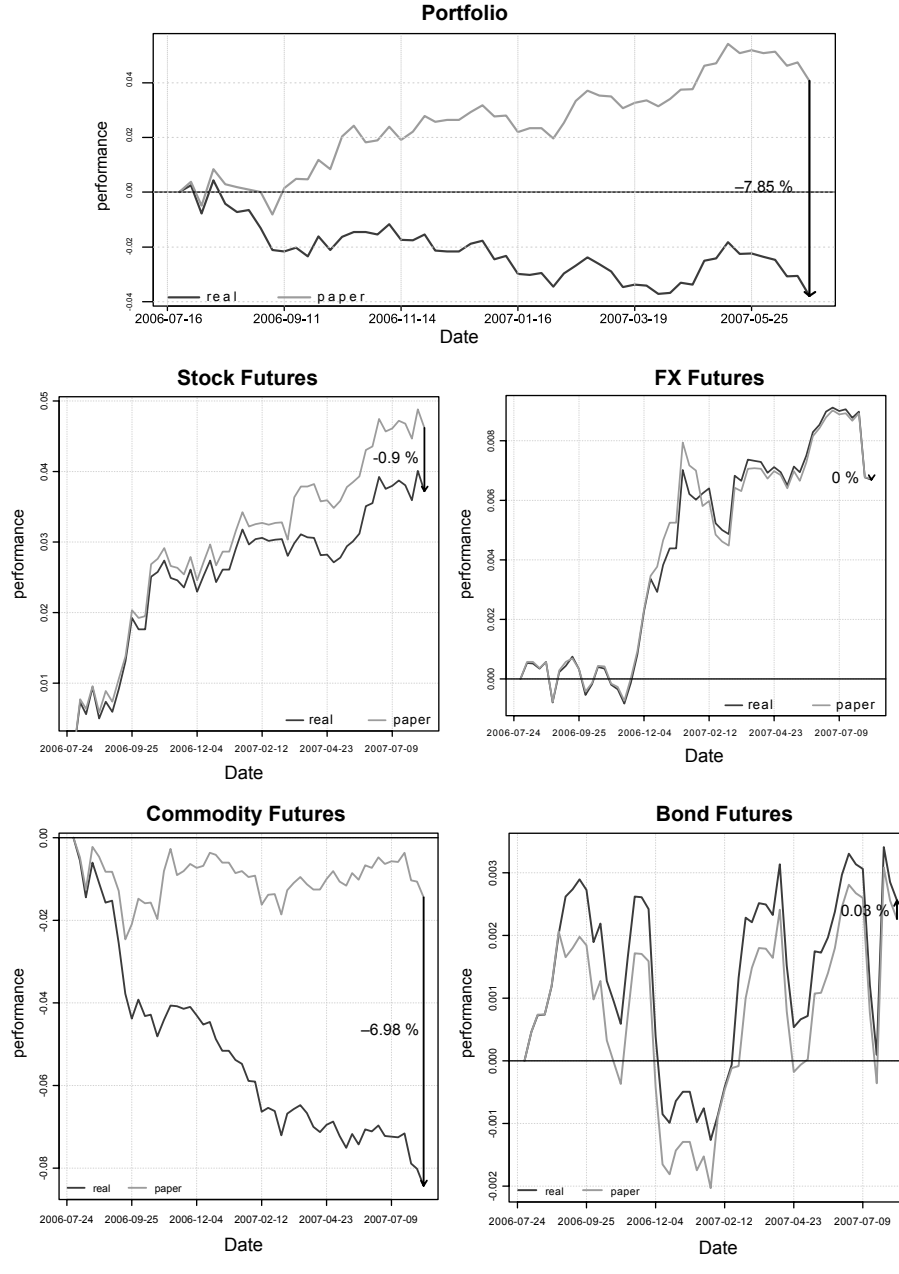
Before we compare the performances of the paper and the real portfolio, we just want to explore the influence of the implementation shortfall. Generally one would assume, that the post-order slippage and consequently the implementation shortfall would clear in the long run, i.e., the expected value of the price deviation between decision and execution price should be approximately equal to zero. But the results presented above repudiate this assumption. However, also figure 11 gives reason to question this fiction.

In figure 11 we only count the cases in which the paper performance is higher/ lower than the real performance relative to the number of observations. If the paper performance is higher than the performance of the traded portfolio then the influence of implementation shortfall is considered as negative (bad) and vice versa. In some cases the performances can also be equal.

The chart shows the frightening result that the influence of implementation shortfall is systematically negative, especially for the commodity futures. This means, for the commodity futures the price deviation has a negative impact on the performance of the portfolio in approximately 80% of all observations.

For a portfolio manager this result is very frightening, because implementing a strategy on the real market negatively influences the performance of the portfolio. Being aware of this a portfolio manager might want to have an estimation of the magnitude of this implementation shortfall. Hence figure 12 shows the performances for both the paper and the real portfolio. Over the observation period the implementation shortfall sums up to approximately 8%. Again one might ask for the reasons. Splitting up the results into the four sectors it becomes obvious that the biggest part is again due to the trades in the commodity futures.

Figure 12: Implementation Shortfall for the whole portfolio and the single sectors



If we would compare the four portfolios regarded in the previous section we would receive similar results as for the post-order slippage, to wit, the

implementation shortfall depends on the volume invested in the portfolio and on the way of orders' submission. While the use of a FIX connectivity might reduce the implementation shortfall for the Stocks, FX and Bond futures, the volume is responsible for the magnitude of the implementation shortfall for the commodity futures.

However, this means disregarding the trading effect implies an implementation shortfall of approximately 8% over approximately one year. However, a portfolio manager has to realize the performance not only on the paper but also in the market. This magnitude of the implementation shortfall points out once again the need for an integrated asset management where each part, to wit, research, portfolio construction and strategy implementation, is regarded.

Of course it is a very hard task for a portfolio manager to integrate also the trading part into his active asset management because trading is the broker's part. Nevertheless, we want to figure out some possibilities for exploiting such inefficiencies as implementation shortfall in the next section.

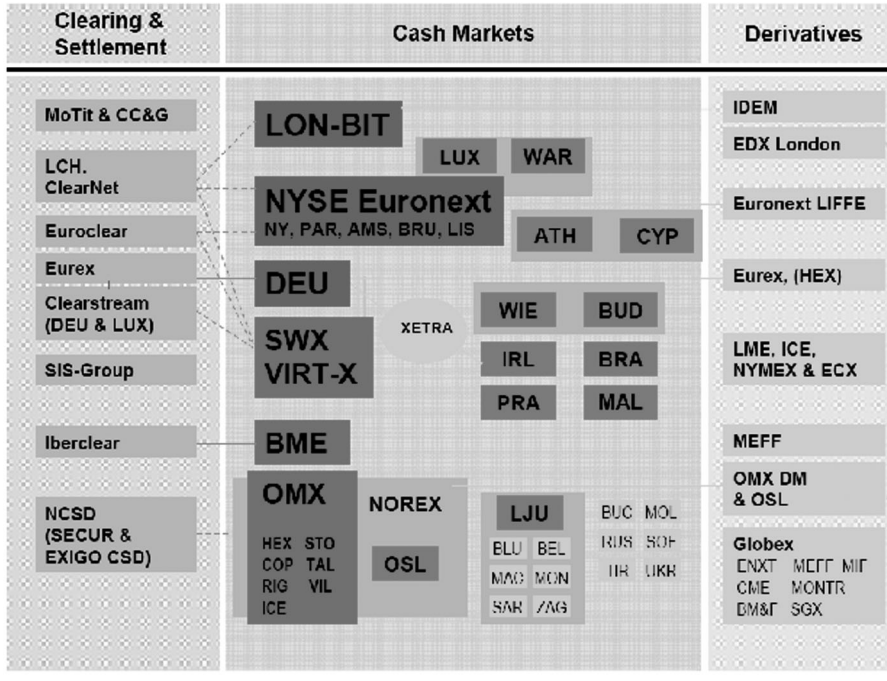
3.2 Price Slippage when Orders are executed

As shown in the previous section implementation shortfall might be considerably high. The magnitudes of the presented figures initiate the idea of exploiting these inefficiencies in trading. Therefore we want to discover possibilities of exploitation at the market's microstructure level. But before we can provide an analysis of the market's microstructure, we want to give a short overview of the European trading landscape.

3.2.1 The European Trading Landscape

The landscape of the European financial industry's market is shown in figure 13, provided by the Federation of European Stock Exchanges (FESE). Figure 13 shows the three market segments, to wit, Clearing & Settlement, Cash Markets and Derivatives Markets. As the lines indicate, the market fragments are interconnected. Without going into much detail the picture clarifies that the European Trading landscape provides a lot of facilities to trade European securities.

Figure 13: Landscape of the financial industry's market in Europe (FESE 2008)



A comparison of the current market with the situation a decade ago points out that the landscape has changed very strongly. The driving force for the change might be the process of consolidation that affects the entire asset management industry. The causing factors for the consolidation are the globalisation and the vanishing of national trading monopolies, technological capabilities regarding communication and computation and finally regulatory activities. It becomes obvious that there has been a need for the regulation of the trading and settlement as it is in the interest of the investors. Therefore a market regulation, such as MiFID was a logical solution. Compared to the US, it only seems to be a first step in the market regulation process, although a major step. There is still a long way to go to achieve a unique information system like the National Best Bid Offer (NBBO) system that is based on the National Market System Regulation (Reg NMS) in the US. As mentioned in table 3 one should bear in mind that the major players in the market are the international banking institutions. This fact complicates the regulation process.

3.2.2 The global Non-Exchange Trading Landscape

As can be seen in table 3 many other trading venues beside the traditional exchanges have emerged since the last 10 years. The first column of the table lists the names of the leading international banks, while the other columns represent a snapshot of some alternative trading platforms exempt from stock exchanges. These trading platforms are mostly joint ventures of big investment banks.

These alternative trading platforms are commonly designated as "Dark Pools". Describing potential liquidity that is not disclosed to the market the term has become quite popular during the last years. Although the players have the possibility to indicate their interest of trading which might be executed if opposite trading interests arise, the liquidity of the dark pool is not represented in an order book in advance. This dark liquidity is the most important aspect concerning dark pools. Due to this fact other market participants cannot be informed about the trading interests in advance, hence there is no possibility of exploiting the trading interests by taking the opposite positions. Furthermore trading at dark pools should avoid market impact effects arising from the transaction, because the trades are not disclosed to the market, at least till the point in time the transaction occurs.

Table 3: Investments with more than two interests in new platforms

Bank	Bats	Boat	Bids	Chi-X	TradeWeb	Turquoise
Credit Suisse	•	•	•	•	•	•
Citi	•	•	•	•		•
Merrill Lynch	•	•	•	•	•	•
Morgan Stanley	•	•	•	•	•	•
Lehman Brothers	•		•	•	•	
UBS		•	•	•	•	•
Deutsche Bank	•	•	•		•	•
Goldman Sachs		•	•	•	•	•
JP Morgan	•		•		•	
BNP Paribas				•		•
Société Général				•		•

Some years ago such facilities providing "dark liquidity" were commonly designated as Automated Trading Systems (ATSs) or Electronic Communication Networks (ECNs). For a while both terms have been used synonymously, but

quite recently the US Securities and Exchange Commission (SEC) has begun to differentiate between them: "An ECN is also an ATS, but is distinguished from a dark ATS by its display of quotes." (Sirri (2008), p. 2)

Even if the process is still going on, a first summary concerning the changes within the trading landscape might be drawn: The structure of the trading landscape is becoming more and more complex, which is due to the fragmentation of both the traditional and especially the innovative trading facilities. Beside dark pools additional facilities have been designed to manage specific trading and transaction tasks. Illustrating the new trends in asset management we just want to mention some these additional facilities:

- Order Management Systems
- Execution Management Systems
- Dark Algorithms
- Crossing Networks
- Transaction Cost Analysis

Table 4: Dark Pools

Independent Dark Pools	Consortium-owned Dark Pools	Broker-Dealer owned Dark Pools
Instinet Crossing	BIDS Trading	ITG and Merrill Lynch's joint venue powered by POSIT: Blockalert
ITG Posit	eBX LLC LeveL ATS	Citi: Markets and Banking Liquifi
Liquidnet	ISE Stock Exchange: MidPoint Match	Credit Suisse: Cross Finder
Liquidnet H20	The NASDAQ: Crossing Network	Fidelity: CrossStream
NYFIX Millenium	NYSE Euronext: NYSE MatchPoint	GoldmanSachs' Execution and Clearing: SIGMA X
Pipeline Trading System		Knight Capital Group: Knight Match
		Lehman Brothers: LCX
		Merrill Lynch: Internal Crossing Network, MLXN
		Morgan Stanley: MS POOL
		UBS Investment Bank: UBS PIN

Table 4 gives an overview of some Dark Pools. The owners of these proprietary systems are once again major investment banks, brokers and stock exchanges. As we just want to give a short overview we do not want to explain the characteristics of each facility. Nevertheless, it should be mentioned that some stock exchanges such as the National Association of Securities Dealers Automated Quotation System (NASDAQ) and the New York Stock Exchange (NYSE) and their European allies are already offering and using such alternative facilities. Similarly, the German stock exchange makes an effort to use them. However, the differentiation of the mentioned computerized systems indicates that trading is becoming a very important issue in the asset management industry. Although additional trading facilities are arising on the market an analysis of the SEC surprisingly points out that the ratio of the volume traded at exchanges to the volume traded at non-exchanges approximately levelled off over the years:

> "In December 2004, the total exchange and ECN share of trading was approximately 85 % in NYSE stocks and 71 % in NASDAQ stocks. By December 2007, total exchange and ECN share trading was approximately 83 % in NYSE stocks and 77 % in NASDAQ stocks. In other words, NYSE volume percentage in quoting venues is roughly flat around 84 %. Moreover, quoting venues increased their percentage share substantially in NASDAQ stocks. If these NYSE and NASDAQ percentages are rounded together loosely for simplification, the bottom line is that the volume percentage of dark pools of liquidity operated by dark ATS's and brokerdealer internalizes has remained approximately 20 % over the last three years." (Sirri (2008), p. 29)

It seems that the SEC is not worried about the emergence of the various alternative facilities. Nevertheless, SEC is quite carefully monitoring the development. The issue of trading shares/securities beyond the official market and the pros and cons of disclosing or hiding trading activities have been discussed since many years: We briefly want to discuss two aspects, firstly the fragmentation and secondly the representativeness of the transaction prices charged.

The rules that determine the price of a transaction are quite different among the various trading facilities. While some of them assume the transaction to be settled at the closing price or the volume weighted average price (VWAP) others assume a price limit. Furthermore, as a major part of the stock's demand and supply is not involved in the price fixing process, the disadvantage is given by the fact that the price charged is biased, i.e. it does not represent the real market's supply and demand. Furthermore it is well known that thin

markets generate prices by chance and the prices do not reflect the true value. However, thin markets provide possibilities to manipulate the price that is also relevant for big off-exchange transactions.

Market fragmentation is an important problem for traders endowed with inadequate technical equipment. Exploiting the currently available data communication facilities by using sophisticated technology might decrease the negative effect of market fragmentation. Thus, beyond doubt big trading institutions claim that they can access every dark pool. Hence market fragmentation seems to be a decreasing problem.

However, with regard to finding a fair price for the transaction a price fixing mechanism that also considers the market's entire volume might be appropriate. But if the intention of trading is disclosed to the market in advance, very attractive trading opportunities arise to people who are aware of these trading interests. As the regulators seem not to be interested in the discussion, it will still take some time till a way of handling both the price fixing process and the disclosure issue is found.

3.2.3 Xetra's detailed Microstructure

Beside the emerging of dark pools a further trend is becoming quite obvious: The asset management industry is even more reacting to individual events, i.e. the market is controlled, each single event on the market is observed and the asset management immediately reacts or consciously does not react regarding each event. However, not only the events on the market, but also events at the microstructure level of an exchange are under control. Hence, we want to analyse the microstructure of an exchange in this section on the basis of order book data of the Frankfurt stock exchange. The Frankfurt stock exchange provides data of its electronic trading system, designated as "Exchange Electronic Trading" (Xetra). The accuracy of the provided data is up to a hundredth of a second. Hence, a detailed analysis is possible.

Presenting the infrastructure of the Xetra order book data we analyse all the orders for the 30 DAX stocks submitted from Wednesday, 5th January 2005 to Wednesday, 12th January 2005 by taking into account the weekendbreak. Table 5[4] gives information about the frequency of different events in the database found in the time period from 5 to 12 January 2005. Each event type

[4] See Prix et al. (2007a), p.721

Table 5: Frequency of different events in the database

Xetra's Order Structure

Event type	Event code	Absolute frequency	% Entry[b]	% Termination[c]
Order entry[a]	1	2,284,628	99.98	
Order modification	2	36,165		
Order Cancellation	3	1,626,896		70.15
Order filled completely	4	675,232		29.12
Order partially filled	5	373,760		
Order deleted automatically	6	16,597		0.72
Technical Entry	101	461	0.02	
Technical Cancellation	103	461		0.02

Note: a. Due to the restriction to a certain observation period, some orders' entries were not observable in the dataset. Similarly, there were orders without a suitable end/event of code 3,4,103 or 6. This is the reason why the sum of order entries (code 1 and code 101 adds up to 2,284,628 + 461 = 2,285,089) does not match the sum of order terminations (codes 3,4,6 and 103 add up to 1626,896 +675,332 + 16,597 + 461 = 2,319,186).

b. Percentage of orders, that are entered via a 1 resp. 101 code. Hundred percent comprises all order entry events in the database.

c. Percentage of orders terminated via a 3,4,6 resp. 103 event. Hundred percent comprises all order terminating events in the database.

is represented by a number designated as event code which will be further discussed in table 6. A total of 5,014,200 database entries were examined. Absolute count data are given in the middle column, while the two columns on the right hand side list the percentage of orders started/ended via each respective event code.

Table 6: Example of a 1-5-5-3 order

Modification Timestamp	Event Code	Buy Sell	Limit	Price	Size
2005–01–05 09:51:27.87	1	S	35.00	0.00	20,000
2005–01–05 13:11:55.05	5	S	35.00	35.00	2,485
2005–01–05 16:27:13.58	5	S	35.00	35.00	377
2005–01–05 16:27:16.11	3	S	35.00	0.00	17,138

Note: The order is inserted with a volume of 20,000 at time 09:51:27.87. Partial execution with a size of 2,485 reduces the available volume to 17,515 (20,000 – 2,485) at the time 13:11:55.05 and then another partial execution of 377 units leads to 17,138 (20,000 – 2,485 – 377) remaining units from 16:27:13.58 on. At 16:27:16.11 the remainng volume of 17,138 units is cancelled altogether. Further data fields omitted in this table entail the order expiry date, auction trade flag, order type, order restriction, trade restriction, order entry timestamp, order number and ISIN code.

Table 6[5] gives an example of the handling of a sell order: The order of 20,000 shares with a price limit of 35.00 Euros is submitted at 9:51:27.87. The order entry is represented by the event code 1. At the timestamp 13:11:55.05 the first partial execution takes place, i.e. 2,485 shares are sold for 35.00 Euros per share. In Xetra partial executions are coded with the number 5. At 16:27:13.58 an additional amount of 377 shares is sold at the price of 35.00 Euros. At 16:27:16.11 the remaining number of 17,138 shares is cancelled. Order cancellations are coded with the number 3. In Xetra the demonstrated example would be represented by the code-sequence 1-5-5-3. According to the second column in table 6 this code represents the following sequence of events: Order entry – order partially filled – order partially filled – order cancellation.

Table 7: Structure of Orders

Order type	Absolute freq.	Freq. as %
1-3	1,501,284	67.06%
1-4	521,251	23.28%
1-5-4	85,020	3.8%
1-5-3	42,210	1.89%
1-5-5-4	25,780	1.15%
1-2-3	21,655	0.97%
1-5-5-5-4	10,234	0.46%
1-5-5-3	8,126	0.36%
1-5-5-5-5-4	4,707	0.21%
(Other)	18,587	0.83%

Table 7[6] gives an overview about Xetra's handling of the orders submitted during the observation period. While the first column shows the code sequence (also designated as order type) as exemplified above, the second column shows the absolute number of the corresponding order sequences. The last column gives information about the relative fraction of each order type. The lion's share of orders, namely 67% is cancelled after submission. Such order entries and cancellations without partial executions are represented by the code sequence 1–3. More than 23% of all submitted orders have the code sequence 1–4, i.e. after the order's entry into the order book the orders are filled completely. An amount of 3.8% of the orders has the code sequence 1–5–4, i.e. the amount remaining after the first partial execution is filled completely. By adding the order types ending

[5] See Prix et al. (2007a), p.722

[6] Aggregated version of Prix et al. (2007a) p. 723

with code 4, i.e. all orders which were finally filled, we end up with 28.9%. The analysis of orders submitted in two other 6-day periods gives similar results.

Table 8: Different order types concerning number of orders and money volume traded in the time from 5 to 12 January 2005

	Numbers of orders submitted[b]			
Restriction[a]	Limit	Market	MtL	Iceberg
None	93.96%	2.40%	0.16%	0.93%
F	0.01%	0.00%	0.00%	0.00%
I	2.34%	0.03%	0.00%	0.00%
S	0.03%	0.16%	0.00%	0.00%
Total %	96.34%	2.59%	0.16%	0.93%
In abs. figures	2,200,868	59,062	3,550	21,148

	Money volume traded[c]			
Restriction[a]	Limit	Market	MtL	Iceberg
None	80.08%	6.32%	0.13%	8.24%
F	0.14%	0.20%	0.00%	0.00%
I	0.02%	0.00%	0.00%	0.00%
S	4.83%	0.03%	0.00%	0.00%
Total %	85.07%	6.55%	0.13%	8.24%
In abs. figures	34,841,574,719	2,683,281,921	53,501,579	3,375,360,805

Note: Observation period covers the period from January 5th to January 12th of 2005. A total of 2,284,628 orders were examined. Percentage of the money volume and number of orders belonging to each category are shown in the table above.

a. Order restriction 'F' means Fill-Or-Kill, Order restriction 'I' means Immediate-or-Cancel and 'S' means Triggered-Stop-Order.

b. The left part of the table shows the relative frequency of each order type entered into the Xetra system in conjunction with each order restriction. 100 percent corresponds to all orders submitted. Thus, in the above part of the table all orders are counted, regardless of whether they are executed or cancelled. The total percentage figures do not sum up to 100% due to rounding effects.

c. The lower part of the table shows the relative amount of money volume traded using each order type in conjunction with each order restriction. Money volume was computed using the size of the execution in shares times the price of the transaction per share. Thus, if the price is better than a possible limit supplied, the transaction price was used for the computation. The cancelled part of any order is disregarded in this part of the table. 100 percent in the lower part of the table corresponds to the total money volume traded on Xetra in the observation period. The total percentage figures do not sum up to 100 % due to rounding effects.

The above part of table 8[7] provides information about the number of different order types and order restrictions. We observed the following order types: Limit orders, Market orders, Iceberg orders and Market to Limit orders. As

[7] Prix et al. (2007a) p. 724

table 8 shows, by taking into account all the different sequences, the limit orders have the highest share of 96.34 % in the total number of orders. Market orders, on the other hand, amount to 2.59 %, while the interesting type of Iceberg orders only adds up to 0.93 %. The other types of orders do not have a significant share in the total number of orders. The right part of table 8 gives a more promising explanation concerning the importance of Iceberg orders. If we calculate the percentage by volume, the share of both Iceberg and Market orders increases to 8.24 % and 6.55 %, respectively. The further differentiation according to the order restrictions "fill or kill" (F), "immediate or cancel" (I), "Triggered stop order" (T) does not provide additional information besides the fact that 4.83 % of total limit are the triggered stop orders.

3.2.4 Slippage by walking up the order book

Table 9[8] provides detailed information about an order "walking" up the order book when different trading volumes are considered. For ease of presentation, the detailed statistics are only given for SAP AG stocks. The table shows the volumes traded at the market price. The figures show that the trading venue at Xetra is quite liquid.

Since we have the detailed information of the entire order volume available, we can perform a more comprehensive calculation of slippage in the context of walking up the order book. Basically, slippage should measure the amount of a price increase in case of a buy order or the amount of a price decrease in the case of a sell order. Hence we do not use the "mid limit" (calculated as the average of best bid and ask) as a reference quantity, but the corresponding best offer. The slippage is calculated as the difference between the best bid or ask and the maximum or minimum price that has to be accepted when the entire order is executed. Table 9 entails the slippage figures calculated for SAP based on our data sample. For each slippage amount ranging from 0 to 35 cent, the money volume traded on both sides of the markets is given.

[8] Prix et al. (2007b), p. 38

Table 9: Slippage in Cent caused by increasing trading volume

Slippage	Matched Bid		Matched Ask	
cents	Abs. (Eur 000s)	Rel. (%)	Abs. (Eur 000s)	Rel. (%)
0	733,719	86.53	720,040	84.03
1	50,113	5.91	57,738	6.74
2	20,994	2.48	26,084	3.04
3	11,78	1.39	12,88	1.50
4	8,217	0.97	10,548	1.23
5	7,621	0.90	10,266	1.20
6	3,179	0.37	3,333	0.39
7	2,895	0.34	3,311	0.39
8	1,95	0.23	1,506	0.18
9	1,856	0.22	2,252	0.26
10	1,454	0.17	2,173	0.25
11	1,325	0.16	1,386	0.16
12	590	0.07	300	0.04
13	166	0.02	635	0.07
14	129	0.02	230	0.03
15	803	0.09	854	0.10
16	21	0.00	297	0.03
17	267	0.03	121	0.01
18	153	0.02	139	0.02
19	106	0.01	151	0.02
20	351	0.04	98	0.01
21	133	0.02	–	–
22	20	0.00	196	0.02
23	17	0.00	506	0.06
24	2	0.00	10	0.00
25	13	0.00	493	0.06
26	–	–	46	0.01
27	–	–	137	0.02
28	–	–	917	0.11
29	–	–	62	0.01
30	–	–	105	0.01
32	88	0.01	–	–
34	–	–	41	0.00
35	21	0.00	77	0.01

Table 10: Order executed by zero Slippage

DAX 30	Matched Bid		Matched Ask	
	(Eur 000s)	(%)	(Eur 000s)	(%)
Dt.Telekom	1,113,578	98.99	1,203,600	97.68
SAP	733,719	86.53	720,040	84.03
Deutsche Bank	698,109	89.01	758,876	90.79
Siemens	629,025	91.36	652,542	89.93
Allianz	454,538	88.96	525,366	85.28
RWE	493,865	90.25	406,656	91.57
E.ON	418,362	87.99	426,587	89.44
Daimler-Chrysler	414,266	93.24	409,357	92.48
Münch. Rückvers.	352,506	89.97	362,653	88.53
BASF	317,073	91.90	344,747	90.28
Bayer	319,895	95.03	340,663	93.78
Bay.Hypo-Vereinsbk.	340,336	93.31	326,027	95.47
Volkswagen	322,593	92.87	317,895	93.22
Schering	272,369	93.70	231,830	88.16
Infineon Tech.	236,572	98.83	247,441	97.38
Bay.Motoren Werke	227,900	93.11	217,481	92.28
Metro	224,767	94.49	202,919	89.58
Commerzbank	239,726	95.71	204,733	95.78
Thyssenkrupp	133,645	96.65	133,160	91.40
MAN	120,533	93.10	114,082	91.24
Continental	119,351	92.97	99,330	91.68
Deutsche Post	104,995	96.51	115,214	96.07
Adidas- Salomon	88,472	90.44	96,132	86.18
Deutsche Börse	86,344	94.11	107,106	95.49
Lufthansa	97,030	96.55	84,391	96.28
Altana	58,730	92.49	81,893	90.72
TUI	72,358	94.15	75,616	91.34
Henkel	68,351	87.37	61,378	92.70
Linde	67,573	89.85	64,400	91.87
Fresen.Med.Care	34,285	90.69	38,664	91.18

The row with slippage equal to 0 cents reads as follows: A money volume of 733,719,000 (720,040,000) Euros was traded on the bid (ask) side with a slippage of 0 cent, meaning that the shares have been traded at the best bid respectively the best offer. This calculation clarifies the problem of the mid price calculation: By calculating slippage based on the mid price the slippage

might have been half the spread instead of zero cents! The relative volume figures amount to 86.53 % (84.03 %) of the entire matched, i.e. traded, bid (ask) money volumes for SAP during the period covered by the data. The row with slippage equal to 25 cents reads as follows:13,000 + 88,000 + 21,000 = 122,000 (1,878,000) Euro were traded with a slippage equal to or larger than 25 cents.

Table 10[9] gives an overview of all DAX 30 companies. The figures give information about the amount of market orders (in absolute and in percentage terms) that have been executed during the 6 trading days without walking up the order book. We call this a zero slippage situation. The table contains the money volume of zero slippage orders for each DAX 30 stock. For example, in case of Deutsche Telecom, the figures of 98.99% for matched bid and of 97.68% for matched ask indicate that 98.99% of bid orders have been executed with a slippage of zero cents and similarly 97.68% of ask orders have been executed at the prevailing market price, i.e. walking up the order not a single cent. While Kempf and Mayston (2005) showed that, based on earlier Xetra data, 20% of all orders walk up the order book, the detailed analysis of SAPtrades (table 9) shows that the adverse price change of market orders is comparably low. These figures indicate a new trend. Our data clearly show a comparable increase in liquidity and improvement of the execution process on the Xetra trading platform. It is probably due to both an improvement in Xetra's trading procedure and the improved of technical trading features. Also, the additional liquidity could have been generated by the so called central counter party. A further research is required in order to confirm the preliminary explanations. However, our preliminary results show that it is very promising to analyse the hitherto neglected microstructure by looking at the tick-by-tick data.

[9] Prix et al. (2007b), p.37

4. Conclusion

We tried to give an overview of all the individual parts of asset management, to wit, Research, Portfolio Construction and Trading. We analyse each part separately and try to discover the opportunities which the integration of the three provides to the market participants. By following a systematic investment strategy the inefficiencies arising from each part might be exploited.

First we introduce such a systematic investment strategy, namely the Relative Value strategy. This strategy is based on the identification of the assets, pairs of which tend to show a stationary pattern over a certain period of time, but which are experiencing deviations from their equilibrium in a short run. Relative Value strategy aims to benefit from these short-term inefficiencies. However, the integrated active asset management requires the integration of the further steps. In the portfolio revision process two aspects should be taken into account, first, the implementation shortfall, and second, the slippage occurring by "walking up the order book" when executing the orders.

The implementation shortfall occurs between the point in time the decision to rebalance the portfolio is made and the point in time the trades are executed. We present an empirical study of the implementation shortfall performed on futures data. The main factor influencing the implementation shortfall is the speed of transmitting the trading proposals to the trader. The study shows that the transmission via the FIX-protocol reduces the transmission time and consequently the implementation shortfall.

The "walking up the order book" slippage is determined by the transaction costs caused by the lack of liquidity in the markets. Measuring the transaction costs by doubling the so called mid price, as proposed by Lee and Ready (1991) nearly 20 years ago seems not to be an appropriate solution, as it is based on the bidask spread. Slippage in the sense of "walking up the order book" is not influenced by the spread but in order to measure it, the order book data should be available. Nowadays, the availability of the tick-by-tick order book data, classifies the "walking up the order book" slippage as an appropriate measure. Based on order book data of the Frankfurt stock exchange we provide the idea of measuring slippage as the difference between the best bid or offer and the maximum or minimum price that has to be accepted when the entire order is executed.

By entering the age of modern asset management, the trading strategies that neglect the markets' microstructure disregard the fact that arbitrage opportunities might exist. As our preliminary results have shown the Integrated Active Asset Management could generate returns by discovering and exploiting these arbitrage opportunities. We do not provide a final solution for exploiting these arbitrage opportunities, but we want to proclaim such analysis of the markets' microstructure as an innovative trend in the active asset management. We presume that an integrated systematic investment strategy combined with a detailed analysis of the market's microstructure might generate returns by exploiting arbitrage opportunities resulting from the exploitation of price inefficiencies emerging through the big variety of trading platforms.

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GLOBAL RESERVES MANAGEMENT

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Abstract

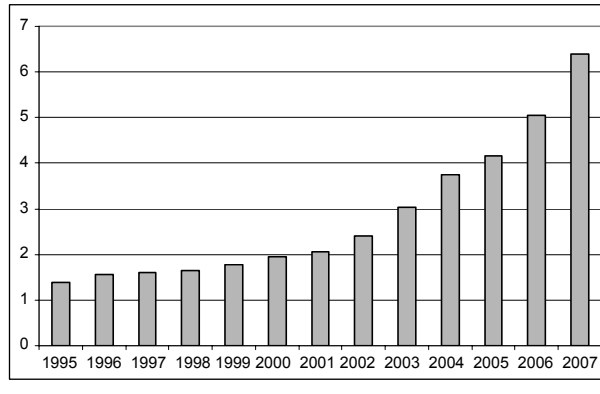
Foreign exchange reserves held by central banks rose to 6.4 trillion dollars in 2007 from 1.5 trillion a decade ago and are expected to rise further in the coming years. Sovereign wealth funds manage assets in excess of 2.5 trillion dollars, and total reserves managed jointly by central banks and SWFs are forecasted to top 10 trillion dollars very soon. This paper presents motives behind this reserves growth and proposes a concept of OCHAR – Opportunity Cost of Holding Ample Reserves – which is defined as a forgone GDP growth resulting from too conservative reserve management by central banks. We estimate OCHAR for a sample of 33 countries which accounted for 80% of total central bank reserves in 2007. We also argue, that unlike in the 20th century, where central banks used to be very secretive institutions, 21st century central banking is characterized by widespread knowledge sharing and transparency. Therefore best practices, such as inflation targeting or efficient reserve management spread out quickly and are adopted by increasing number of central banks. Thus central banks collectively embarked on a reserves diversification journey, it does appear to be the central banks collective mindset and we can speak of the global reserves management in the 21st century. At the end of the paper

[1] Authors are respectively: (1) partner at Ernst & Young and former deputy governor of the National Bank of Poland and former member of the Polish Financial Services Authority; (2) economist at Millennium Bank in Warsaw and former economist at the National Bank of Poland. The views presented in this paper are those of the authors and do not represent the official position of institutions that authors are or were affiliated with. This paper was inspired by World Bank Treasury Jennifer Johnson-Calari and Roberts Grava presentations, who drew authors' attention to the problem of rising opportunity cost of holding ample reserves. We thank Roberts Grava and Ewa Szafarczyk for helpful comments on the earlier draft, all remaining errors are ours.

we put forward several hypotheses of what could be the consequences of this diversification journey. It seems that relative prices of various assets will find new steady states, which may have little in common with relative valuations seen in the 20th century. We also expect that slowly, over time, US "exorbitant privilege" will be eliminated. Finally we consider global stability risks in the context of the new reserves management style adopted by central banks. We postulate that due to the increasingly global nature of shocks as long as central banks and governments in countries-stakeholders of global imbalances focus their actions on maintaining global price and financial stability, central banks in smaller emerging markets can afford to improve reserve management without incurring additional stability risk.

In 2007 foreign exchange reserves held by central banks and sovereign wealth funds likely topped 9 trillion dollars. According to IMF COFER database central bank reserves stood at 6.4 trillion dollars at the end of 2007 and assets under management by SWFs were estimated at around 2.5–3 trillion dollars[2]. With oil spot-trading above 120 dollars per barrel and oil futures remaining above 100 dollars for 2016 contracts and with gradual approach to enhancing exchange rate flexibility in China further sharp growth of central bank and sovereign wealth funds assets should be expected in the coming years.

Figure 1: The stock of central bank reserves, year end, measured in billions of USD)



Source: IMF COFER database

[2] MGI (2007) estimates that Sovereign Wealth Funds account only for 60 percent of petrodollar assets, with the rest managed by wealthy private individuals

1. The origins of the sharp rise in foreign exchange reserves.

Large and unprecedented rise of foreign exchange reserves led to many attempts to explain the reasons behind this trend.

In January 1999 Martin Feldstein, the President of the National Bureau of Economic Research, the famous US think-tank, wrote an article in the aftermath of the Asian crisis arguing for the need to keep large foreign exchange reserves, that would serve as source of protection, flexibility and trust[3]. In March 1999 Alan Greenspan, Federal Reserve chairman spoke on this issue during the World Bank conference[4]. Those days economists focused their attention on the need to build large reserves to hedge emerging markets against capital flight and sudden stops. Economists discussed whether the rule of thumb such as reserves coverage ratio of six months of imports is good enough, or whether one should also take into account short-term debt, which shortly after Greenspan speech was labeled as Greenspan-Guidotti rule. This rule states that a country should keep its reserves large enough to survive one year without new loans.

From today's perspective it may seem improbable, but it was only eight years ago when economists recommended building up of sizeable foreign exchange reserves in emerging markets. Today, as shown in this paper, many countries amassed reserves well in excess of what can be considered a safe and desirable level. Problem of too few has been replaced in many countries by a problem of too plenty.

Several papers identified Asian crisis in 1997 as the time series structural break which explains why in late 1990s US current account deficit and Asian foreign exchange reserves started to grow simultaneously and what led Dooley et al. (2003, 2004, 2005) to formulate the new Bretton Woods hypothesis[5]. For example Gruber and Kamin (2005) estimated a model explaining current account to GDP ratio for a panel of 61 countries in 1982–2003 period. The pretty much standard model, using budget deficit, net international

[3] Feldstein (1999)

[4] Greenspan (1999)

[5] Rybinski (2007) discusses all existing theories of global imbalances, shows their strengths and weaknesses (book, in Polish).

investment position, income per capita, GDP growth, demographic variables, terms-of-trade volatility and openness fails to explain why US recorded huge current account deficits and why Asian countries posted sizeable current account surpluses accompanied by rapidly rising foreign exchange reserves. However adding dummies for crisis years in Asia explains the lion's share of current account surpluses in Asian countries. Authors conclude that Asian countries in post-crisis period adopted macroeconomic policy based on domestic spending restraints, investment spending in particular, and undervalued exchange rates, which required heavy interventions and led to massive reserves accumulation after few years of such macromanagement. Malecki et al. (2001) use financial markets microstructure analysis to show that it is justified to link the Asian crisis to post-crisis reserves accumulation. They show that the direct cause of speculative attacks on Asian currencies was low level of foreign exchange reserves on net basis. Attack on Thai baht took place when markets learned that net foreign reserves in the coffers of Bank of Thailand were much smaller than those reported in bank assets amid large foreign currency sales in forward transaction conducted by the central bank. In other countries in the region speculative attacks were triggered by market assessments that foreign exchange reserves were too small relative to foreign currency denominated loans taken out at commercial banks. Investors knew that these banks will not be able to renew such loans and that they will have to purchase foreign exchange from the central bank to make payments on existing loans. Anticipation of such massive purchases led to speculation against local Asian currencies.

There is little doubt that the roots of the rapid reserves accumulation are in the hangover period after the Asian crisis. Even larger literature deals with explanation of the magnitude of reserve holding increases in the past decade, testing different motives and target size of reserves with mixed success. Examples are Mendoza (2004), Garcia, Soto (2004), Caballero, Panageas (2004a, 2004b), Aizenman, Lee (2005), Gosselin, Parent (2005), ECB (2006), Aizenman (2006), Jeanne, Ranciere (2006), Ricerche (2007), Cifarelli, Paladino (2007), Green, Torgerson (2007).

There could be many different motives of building large reserves pool: economics, politics, or reputation. Two economic motives are analyzed in Aizenman, Lee (2005) paper, i.e. precautionary motive and mercantilist motive. In the first case, in line with Martin Feldstein recommendations reserves are built to hedge the country against sudden stops and against financial markets volatility. In the second case reserve accumulation is a natural consequence of industrial policy based on maintaining undervalued exchange rate to stimulate

exports, which involves central bank interventions to prevent currency from strengthening. Aizenman and Lee analyze 53 countries in the period 1980–2000. Their results indicate that variables related to trade openness, capital flows openness and experienced financial crises explain level of foreign exchange reserves quite well, are statistically significant and economically important. On the contrary, variables related to mercantilist motive, such as export growth or exchange rate, do not influence reserves accumulation in a sizeable manner, although some are statistically significant.

Gosselin, Patent (2005) analyse the accumulation of foreign exchange reserves in eight Asian countries, and they analyze time series which include also years 2003–2004, when reserves grew rapidly. Authors show that time series exhibit a structural break in 1997–1998, and that after the Asian crisis demand for foreign exchange reserves at central banks did increase significantly. However, the actual level of reserves observed in 2003–2004 was much higher than the model predictions, which led to the following conclusion. If historical relationships between analyzed economic variables[6] still prevail one should expect slower growth of foreign exchange reserves in the years to come, which could create risk of US dollar depreciation amid less abundant current account deficit funding available in the future. Well, the frantic pace of reserves growth in 2006 suggests that either relationships between economic variables did change, or that there is another factor, missing in the analysis, that has led to acceleration of reserves accumulation.

Also Jeanne, Ranciere (2006) find that recent accumulation of reserves by Asian central banks cannot be explained by an insurance motive against sudden stops. Authors present a model of optimal level of foreign exchange reserves and find that Greenspan-Guidotti rule is a very good approximation of their model results, with an exception, when the short-term debt to GDP ratio is less than 2.5%, then the optimal size of foreign exchange reserves is zero.

[6] The most parsimonious cointegrating relationship contains the following variables: ratio of reserves to nominal GDP, imports to GDP, broad money to GDP, volatility of export revenues and structural changes in coefficients related to imports to GDP and money to GDP after the Asian crisis.

The buffer stock model was used by Cifarelli, Paladino (2007) in order to understand the motives of reserves accumulation[7]. The basic model assumes that there are two types of costs related to holding reserves: the opportunity cost of holding reserves and the adjustment cost of reserves restocking, amid need to generate balance of payments surplus to build up reserves which reduces output. With growing level of reserves opportunity cost rises and the adjustment cost falls. Authors use cointegration analysis to capture the long term relationships and error correction method to model the short-term dynamics. Their results suggest that in the long run precautionary motive is a valid explanation of rapid reserve accumulation in many emerging economies. However authors also find, that in some countries short-term dynamics of reserves accumulation does depend on mercantilist motives, as reserves accumulation speed increases with appreciation of the real effective exchange rate.

One general conclusion can be formed basing on to-date empirical research. It appears that precautionary motive of reserves accumulation has dominated over other motives in the period following the Asian crisis. Central banks used large foreign reserves as an insurance or hedge against the risk of liquidating long-term investment projects in situation when country experiences sudden stop. Existing evidence shows that the cost of such hedge has been growing over time. Mark-to-market losses on reserves related to local currency appreciation may lead to massive losses in central banks balance sheets, in extreme cases topping 10 percent of GDP[8]. Many countries face rising costs of sterilization, which are particularly high in situations when local interest rates are above the level of interest rates in the United States or in the Eurozone.

[7] Cifarelli, Paladino (2007) present a discussion of previous empirical research utilizing buffer stock model. In particular they show that two strands of papers emerged. First one attempts to adopt the buffer stock model to emerging markets characteristics by adding proper institutional variables. Second one focuses on quantitative aspects of the cost- benefit structure, e.g. estimating relationship between reserves and the probability of costly default. For example Rodrik and Velasco (2000) estimated that the probability of the sudden stop would fall by 10 percent if a country fulfilled Greenspan-Guidotti rule.

[8] Green, Torgerson (2007).

2. Is excessively prudent foreign exchange reserve management costly?

As discussed above the precautionary motive led to a purchase of a possibly very expensive insurance against the sudden stop risk. However sterilization costs and local currency appreciation implications may be relatively minor costs in relation to the opportunity cost of holding reserves accumulated over the years. Opportunity cost of holding reserves has been discussed in economic literature since 1960s[9]. There were many attempts to measure the opportunity cost. For example Ben-Bassat, Gottlieb (1992) use a difference between return on capital in domestic projects[10] and interest income earned on reserve investment in foreign deposits and fixed income securities. Rodrik (2006) assumes reasonable spreads between the yield on reserve assets and the cost of foreign borrowing, and computes that the income loss to developing countries amounts to close to 1% of GDP. Paper argues that conditional on existing levels of short-term foreign borrowing, this does not seem too steep a price as an insurance premium against financial crises. Paper asks a question why developing countries have not tried harder to reduce short-term foreign liabilities in order to achieve the same level of net liquidity (thereby paying a smaller cost in terms of reserve accumulation) and concludes that it remains an important puzzle.

As shown above there are several definitions of the opportunity costs of holding large reserves, and each of them has short-comings. Therefore we propose our own concept of opportunity cost of holding ample reserves. The name implies that definition applies only to situations when level of central bank reserves is beyond what could be considered as adequate to fulfill central bank goals related to financial stability and exchange rate policy implementation.

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[9] Kenen, Yudin (1965), Courchene, Youssef (1967), Flanders (1971), Frenkel, Jovanovic (1981), Edwards (1985), Landell-Mills (1989), Ben-Bassat, Gottlieb (1992).

[10] They used a maximum of return on business projects and government projects. The latter was approximated by return on investment in infrastructure. The difference between real return on domestic projects and on foreign reserve investments was always positive in the analyzed case of Israel, and remained in the range 5 to 15 percentage points. This strand of literature used opportunity cost of holding reserves to estimate the demand for reserve assets, it did not focus on the forgone potential GDP growth.

We define opportunity cost of holding ample reserves (OCHAR) as a forgone growth of GDP amid too conservative central bank reserve management[11].

The opportunity costs of holding ample reserves (OCHAR) depends on three factors:

(1) the size of reserves (the absolute size and the excess over the amount needed to perform central bank stability and exchange rate policy functions);

(2) the deviation of the strategy optimal in the long run from the actual investment strategy pursued by the central bank focused entirely on short-term financial and economic stability objectives;

(3) the country specific ability to translate additional income into socially useful projects with high social rate of return (road, telecom or knowledge infrastructure, education etc.).

Factors (1) and (2) combined correspond to opportunity cost concept discussed in economic literature in the past forty years, but we adopt a more sophisticated measure of forgone profits amid explicit assumptions related to actual and desired asset management styles.

We analyze all three factors below for a selected sample of countries[12], which accounts for c.a. 80% of global foreign exchange reserves. There are many rules of thumb regarding proper level of reserves: they should cover above three or above six months of imports of goods and services (depends on the exchange rate regime, the sign and size of trade balance, on country rating), they should cover certain percentage of money in circulation (5–20% depending on currency regime[13]), and they should allow a country to survive without new loans for at least a year. The latest rule is called Greenspan-

[11] We limit our analysis to central bank portfolios amid very limited information about asset size and investment styles of many sovereign wealth funds (truly exceptional in this respect is the Government Pension Fund of Norway which is a very transparent institution)

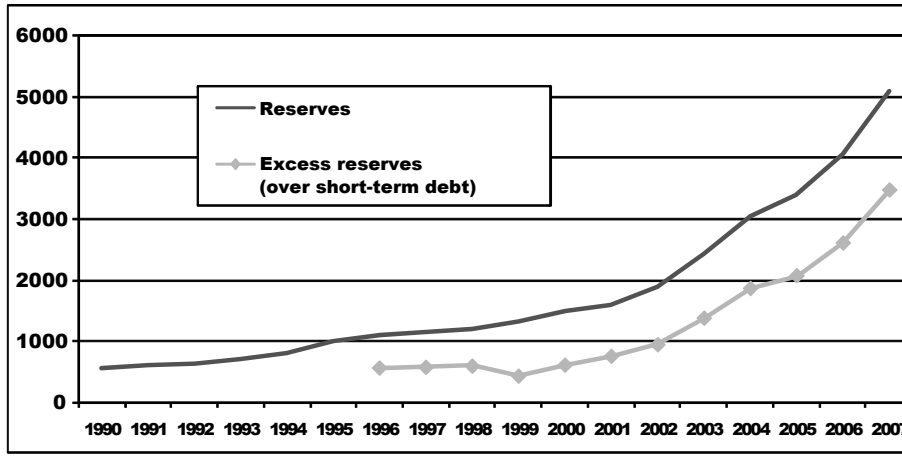
[12] These countries are: Germany, France, Switzerland, Sweden, Poland, Hungary, Czech Republic, Slovakia, Japan, China, Korea, Thailand, Taiwan, Singapore, Hong Kong, Russia, Norway, Saudi Arabia, Nigeria, Venezuela, Kuwait, Mexico, Algeria, United Arab Emirates, Brazil, Argentina, Chile, Colombia, South Africa, Sudan, Kenya, Botswana, Ghana. We excluded U.S.A. from the analysis as we think that it would be odd to add the biggest world debtor into the global assets analysis. The same could apply to Western European countries, as in every case the country short-term debt vastly exceeds country foreign exchange reserves.

[13] Wijnholds, Beaufort, Kapteyn (2001)

Guidotti rule and appears to be cited in the literature more often than other rules, so we also take this approach. We adopt the standard definition of the short-term debt and country liabilities payable to non-resident holders within one year, irrespective of the currency in which they are issued[14].

Figure 2 and table 1 below present foreign exchange reserves and outstanding short-term foreign debt for the sample of selected countries. It is evident that reserves are growing fast in every location with exception of developed countries in Western Europe and that reserves above the short-term debt are also rising fast. For the analyzed countries the total excess reserves according to Greenspan-Guidotti rule likely topped USD 3.5 trillion in 2007 compared with USD 500 billion a decade ago.

Figure 2: Total and excess reserves for the analyzed countries, USD billion.



Note: short-term data for 2007 not available, we used data for 2007 Q2
Source: IMF, BIS-OECD-IMF-World Bank

Above we calculated the first OCHAR factor, which was the easiest to calculate among the three factors. In order to identify the second OCHAR factor we have to make numerous assumptions. Firstly data on actual return on foreign reserves is available only for half of the sample of the analyzed countries[15]. So while we calculate the second OCHAR factor for reporting countries, we will also make assumption what that factor estimate would be if central bank followed certain stylized investment strategy. We will define

[14] For a recent review of other reserve adequacy rules see Green, Torgerson (2007).

[15] See table 6 in the appendix. Only 16 out of analyzed 33 countries reported return on reserves in for at least one year in 2004–2006 period. Out of 16 countries four report returns in local currency, which further complicates calculations.

the typical central bank portfolio as US, eurozone and UK government bonds with duration 1–3 years. For comparative purposes we will use a long-term focused investment strategy often adopted by pension funds. We will also define a combined strategy which assumes that reserves consistent with Greenspan-Guidotti rule are invested according to the central bank typical style, while reserves above that level are invested according to stylized pension fund investment style.

Stylized central bank portfolio return was calculated on the basis of the rate of return for the weighted average of bond indices for the main reserve currencies (US Treasuries 1–3, EMU Government 1–3, UK Governments 1–3). Currency composition of foreign reserves was obtained from the IMF COFER data. For the observations before 1995 currency composition for 1995 was assumed.

Stylized pension portfolio return was calculated on the basis of stylized central bank portfolio rate of return (with 40% weight) and weighted average of stock indices returns for the main reserve currencies (DowJones, DAX, FTSE). We assumed that such weighted average of stocks accounted for 60% of the pension portfolio.

Stylized combined portfolio return was calculated after splitting reserves into two parts: traditional reserves component and sovereign wealth component[16] (excess over short term debt according to Greenspan-Guidotti rule). We assumed stylized central bank return for traditional part of reserves and more aggressive pension strategy for the sovereign wealth part of reserves.

[16] Coming from the central banking community we do acknowledge that splitting reserved into "traditional reserves" and "sovereign wealth component" is controversial. It raises questions whether central banks should act as sovereign wealth managers given institutional constraints they face (see Bakker, van Herpt (2007)). Hildebrand (2007) asks a question whether it is appropriate at all to treat reserves above any rule the same way we treat assets in sovereign wealth funds. These are important considerations but in-depth discussion of these issues extends beyond the limited scope of our paper.

Table 1: Reserves and short term debt in analyzed countries (USD m)

	2005	2006	2007	2005	2006	2007Q2	2005	2006	2007*
		Reserves			Short-term debt			Reserves exceeding short-term debt	
Germany	101675.9	111637.0	136234.4	988470.0	1091577.0	1344252.0	0.0	0.0	0.0
France	74360.0	98239.1	115717.2	748095.0	1038080.0	1249240.0	0.0	0.0	0.0
Switzerland	57639.6	64497.5	75372.1	411942.0	419299.0	550819.0	0.0	0.0	0.0
Sweden	24890.1	28022.8	31037.4	156919.0	179865.0	202853.0	0.0	0.0	0.0
Poland	42560.9	48474.2	65734.2	16564.0	17130.0	23339.0	25996.9	31344.2	42395.2
Hungary	18603.1	21590.0	24051.8	15899.0	18215.0	22928.0	2704.1	3375.0	1123.8
Czech Republic	29363.8	31220.8	34594.3	11975.0	13005.0	13422.0	17388.8	18215.8	21172.3
Slovakia	15479.6	13364.0	18976.1	5929.0	6725.0	7462.0	9550.6	6639.0	11514.1
Japan	835505.7	880977.4	954144.7	426468.0	383513.0	380547.0	409037.7	497464.4	573597.7
China	825588.0	1072564.0	1534354.0	63106.0	79984.0	103817.0	762482.0	992580.0	1430537.0
Korea	210390.6	238956.2	262224.3	62719.0	100055.0	122804.0	147671.6	138901.2	139420.3
Thailand	52064.9	66984.7	87455.2	12774.0	14452.0	10654.0	39290.9	52532.7	76801.2
Taiwan	257952.1	270840.0	275027.0	38091.0	33184.0	50899.0	219861.1	237656.0	224128.0
Singapore	116172.0	136259.0	162957.0	82888.0	102490.0	123764.0	33284.0	33769.0	39193.0
Hong Kong	124278.3	133210.5	152701.9	79279.0	93368.0	97244.0	44999.3	39842.5	55457.9
Russia	182240.0	303732.4	476390.9	48444.0	57528.0	73553.0	133796.0	246204.4	402837.9
Norway	46985.9	56841.6	60839.6	74349.0	138649.0	181426.0	0.0	0.0	0.0
Saudi Arabia	26759.9	27764.9	34014.4	13644.0	11886.0	19418.0	13115.9	15878.9	14596.4
Nigeria	28279.7	42298.8	51334.4	1930.0	4042.0	3802.0	26349.7	38256.8	47532.4
Venezuela	29636.8	36672.3	33477.1	6728.0	4629.0	5746.0	22908.8	32043.3	27731.1
Kuwait	8971.5	12675.8	16776.3	7320.0	8262.0	10770.0	1651.5	4413.8	6006.3
Mexico	74054.1	76270.5	87109.2	29002.0	31189.0	27554.0	45052.1	45081.5	59555.2
Algeria	56582.4	78207.7	110626.8	1076.9	989.0	910.0	55505.5	77218.7	109716.8
UAE	21010.3	27617.4	n.a	19608.0	27849.0	29728.0	1402.3	0.0	n.a
Brazil	53799.3	85838.9	180333.7	45583.0	45848.0	52370.0	8216.2	39990.9	127963.7
Argentina	28086.7	32026.0	46116.5	13793.9	13296.0	14883.0	14292.8	18730.0	31233.5
Chile	16932.5	19396.3	16842.2	12426.0	14470.0	16144.0	4506.5	4926.3	698.2
Colombia	14954.6	15437.2	20952.1	5733.0	5710.0	10388.0	9221.6	9727.2	10564.1
South Africa	20629.7	25586.9	32942.9	8615.0	15635.0	16480.0	12014.7	9951.9	16462.9
Sudan	1868.6	1659.9	1377.9	1904.5	1959.2	2105.5	0.0	0.0	0.0
Kenya	1799.1	2416.1	3355.2	529.9	625.8	730.2	1269.1	1790.2	2625.1
Botswana	6309.1	7992.4	n.a	50.0	32.0	46.0	6259.1	7960.4	n.a
Ghana	1897.4	2268.1	n.a	839.1	1194.8	742.8	1058.3	1073.4	n.a

*We used short-term debt for 2007 Q2.
Source: IMF, BIS-OECD-IMF-World Bank

We begin by looking at the actual returns as reported by central banks in their annual reports. In our sample of 33 central banks only 16 report actual returns, and in four cases these returns are measured in local currency (Germany, France, Switzerland, Hong Kong), which makes it impossible to compare these returns with those achieved in other countries. Table 2 below presents the results[17].

Table 2: Actual rates of return on foreign reserves

		Actual rates of return			
		2004	2005	2006	2007
Western Europe	Germany*		1.4%	1.7%	1.5%
	France*	2.0%	3.5%	3.8%	3.9%
	Switzerland*	2.3%	10.8%	1.9%	3.0%
	Sweden			2.0%	5.1%
CEE	Poland	2.6%	2.6%	3.2%	5.4%
	Hungary		2.6%	3.6%	
	Czech Republic	2.8%	2.6%	3.0%	
	Slovak Republic		2.2%	2.4%	
Asia	Hong Kong*	5.7%	3.1%	9.5%	11.8%
Oil exporting countries	Russia		3.0%	3.8%	
	Norway **	7.8%	9.1%	7.30%	3.4%
	Mexico	2.0%	1.7%	4.9%	
	United Arab Emirates	1.3%	2.6%	2.7%	
Latin America	Argentina***	3.1%	3.1%	5.7%	
	Chile	1.8%	2.9%	2.5%	
	Colombia		2.7%	3.9%	

* indicates that returns were reported in local currency
**data refers to investment portfolio only
***return in USD terms
Source: Central banks annual reports and authors calculations.

It is evident, that in the era of low global interest rates central banks are not able to generate high rates of return on their reserves amid conservative investment strategies basing on high grade fixed income instrument in most liquid markets. Norges bank and Hong Kong Monetary Authority are notable exceptions, and they reported higher than typical central bank returns amid more diversified portfolio and more aggressive investment style, which

[17] Actual rates of return were obtained from the central banks' annual reports. They were either reported directly or calculated on the basis of reported interest income on foreign exchange assets.

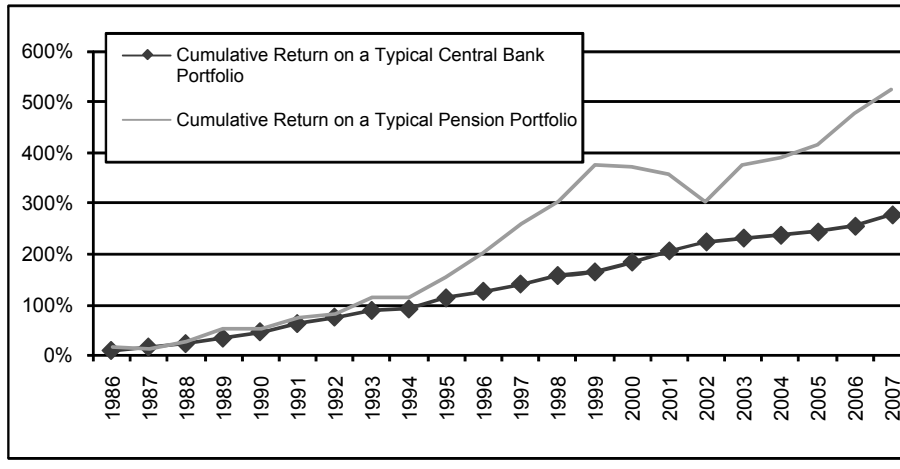
includes equities[18]. In the case of Norway the turmoil on the credit markets triggered by bursting bubble of the US housing market reduced investment results in 2007, especially in the second half of the year, so the rate of return was lower than in the previous years. Table 7 in the appendix presents the opportunity cost (first and second OCHAR factor put together) for countries that report actual returns on foreign reserves. For example this cost for CEE countries is estimated between 1.2 and 2.3% of GDP in 2006, for commodity exporters at 0.7–2.5% of GDP, measured against the stylized pension portfolio. In other words if central banks in CEE had pursued investment style typical for pension funds their profits would have been larger by 1.2–2.3% of GDP, which is a very large sum and often covers large percentage of budget deficit in these countries.

Because we have very limited data on actual returns in what follows we assume that central bank allocate their reserves according to central bank stylized portfolio, and we measure the opportunity cost in comparison with stylized pension and combined portfolio. There are always several caveats of such analysis. Firstly, how far back one should go. With massive changes in the global economy and global financial markets – such as Great Moderation to mention one major structural change – we decided to follow Alan Greenspan advice and use the last 20 years of data that does respond to the Great Moderation period[19]. Of course there is an immediate question whether our OCHAR calculations would still hold in the long run in the post Great Moderation period, with more volatility in the markets. Our answer is affirmative and we discuss it in the last part of this paper.

[18] Swiss National Bank also manages a well diversified portfolio has included equities since 2004, see Hildebrand (2007).

[19] In this decision we follow Greenspan (2005) who said: "*Over the past two decades, inflation has fallen notably, virtually worldwide, as has economic volatility. Although a complete understanding of the reasons remains elusive, globalization and innovation would appear to be essential elements of any paradigm capable of explaining the events of the past ten years. If this is indeed the case, because the extent of globalization and the speed of innovation are limited, the current apparent rapid pace of structural shift cannot continue indefinitely. While the outlook for the next year or two seems reasonably bright, the outlook for the latter part of this decade remains opaque because it is uncertain whether this transitional paradigm, if that is what it is, is already far advanced and about to slow, or whether it remains in an early, still-vibrant stage of evolution*".

Figure 3: Cumulative return, stylized central bank and stylized pension portfolio



Source: Authors calculations based on Merill Lynch indices

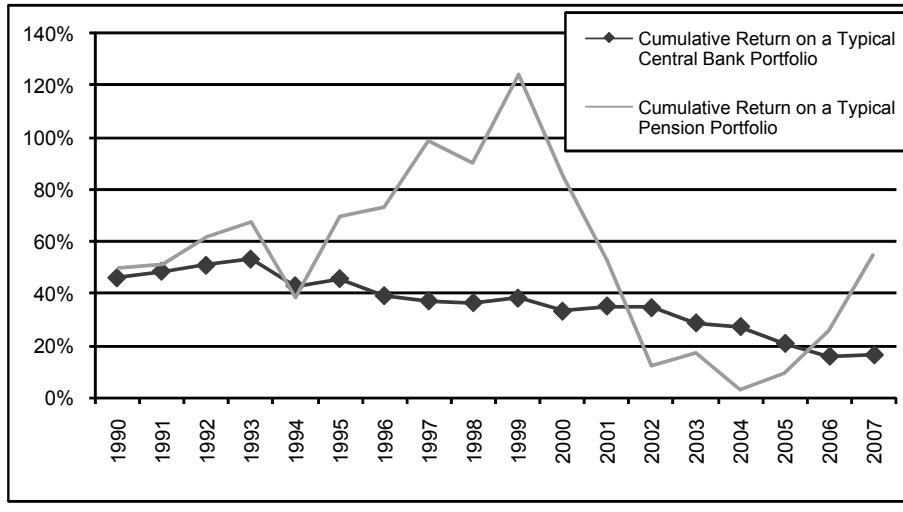
Second caveat is that even in a Great Moderation period returns on various portfolios vary a great deal, so it makes sense to use multi-year averages. We decided to use five-year average as it often corresponds to a central banker term in the office. In other words when central banker makes asset diversification decisions she would probably be concerned how these decisions affect returns on reserve assets during her term, as poor performance may lower chances of reelection[20].

Figure 4 below presents rolling cumulative returns for both investment strategies over the period of past five years, the data is plotted for each year between 1990 and 2007. Few observations do stand out. Firstly, in low global interest rate environment stylized central bank portfolio returns exhibit downward trend. Secondly, in some years stylized pension portfolio returns were two to three times higher than stylized central bank portfolio returns. Finally in the periods following the burst of the Internet bubble pension portfolio did bring returns below the central bank portfolio, but it has never resulted in a capital loss over the five year period. So our stylized pension portfolio has yielded a successful capital protection strategy even in the aftermath of the bursting stock market bubble, assuming five year verification period.

[20] We assume that central bankers love their jobs and they do want to be reelected or reappointed.

Figure 4 shows also that pension portfolio volatility is much higher than central bank portfolio volatility.

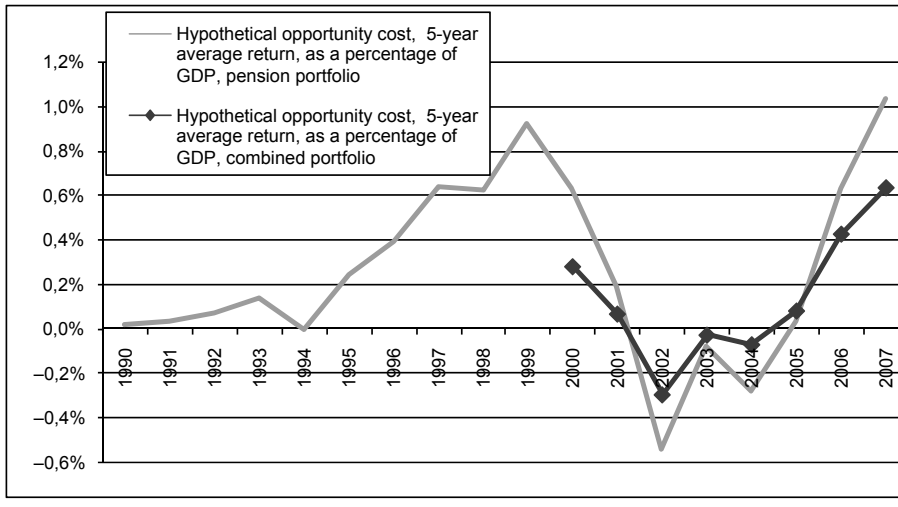
Figure 4: Cumulative return over the previous five years.



Source: Authors' calculations based on Merill Lynch indices

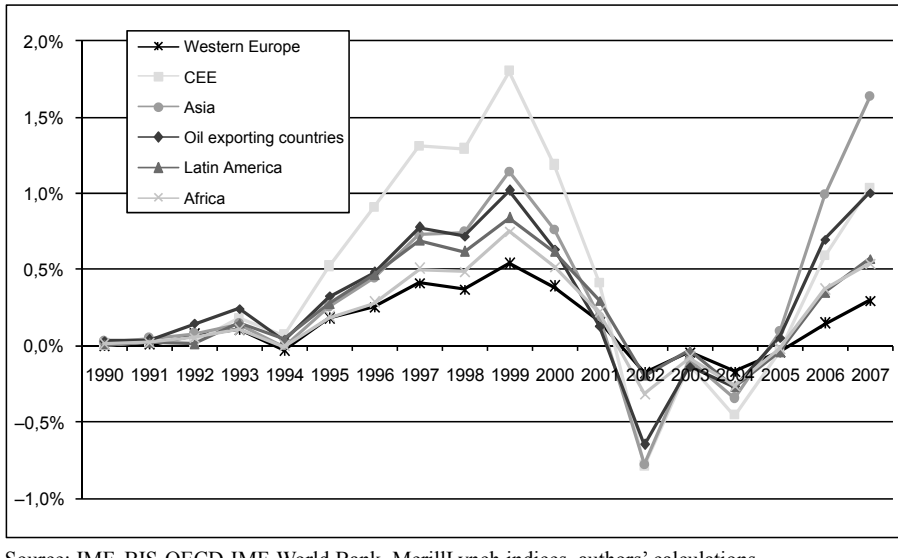
In what follows we take the estimated annual differences in returns between central bank portfolio, pension portfolio and combined portfolio, take into account size of reserves and measure the opportunity cost as a percentage of GDP. Figure 5 below presents these results in the form of a five year arithmetic average for the whole sample of 33 countries. There are four periods: low reserves period with low opportunity cost; pre-internet- bubble period, when this cost stands at 0.4–0.9% of GDP; post-bubble period when opportunity cost turns negative; and in 2005–2007 the five year average opportunity cost turn positive again and reaches levels even higher than before the Internet bubble crisis.

Figure 5: Total, hypothetical opportunity cost as a percentage of GDP, 5-year average[21].



Source: IMF, BIS-OECD-IMF-World Bank, Merill Lynch indices, authors' calculations.

Figure 6: Hypothetical opportunity cost as a percentage of GDP, pension portfolio, 5-year average, by groups of countries.



Source: IMF, BIS-OECD-IMF-World Bank, MerillLynch indices, authors' calculations.

[21] Short-term debt data for 2007 not available, we used the data for 2007 Q2, for the period 1990–1996 reserves data for some countries (Taiwan, Russia, Czech Republic, Slovak Republic, Hong Kong) are missing, for those years we calculated average opportunity cost excluding countries with missing data.

The average opportunity cost masks wide differences between groups of countries. As shown in figure 6 in mid-90s CEE countries faced highest opportunity cost of around 1.5% of GDP (measured against pension portfolio), while for remaining groups of countries this cost stood between 0.5 and 1% of GDP. The reason for that is high reserves/GDP ratio in CEE countries, which was equal to 18% in 1999. In the same year reserves amounted to 13% of GDP in Asia and not more than 10% in the rest of analyzed countries. In 2007, however Asia was the biggest reserve holder with reserves equal to 36% of GDP, while the same ratio for CEE countries amounted to "only"18%. In line with sharp rise of reserves, the highest five-year average opportunity cost was calculated for Asian countries, closely followed by oil exporters and by CEE countries[22].

Table 3: Total, hypothetical opportunity cost for different alternative investment strategies (USD million or % GDP, sample of 33 countries, data for each year)

	2004	2005	2006	2007*
Stylized central bank portfolio return	51 357.3	64 657.4	135 366.5	323 001.2
Stylized pension portfolio return	101 433.5	171 848.7	483 453.5	429 447.8
Stylized combined portfolio return	81 878.2	129 742.7	358 123.5	395 442.8
Hypothetical opportunity cost, pension portfolio	50 076.2	107 191.2	348 087.0	106 446.7
Hypothetical opportunity cost, combined portfolio	30 520.9	65 085.3	222 757.0	72 441.6
Hypothetical opportunity cost as a percentage of GDP, pension portfolio	0.29%	0.56%	1.69%	0.46%
Hypothetical opportunity cost as a percentage of GDP, combined portfolio	0.17%	0.34%	1.08%	0.31%

*We used short-term debt for 2007 Q2.
Source: Authors' calculations based on IMF, WEO, BIS-OECD-IMF-World Bank data and Merill Lynch indices

[22] At the National Bank of Poland we conducted the following exercise. We assumed that we are allowed to invest in ten currencies (USD, EUR, GBP, CHF, JPY, DKK, SEK, NOK, AUD, CAD) and there are no limits on the share of a particular currency. We conducted the optimization procedure, using PLN as base currency and assumed investments in asset classes that we actually use (governments and high rated agencies). We then selected the optimal unconstrained portfolio, which had the same volatility as the actual portfolio (the same risk related to volatility of returns). This theoretical portfolio had a return of 2.7 pp. higher than the actual one, on average each year, which could have translated into 0.4–0.5% of GDP of additional revenue to the budget each year. The currency structure of the theoretical portfolio would have probably been unacceptable amid to high share of CAD and NOK, which are not liquid enough markets given the size of Poland's reserves. But this exercise shows what is the magnitude of the opportunity cost, even before one starts to think about opportunity costs related to diversification across asset classes.

Tables 3 and 4 show opportunity cost estimates for the last four years, in each of these years for both pension and combined portfolio. For 2006 this hypothetical cost for analyzed Asian countries was estimated at 2.7% of GDP or 239 billion dollars. In 2007 the cost decreased to 0.75% of GDP as a result o significant increase of rate of return on typical central bank portfolio and decrease of return on typical pension portfolio. Opportunity cost estimates for individual countries for the period 2005–2007 are presented in table 8 in the appendix.

Table 4: Hypothetical opportunity cost as a percentage of GDP, by group of countries (USD million).

	Hypothetical opportunity cost, pension portfolio				Hypothetical opportunity cost, combined portfolio			
	2004	2005	2006	2007	2004	2005	2006	2007*
Western Europe	4491.7	8134.2	25852.7	7475.2	0.0	0.0	0.0	0.0
CEE	1573.3	3334.9	9801.7	2990.3	957.0	1750.4	5093.1	1589.6
Asia	35836.4	76192.4	239361.8	71523.8	25358.7	52116.0	170365.2	52964.7
Oil exporting countries	6090.4	14928.0	56603.1	18159.5	3736.5	9430.9	39249.5	13933.5
Latin America	1674.6	3579.2	13054.6	5512.0	272.6	1140.0	6273.0	3555.7
Africa	409.8	1022.5	3413.2	785.9	196.1	648.1	1776.2	398.2
	Hypothetical opportunity cost as a percentage of GDP. pension portfolio				Hypothetical opportunity cost as a percentage of GDP. combined portfolio			
	2004	2005	2006	2007	2004	2005	2006	2007*
Western Europe	0.08%	0.14%	0.43%	0.11%	0.00%	0.00%	0.00%	0.00%
CEE	0.31%	0.57%	1.50%	0.37%	0.19%	0.30%	0.78%	0.20%
Asia	0.45%	0.90%	2.72%	0.75%	0.32%	0.62%	1.93%	0.55%
Oil exporting countries	0.27%	0.55%	1.76%	0.48%	0.17%	0.35%	1.22%	0.37%
Latin America	0.17%	0.27%	0.83%	0.29%	0.03%	0.09%	0.40%	0.19%
Africa	0.15%	0.33%	1.00%	0.20%	0.07%	0.21%	0.52%	0.10%

*We used short-term debt for 2007 Q2.
Source: Authors' calculations based on IMF, WEO, BIS-OECD-IMF-World Bank data and MerrillLynch Indices

We have estimated above two out of three OCHAR factors. Estimating the third factor is even more difficult, and there are very few studies and very limited data on government ability to generate projects with high social rate of return, and there is hardly any data available to measure what percentage of the "windfall profit" will be spent on such welfare-enhancing projects,

and what will be spent on current consumption or growth reducing social hand-outs, very much in line with windfall proceeds from the first oil shock. Alternatively, governments may decide to save part of the proceeds for future generations, as was indeed the case in many of commodity exporting countries: Norway, Russia, Venezuela, Trynidad and Tobago, Botswana, Nigeria, Kazakhstan, Korea, Chile and Kuwait have invested part of its foreign exchange reserves through special purpose funds that aim to preserve national wealth[23]. Many oil exporting countries are heavily investing to improve infrastructure and to develop alternative activities, where Dubai Outsource Zone[24] serves as the best example.

In order to estimate OCHAR we will assume that governments invest 100 percent of extra profits made by central banks to improve the national infrastructure, which is often a growth bottle-neck in many emerging economies. There are of course other ways of public spending that stimulate long-term growth and potentially have higher growth multiplier than spending on infrastructure, for instance education or well-targeted research and development. In this version of the paper however we focus on the infrastructure development, but we do acknowledge that the OCHAR estimates based on this spending assumption may be in the lower end of the actual OCHAR, when all desired public investment opportunities are taken into account[25].

An adequate supply of infrastructure services is an essential ingredient for productivity and growth[26]. Aschauer (1989) in his classic study used a Cobb-Douglas production function to analyze 1970's data from the United States. He found that the output elasticity of public investment in core infrastructure was about 0.4. Which means that 1% increase in investment in public infrastructure would lead to a 0.4% increase in output of the private sector. Wylie (1996) obtained similar results for Canada. He concluded that the investment in infrastructure, especially public one, has significant and positive role to play in national economic growth and productivity[27]. However

[23] Pringle, Carver (2007), Johnson-Calari, Rietveld (2007), presentations at the World Bank Sovereign Investment Partnerships forum, Washington, 16–18 April 2007.

[24] www.doz.ae

[25] On the other hand one can assume that going forward significant percentage of central bank reserves in countries holding ample reserves will be allocated to SWFs (recently in Korea, plans announced in China and Japan). In such case, if profits of SWFs are retained, then our OCHAR estimate may be too high as investments in physical or intellectual assets will not be forgone, they will be shifted to the future. We reiterate that the 3rd OCHAR factor is country-specific as there are "good governments" as well as "bad governments" when it comes to spending extra revenues. Here we use "average government" assumption for all countries.

[26] Calderón , Servén (2004).

[27] Wylie (1996).

elasticities derived from different studies vary significantly. The frame below presents results obtained for United States and Japan. 1% increase in investment in public infrastructure would lead to 0.03%–0.39% increase in the output of the private sector. One may expect that output elasticity is higher in developing countries, as road and telecommunication infrastructure is much more underdeveloped there. Indeed Calderón and Servén (2003) find that lagging infrastructure accounts for about one-fifth of the GDP growth differential between Latin America and East Asia over the last 20 years – nearly one percentage point per annum. This suggests that the growth payoff from infrastructure catch-up would be quite significant[28].

In what follows we use the highest estimate presented in Munnell (1992) – see the frame below – to calculate forgone GDP growth. The result is presented in the table 5 below. We calculated average forgone GDP growth for four periods 1990–1995, 1996–1999, 2000–2003, 2004–2007. In the first, second and fourth period cost was positive. The third period, which corresponds to the dot-com bubble burst, was characterized by negative cost. It means that stylized central bank portfolio was more profitable than stylized pension portfolio, and as a result central banks transferred more profit to the state budgets than under more diversified investment strategies. It is however worth repeating that the cumulative 5-year return was never negative in the analyzed period for any of the analyzed strategies.

Production Function Estimates of the Output Elasticity of Public Capital by Level of Geographic Aggregation

Author	*Level of Aggregation*	*Specification*	*Output Elasticity of Public Capital*
Aschauer (1989)	National	Cobb-Douglas; Log levels	.39
Holz-Eakin (1988)	National	Cobb-Douglas; Log levels	.39
Munnell (1990a)	National	Cobb-Douglas; Log levels	.34
Costa, Ellson, Martin (1987)	States	Translog; Levels	.20
Eisner (1991)	States	Cobb-Douglas; Log levels	.17
Mera (1973)	Japanese regions	Cobb-Douglas; Log levels	.20
Munnell (1990b)	States	Cobb-Douglas; Log levels	.15
Duffy-Deno and Eberts (1989)[a]	Metropolitan areas	Log levels	.08
Eberts (1986, 1990)	Metropolitan areas	Translog; Levels	.03

Source: Munnell (1992)

[28] Calderón , Servén (2003).

Table 5: OCHAR estimates 1990–2007.

	1990–1995	1996–1999	2000–2002	2003–2007	1990–2007
			Pension		
Western Europe	0.01%	0.23%	–0.27%	0.12%	0.04%
CEE	0.11%	0.74%	–0.91%	0.46%	0.18%
Asia	0.03%	0.50%	–0.82%	0.66%	0.17%
Oil exporting countries	0.04%	0.42%	–0.58%	0.42%	0.13%
Latin America	0.05%	0.35%	–0.42%	0.25%	0.10%
Africa	0.03%	0.32%	–0.46%	0.23%	0.07%
			Combined		
Western Europe	n.a.	0.10%	0.00%	0.00%	0.03%
CEE	n.a.	0.42%	–0.50%	0.26%	0.12%
Asia	n.a.	0.24%	–0.49%	0.46%	0.15%
Oil exporting countries	n.a.	0.14%	–0.23%	0.25%	0.09%
Latin America	n.a.	0.04%	–0.07%	0.08%	0.03%
Africa	n.a.	0.15%	–0.18%	0.11%	0.05%

(unweighted average, for the elasticity equal to 0.39).
Source: Authors' calculations

As shown in this section OCHAR can be very high. In 2003–2007 hypothetical OCHAR amounted to almost 0.7% of forgone GDP growth for Asian countries, while oil exporters and CEE economies lost almost 0.5% per annum and Latin American countries lost 0.3% of GDP growth in the last three years. Of course in a very bad year, such as the stock exchange crash, the OCHAR can turn negative, as was the case for all countries in 2000–2002 period. But as shown in figure 3 and table 5 the cumulative return on stylized pension portfolio has been much higher then on stylized central bank portfolio, so the cumulative OCHAR over that last twenty years was high and positive. Average forgone GDP growth for the whole period 1990–2007 was positive, and amounted to 0.18% in CEE, 0.17% in Asia and 0.13% in oil exporting countries. These estimates are not high, which is mainly the result of negative opportunity cost during the period 2000–2002. Going forward many countries face very large opportunity costs of holding ample reserves, given forecasts of further reserves growth, forgone GDP growth may top 0.5% per annum in the long run.

These are conservative estimates using infrastructure multipliers, while we should assume that if extra central bank profit is invested in R&D, or in education which could have much higher marginal return in the knowledge

economy, then increase in the potential GDP amid less conservative reserve management can be even larger over the long run[29].

[29] "Government clearly has a role in financing basic research, but government programs to finance commercial R&D have a mixed record. The government often has difficulty in selecting appropriate research projects and in motivating researchers to focus on developing viable projects. Researchers applying for grants have an incentive to present the prospects of success in the best possible light to increase their chances of receiving funding. Research administrators in turn have incentives to tell their superiors that prospects for success are bright in order to increase the budgets of their divisions". (Glennerster R., Kremer M. (2000)). Public R&D spending may thus turn wasteful or unproductive. One can escape from that limitation using a maximum of return on business projects and government projects (see Ben-Bassat, Gottlieb (1992)) while estimating the opportunity cost. It is equivalent to the assumption that the government either finances R&D by itself, or lowers taxes in order to stimulate private R&D spending.

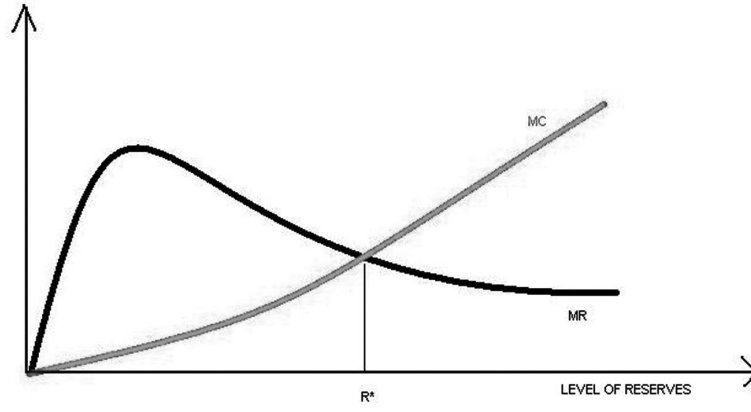
3. How central banks change their thinking about reserves management.

Opportunity cost of holding ample reserves (OCHAR) is a new concept, but is closely related to opportunity cost idea discussed in economic literature in the past forty years. However it was only in the last few years that central banks collectively started to think in these terms when taking reserve management decisions. There is overwhelming evidence now that central banks will manage foreign exchange reserves differently in the 21st century, than they managed in the 20th century. Previously often almost 100 percent weight was given to the following goals: capital preservation, the role of lender of last resort, the intervention needs, preventing financial crises. Nowadays these goals remain very important, but the ample level of reserves increased the weight attached by central bankers to the return on reserve assets. There are also other factors, nicely put together by Rietveld and Pringle (2007):

> "*What changed? Countries have become better stewards of their national wealth, with commodity revenues now being channeled into endowment funds for social and economic purposes rather than private bank accounts or politically-inspired investments. The production of manufactured goods has shifted massively to emerging market countries, creating the accumulation of national wealth in the form of foreign currency reserves. Finally, governments have benefited from "windfall" revenues from the privatization of state-owned companies* ".

There are two different types of strategies being pursued. Some countries (a clear minority, e.g. Mexico, Slovakia and Switzerland) try to estimate what is the "optimal" level of reserves, and achieve this level via various transactions on the market or with other local stakeholders. This approach could be modeled using approach proposed in Green, Torgerson (2007), where the optimal level of reserves R^* can be formally determined such that marginal cost of holding reserves equals marginal revenue.

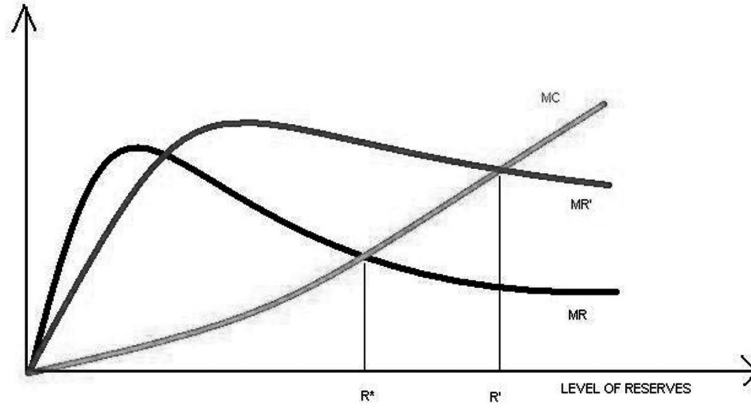
Figure 7: Possible reserves marginal revenue and marginal cost, and the equilibrium level of reserves.



Source: Green, Torgerson (2007), authors modifications.

However majority of central banks have adopted a different approach. Instead of targeting the optimal level of reserves (which often cannot be precisely determined and changes over time, similarly to the natural rate and potential output estimates) they choose to increase returns on existing pool of reserves in order to reduce OCHAR, which can be sizeable as shown in the previous section. This is equivalent to the following strategy depicted in figure 8.

Figure 8: Possible reserves marginal revenue and marginal cost, and yield enhancement strategy



Source: Green, Torgerson (2007), authors modifications.

Yield enhancement strategy (for example by adopting a stylized pension investment style) may lead to higher marginal revenue curve MR', and the higher level of reserves R'>R*, which can also become the optimal level of reserves. For high-rated countries, which face low borrowing costs this strategy may be very tempting. In the long run the country can borrow at low cost, and amid high rating will face slowly upward sloping marginal cost curve. However a properly diversified investment portfolio with a proper long-term horizon may lead to high marginal revenue curve, and this would result in a very large equilibrium level of reserve assets. These properties have been used by United States on the macro level, which in the post Bretton Woods period enjoyed twice as high return on its total foreign assets (6.82%) that cost of its liabilities (3.5%), which was labeled as the "US exorbitant privilege"[30].

One can try to formalize the reserves management change process in the following way. A country has a given social preference function related to reserves. We may assume that central bank utility function is identical to the social preference function. In general terms it can be written as:

$$L = f(\overset{(+)}{return}, \overset{(-)}{risk}, \alpha)$$

where first derivatives of utility with respect to return and risk are positive and negative respectively, and α denotes bank's risk appetite. The central banks face problem of maximizing such a utility function subject to various constraints, such as:

- Appropriate part of reserves should be invested in liquid markets, which implies that liquidity can be sourced from these markets instantly and the loss of reserves value resulting from such transaction cannot be significant (related to spread, or to market ability to absorb sizeable asset sales);
- Currency structure and also general guidelines for asset structure of reserves should be relatively stable in short run;
- Changes in central bank investment policy should be market neutral;
- Some countries, depending on the level of reserves, the exchange rate regime or the exports structure may wish to impose other "expert constraints" in the optimization process. For example commodity exporter may wish to reduce exposure to currencies that are positively correlated with commodity prices; some less developed countries may wish to invest in currencies which are used in import invoicing, etc.

[30] See Gourinchas, Rey (2005).

To illustrate this problem consider maximization of a very simple utility function:

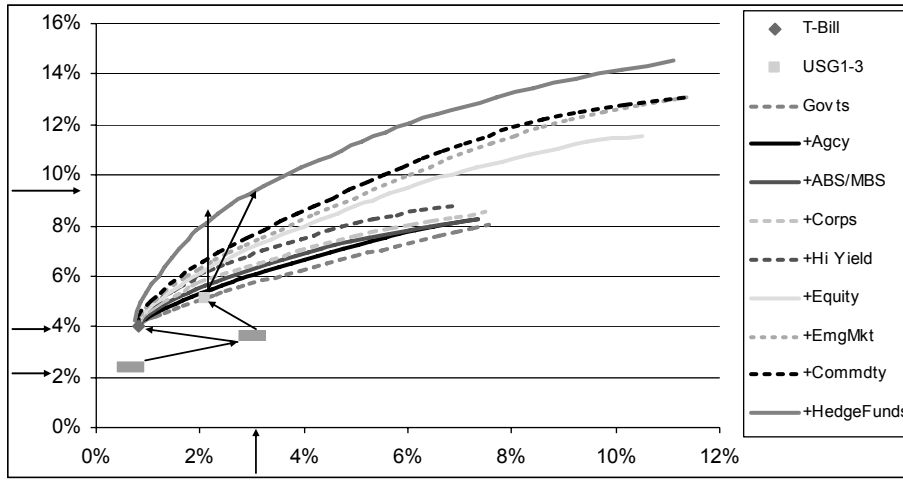
$$\max(\alpha E(S) - (1-\alpha) Var(S)$$

Where S denotes investment portfolio, E and Var denote expected return and variance of returns respectively. In optimization process the volatility of returns related to exchange rates was by an order of magnitude higher that the volatility related to interest rate changes. Hence it was natural for central banks to determine the optimal currency allocation as a minimum variance portfolio on the efficiency frontier. However, it implied that α was set to zero in the above utility maximization problem. Now it appears that many central banks are gradually raising their risk appetite which corresponds to adopting higher (non-zero) α in the optimization process, and central banks are also moving across different efficiency frontiers, as shown on figure 9 below.

We are aware that not every central bank used formal optimization techniques in order to optimize currency structure of the reserves portfolio. Often such decisions are taken on the basis of the expert view, are affected by the country exchange rate regime, export or import structure, and the need for investment policy changes to be market neutral. However even in such case the above modeling framework would apply to the thinking process about reserves management in the 21st century.

Central banks are changing their reserve management strategies also by improving risk management, by building in house capacity to invest in new asset classes or cooperating with external asset managers. There is vast literature with examples of such strategies and large investment banks are producing numerous reports on this topic. So it is not necessary to repeat this evidence here. However it is worth looking at the chart below in order to understand the journey the central banks embarked on some time ago.

Figure 9: The central banks diversification journey



Source: World Bank Treasury presentation, authors' modifications. This figure is for illustrative purposes only.

This stylized journey started some time ago, with central banks pursuing a very conservative capital protection strategy, which implied very safe investments, such as deposits with highly rated institutions. This is the low-left box-mark in figure 9. Then central banks realized, that capital protection strategy may be relaxed a bit, to allow for a very low likelihood of limited capital loss in the short run. This implied enhancing central bank reserves portfolio by adding treasuries of largest developed countries, usually US treasuries, German bunds, UK gilts, and similar instruments denominated in Japanese yen or in Swiss franc, but to a much lesser degree. However the old, very rigid risk limits were still in place, which implied that central banks were not able to achieve risk-return profiles implied by treasury efficient frontier. The situation improved with better risk management systems put in place. Then central banks continued their journey, started diversifying across currencies (in some countries in the eurozone the reverse was observed in order to reduce balance sheet volatility) and started adding new instruments. There are some examples of central banks which invest in emerging markets and in hedge funds. On one of the trips to London one of the authors found, that a London-based hedge found has received a mandate from an Asian central bank to invest in CEE4 currencies. It has been reported, that the Singapore GIC achieved the annual average return of 9.5% in the past 25 years, and GIC is probably a very good example of the monetary authority that "sits" on a very high efficiency frontier.

One should also observe that diversification across instruments and currencies makes it possible to move up-left, i.e. it is possible to improve returns and reduce volatility of returns at the same time. This is not a free lunch however, there are other types of risk that do increase, such as liquidity risk, which may become a significant source of capital losses as shown so painfully in the current credit markets turmoil.

4. What are the implications of the global change in reserves management?

As documented by actions and by public announcements many central banks have already embarked or are planning to embark on a journey that leads to a more efficient reserves management. Recent creation of the new investment company in China – China Investment Corporation – new investment funds in Korea and Japan, increasing allocation to equities from 40% to 60% by Norway Pension Fund or more aggressive allocation of Russian oil export proceeds, serve as best examples.

This will imply slow but sure move towards more diversified portfolios (across currencies and instruments), while at the same time monetary policy goals and financial stability needs will remain binding constraints.

This trend, which appears to be a commonly shared vision in the vast majority of public sector institutions (central banks and sovereign wealth funds) jointly managing more than 9 trillion dollars, is likely to result in shift of relative demand across asset classes. It will likely be associated with further effects, as public institutions actions tend to coordinate private sector actions around trends.

These trends would probably imply gradual reallocation of reserve assets away from treasury bonds and away from the dollar-denominated assets. While many central banks ruled out net sales of dollars, it is not a universal assumption, for example the National Bank of Poland was a net seller of dollars and US treasuries in the last two years and the share of US dollar in its portfolio fell from 50% to 40%. So far the IMF COFER data does not

indicate that central banks started to move away from dollars, and public announcement by countries which hold large reserves assets and have currencies pegged to the dollar reaffirm this view[31].

This long term shift away from dollars and towards riskier assets, *ceteris paribus*, could provide additional safety cushion to emerging markets in the post Great Moderation period. Global Financial Stability Report published by the IMF in April 2008 argues that there are several risks to continuation of remarkable emerging markets stability in the face of the global credit and confidence crisis. Namely, parent banks may pare back funding to their emerging markets subsidiaries, balance sheet contraction may reduce funding and raise funding costs for investments by hedge funds and other institutions investing in emerging markets, emerging markets financial institutions may yet prove vulnerable to financial contagion and a spike in exchange rate volatility could slow or reverse flows into emerging markets fixed income classes. These risks may materialize, especially in countries with high external imbalances and with large share of short-term financing. However at the same time reserves managers may use the opportunity to accelerate asset diversification to benefit from much more attractive valuations than in the last few years[32], thus providing a safety cushion for emerging markets with sound fundamentals.

This is also consistent with weakening of the US dollar[33] and steepening of the US yield curve at the same time (whether it is rising long term rates and falling short term rates depends on the US growth and inflation outlook, which is not relevant for our discussion). On balance it should contribute to reducing the global imbalances problem in the long run.

In May 2007 version of this paper we wrote that *ceteris paribus* was not a relevant assumption here. We argued that credit derivatives markets

[31] Although one has to acknowledge that the US dollar peg is complicating macroeconomic situation in some GCC countries. While these countries should be raising rates amid high inflation, the Federal Reserve has been cutting rates to avoid credit-crunch led recession, which limits the GCC central banks ability to raise rates.

[32] Example of such diversification is a series of investments by emerging markets SWFs in large US, Swiss and British financial institutions in the last few quarters. There is however a debate whether SWFs moved in too quickly and "burnt their fingers" as the mark-to-market valuations few months after the purchases shows significant losses. It is however worth recalling, that SWFs have much longer investment horizons than typical private sector investors and may pay more attention to fundamental valuations that to quarterly mark-to-market outcomes.

[33] US dollar perspectives will also depend on the home bias developments in the US. It the last few years US investors have diversified assets internationally and the home bias fell. It remains to be seen whether the dollar weakening that took place in 2007 and 2008 to date will reduce or reverse this process.

could be a source of large shocks and that originate-to-distribute business model made it impossible to understand what the risks are and how they are distributed across institutions and across borders. Late 2007 and early 2008 did show that it was the case indeed.

US subprime credit crisis and implosion of credit derivatives markets indicate that asset valuations in the last few years did not reflect all risks properly and currently markets are in the process of finding the new equilibrium, where liquidity risk will be adequately priced. Similarly the changes in global reserve management imply continued trend towards new equilibrium, where relative prices of various asset classes will find its 21st century steady state, in which some assets prices will likely have very little in common with their historical 20th century averages. This trend will probably be interrupted from time to time by bouts of volatility related to sentiment shifts in this or that market (with subprime crisis as far sigma example of such event). Recent evidence of sovereign wealth funds purchases confirms that such episodes will be used by public sector asset managers (including central banks) to accelerate asset diversification.

In May 2007 version of this paper we also asked a question what if central banks moved too far with yield enhancement strategy, and they invested in markets that appeared liquid in a world within two-sigma deviations, and then four-sigma global event hit the markets. Will these markets remain liquid, will central banks be able to take timely actions to preserve liquidity and stability? Few moths later such a global shock did happen. Well, with shocks becoming increasingly global[34] this global stability responsibility obviously lies with the biggest central banks, banks of rich countries which do not have large opportunity costs of poor investment strategies and possibly with PBoC, which faces huge opportunity costs but also has huge reserves to be utilized for monetary policy and stability purposes. Another question is whether large central banks should act in such event? This is a Greenspan-put question, beyond the scope of discussion in this paper. So it appears that as long as smaller central banks in emerging markets have trust in the ability of large central banks[35] to deal with global shocks, they may afford to improve the returns on their reserves to a certain degree.

[34] In the late 20th century Federal Reserve assumed this responsibility in the face of Russian and LTCM crisis. In the 21st century it will likely be joined in this role by ECB and PBoC, with smaller global roles played by BoJ and SAMA. On global nature of shocks see for example Ehrmann, Fratzscher (2006).

[35] Multilateral consultations coordinated by IMF with the participation of United States, Eurozone, China, Saudi Arabia and Japan are testing the ability of large stakeholders of global imbalances to deal with this issue. See IMFC statement http://www.imf.org/external/np/sec/pr/2007/pr0772.htm

One more trend, which is slow but deterministic, is the financial deepening in Asia. This is a welcome development, because in the long run highest returns should be expected in regions with highest potential growth rates. This is probably Asia in the first 50 years of the 21st century, and Africa in the following 50 years. This trend will have gradual but far reaching impact of global reserve management. It is likely that in 20-30 years Asian currencies will have a large share in central bank portfolios around the world, and this share could dwarf dollar and euro if the single Asian currency is created.

Let us restate our main claim in this section. We are in an unprecedented process of finding a new 21st century steady state in terms of relative prices of various asset classes[36]. Actually this equilibrium should have been found already, but the fact that big chunk of financial intermediation takes place via central banks, which behave in a different manner than private institutions and individuals, has delayed the process. But the common, collective mindset, to improve reserves management by central banks and sovereign wealth funds will slowly remove this distortion. Let's hope this will be a smooth adjustment.

Global collective move of central banks towards more diversified portfolios will also gradually take away US "exorbitant privilege", by shifting it to reserve abundant emerging markets. This will not be a zero-sum game, as more diversified and more efficient reserve allocation will result in higher global growth, which will be a positive sum outcome, with higher percentage slice of the bigger pie going to emerging markets.

This section puts forward a number of hypotheses that will be tested in the coming years. The empirical research on the topic of global reserves diversification and its impact on asset prices is still rare[37], and this issue will certainly attract more attention of researchers in the coming years.

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[36] For example B-rated and BB-rated emerging market CDS spreads fell below spreads on similarly rated US corporate in 2007, see BIS(2007). Another example is given by PIMCO (2007) research which notes that local and external market debt have been among the most stable asset classes in the episode of market volatility in late February – March 2007. Finally, as documented by JPMorgan (2006), the correlation between VXY and EM-VXY, which are volatility indices for G-7 and for emerging markets has gone up significantly in recent two-three years, which reflects the fact that global investors cross asset classes borders much more often than before.

[37] A very good survey and some early empirical results are reported in the IMF Global Financial Stability Report (2007).

5. Conclusions

Foreign exchange reserves held by central banks rose to 6.4 trillion dollars in 2007 from 1.5 trillion a decade ago and are expected to rise further in the coming years. Sovereign wealth funds manage assets in excess of 2.5–3 trillion dollars. This paper presents motives behind rapid reserves growth and proposes a concept of OCHAR – Opportunity Cost of Holding Ample Reserves – which is defined as a forgone GDP growth amid too conservative reserve management by central banks. We estimate OCHAR for a sample of 33 countries which account for 80% of total central bank reserves. We also argue, that unlike in the 20th century, where central banks used to be very secretive institutions, 21st century central banking is characterized by widespread knowledge sharing and transparency. Therefore best practices, such as inflation targeting or efficient reserve management spread out quickly and are adopted by increasing number of central banks. Thus central banks collectively embarked on a reserves diversification journey, it does appear to be the central banks collective mindset and we can speak of the global reserves management in 21st century. At the end of the paper we put forward several hypotheses of what could be the consequences of this diversification journey. It seems that relative prices of various assets will find new steady states, which may have little in common with relative valuations seen in 20th century. We also expect that slowly, over time, US "exorbitant privilege" will be eliminated. Finally we consider global stability risks in the context of the new reserves management style adopted by central banks. We postulate that due to the increasingly global nature of shocks as long as central banks and governments in countries-stakeholders of global imbalances focus their actions on maintaining global price and financial stability, central banks in smaller emerging markets can afford to improve reserve management without incurring additional stability risk.

In our analysis we encountered significant problems with access to data on central bank reserves, such as investment structure, currency composition and returns achieved in the past. This problem is particularly severe in some Asian countries. We therefore welcome IMF initiatives such as CPIS and JEDH[38] and we are of the opinion that expanding these initiatives to include multilaterally agreed format of reporting reserves structure and reserve returns would be a further desirable step in the right direction.

[38] See IMF (2007), page 77.

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APPENDIX.

Table 6: Actual returns and opportunity cost of reserves as compared to combined portfolio (in USD m, % GDP)

		Actual return on reserves			Typ. combined return on reserves			Actual opportunity cost			Actual opportunity cost % of GDP		
		2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Western	Germany*	1442.6	1948.4	2043.5	1929.4	3711.6	8623.0	486.8	1763.2	6579.5	0.02%	0.06%	0.20%
Europe	France*	2630.9	3733.1	4513.0	1411.1	3266.2	7324.4	–1219.9	–466.9	2811.4	–0.06%	–0.02%	0.11%
	Switzerland*	6225.1	1225.5	2261.2	1093.8	2144.3	4770.7	–5131.3	918.9	2509.5	–1.38%	0.24%	0.59%
	Sweden		560.5	1582.9	472.3	931.7	1964.5		371.2	381.6		0.09%	0.08%
CEE	Poland	1106.6	1551.2	3549.6	1625.5	4291.3	5045.0	518.9	2740.1	1495.4	0.17%	0.80%	0.36%
	Hungary	483.7	777.2		438.1	1006.3	1545.8	–45.6	229.1		–0.04%	0.20%	
	Czech Republic	775.2	942.9		1104.2	2595.3	2631.3	329.0	1652.4		0.26%	1.16%	
	Slovak Republic	341.7	323.0		594.2	1011.9	1441.3	252.5	688.9		0.53%	1.23%	
Asia	Hong Kong*	3852.6	12655.0	18018.8	3773.9	7835.1	10822.1	–78.7	–4819.9	–7196.7	–0.04%	–2.54%	–3.48%
Oil	Russia	5467.2	11541.8		7667.3	31146.9	38556.3	2200.1	19605.0		0.29%	1.98%	
exporting	Norway **	4266.3	4149.4	2050.3	891.6	1889.8	3850.9	–3374.7	–2259.6	1800.6	–1.12%	–0.67%	0.46%
countries	Mexico	1226.1	3722.0		2822.6	6389.9	6755.9	1596.5	2667.9		0.21%	0.32%	
	United Arab Em.	540.8	756.7		442.8	918.2		–98.0	161.5		–0.07%	0.10%	
Latin	Argentina***	873.5	1825.5		982.6	2666.1	3570.5	109.1	840.6		0.06%	0.40%	
America	Chile	491.0	475.2		463.1	1066.0	1080.6	–28.0	590.8		–0.02%	0.41%	
	Colombia	410.6	599.9		573.9	1344.8	1546.5	163.2	745.0		0.13%	0.55%	

* actual rate of return were calculated in national currency term, date not comparable with the rest of the countries
**data refers to investment portfolio only
***return in USD terms
Note: short-term data for 2007 not available, we used short-term debt for 2007 Q2
Source: Authors' calculations based on IMF, WEO, BIS-OECD-IMF-World Bank data, Merrill Lynch indices and central banks' annual reports

Table 7: Actual returns and opportunity cost of reserves as compared to pension portfolio (USD million, %GDP)

		Actual return on reserves			Typical pension return on reserves			Actual opportunity cost			Actual opportunity cost as a percentage of GDP		
		2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007
Western	Germany*	1442.6	1948.4	2043.5	5128.0	13255.7	11464.8	3685.5	11307.4	9421.3	0.13%	0.39%	0.28%
Europe	France*	2630.9	3733.1	4513.0	3750.4	11664.9	9738.2	1119.4	7931.8	5225.2	0.05%	0.35%	0.20%
	Switzerland*	6225.1	1225.5	2261.2	2907.1	7658.4	6342.9	–3318.0	6433.0	4081.8	–0.89%	1.66%	0.96%
	Sweden		560.5	1582.9	1255.3	3327.4	2611.9		2767.0	1029.0	0.00%	0.70%	0.23%
CEE	Poland	1106.6	1551.2	3549.6	2146.6	5755.8	5531.8	1040.0	4204.6	1982.2	0.34%	1.23%	0.47%
	Hungary	483.7	777.2		938.2	2563.6	2024.1	454.6	1786.4		0.41%	1.58%	
	Czech Republic	775.2	942.9		1481.0	3707.1	2911.3	705.8	2764.3		0.57%	1.93%	
	Slovak Republic	341.7	323.0		780.7	1586.8	1596.9	439.0	1263.8		0.92%	2.26%	
Asia	Hong Kong*	3852.6	12655.0	18018.8	6268.0	15817.4	12850.6	2415.4	3162.4	–5168.2	1.36%	1.66%	–2.50%
Oil	Russia	5467.2	11541.8		9191.3	36065.1	40090.6	3724.1	24523.3		0.49%	2.48%	
exporting	Norway **	4266.3	4149.4	2050.3	2369.7	6749.4	5119.9	–1896.6	2599.9	3069.6	–0.63%	0.77%	0.78%
countries	Mexico	1226.1	3722.0		3734.9	9056.3	7330.7	2508.9	5334.3		0.33%	0.64%	
	United Arab Emirates	540.8	756.7		1059.7	3279.3		518.9	2522.6		0.39%	1.54%	
Latin	Argentina***	873.5	1825.5		1416.6	3802.8	3880.9	543.1	1977.3		0.30%	0.93%	
America	Chile	491.0	475.2		854.0	2303.1	1417.4	362.9	1827.9		0.31%	1.25%	
	Colombia	410.6	599.9		754.2	1833.0	1763.2	343.6	1233.1		0.28%	0.91%	

* actual rate of return were calculated in national currency term. date not comparable with the rest of the countries
**data refers to investment portfolio only
***return in USD terms
Source: Authors' calculations based on IMF. WEO. BIS-OECD-IMF-World Bank data. Merrill Lynch indices and central banks' annual reports

Table 8: Hypothetical opportunity cost (USD million. % GDP)

		Hypothetical opportunity cost			Hypothetical opportunity cost. combined portfolio			Hypothetical opportunity cost as a percentage of GDP			Hypothetical opportunity cost as a percentage of GDP. combined portfolio		
		2005	2006	2007	2005	2006	2007*	2005	2006	2007	2005	2006	2007*
Western Europe	Germany	3198.6	9544.1	2841.8	0.0	0.0	0.0	0.11%	0.33%	0.09%	0.00%	0.00%	0.00%
	France	2339.3	8398.7	2413.8	0.0	0.0	0.0	0.11%	0.37%	0.09%	0.00%	0.00%	0.00%
	Switzerland	1813.3	5514.1	1572.2	0.0	0.0	0.0	0.49%	1.42%	0.37%	0.00%	0.00%	0.00%
	Sweden	783.0	2395.7	647.4	0.0	0.0	0.0	0.21%	0.61%	0.14%	0.00%	0.00%	0.00%
CEE	Poland	1338.9	4144.2	1371.2	817.8	2679.7	884.3	0.44%	1.21%	0.33%	0.27%	0.78%	0.21%
	Hungary	585.2	1845.8	501.7	85.1	288.5	23.4	0.53%	1.63%	0.36%	0.08%	0.26%	0.02%
	Czech Republic	923.8	2669.1	721.6	547.0	1557.3	441.6	0.74%	1.87%	0.41%	0.44%	1.09%	0.25%
	Slovak Republic	487.0	1142.5	395.8	300.5	567.6	240.2	1.02%	2.04%	0.53%	0.63%	1.01%	0.32%
Asia	Japan	26284.2	75317.1	19902.8	12868.0	42529.6	11964.9	0.58%	1.72%	0.45%	0.28%	0.97%	0.27%
	China	25972.2	91696.4	32005.6	23987.0	84858.3	29840.0	1.16%	3.47%	0.98%	1.07%	3.21%	0.92%
	South Korea	6618.7	20429.0	5469.8	4645.6	11875.0	2908.2	0.84%	2.30%	0.57%	0.59%	1.34%	0.30%
	Thailand	1637.9	5726.7	1824.3	1236.1	4491.2	1602.0	0.93%	2.77%	0.74%	0.70%	2.17%	0.65%
	Taiwan	8114.9	23154.8	5736.9	6916.6	20317.9	4675.2	2.28%	6.33%	1.50%	1.94%	5.56%	1.22%
	Singapore	3654.7	11649.1	3399.2	1047.1	2887.0	817.5	3.05%	8.53%	2.11%	0.87%	2.11%	0.51%
	Hong Kong	3909.7	11388.5	3185.3	1415.6	3406.2	1156.8	2.20%	5.99%	1.54%	0.80%	1.79%	0.56%
Oil exporting countries	Russia	5733.1	25966.9	9937.2	4209.1	21048.7	8402.9	0.75%	2.63%	0.77%	0.55%	2.13%	0.65%
	Norway	1478.1	4859.5	1269.1	0.0	0.0	0.0	0.49%	1.44%	0.32%	0.00%	0.00%	0.00%
	Saudi Arabia	841.8	2373.7	709.5	412.6	1357.5	304.5	0.27%	0.68%	0.19%	0.13%	0.39%	0.08%
	Nigeria	889.7	3616.2	1070.8	828.9	3270.7	991.5	0.79%	2.46%	0.64%	0.74%	2.23%	0.59%
	Venezuela	932.3	3135.2	698.3	720.7	2739.5	578.5	0.65%	1.70%	0.30%	0.50%	1.49%	0.24%
	Kuwait	282.2	1083.7	349.9	52.0	377.3	125.3	0.35%	1.10%	0.31%	0.06%	0.38%	0.11%
	Mexico	2329.7	6520.6	1817.0	1417.3	3854.1	1242.3	0.30%	0.78%	0.20%	0.18%	0.46%	0.14%
	Algeria	1780.0	6686.2	2307.6	1746.2	6601.6	2288.6	1.73%	5.82%	1.75%	1.70%	5.75%	1.74%
	United Arab Em.	661.0	2361.1	n.a	44.1	0.0	n.a	0.50%	1.45%	n.a	0.03%	0.00%	n.a
Latin America	Brazil	1692.5	7338.6	3761.6	258.5	3418.9	2669.2	0.19%	0.68%	0.29%	0.03%	0.32%	0.20%
	Argentina	883.6	2738.0	962.0	449.6	1601.3	651.5	0.49%	1.29%	0.37%	0.25%	0.75%	0.25%
	Chile	532.7	1658.2	351.3	141.8	421.2	14.6	0.45%	1.14%	0.21%	0.12%	0.29%	0.01%
	Colombia	470.5	1319.8	437.0	290.1	831.6	220.4	0.38%	0.97%	0.25%	0.24%	0.61%	0.13%
Africa	South Africa	649.0	2187.5	687.2	378.0	850.8	343.4	0.27%	0.85%	0.24%	0.16%	0.33%	0.12%
	Sudan	58.8	141.9	28.7	0.0	0.0	0.0	0.21%	0.39%	0.06%	0.00%	0.00%	0.00%
	Kenya	56.6	206.6	70.0	39.9	153.0	54.8	0.30%	0.91%	0.24%	0.21%	0.67%	0.19%
	Botswana	198.5	683.3	n.a	196.9	680.6	n.a	1.87%	6.18%	n.a	1.86%	6.16%	n.a
	Ghana	59.7	193.9	n.a	33.3	91.8	n.a	0.56%	1.53%	n.a	0.31%	0.72%	n.a

*We used short-term debt for 2007 Q2.

Source: Authors' calculations based on IMF. WEO. BIS-OECD-IMF-World Bank data. Merrill Lynch indices

THE IMPACT OF DERIVATIVE MARKETS ON ASSET MANAGEMENT AND THE ECONOMY

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Abstract

During the last decade, derivatives markets became an asset class of their own and influenced the financial landscape strongly. While the financial sector contributes positively to overall economic growth in many studies up to the mid nineties, a positive contribution of the financial sector to economic growth in mature market economies is less evident with more recent data. What has happened? Is the rapid growth of derivative markets a catalyst for changes in the financial sector? Did the impact of asset management on the economy change? Drawing on the Merton and Bodie (1995) functional perspective, this paper tries to explain this change by discussing the spheres of derivative impact. We find that derivatives appear to fill part of the gap that traditional products and participants recently face in explaining the fostering of economic development.

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1. Introduction

The establishment of the first derivative exchanges in the seventies and eighties and the appearance of derivative product innovations gave asset managers and market participant's a large access to a broad range of new financial instruments and enabled the development of new trading strategies.[2] New possibilities of risk sharing and risk diversification uncovered interdependencies between the various sectors of the financial market in a transparent way. The development of new asset classes and changing institutional structures can a priori be expected to strengthen the financial sectors ability to foster economic growth. The question if financial markets have a positive influence on economic growth (Schumpeter, 1911/1959, Goldsmith, 1969, McKinnon, 1973) and if financial development enhances growth or vice-versa (Greenwood and Jovanovic, 1988, Pagano, 1993) has been discussed for many years. While many studies up to the mid 90s showed a positive link between the financial sector and economic growth (King and Levine, 1993), recent theoretical and empirical work by Rousseau and Wachtel (2006) shows a weakening link. What has caused the finance-growth relationship becoming less robust when using more recent data? Are there changes in the structure of the financial markets that have influenced this link sustainable? Did the advent of derivatives markets encourage speculation in the underlying asset markets, diverting private and public resources from efficient allocation (Tobin, 1984)?

To cope with the rapid financial development, various scholars have extended previous finance-growth studies by including additional financial sectors and segments (e.g. Obstfeld, 1994; Levine and Zervos, 1998; Fink, Haiss, Hristoforova, 2006; Haiss and Sümegi, 2008; Haiss and Pantel 2008), industry effects (Rajan and Zingales, 1998), the role of law (LaPorta et al, 1998), and integration and liberalisation effects (Rusek, 2004; Haiss and Fink, 2006; Pichler et al, 2008). Significant differences could be caused by the growth of derivatives exchanges, by the process of liberalization and integration within the financial markets, the appearance of new institutional investors as pension funds, insurance companies and hedge funds, and by new techniques of taking and transferring risk. New financial products, improved computer and telecommunication techniques and advances in the theory of finance have generated rapid changes in the structures of global financial markets. Progress

[2] While not all derivatives are new – some were actually traded e.g. at the Amsterdam Securities Exchange in the 1600s – the emphasis here is on their growth and wide-spread usage.

in the finance theory has strongly influenced a wide spectrum of finance applications and has enabled advancements in asset allocation models, performance measurement and risk management (Merton and Bodie, 2005).

The rise of derivatives markets sticks out in the change to the financial architecture. "Finance science has contributed fundamentally to the remarkable rate of globalization of the financial systems" (Merton and Bodie, 2005) and derivative instruments function as "adapter" for the integration of the markets. They allow the flow of funds and risk sharing among national systems with different institutional shapes and sizes. In using Merton's and Bodie's (1995) financial functions approach we will derive three channels through which derivatives influence the integration of financial markets and the economic development. In the following we investigate whether the changing approaches to asset allocation have changed the interaction of the financial sector at large with the real economy. We argue that the emergence of derivative markets and the associated structural move from regulated to more unregulated market activity has influenced the key financial segments (banks, insurance, stock and bond markets) ability to foster growth. Asset management clearly plays a pivotal role which changed through the advent of derivatives. Finally we will discuss if the rapid development of derivatives markets has increased the sensitivity of the financial markets with respect to risk and financial crisis. The expansion of risk spreading abilities, the increase in the risk bearing capacity of economies and the emergence of new intermediaries with rising appetite for risk has caused concern that financial systems are more vulnerable to shocks and financial crisis. "Under some conditions economies may be more exposed to financial-sector-induced turmoil than in the past" (Rajan, 2005) though we argue that the "unobserved alternatives" (Mason, 1995) need to be taken into consideration. We contribute to the existing literature by extending the conventional finance-growth view to the derivatives markets, by providing a theoretical framework for analyzing the impact of derivatives on the ability of the financial sector to support growth and investment, and by providing respective descriptive data on the relevance of derivatives markets.

In the first section of our paper we review selected theoretical and empirical literature in the finance-growth nexus research to provide a framework to introduce derivative markets as additional determinant in this context. In the following section we will explore the impact of derivative markets on the finance-growth nexus by using Merton's and Bodie's (1995) methodology. We will theoretically derive three channels through which derivatives may influence financial markets and economic development (the volume

channel, the efficiency channel and the risk channel). In addition the structure-conduct-performance paradigm (Waterson, 1984; Hahn 2001) shall give a theoretical framework to discuss the ability of the structure of derivative markets and the behavior of the market participants to influence the Merton & Bodie (1995) channels. Section four is devoted to analyzing three channels of derivative influence which act the transmission channels. Section five shall conclude and discuss the various findings in this paper.

2. The Finance-Growth Nexus Revisited

2.1 Introduction

The relationship between financial development and economic growth has received great attention throughout the modern economic history. A host of studies have been carried out to find evidence that a well-developed financial system promotes economic growth. Already Schumpeter emphasized the importance of financial services in promoting growth (Schumpeter, 1911, 1959). Based on the work of Schumpeter, Goldsmith (1969) and McKinnon (1973) illustrated the close link between financial development and economic growth for a few countries. Lucas (1988), on the other hand, described the relationship between financial and economic development as "overstressed".

In their prominent paper King and Levine (1993) presented evidence that supported Schumpeter's view that services provided by financial intermediaries stimulate technological innovation and economic development. King and Levine found various measures of financial development that were strongly linked to current and later rates of economic growth. Greenwood and Jovanovic (1988) address the issue of causality between financial development and economic growth. According to Greenwood and Jovanovic "Financial intermediation promotes growth since it allows a higher rate of return to be earned on capital, and growth in turn provides the means to implement costly financial structures". Pagano (1993) addresses whether financial development enhances growth by raising the efficiency of investment or the rate of investment. In addition he argues for more disaggregated measures of financial intermediation to examine the finance-growth link.

Besides the historical focus on banking, research expanded into other financial segments in the finance-growth equation. Obstfeld (1994) includes internationally integrated stock markets and demonstrates that "international risk-sharing can yield substantial welfare gains through is positive effects on expected consumption growth. The mechanism linking global diversification to growth is the attendant world portfolio shift from safe, but low-yield, capital into riskier, high-yield capital". Levine and Zervos (1998) analyze if well-functioning stock markets and banks promote long-run economic growth and find evidence that even after controlling for many factors associated with growth both stock market liquidity and banking development are positively and robustly correlated with contemporaneous and future rates of economic growth, capital accumulation, and productivity growth.

Levine and Zervos's results - services provided by financial institutions and markets are important for long-run growth – complement microeconomic studies as performed by Rajan and Zingales (1998). They examine if financial development reduces the cost of external finance to firms. They ask "whether industrial sectors that are relatively more in need of external finance develop disproportionately faster in countries with more developed financial markets". Rajan and Zingales (1998) conclude that financial development fosters economic growth by reducing the cost of external finance to financially dependent firms. In addition they provide evidence that financial market imperfections have an impact on investment and growth. Finally they assume that "the existence of a well developed market in a certain country represents a source of comparative advantage for that country in industries that are more dependent on external finance".

2.2 Challenges to the "Classical" Finance-Growth-Findings

In their paper "Finance and Growth – Schumpeter might be right", King and Levine (1993) examine if higher levels of financial development are positively associated with economic development. King and Levine (1998) tested the empirical relationship between financial indicators and macroeconomic indicators using a cross-country analysis with data on over 80 countries over the 1960–1989 periods. They find evidence that each financial indicator is positively and significantly correlated with each growth indicator. Their "classical" conclusion is that the predetermined component of financial development is a good predictor of long-run growth and that financial development predicts (1) the rate of physical capital accumulation and (2) the rate of improvement in the efficiency with which economies allocate physical capital. King and Levine (1998) summarise: "Finance does not only follow

growth; finance seems importantly to lead economic growth." They conclude that the used financial indicators are strongly and robustly correlated with growth, the rate of physical capital accumulation, and the improvements in efficiency of capital allocation.

Despite growing consensus in the empirical literature that financial sector development has a significant impact on economic growth[3], Rousseau and Wachtel (2006) find evidence that the finance-growth link weakened considerably over time. By addressing the question "What is happening to the impact of financial deepening on economic growth" they re-examine the results found by King and Levine (1993) by adding more recent data. Rousseau and Wachtel (2006) use cross sectional and panel data on financial and macroeconomic indicators over the period 1960 to 2003. Surprisingly they found that the impact of financial deepening on economic growth was not as robust with more recent data as it appeared in the original study by King and Levine with data from 1960–1989.[4] Rousseau and Wachtel's main hypotheses regarding the decreasing influence of finance on growth were (1) the incidence of financial crisis and (2) country efforts at financial liberalization. They emphasize the role of financial crises and underlying excessive financial deepening in their analysis.

2.3 Broadening the View

With regard to the ability of the financial sector to influence growth, various scholars have broadened previous approaches, e.g. by focusing on financial integration and growth (Rusek, 2004), by including financial innovations and the sensitivity of financial systems towards risk (Rajan, 2006), by emphasizing the impact of the stage of economic development (Rioja and Valev, 2004; Fink, Haiss and Vuksic, 2009), by including further sectors in the finance-growth equation (bond markets: Fink, Haiss and Kirchner, 2005; insurance sector: Haiss and Sümegi, 2008), by stressing the complexities of the finance-growth linkage (Favara, 2003; Manning, 2003) and by analyzing the disconnection of

[3] For recent positive findings, see Haiss and Sümegi (2008) for the insurance sector and Arena (2006) who provides empirical evidence that the bank/stock market-economic growth relationship holds for sample periods including the nineties.

[4] The general Rousseau and Wachtel (2006) results across the sample were largely consistent with King and Levine´s (1993) findings. Dramatic differences appeared when they estimated the equation for two time periods (period 1: 1960–1989, period 2: 1990–2003). In the historic period 1, all financial indicators showed a significant influence on growth, whereas only one indicator was significant in period 2. Whereas the other coefficients in the growth equation were relatively stable across the time periods, the effects of financial depth on growth were simply smaller and not significantly different from zero in the more recent period.

growth theory and growth empirics (Trew, 2006; see table 1). While Rousseau and Wachtel (2006) found no clear evidence that innovation and liberalization was the reason for the weakening of the finance-growth link, several authors (e.g. Favara, 2003; Haiss and Fink, 2006; Moutot et al, 2007) argue that new functional and institutional features of the financial architecture need to be taken into consideration in such analysis. In drawing on the derivatives sector we offer additional thoughts to the finding of Rousseau and Wachtel (2006).[5]

Table 1: selected recent studies on the finance-growth-nexus

Study	Focus	Countries	Time period	Method/ Variables	Major findings
Favara (2003)	Reexamination of the empirical relationship between financial development and economic growth	85 countries	1960-1998	Empirical/control variables (e.g. real per capita GDP, av. years of attainment in sec. and higher education, ratio of export plus import over GDP), amount of liquid liabilities of the financial system (in % of real GDP), value of loans to the private sector (in % of real GDP)	The relationship between financial development and economic growth is weak and there is evidence that the link is not linear, suggesting that finance matters for growth only at intermediate levels of financial development. For some specifications of the model the estimated effect of financial development on GDP growth is often negative. "The proxies of financial development considered might be inadequate to capture the beneficial effects of a good system of financial intermediation", and further research is needed to investigate several channels through which financial development affects economic growth.
Rioja and Valev (2004)	Effects of financial development on sources of growth in different groups of countries	74 countries	1961-1995	Empirical/Real GDP, Private credit, Commercial vs. Central bank, liquid liabilities	Finance affects growth predominantly through capital accumulation in low-income countries. Have countries reached a certain income level, financial development strongly contributes to productivity growth.
Fink, Haiss, Hristoforova (2006)	Influence of bond markets on finance-growth nexus	7 countries	1950-2001	Empirical/Real GDP, Volume of bonds, volume of stocks, volume of credit	Causality from either bond market growth or stock market growth or credit amounts growth to GDP can be found in all analyzed countries except Germany. Causality from economic development to the development of the financial markets was determined in Germany, Japan, and the Netherlands.
Manning (2003)	complexities of the finance-growth linkage			Descriptive	"It is difficult to disentangle the effect of financial development from that of other correlated factors". In cross country studies it is difficult to isolate the true impact of finance upon growth because of high correlations between financial, institutional, legal and regional factors. It should be focused on long-range historical studies covering a small number of countries at similar stages in their economic development or individual country studies.
Rusek (2004)	Financial integration and growth in Europe, Japan, and the United States, "the role of financial markets in facilitating the engine of modern growth - the new economy of creativity, innovation, and entrepreneurship".	3 countries	1993-2003	Descriptive	Similar resource endowments, but higher average annual economic growth in the US compared to Europe and Japan. Different nature of the financial systems (bank based financing in Europe and Japan, market based financing in the US) as possible reason for the different growth rates. The combination of new economic activity, financial development, financial integration and the creation of innovative financial products seemed to be most successful in the US and serves as explanation for the different growth rates.

[5] Pantel and Haiss (2008) similarly analyze the role of hedge funds.

Merton, Bodie (2005)	Functional approach to the design of financial systems by applying a synthesis of the neoclassical, the new institutional, and the behavioral perspectives on finance			Descriptive	Dramatic and rapid changes in the structure of financial markets and institutions caused by new financial product and market designs, improved computer and telecommunication technology, and advances in the finance science. Derivative instruments as "adapter" for the integration of financial systems that are rarely compatible in terms of regulations, laws, tax structures and institutional forms. Innovations in telecommunications, information technology, and financial engineering as channels for the financing of economic growth.
Fink, Haiss (2006)	Inclusion of "liberalization and integration effects, the bond and insurance sector, and effects of foreign bank entry and investment into future research on Finance-Growth-Nexus			Descriptive	A reason for the less robust relationship between the financial sector and economic development when using more recent data could be "the liberalization and integration of the financial markets, and the emergence of new institutional types, such as e.g. hedge funds, and more recent techniques, such as securitization...". New influential players and new financial techniques change the channels which lead to the financing of the economic development.
Trew (2006)	Disconnection of the theoretical, contemporary econometric and historical literatures on the finance-growth-nexus.			Descriptive	Current studies do not adequately consider experiences of countries going through industrial revolution and cross-sectional studies do not consider the impact of transition over time of countries on the finance-growth-nexus. Focus on historical experience of industrialization, asymmetric information and intermediation and the construction of a growth theory that is founded in microeconomics.
Rajan (2006)	"Has Finance Made the World Riskier?"			Descriptive	Expanding credit and risk sharing opportunities caused by technological change, market liberalization, and institutional change. Emergence of a range of intermediaries with an expanding appetite for risk. Economies that are "more exposed to financial-sector-induced turmoil and the possibility of low probability but costly downturns.

Source: compiled by the authors

3. Transmission Mechanisms

Can derivative markets play an important role in the economic development of a country? As we have seen in the first section of this paper there have been many scholars exploring the impact of financial development on economic growth. While the financial sector contributes positively to overall economic growth in many studies up to the mid nineties (King and Levine, 1993), a positive contribution of the financial sector to economic growth in mature market economies is less evident in several studies with more recent data (Rousseau and Wachtel, 2006) as shown in the previous section. Are derivative markets responsible for the weakening linkage between financial development and economic growth? Has the rapid development of

this innovative financial sector influenced the financial landscape in a way that financing through the "traditional" financial sectors (e.g. banks, equity markets, and bond markets) has become less important?

We will explore the question how derivative markets have possibly influenced the finance-growth linkage by focusing on the functions these perform. In emphasizing functions over institutions we follow the Merton and Bodie (1995) framework, i.e. we analyze what the functions provided by derivatives are in the financial market and for asset management. According to Merton and Bodie (1995) "the functional perspective views financial innovation as driving the financial system toward the goal of greater economic efficiency". Merton and Bodie (1995) identify six core functions performed by the financial system to facilitate the allocation and deployment of economic resources:

These functions are:

(1) To provide ways of clearing and settling payments to facilitate trade
(2) To provide a mechanism for the pooling of resources and for the subdividing of shares in various enterprises
(3) To provide ways to transfer economic resources across time and space
(4) To provide ways of managing risk
(5) To provide price information
(6) To provide ways of dealing with incentive problems

The first function of the financial system is the provision of ways of clearing and settling payments to facilitate the exchange of goods, services, and assets. This function includes the provision of wire transfers, checking accounts, credit and cash cards, and clearing and settlement systems for securities transactions. According to Mason (1995), derivative instruments serve as an important extension of the payment system because they substitute in a variety of ways for trading cash market instruments.

The second function of the financial system is the pooling of funds and the subdividing of shares in enterprises to facilitate diversification. This function enables the pooling of funds from individual households into larger amounts of capital for the use of business firms. As profitable investment projects often require large capital inputs, the financial system provides opportunities for households to participate in these projects. By subdividing the individual unit size of the traded securities they hold and by packaging non-traded assets from financial intermediary's balance sheet and selling them to investors'

mutual funds and the securitized assets are good examples how financial systems provide this function.

Financial systems provide ways to transfer economic resources through time, across geographic regions, and among industries (third function of financial systems). A well-developed financial system facilitates the efficient allocation of physical capital to its most productive use, the efficient life-cycle allocation of household consumption and the efficient separation of ownership and management, which enables the use of comparative advantages and the specialization in production.

The fourth function of financial systems is the risk management and risk controlling function. Financial systems provide mechanisms for pooling, trading and sharing risks for both households and business firms. In addition this function allows the separation of real investment and risk capital and fosters specialization in production according to the principle of comparative advantage. Derivative instruments are important innovations to diversify, and to hedge and insure against risk.

Financial systems provide information useful for decision-making (fifth function of financial systems). Information provided by financial systems are important for households to make their consumption-savings decisions and to choose appropriate portfolio allocations, and for managers of firms to evaluate interesting investment projects.

According to Merton and Bodie (1995) financial systems provide "ways to deal with the incentive problems when one party to a financial transaction has information that the other party does not, or when one party is an agent for another" (sixth function of financial systems).

Coming back to one of King's and Levine's (1993) key core statements that the predetermined component of financial development is a good predictor of long-run growth and that financial development predicts (1) the rate of physical capital accumulation and (2) the rate of improvement in the efficiency with which economies allocate physical capital, we will identify certain channels through which derivatives are able to influence financial markets and the economic development. Merton's and Bodie's (1996) core functions of a financial system shall give guidance to develop appropriate channels of derivative influence.

First we will define a "volume channel" via which derivative markets exercise their influence on financial markets and the economic development. This channel (termed "the pooling of resources and subdividing shares" by Merton and Bodie (1995) facilitates and increases the accumulation of capital (Levine 1996). The mobilization of savings from many individuals and the investment in a diversified portfolio of risky projects facilitate a reallocation of investment towards higher return activities with positive implications on economic growth. As we will see in the next chapter derivatives markets have been very successful in pooling enormous amounts of capital in the last years and the creation of a broad range of derivative instruments which enabled to build up any needed risk-return profiles has drawn the attention of various types of investors to build up exposure in derivative markets.

The "efficiency channel" of derivatives summarizes several of Merton's and Bodie's (1996) functions in efficiently substituting cash market trades, transferring resources across time and space, managing risk and pricing information, thus improving the efficiency with which economies combine capital and labor in production (Levine, 1996). Corporations, financial institutions and governments all benefit from derivative markets through lower funding costs and more diversified funding sources (see Culp and Mackay, 1994). Institutional investors and portfolio managers can for example enhance asset yields and build up exposure in attractive asset classes and markets with poor liquidity by using derivatives. Companies can borrow in the cheapest capital market (domestic or foreign) without regard to the currency in which the debt is denominated or the form in which interest is paid (fixed or floating) by using currency or interest swaps. Foreign currency flows derived from entrepreneurial activity can - for example – be hedged into the home currency eliminating foreign currency risk.

We argue that the net effects of enhanced risk allocation, reduction in transaction costs and improved informational efficiencies via derivatives benefits the economy, though we recognize that derivatives securities may also impact the volatility of other markets and may not be suitable for all types of investors at all times (Mason, 1995). Via derivatives markets, exposures can be better hedged against price and interest fluctuations. Derivatives are a powerful tool for limitating risks that individuals and companies are facing in their ordinary course of business. According to Kolb (2003) financial derivatives also "play a valuable role in financial markets because they help to move the market closer to completeness. If we consider two financial markets that are the same, except one includes financial derivatives, the market with financial derivatives will allow traders to more exactly shape the risk and return

characteristics of their portfolio, thereby increasing the welfare of traders and the economy in general". Finally derivatives are a useful instrument to drive the markets towards one common price for a specific asset. Does the same asset or two assets with identical cash flows not trade at the same price in all markets, or does one asset with a known price in the future not trade at its future price discounted at the risk-free interest rate today, arbitrage is possible. The use of derivatives to profit from arbitrage opportunities therefore helps to eliminate market inefficiencies. Since derivatives help to eliminate price differentials they fulfill the information function described by the fourth function of financial systems ("financial systems provide price information", Merton and Bodie, 1995).

Finally we define the "risk channel" through which derivatives may negatively influence financial markets and the economic development. The theoretical rationale rests e.g. in claims that derivatives markets encourage speculation in the underlying asset, i.e. that they add unnecessary risk to the economy (Tobin (1984)). Rousseau and Wachtel (2006) already suggested that financial crises could be one reason for the weakening link between financial development and economic growth. Their study found evidence of a positive and significant impact of finance on growth in non-crisis observations, but a negative correlation between financial development and economic growth when a country is in crisis. In this context we will examine both the influence of derivatives on the credit, market and liquidity risk of market participants and possible derivative influences that are capable of destabilizing the banking and financial system (systemic risk). A discussion of various examples (LTCM, the subprime-securitization) shall help to assess the ability of derivatives to negatively impact the financial system and the economy.

4. Derivative Channels

4.1 Volume Channel

The volume channel acts as transmission channel through which derivatives influence financial markets and thus economic development. According to King and Levine (1993) financial development predicts the rate of improvement in efficiency and the rate of physical capital accumulation with

which economies allocate physical capital. Merton and Bodie (1995) name the pooling of resources as one core function of financial systems to facilitate the allocation and deployment of economic resources. We will examine therefore if derivatives markets are capable of mobilizing resources and acting as transmission channel to finance growth.

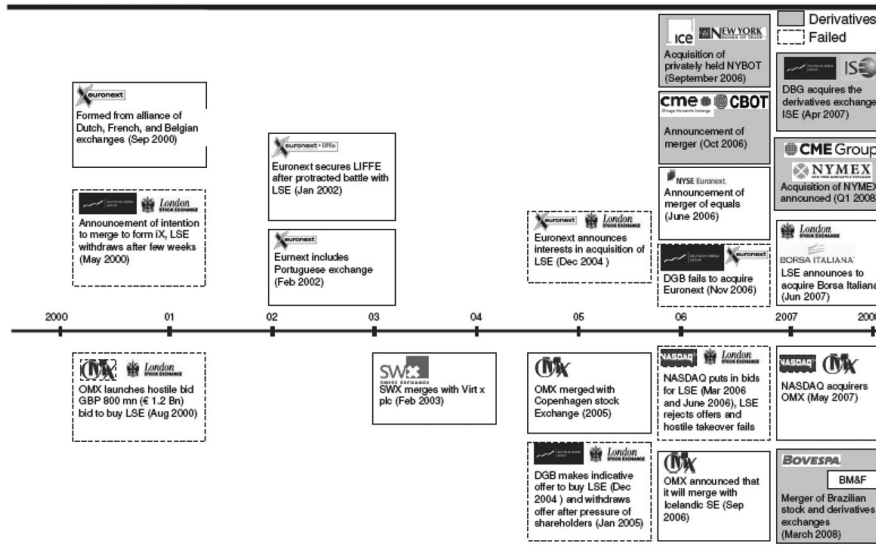
To analyze derivative markets, we collected data from various sources. Statistical data on exchange-traded derivatives are available through the World Federation of Exchanges (www.world-exchanges.org) and the Bank for International Settlements (www.bis.org). The World Federation of Exchanges started to collect statistical derivatives data in the 1990's and provides notional value data of stock options, stock index options, stock index futures, government debt options and government debt futures for worldwide derivatives exchanges since 1995. In 2002 the World Federation of Exchanges began on the one hand to provide data on currency options and currency futures, on the other hand government debt instruments have been segmented in short term interest rate options and futures and long term interest rate options and futures. Unfortunately notional value data have not been collected in 2000 and 2001. In 1986 the Bank for International Settlements (BIS) began to collect statistical data on exchange-traded derivatives. Since then turnover and open interest data in both number of contracts and notional amounts are available. The highly aggregated data set includes data on interest rate, currency and equity-linked options and futures for North America, Europe, Asia and Pacific and Other Markets.

In June 1998 central banks of the G10 countries started reporting to the BIS semiannual over the counter (OTC) derivatives statistics on forwards, swaps and options of foreign exchange, interest rate, equity and commodity derivatives. Data are available by risk category and instrument, by currency, and by maturity and counterparty. As of end-December 2004 semi-annual data on credit default swaps (CDS) including notional amounts outstanding and gross market values for single- and multi-name instruments are released by the BIS. Additional information on CDS by counterparty, sector and rating are available since December 2005.

Since 1995 the BIS publishes the "Central Bank Survey of Foreign Exchange and Derivatives Market Activity". In absence of records of over-the-counter traded derivatives, central banks of the G10 countries started in 1995 to collect and publish data on OTC-traded derivatives together with the tri-annual survey of foreign exchange market activity. This survey gives a detailed picture of the structure and size of OTC-traded derivatives for the first time.

Although data on derivatives (both exchange-traded and OTC-traded) are available since the mid 1990's, an interpretation and a coverage of derivatives development faces various problems. Firstly, continuous data on exchange-traded derivatives are not available for 2000 and 2001 since notional values have not been collected by the World Federation of Exchanges. Secondly, the markets for exchange-traded derivatives have been confronted with various exchange mergers and cooperations that influenced data availability considerably. Liffe, for example, the international derivatives business of the NYSE Euronext Group (the transatlantic exchange has been formed in 2007) operates regulated derivatives markets in Amsterdam, Brussels, Lisbon, London and Paris. Derivatives data published for each of the markets have been aggregated by the World Federation of Exchanges to total Euronext numbers since the merger of the derivatives exchanges. This aggregation implies a time-series breach for these markets since data available for each market have been aggregated to Euronext numbers not allowing the development of derivatives activity to be examined in these markets across time.

Chart 1: Global consolidation of exchanges as a result of increased competition and higher expectations



Source: Pitsilis, 2008, McKinsey & Company, presentation to the World Federation of Exchanges

In addition, derivatives markets faced tremendous liquidity shifts within the last 10 years making it difficult to examine the development of derivatives

activity on a country-basis. A good example for the tremendous changes taking place in derivatives markets is the European bond sector and the sector for European government debt derivatives (see Kaiser et al, 1999). With the introduction of the Euro the second largest market for bonds and the largest market for government bonds in the world formed. Prior to the introduction of the Euro, bond yields began to converge. Spreads between different bond asset classes resulted from foreign exchange rates risks and the different credit ratings of the various national issuers. With the introduction of the Euro exchange rate risks became obsolete and the different yields of government bonds were mainly based on the assessment of the credit ratings of the various national issuers. In addition, increased competition among national bond issuers emerged (Haiss and Marin, 2005). Prior to European Economic and Monetary Union each national issuer issued benchmark-bonds for the national markets. Afterwards national issuers competed against each other for the provision of European benchmark-bonds. Bonds are qualified as benchmark-bonds if they are both issued by prime-issuers and characterised by high liquidity. In the first month after the introduction of the Euro French and German government bonds obtained benchmark-status for different maturities.

Another condition for the attainment of the benchmark-status is the existence of efficient and liquid markets for government debt derivatives. According to the statistical data provided by the World Federation of Exchanges (www.world-exchanges.com) several European derivatives exchanges have been successful in accumulating liquidity in government debt instruments. Although various European derivatives exchanges introduced government debt instruments up to the mid 1990's, only a few exchanges were able to provide significant liquidity in government debt instruments. Liquidity became a „critical success factor". The Bund-future traded at the German/Swiss EUREX exchange became the most liquid government debt instrument in Europe. According to Kaiser et al (1999) the EUREX Bund-future has been used by many market participants to hedge positions in government bonds other than German Bunds. The risk due to imperfect hedging has been accepted in favour of liquidity. The concentration of European government debt derivatives towards only a few highly liquid instruments showed that certain segments of derivatives markets (especially government debt instruments) decoupled from national development and turned into a regional phenomenon. According to the ECB (2007a) "futures and options on Euro-denominated government bonds are almost exclusively traded on one trading platform" (EUREX), showing again the internationalization of interest rate derivatives. European markets for equity-linked derivatives seem much more fragmented since trading in equity-linked instruments still takes place in

many European markets. According to Kaiser et al (1999) accounting regulations, corporate structures and different investment mentalities may have restrained a extensive integration of European markets for equity-linked derivatives. According to the World Federation of Exchanges (2003) equity market volumes and derivatives market notional values are strongly correlated. "The relationship is close to one for one – a dollar of equity trading is associated with a dollar of equity derivatives trading (except in Korea and Israel, and for Eurex)".

Exchange traded and over-the-counter ("OTC") traded derivatives have experienced enormous growth rates during the last years.[6] Table 2 shows the development of worldwide derivative instruments traded on organized exchanges and over-the-counter from 1998 to 2006 (amounts outstanding in billions of US dollars). In 1998 $13,931.8 billion were traded on organized exchanges, whereas $80,317 billion were traded over-the-counter. With a market share of 85.2% in 1998 the OTC segment was by far the most used segment for derivatives trading. Until 2006 both market segment experienced enormous growth rates; in 2006 amounts outstanding of $ 70,443.3 billions can be recorded in the exchange traded segment, the OTC segment saw amounts outstanding of $ 385,639.0 billion. With a market share of 84.6% in 2006 the OTC segment remained nearly unchanged. Classified according to the popularity of instruments interest rate derivatives are ranked first, followed by foreign exchange and equity-linked products. A majority of derivative interest rate and foreign exchange trading is done in the OTC segment, only equity index derivatives traded on organized exchanges can maintain a significant market position within the derivative universe. Looking at growth rates, amounts outstanding of the exchange traded segment rose 405.6% from 1998 to 2006. Especially interest rate (724.4%) and equity index (616.1%) options and currency futures (409.2%) showed strong increases within the period. The OTC segment experienced a growth rate of 380.15% from 1998 to 2006. Especially commodity instruments (1,614.5%) enjoyed rising interest from market participants, followed by interest rate (482.1%) and equity-linked (403.2%) OTC derivatives.

[6] Due to the fact that derivatives data are not consistent over time and because various derivative segments have decoupled from national developments, we rather use aggregated data (provided by the BIS) to describe the development of worldwide derivatives markets in the following.

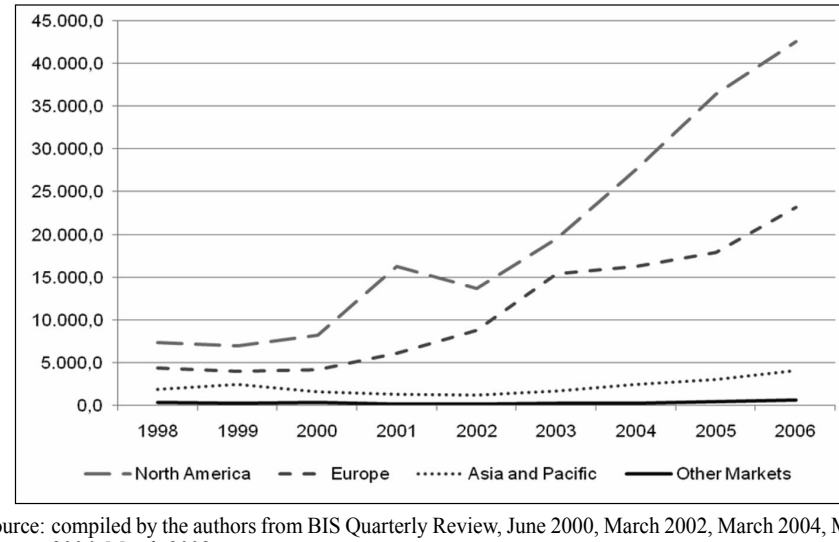
Table 2: Derivative financial instruments traded on organized exchanges and over-the-counter (OTC), amounts outstanding in billions of US dollars, 1998–2006

Derivative financial instruments traded on organised exchanges and over-the-counter (OTC) Amounts outstanding in billions of US dollars									
Product/Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Exchange Traded	**13,931.8**	**13,552.6**	**14,214.6**	**23,759.8**	**23,810.3**	**36,787.0**	**46,592.4**	**57,788.5**	**70,443.3**
Futures	**8,342.3**	**8,294.0**	**8,338.4**	**9,664.8**	**10,323.2**	**13,752.9**	**18,903.6**	**21,600.4**	**25,682.9**
Interest Rate	8,019.9	7,913.9	7,892.1	9,265.3	9,950.7	13,123.7	18,164.9	20,708.8	24,476.2
Currency	31.7	36.7	74.4	65.6	47.0	79.9	103.5	107.6	161.4
Equity Index	290.7	343.4	371.9	333.9	325.5	549.3	635.2	784.0	1,045.3
Options	**5,589.5**	**5,258.6**	**5,876.2**	**14,095.0**	**13,487.1**	**23,034.1**	**27,688.8**	**36,188.1**	**44,760.4**
Interest Rate	4,623.5	3,755.5	4,734.2	12,492.8	11,759.5	20,793.8	24,604.1	31,588.3	38,116.5
Currency	49.2	22.4	21.4	27.4	27.4	37.9	60.7	66.1	78.6
Equity Index	916.8	1,480.7	1,120.6	1,574.8	1,700.2	2,202.4	3,024.0	4,533.7	6,565.3
OTC Traded	**80,317.0**	**88,200.0**	**95,200.0**	**111,179.0**	**141,680.0**	**197,167.0**	**251,823.0**	**283,760.0**	**385,639.0**
Foreign Exchange	18,011.0	14,344.0	15,666.0	16,748.0	18,460.0	24,475.0	29,580.0	31,364.0	40,239.0
Interest Rate	50,015.0	60,091.0	64,668.0	77,568.0	101,658.0	141,991.0	190,502.0	211,970.0	291,115.0
Equity-linked	1,488.0	1,809.0	1,891.0	1,881.0	2,309.0	3,787.0	4,385.0	5,793.0	7,488.0
Commodity	415.0	548.0	662.0	598.0	923.0	1,406.0	1,443.0	5,434.0	7,115.0
Unallocated	10,388.0	11,408.0	12,313.0	14,384.0	18,330.0	25,508.0	25,913.0	29,199.0	39,682.0
Total	**94,248.8**	**101,752.6**	**109,414.6**	**134,938.8**	**165,490.3**	**233,954.0**	**298,415.4**	**341,548.5**	**456,082.3**

Source: compiled by the authors

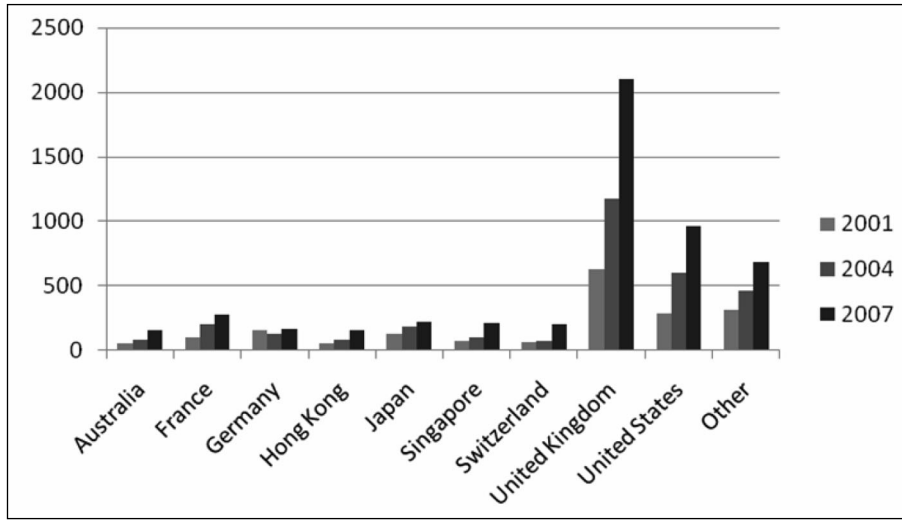
The development of derivatives traded on organised exchanges shows strong growth rates in North America (478.1%) and Europe (427.6%). Exchange traded derivatives grew only 116.5% in the Asia and Pacific region over the period 1998 to 2006, but showed strong growth rates in the last couple of years.

Chart 2: Derivative financial instruments traded on organized exchanges, by location, 1998–2006



Source: compiled by the authors from BIS Quarterly Review, June 2000, March 2002, March 2004, March 2006, March 2008

Chart 3: Geographical distribution of reported OTC derivatives market activity, average daily turnover, in billions of US dollars



Source: BIS, Triennial Central Bank Survey, December 2007

According to the data provided by the Triennial Central Bank Survey (BIS, 2007) around 85% of worldwide OTC derivatives trading takes places in nine financial centers (Australia, France, Germany, Hong Kong, Singapore, Switzerland, United Kingdom, United States), with UK and the US accounting for around 60% of the worldwide daily OTC turnover in 2007. In addition the data confirm London's role as the largest international centre for OTC trading activities.

Table 3 shows amounts outstanding of OTC traded derivatives by the type of counterparty. According to the Bank for International Settlement (see BIS, Triennial Central Bank Survey, 2007) 3 types of counterparties can be distinguished: "reporting dealers", "other financial institutions" and "non-financial customers". Reporting dealers are "financial institutions that actively participate in local and global foreign exchange and derivatives markets. These are mainly large commercial and investment banks and securities houses…" (BIS, 2007). Other financial institutions are financial institutions, such as smaller commercial bank, investment banks, securities houses, mutual funds, pension funds, hedge funds, currency funds, money market funds, building societies, leasing companies, insurance companies, other financial subsidiaries of corporate firms and central banks (BIS, 2007). Non-financial customers are mainly corporate firms and central banks (BIS, 2007).

A majority of derivative activity is concentrated within the group of reporting dealers and other financial institutions (see table 3). These counterparties account for 78.34% of total foreign exchange, 86.84% of total interest rate and 91.24% of equity-linked amount outstanding in 2007. The market share of all three types of counterparties is relatively stable over the period 1998 to 2006 in the foreign exchange and interest rate segment. Only the equity-linked segment faces significant movements of market shares over the period 1998 to 2006. The strongest increase in market share can be seen within the group of other financial institutions (1998: 39.18%, 2006: 57.36%), probably due to the fact that equity-linked derivatives experienced rising popularity within the asset management industry. The sharpest decrease (in equity-linked instruments) in market share faced the non-financial institutions sector (1998: 33.06%, 2006: 8.76%). It can be supposed that corporations and central banks are mainly interested in foreign exchange and interest rate derivatives for risk management reasons. According to Sundaram and Willey (2008) the top 25 US banks, for example, account for 99% of the total notional amounts of derivatives in the US commercial banking system, showing the high concentration of derivatives activity in the US. A similar concentration can be found in the credit derivatives sector. According to Eichhorn and Eichhorn-Schurig (2007), 86% of the volume of credit derivatives in 2006 is concentrated within 10 counterparties worldwide, suggesting a rising need to consider counterparty risks.

Table 3: Derivative financial instruments traded over-the-counter (OTC), by product and counterparty, amounts outstanding over 1998–2006 (in USD bn)

Derivative financial instruments traded over-the-counter (OTC) By instrument and counterparty, amounts outstanding in billions of US dollars									
Product and Counterparty/Year	1998	1999	2000	2001	2002	2003	2004	2005	2006
Foreign exchange	**18,011**	**14,344**	**15,666**	**16,748**	**18,460**	**24,475**	**29,580**	**31,364**	**40,239**
with reporting dealers	7,284	5,392	5,729	5,912	6,845	8,660	11,674	12,161	15,503
with other financial institutions	7,440	6,102	6,597	6,755	7,602	9,450	11,640	12,721	16,019
with non-financial institutions	3,288	2,850	3,340	4,081	4,012	6,365	6,266	6,482	8,717
Interest Rate	**50,015**	**60,091**	**64,668**	**77,568**	**101,658**	**141,991**	**190,502**	**211,970**	**291,115**
with reporting dealers	24,442	30,518	31,494	35,472	46,722	63,579	82,258	91,541	127,140
with other financial institutions	19,790	24,012	27,048	32,510	43,607	57,564	85,728	95,320	125,654
with non-financial institutions	5,783	5,562	6,126	9,586	11,328	20,847	22,515	25,109	38,321
Equity-linked	**1,488**	**1,809**	**1,891**	**1,881**	**2,309**	**3,787**	**4,385**	**5,793**	**7,488**
with reporting dealers	413	522	609	644	739	1,008	1,334	1,940	2,537
with other financial institutions	583	790	668	847	1,053	2,091	2,485	3,332	4,295
with non-financial institutions	492	497	614	390	516	688	566	520	656

Source: compiled by the authors

Having analyzed the size and the structure of worldwide derivatives markets we examine the size of North American derivatives markets in comparison to various financial indicators and to GDP (see charts 4 and 5). We use bank assets, stock market capitalization, total debt securities, total of bonds/equities/ bank assets and GDP compared to exchange-traded derivative instruments for

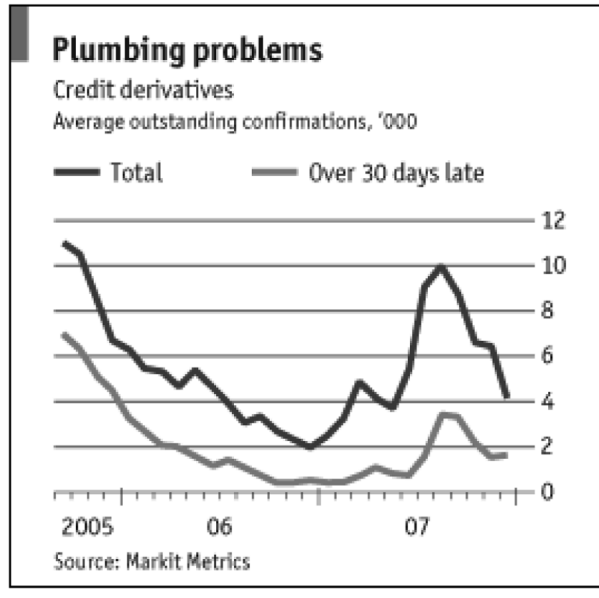
North America as provided by the International Monetary Fund (2003–2008). The comparison shows that derivatives have experienced enormous growth rates in North America between 2001 and 2006. Although bank assets, bonds, equities and the GDP have experienced a steady growth from 2002 until 2006, derivatives instruments have exceeded this development by far. Knowing that North American markets are responsible for approximately 20% of worldwide daily OTC turnover in 2004 and 2007 (BIS, 2007), and knowing that OTC traded derivatives amounted to USD 385,639.0 billion in 2006 (see table 2), we can roughly estimate USD 120,000 billion (amounts outstanding) that were traded on organized exchanges and OTC in 2006. This estimate can give an impression of the huge size of derivatives markets compared to various financial indicators and the GDP in North America.

Box 1: Recent development in market for credit derivatives

While we concentrate mainly on conventional derivatives here, we acknowledge the rise of credit derivatives as well. The overall market for OTC derivatives amounted to $455 trillion at the end of 2007, with credit derivatives showing rapid expansion and accounting for $62 trillion (The Economist, 2008). Rising fears that the market's infrastructure will not be able to cope with the rapid expansion of credit default swaps (CDS) and the nearly default of Bear Stearns – a top ten actor in the CDS market – have sparked discussions to regulate this market. CDSs have been created as hedging tool but enjoyed rising popularity to speculate on the likelihood of the default of a company. The rapid development of CDSs markets led to processing backlogs and errors and forced the industry to accelerate trade automation and to clarify the rules of engagement. Problems remained as the peak in trading in the summer 2007 was accompanied by a rise in late confirmations (see chart). To cope with the rapid growth of the CDSs regulators argue for cash settlement, rather than physical delivery of bonds.

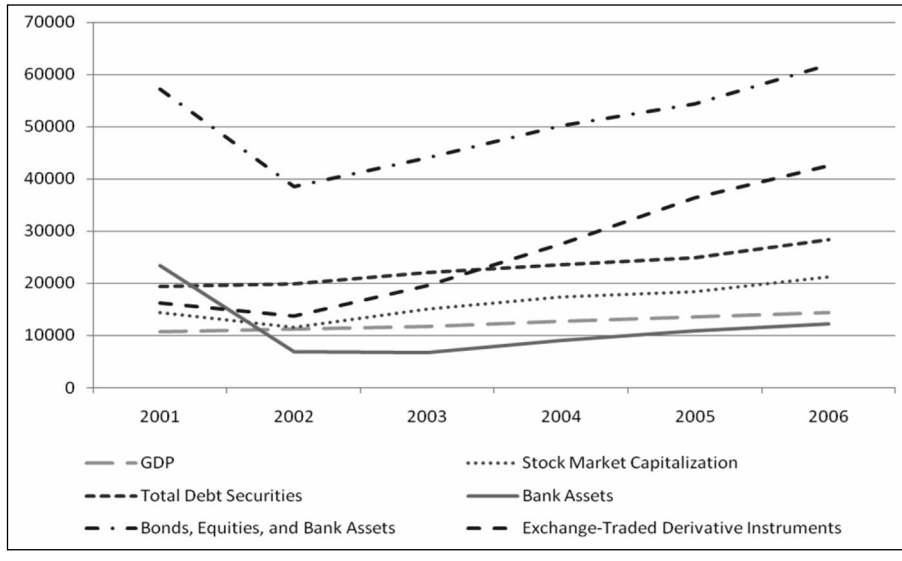
Dealers announced efforts to reduce unconfirmed backlogs and the collection of data about trades. In addition large dealers plan clearing facilities for CDSs through a central counterparty to reduce the overall amount at risk by "netting" offsetting contracts. Also exchanges are thinking about the provision of clearing facilities and turning credit derivatives into exchange-traded products. The question is if credit derivatives are amenable to standardization and if dealers are willing to abstain from generating fees.

Derivatives – Clearing the Fog, The Economist, April 19 2008, p.78



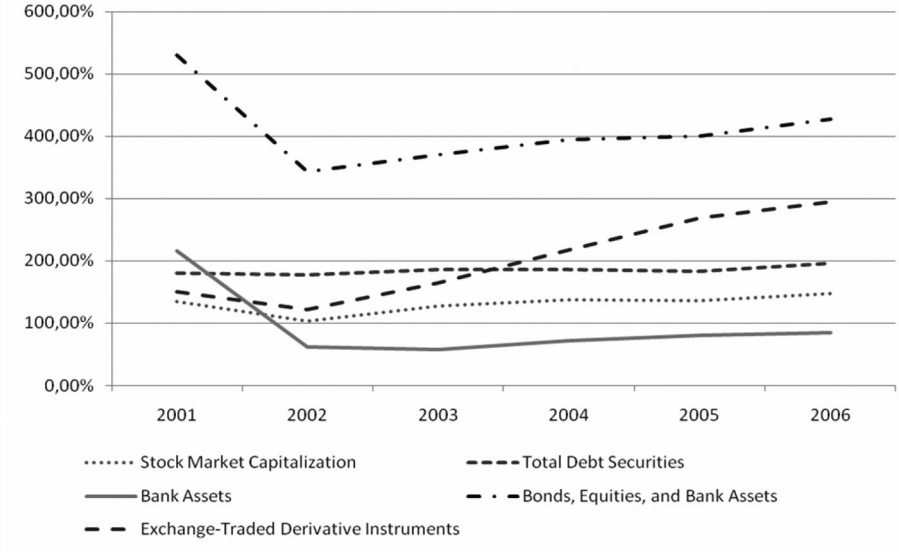
A look at the development of derivatives markets expressed in percentage of the GDP confirms that this financial sector has developed rapidly (see chart 5). In 2001 derivatives amounted to 150% of North American GDP, ranked third after bonds and bank assets. In 2006 derivatives amounted to nearly 300% of GDP, getting ahead of bonds, equities, and bank assets by far. Taking into account the enormous growth and the importance of the derivatives sector it seems that derivatives markets have decoupled from various financial indicators and the real sector as measured by GDP.

Chart 4: Selected indicators on the size of the capital markets in North America (in billions of US dollars)



Source: compiled by the authors from Global Financial Stability Report, IMF, March 03, September 04/05/06, April 07/08

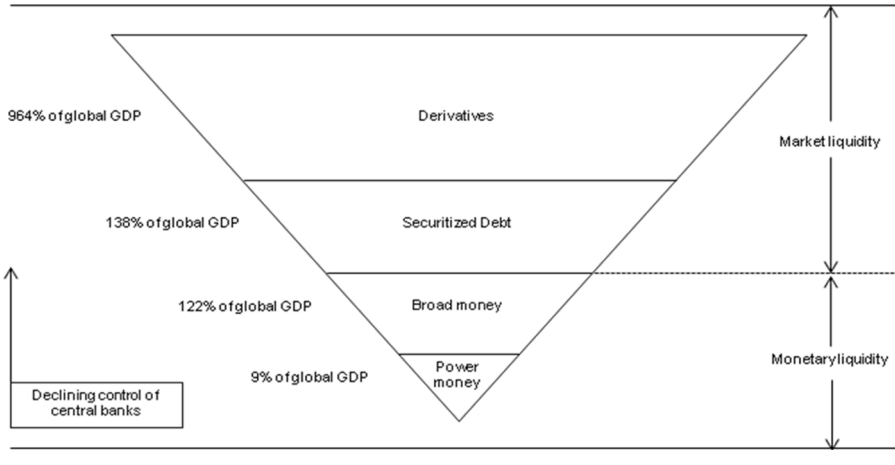
Chart 5: Selected indicators on the size of the capital markets in North America (in % of GDP)



Source: compiled by the authors from Global Financial Stability Report, IMF, March 03, September 04/05/06, April 07/08

Chart 6 gives an impression of the importance of market liquidity compared to monetary liquidity with derivatives accounting for nearly ten times global GDP. Cash and minimum reserves account for only 10% of global GDP; adding broad monetary aggregates the share rises to 122% of global GDP. According to UniCredit (2007) the rising importance of derivatives can foster a decoupling between monetary and financial liquidity via leveraging. As derivatives are claims on the underlying asset they represent a form of "quasi money". Due to the fact that leveraged positions only require a small cash transaction in the beginning it is not surprising that the following "global liquidity pyramid" (Chart 6) has been built up within a few years. Taking into account the importance of market liquidity one could ask if central banks have lost control over global liquidity (UniCredit, 2007)? According to UniCredit (2007) "there is little doubt that monetary policy has lost some influence on national liquidity conditions". Under the assumption that central banks have superior information and "a broader and far more meaningful overview than individual investors and banks can ever get" (UniCredit, 2007), central banks can still exercise strong leadership on financial markets.

Chart 6: Global Liquidity Pyramid



Source: UniCredit, Economic & Commodity Research, Economic Special, 2007

4.2 Efficiency Channel

We have defined the efficiency channel as second transmission mechanism through which derivatives influence financial markets and the economic development. As we have already discussed in chapter 2 of this paper the

efficiency channel allows an efficient allocation of capital by facilitating trade and risk management, and by driving the markets to one common price for a specific asset through the use of arbitrage opportunities. The use of derivatives for speculation, hedging and risk sharing purposes, and arbitrage strategies has been discussed by many scholars and market participants (e.g. Kolb, 2003, Hull, 2007). Derivatives are useful instruments to allocate risk to market participant that are able to bear those risks, to build up exposure in assets in a cost efficient manner and to use price and market inefficiencies by arbitrage strategies. Both the efficiency and the complexity of the risk allocation function was considerably increased by innovations in the area of derivatives (Mason, 1995). In addition derivatives "can provide investors with opportunities that would otherwise be unavailable to them at any price". That is, derivatives can provide payoffs that simply cannot be obtained with other, existing assets. In theory, derivative contracts can be written to provide any conceivable pattern of payoffs that depend on future conditions, i.e. derivatives can make markets "complete" (Sill, 1997; Mason, 1995). As those characteristics of derivatives have been widely discussed in the past, we will have a closer look at the transmission channel, through which derivatives influence the economic development and the asset management industry. We will ask the question if and to what extent derivatives – apart from their basic benefits – are used by market participants and if derivatives are capable of influencing the financial markets and the economic development positively. In the following, we will have a closer look at two beneficiaries of financial innovations: (1) Corporations using derivatives for corporate risk management purposes, and (2) Institutional investors and asset managers using derivatives to enhance asset yields, build up exposure in attractive asset classes with poor liquidity and hedge certain unmeant risks in their portfolios.

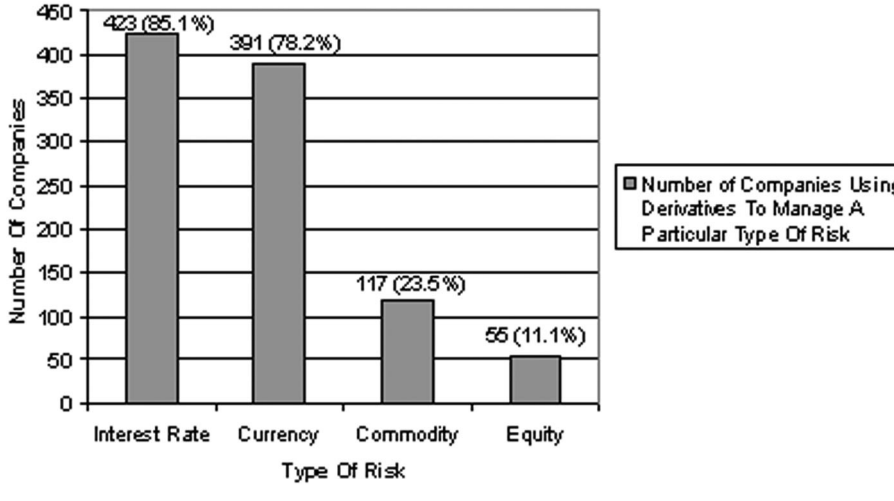
4.2.1 Corporate use of derivative instruments

An important element of a firm's overall business strategy is corporate risk management. Companies may – for example - borrow in the cheapest capital market (domestic or foreign) without regard to the currency in which the debt is denominated or the form in which interest is paid (fixed or floating) by using currency or interest swaps. Foreign currency flows derived from entrepreneurial activity can - for example – be hedged into the home currency eliminating foreign currency risk. Derivatives enable companies to better hedge and manage exposure to risk from price and interest fluctuations.

According to Stulz (1996) "the primary goal of risk management is to eliminate the probability of costly lower-tail outcomes – those that would cause financial distress or make a company unable to carry out its investment strategy". "Moreover, by eliminating downside risk and reducing the expected cost of financial trouble, risk management can also help move companies toward their optimal capital and ownership structure" (Stulz, 1996). As Guay and Kothari (2003) notice "financial derivatives – currency, interest rate, and commodity derivatives – are one means of managing risks facing corporations. If a firm's derivative position generates positive cash flows or value in periods of economic adversity, then those derivatives are deemed to hedge the firm's risk".

According to a survey by the International Swap and Derivatives Association (2003) over 90% of the world's 500 largest companies are using derivatives to manage their risks (chart 7). The survey was conducted by ISDA in March and April 2003 and included the world's 500 largest companies ranked by revenues as of year-end 2001. The companies are located in 26 countries around the world and represent a broad variety of industries. Roughly 92% of the companies covered in the survey use derivatives to manage and hedge their risk more effectively. Of those companies using derivatives, 92% or 85% of the total sample use derivatives to manage interest rate risk. Derivatives to manage currency risk are used by 85% of the companies (or 78% of the total sample), 25% of the companies (23.5% of the total) apply derivatives to manage commodity price risk and 12% (11% of the total) use derivative instruments to manage equity price risk.

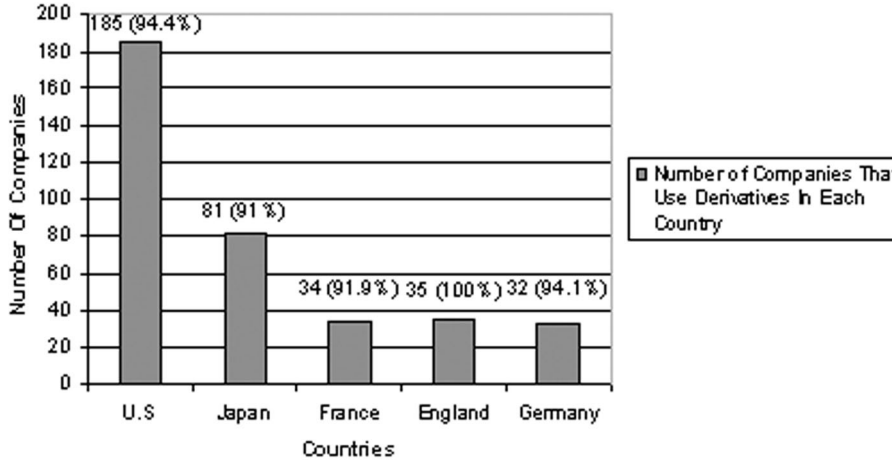
Chart 7: Number of the world's top 500 companies that use derivatives: by type of risk (2003 derivatives usage survey, ISDA)



On a geographic basis, 196 or 94% of the US companies included in the survey use derivatives to manage and hedge their risks (Chart 8). In Japan 89 or 91%, in France 37 or 92%, in UK 35 or 100% and in Germany 34 or 94% of the covered companies apply derivatives.

According to Pickel (ISDA, 2003)[7] "The survey demonstrates that derivatives today are an integral part of corporate risk management among the world's leading companies. Across geographic regions and industry sectors, the vast majority of these corporations rely on derivatives to hedge a range of risks to which they are exposed in the normal course of business."

Chart 8: Number of the world's top 500 companies that use derivatives: by country (2003 derivatives usage survey, ISDA)



4.2.2 Derivative use in fund management

In the third survey of European asset managers, Financial News (2006) polled European fund management companies on the use of derivatives in their investment activities. The survey received 209 responses representing financial institutions that manage USD 9.4 trillion globally. The rapid growth of derivatives markets (see section "volume channel") is also reflected in the European asset management industry. According to the survey, seven out of ten asset management companies are engaged in derivatives markets,

[7] executive director and chief executive officer of ISDA

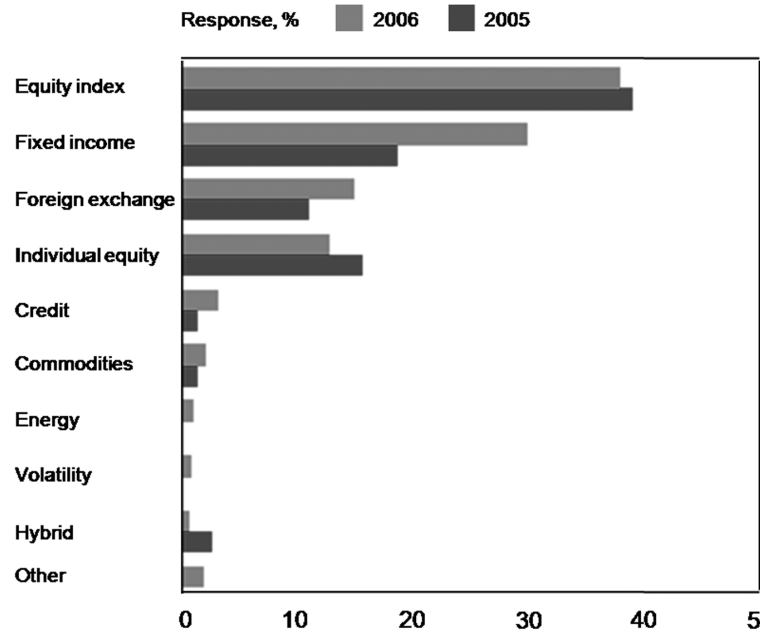
up from only four in the 2004 survey. On a geographic basis, Spain (all 12 institutions), France (19 of 22 institution), Italy (12 of 15), the Netherlands (8 out of 10), and Switzerland (15 out of 19 institutions) showed the highest penetration of derivatives usage. According to the survey not only the breadth of derivatives use grew dramatically, fund managers regarded derivatives increasingly important for their activities; two thirds regarded derivatives as either vital or integral to their investment activities. Asked for the reason of derivatives usage respondents named hedging as by far the most important use of derivatives, followed by overlay and cash management strategies. According to the study liability-driven investing and absolute return saw notable increases compared to the 2005 survey (table 4). Surprisingly the importance of return enhancement as driver of derivatives use declined according to the study.

Table 4: asset manager's derivatives use

Strategy	Score 2006	Score 2005
Hedging	3.7	3.2
Overlay	3.2	3.3
Cash management	3.1	3.1
Absolute return	2.7	2.5
Return enhancement	2.5	2.8
Liability driven investing	2.2	1.8
Trading efficiently	2.2	2.2
Alpha transport	2.1	1.9
Tax efficiency	1.6	1.5
Transition management	1.5	1.3

*Score from 1 to 5 where 1= not important and 5 = very important
Source: Third annual survey of European asset managers, Financial News, 2006)

Chart 9: usage of derivatives split between different products



Source: Third annual survey of European asset managers, Financial News, 2006)

An analysis of the use of derivatives split between different products (chart 9) showed that equity linked derivatives are the most applied instruments within the asset management sector, followed by fixed income instruments, which showed rapid expansion from 2005 to 2006. Significant expansion can also be seen in credit and foreign exchange derivatives, reflecting the trend towards active currency management.

Summarizing the Financial News (2006) survey shows that derivatives play a vital part in asset management activities. Hedging against certain risks is by far the most important strategy applied by asset managers whereas return enhancement is awarded more importance than the reality shows. Also the broad use of derivatives (seven out of ten asset managers are using derivatives) shows the importance of those instruments in today's asset management business.

4.3 Risk Channel and Discussion

In the last section ("efficiency channel") we have delineated the benefits of derivatives instruments. In addition we have defined a "risk channel" to cover derivatives and their ability to negatively influence financial markets and economic development. As we have already examined in section I., Rousseau and Wachtel (2006) suggested financial crisis to be responsible for the weakening link between financial development and economic growth. In this section we will discuss the influence of derivatives on the credit, market and liquidity risk and possible derivative influences that are capable of destabilizing the financial system. In a first step we will give a short explanation of these risks and, in a second step, we will discuss if the existence of derivatives makes it necessary to evaluate these risks in a different way.

Credit, market and liquidity risks are neither new nor unique to users of derivatives instruments. Credit risk can be defined as risk to both parties of a transaction (e.g. a loan, a derivatives transaction) that a loss will occur because one party fails to make the payments due in time. Easily speaking credit risk becomes effective if one party may default on the contract. According to Sill (1997) "credit risk is not much a problem of for derivatives traded on organized exchanges, since these exchanges are designed in such a way that their contracts are almost always honored. Credit risk is much more a problem in the OTC market, where two parties negotiate a derivative contract specific to their needs". Exchange traded derivatives are always settled through a derivatives exchange and their members, the clearing banks, which guarantee the fulfillment of the traded contracts. A derivatives contract is thus separated in two agreements, and each party to a contract is contracting with a clearing bank. The credit risk is accordingly concentrated on the clearing bank. The concept of margin requirements for trading a derivatives contract assures the limitation of credit risk for the contracting parties. OTC traded derivatives are – in contrast – not cleared through a central clearing party. OTC trading happens directly between the contracting parties, whereas each party is bearing the credit risk that the opposite party is defaulting.

Generally speaking market participants face liquidity risk when assets cannot be traded because nobody in the market wants to trade the asset (i.e. buy). Market liquidity risk is a risk that a large transaction in a specific asset can have an adverse impact on its market price. Market risk is a risk that the value of an asset will change when market conditions change. Common market risk factors are: equity risk (the risk that stock prices will change), interest rate

risk (the risk of changing interest rates), the currency risk (risk of changing foreign exchange rates) and the commodity risk (the risk that commodity prices will change).

Especially the case of the near default of the hedge fund "Long Term Capital Management" (LTCM; see Single and Stahl, 2000, or Fungh and Hsieh, 2000) and the recent subprime-securitization crisis shows that financial markets have been more vulnerable to certain risks than expected. LTCM used arbitrage strategies to take advantage of minimum price differences of various bond asset classes. To maximize profit LTCM traded large volumes of derivative instruments (more than $ 1.200 billion). The fund's strategy was based on the assessment that bond spreads, which widened in the course of the Asian crisis, should decrease and reach a normal level. The strategy was mainly implemented using OTC traded derivatives. In defiance of the fund's strategy, Russia defaulted in summer 1998. Market participants flew in the save government bond haven and "non-prime" bonds faced dramatic spread widenings. Historically positive correlations between various bond asset classes suddenly turned negative. Having speculated on decreasing spreads, LTCM faced enormous losses within short spell.[8] Not knowing the nature and the volumes LTCM has traded with other counterparties several contracting parties pushed LTCM to repay the given loans and to meet open margin calls resulting from existing derivatives contracts. Thereinafter it became public that LTCM has traded a volume of $ 1,000 billion of interest rate swap with only 50 counterparties. Since several banks acted as counterparty and creditor vis-à-vis LTCM, financial markets had to worry about possible domino effects. Only a US Federal Reserve intervention and a liquidity injection initiated by 16 banks avoided a default of LTCM and a major crisis of the financial sector; similar actions proved necessary more recently in course of the failure of Bear Stearns.

The LTCM case has shown how exposed market participants were to liquidity risk within short notice. Since more than 5% of the registered swaps of market participants covered by the triennial survey with "other financial institutions" were associated with LTCM, the hedge fund cannot be regarded as minor player in the market. It can be assumed that the market for OTC traded derivatives is an oligopolistic market and pricing does not take place in a perfect competition environment. Is an important market player forced to sell large amounts of his positions, which exceeds the receptiveness of the markets, counterparties - knowing about the necessity to liquidate - will lower

[8] LTCM's asset under management at the beginning of 1998: $4.8 billion, assets under management in September 1998: $ 1.5 billion.

their bids to maximize their profits (at the expense of the liquidating party). Already the expectation of a compulsory liquidation can prompt a sell-off with dramatically falling prices; the actual liquidation of large positions can be executed only at dumping prices under these circumstances (Single and Stahl, 2000). The LTCM crisis went along with a flight in save-havens and a sell-off of risky positions. Formerly liquid market segments became illiquid within short notice and market participants were suddenly exposed to unexpected liquidity risk.

Although market risk – the risk that the value of an asset will change when market conditions change – is not new for market participants, the LTCM case has shown that long standing market conditions can change within short notice; more recently markets were again reminded about this fallacy. The market-neutral bond-arbitrage strategy of the hedge fund was based on historic correlation estimates that turned negative in course of the crisis. The hedge fund was suddenly exposed to market risk although market conditions seemed stable before. Especially in the derivative market segment misinterpretations of future conditions can cause severe problem. Since derivatives allow the accumulation of large positions at low costs, unexpected changes of market conditions can lead to an accumulation of losses of market participants.

Finally the LTCM crisis also showed the market participants' exposure to credit risk. Since LTCM took large positions with various banks, a default of the hedge fund would have transformed the market risk to the various counterparties and intensified the crisis through possible domino effects: derivatives markets can become a trigger for contagion.

As already discussed market, credit and liquidity risks are neither new nor well understood. However the development of derivative markets and the LTCM crisis has highlighted that certain risks have to be evaluated differently. Due to the off-balance character of derivatives transactions (especially OTC traded derivatives), assessments of the creditworthiness of counterparties become more difficult. Derivatives' trading fosters the integration of the financial markets and may allow shocks to be transferred to other financial sectors more easily at times, while also providing a cushion in regular circumstances. Oligopolistic structures in the derivatives segment can encourage the building of risk concentrations with possible domino effects, if important market participants default. In addition liquidations of large derivative positions can overburden the liquidity of the markets. Due to the complexity of derivatives risk controlling becomes more important for market participants to allow an accurate assessment of derivatives risk. Finally attention should be paid to the

popularity of trading strategies that can lead to herding behavior ("crowded trades") of market participants (see Bertuch-Samuels and Störmann, 1995, and ECB, 2007b).

The recent "subprime-securitization-crises" has once again shown the sensitivity of the markets towards risk.[9] The subprime crisis "started as a problem in the lower-quality section of the market for US housing finance. It was triggered by a combination of rising borrowing costs and falling housing prices, themselves brought on by overbuilding, with rising levels of consumer leverage" (JPMorgan, 2008). A long-term trend of rising housing prices and loan incentives encouraged (especially higher-risk) borrowers to assume mortgages, believing that they would be able to refinance at more favorable terms later on. When housing prices started to decrease in 2006–2007, refinancing became more difficult for many borrowers. In the course of a rising interest and a decreasing housing price environment many borrowers became unable to repay their loans and mortgage lenders were the first that have been affected by risk of payment default of their borrowers. In addition many mortgage lenders passed the rights to the mortgage payment and the default risk via securitization (mortgage-backed securities, collateralized debt obligations) to investors, which experienced significant losses when the underlying mortgage pools declined or defaulted. Beside a reduction of lending activities and the danger of a credit crunch many investors (especially banks) had to depreciate their credit portfolios significantly. Similar to the LTCM case investors shifted their money in safe haven like the government bond sector or kept their money in cash. The market for mortgage-backed and asset-backed securities "dried up" and equities and corporate bonds faced significant losses. The corporation's ability to finance trough loans or the issuance of bonds was restricted within short notice and central banks have been flooding the financial markets with fresh money. Once again the subprime crisis has showed that credit, market, and liquidity risk is a "permanent companion" of market participants and that transparency about the investor's exposure in securitized loans would have helped to better assess certain risks.

In applying the structure-conduct-performance-paradigm (Waterson, 1984), we can argue that the emergence of derivatives and related financial instruments has altered the structure and conduct of financial markets. Derivatives have added both to to the efficiency and volatility of financial

[9] For space considerations, we can only summarize main issues pertaining to derivatives. For a more detailed review of the subprime-securitization crises, see e.g. Dell´Ariccia et al (2008), Blundell-Wignall (2008), Greenlaw et al (2008), Kregel (2007), Russo (2007) or Wray (2007).

systems and the real economy and actually appear to fill part of the gap that traditional products and participants recently face in explaining the fostering of economic development. As derivatives increased the ability of the financial sector to spread risk, it also altered its performance. According to Rajan (2006) "the increase in the risk bearing capacity of economies, …, has led to a range of financial transactions that hitherto were not possible, and has created much greater access to finance for firms and households". We have also seen oligopolistic structures in the derivatives sector and financial intermediaries that are exposed to huge derivatives amounts, and possible triggers for contagion. In discussing the two examples (LTCM, subprime-securitization) we have highlighted that certain risks (market, liquidity, and credit-risk) are not new, but have to evaluated differently. According to Rajan (2006) "risk can never be reduced to zero, nor should it be. We should be prepared for the low probability but highly costly downturn" (see LTCM and the subprime-securitization). Further research could dig deeper into "what are the alternatives", i.e. what if there were no derivatives? What actions would market participants (have) to take in the absence of derivative markets, would these be less "risky"? This "unobserved alternative" (Mason, 1995) could provide an interesting path for further research as would econometric approaches to the evaluation of the impact of derivatives to asset management and economic development.

5. Summary and Conclusion

We examined the impact of derivatives markets on asset management and the economy through three transmission channels: (1) the volume channel, (2) the efficiency channel, and (3) the risk channel. At the outset of our analysis was the question, whether the growing importance of derivatives changed the financial sectors' ability to support economic growth and development. After all, certain empirical studies with recent data (e.g. Rousseau and Wachtel, 2006) could not reconfirm the positive finance-growth-nexus typically found in the classical studies on older data (e.g. King and Levine, 1993). What has happened? Have financial markets become more crisis-prone? Or has the advent of derivatives changed the structure and thus conduct and performance of the financial sector and asset management?

In analyzing these questions, we contribute to the literature by (1) introducing derivatives within the context of the finance-growth-literature; (2) by applying the Merton and Bodie (1995) functional framework to discussing the spheres of derivatives influence, (3) by delineating the volume, the efficiency and the risk channel, and (4) by providing descriptive and comparative evidence. With regard to the impact of derivatives on the finance-growth-nexus, we argue that their huge volumes are clear sign that funds are drawn in from the real side of the economy, while at the same putting these to more productive use within the financial sector via the efficiency channel; given that markets are sub-perfect, these flows add a certain dose of risk to financial markets, at least at times. The true question, however, is: what is the alternative to derivatives?

To sum up in more detail: we find that the exchange traded segment and the over-the-counter segment have experienced strong growth rates during the period 1998 to 2006. Especially the OTC traded segment faced enormous growth rates during the period suggesting that market participants honor the unregulated character and the flexibility of this segment. A comparison of exchange traded derivatives with bank assets, equities, bonds and the GDP in North America shows that the derivatives sector is by far the biggest financial sector in North America, amounting to nearly 300% of GDP. Taking OTC-traded derivatives into account the size of the derivatives sector exceed "traditional" financial sector even more clearly. Compared to market liquidity indicators (cash, minimum reserves, broad monetary aggregates) derivatives account for more than 8 times the global GDP and represent the majority of global liquidity. Given the huge derivative amounts outstanding it seems that derivative markets have decoupled from other financial sectors and the real economy.

Interpreting descriptive data shows that certain derivatives sectors have become international. Whereas equity-linked derivatives still seem to have a national focus, government debt derivatives already decoupled from national development and turned into a regional phenomenon in Europe. Liquidity became a "critical success factor" and forced derivatives exchanges to provide highly liquid government debt derivatives in Europe. OTC-traded derivatives have decoupled from national or regional markets long ago and represent the most internationalized derivative segment.

Derivatives have become a common instrument for a broad range of users, particularly financial institutions, asset managers and corporations. In allowing speculation, arbitrage and hedging, and in making the markets more complete,

derivatives have been identified as useful instrument to foster the efficiency of financial markets and economic growth. In allowing the flow of funds and risk sharing among national systems with different institutional shapes and sizes derivative instruments function as "adapter" for the integration of the markets. Especially asset managers regarded derivatives increasingly important for their activities and named hedging as by far the most important use of derivatives, followed by overlay and cash management strategies.

Given the size, the concentration, and the oligopolistic structure of the derivatives markets, we have highlighted certain risks (market, liquidity, and credit-risk) that have to be evaluated differently from market participants. As the LTCM case and the subprime-securitization crisis showed, financial institutions and asset managers have to draw more attention to risk controlling and transparency to better assess certain risks associated with derivatives. Due to the fact that derivatives markets are characterized by a huge accumulation of assets and a highly concentrated market structure, we should be prepared for low probability but highly costly downturns. So stress testing is key for asset management and for analyzing counterparty risk. To analyze the impact of derivatives on financial market performance, further quantitative analysis is necessary, including the alternative of "no derivatives".

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