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# **On the manic-depressive fluctuations of speculative prices**

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Erratum: In the above published version, the ratio between financial transactions and nominal GDP was erroneously reduced by the factor 0.01. Hence, the description of the y-axis in figures 4 and 5 should read "Nominal GDP = 1" (instead of 100), and in the 2nd paragraph of section 4 it should be stated that financial transactions were 68 times higher than nominal world GDP (instead of "amounted to 68% of nominal OECD GDP").

## **Introduction**

This paper deals with the relationship between the following two phenomena:

- Exchange rates, stock prices as well as commodities prices (in particular crude oil prices) move in a sequence of upward trends ("bull markets") and downward trends ("bear markets") which last for several years. As a consequence, asset prices do not converge towards their fundamental equilibrium but overshoot it most of the time.
- Trading volume in financial markets of industrial countries has expanded enormously, at present it is almost 100 times higher than nominal GDP. One of the most main drivers of this extremely high level of trading is the increase in the speed of trading: The time horizon of most transactions is shorter than a few hours.

The coincidence of both developments constitutes a puzzle. How can very short-term transactions generate asset price movements which accumulate to long-term "bull markets" and "bear markets"? To put it differently: Which properties of asset price dynamics cause asset prices to move in long-term irregular cycles, i. e., in a sequence of upward and downward trends?

At first, I shall sketch a hypothetical picture of expectations formation, trading behavior and price dynamics in asset markets like the market for stocks, currencies or commodities. I have been developing this picture over the past 25 years in an inductive manner. Hence, this view of the financial markets is primarily based on information stemming from markets participants and from empirical investigations into their trading practices (see, e.g., Schulmeister, 2006, 2008; Schulmeister – Schratzenstaller – Picek, 2008).

In the second part I present some empirical evidence about long swings of asset prices, taking the US-dollar/Euro(ECU) exchange rate, stock prices in the US and Germany, as well as the crude oil price as examples. Then I shall document the expansion of trading activities in modern asset markets.

The main part of this paper deals with the interaction between short-term price runs and long-term price trends in asset markets, taking the cycle of the US-dollar/Euro exchange rate between 1999 and 2005 as example.

I conclude with some remarks on the relationship between the results of this paper and the most common views of the "financial world" at present like the efficient market theory or behavioral finance.

### **Transaction behavior and asset price dynamics – a hypothetical picture**

Over the (very) short run asset prices fluctuate stronger than implied by the random walk hypothesis. However, prices fluctuate almost always around "underlying trends" (sideways movements occur comparatively seldom). If one smoothes the respective price series using simple moving averages, one can easily identify the underlying upward or downward trends (as in figures 6 and 7).

The phenomenon of "trending" repeats itself across different time scales, e.g., there occur trends based on 1-minute-data as well as trends based on daily data. However, the volatility of price movements around the trend is higher the higher is the data frequency.

Long-term upward or downward trends ("bulls and bears") are the result of the accumulation of price runs based on daily data which last in one direction for several years longer than the counter-movements (e.g., "bear markets" are not due to downward movements being steeper than upward movements – the former just last longer). Figure 6 depicts this phenomenon on the basis of daily data for the downward trend of the \$/€ exchange rate (period A) as well as for the upward trends (period C).

The sequence of persistent price movements can be observed on every time scale (data frequency). The accumulation of these short-term runs result in long-term trends ("bull markets" or "bear markets"): Several runs based on minutes or five minutes data which last in one direction longer than the counter-movements add up to one trend based on hourly data (figure 7), many hourly trends add up to one trend based on daily data, several daily trends result in one trend based on monthly data, etc. Over periods of several years this pattern of asset price dynamics brings about long-term upward and downward trends (see figures 1 to 3 as examples).

Price runs are usually triggered by news, in particular those news which concern the most relevant fundamentals of the respective asset price. If such news hit the markets traders have to gauge within seconds how the majority of other traders might react to the new

information. If a trader expects most other traders to expect (most other traders to expect, etc) a price increase he/she will buy the respective asset (Keynes' "beauty contest" – Keynes, 1936, p. 156).

In order to reduce the complexity of trading decisions under extreme time pressure to the minimum sufficient for making profits, traders form only qualitative expectations in reaction to news, i.e., expectations about the direction of the imminent price move (but not to which level and at which speed the price might rise or fall). E.g., in case of an unexpected and strong reduction of the Federal Funds Rate traders will immediately expect the dollar to depreciate and, hence, will sell dollars at once.

Subsequent to an initial upward (downward) price movement triggered by news follows a "cascade" of buy (sell) signals stemming from trend-following technical trading systems. At first the most price-sensitive models based on high frequency data ("fast models") produce signals, at last the slowest models based on hourly or daily data. The execution of the trading signals in turn strengthens and lengthens the price movement. As a consequence, this feedback-mechanism will transform the news-induced price change into a trend.

In many cases the price trends continues after (almost) all technical models have already opened a position congruent with the trend. This trend prolongation is mainly due to a bandwagon effect on behalf of amateur traders who usually jump on a trend later than professional actors.

The longer an asset price trend lasts the greater becomes the probability that it ends. This is so for at least three reasons. First, the number of traders who get on the bandwagon declines. Second, the incentive to cash in profits rises. Third, more and more contrarian traders consider the dollar overbought (oversold) and, hence, open a short (long) position in order to profit from the expected reversal of the trend.

Many of the "contrarians" use technical models which produce sell (buy) signals when prices are still rising (falling) but at a declining speed. Finally, the trend "tilts", usually triggered by news and fostered by technical trading, first by the signals of contrarian models, and later by the signals of trend-following models.

The phenomenon that persistent price movements in one direction last for several years in one direction longer than the counter-movements has to be attributed to the presence of an expectational bias in favor or against an asset. Such a bias reflects the - optimistic or pessimistic – state of the "market mood" which practitioners call "bullishness" or "bearishness".

Any change in the "market mood" and, hence, any "establishment" of a new expectational bias in favor or against an asset depends on economic, psychological and social factors. The most important economic factor is the extent of the over(under)valuation of the asset. The longer an overshooting process lasts and the more an asset is therefore over(under)valued, the weaker becomes the "bullishness" ("bearishness"). As a consequence, more and more

market participants change their expectations and their trading behavior from "buy" to "neutral" or even "sell".

The main economic cause of this change lies in the impact of the over(under)valuation on the real side of the economy. E.g., the more a currency overappreciates the more it will dampen exports and production. This development will in turn strengthen the expectation of a "correction", i.e., a depreciation of the respective currency. If the overvaluation of an asset does stimulate the real economy as in the case of rising stock or house prices (primarily via wealth effects on consumers' demand), an appreciation bubble can last much longer than in the case of exchange rates. However, sooner or later also a stock or housing price bubble will burst due to the growing discrepancy between the market price of the asset and its fundamental value.

Emotional factors also do play a role in the dynamics of asset prices. This is particularly evident during "manic" phases (i.e., when prices strongly rise) as well as during "depressive" phases (when prices fall). These emotions are "bundled" through world-wide information networks. The related herd effects in turn strengthen asset price trends.

The recommendations of analysts as well as the evaluations of rating agencies have a similar effect as they mostly confirm that an ongoing boom is fundamentally sound. Thus, these actors tend to strengthen the "market mood" when asset prices, in particular stock prices, rise. During a "bear market", however, these actors often recommend private investors not to panic and, hence, not to sell. As a consequence, there prevails an optimistic bias in the recommendations of analysts and the evaluations of rating agencies over the long run.

The dominance of either an (over)optimistic or an (over)pessimistic "market mood" causes a "recognition and reaction bias" on behalf of market participants. News in line with the prevailing expectational bias get higher recognition and reaction than news which contradict the "market mood". Hence, traders put more money into an open position and hold it longer if the current run is in line with "bullish" or "bearish" sentiment than in the case of a run against the "market mood" (overnight positions in line with the latter are known as "strategic positions").

In the aggregate, this behavior of market participants cause price runs in line with the "market mood" to last longer than (quasi)monotonic counter-movements. In such a way short-term runs accumulate to long-term trends, i.e., "bull markets" and "bear markets". The sequence of these trends then constitutes the pattern in long-term asset price dynamics: Prices develop in irregular cycles around the fundamental equilibrium without any tendency to converge towards this level.

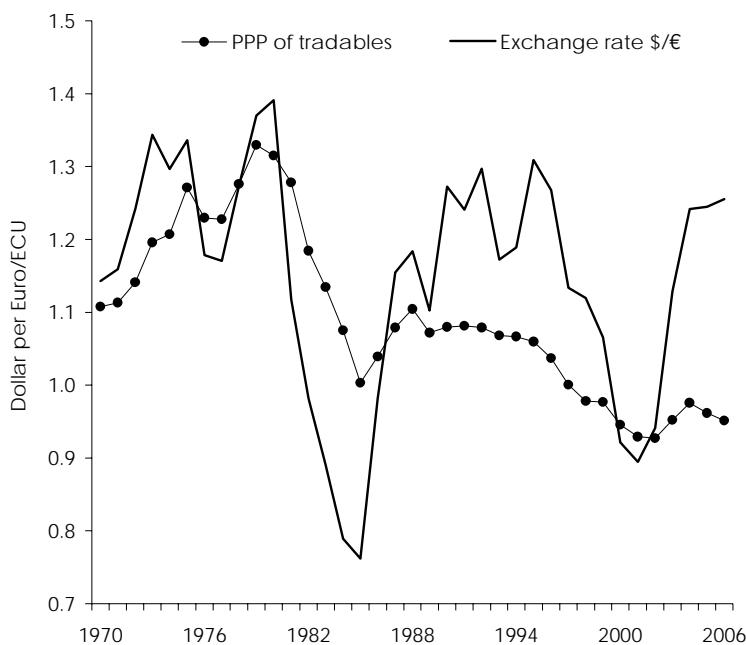
## Long swings of asset prices

In this section I shall present some empirical evidences about the long-term cycles of speculative prices taking three particularly important prices as example, the US-dollar/Euro(ECU) exchange rate, the stock prices in the US and Germany, and the price of crude oil.

Figure 1 shows the wide fluctuations of the US-dollar/Euro(ECU) exchange rate around its theoretical equilibrium level, i.e., the purchasing power parity (PPP) of internationally traded goods and services (for the calculation of PPP based on tradables see Schulmeister, 2005). Between 1980 and 1985 the dollar strongly appreciated, hence, the undervaluation of the ECU became progressively more pronounced. The subsequent (again overshooting) dollar depreciation caused the ECU to become more and more overvalued during the first half of the 1990s. This overvaluation was corrected by the strong appreciation of the dollar between 1995 and 2000.

However, after the recession in 2001 the US central bank adopted a policy of extremely low interest rates. This policy together with the deterioration of the US current account caused the dollar to depreciate again. This sequence repeated itself when the US economy started to cool down by the end of 2007. As a consequence, the euro is now more overvalued relative to the dollar than ever since.

*Figure 1: Dollar/euro exchange rate and purchasing power parity*

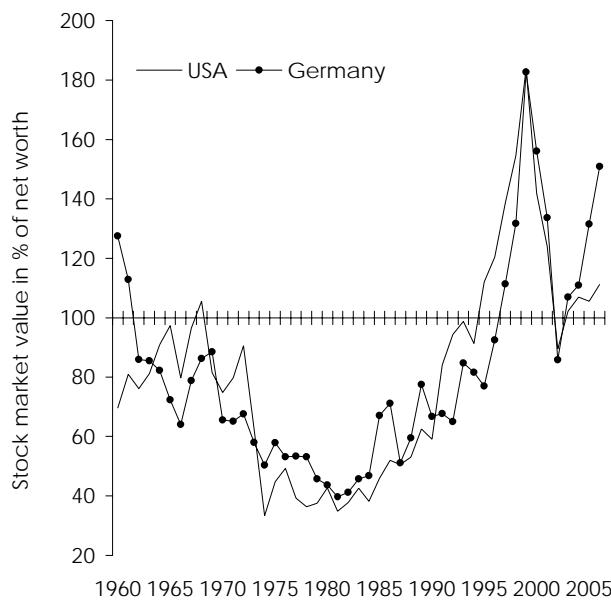


Source: OECD, Eurostat, Schulmeister (2005).

Figure 2 shows that stock prices in the US and Germany became progressively undervalued over the 1960s and 1970s: The stock market value of non-financial corporations strongly declined relative to their net worth (real assets at goods market prices minus net financial liabilities<sup>1</sup>). This development can be explained by the fact that during this phase of post-war development the striving for profits focused on the real side of the economy. As a consequence, real capital accumulation was booming und stock prices rose comparatively little (partly because corporate business financed investments through increasing the supply of stocks).

The stock market boom of the 1980s and 1990s and the slow-down in real investment dynamics caused stock prices to become progressively overvalued. By the end of the 1990s the stock market value of corporate business in the US as well as in Germany was roughly 80% higher than its net worth. This discrepancy was the most important cause of the "tilt" from a "bull market" into a "bear market" in 2000.

*Figure 2: Stock market value and net worth of non-financial corporations*



Source: Federal Reserve Bank, Deutsche Bundesbank, Destatis, Schulmeister (2003).

Between spring 2003 and summer 2007 stock prices were again booming, in Germany even stronger than in the US. At the same time real investment expanded in the US much stronger than in Germany. Hence, the discrepancy between the stock market value of non-financial corporate business and its net worth rose much stronger in Germany than in the US (figure 2).

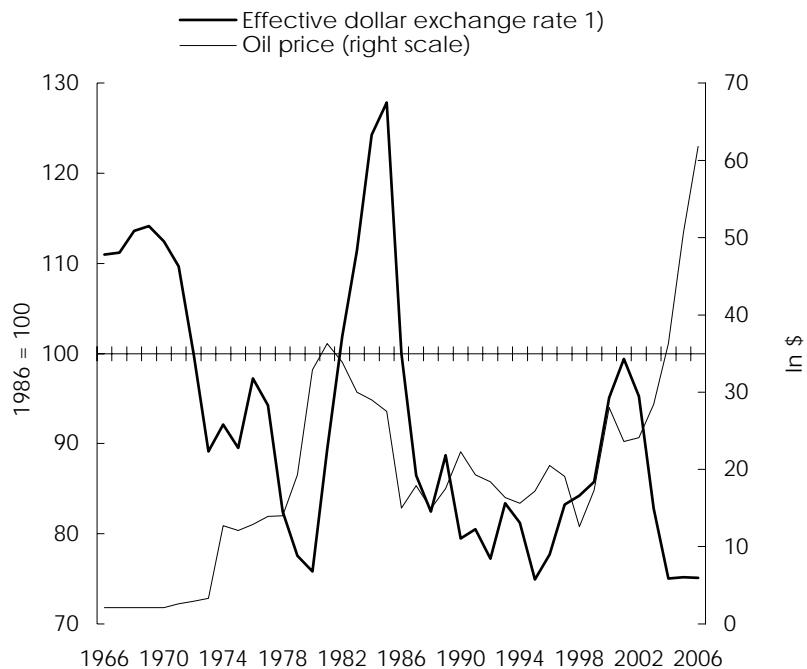
<sup>1)</sup> The relation depicted in figure 2 is an estimate of Tobin's q. For the data series and the method to calculate this relation see Schulmeister, 2003.)

Unsurprisingly, since summer 2007 stock prices have fallen much stronger in Germany as compared to the US.

For at least two reasons it is hardly possible to quantify the fundamental equilibrium price of crude oil. First, crude oil is an exhaustible resource, and, second, its price is to a large extent determined by non-economic factors, in particular by political factors. However, it is practically impossible that the fundamental equilibrium price of crude oil fluctuates as widely as the market price (figure 3). It seems more plausible that also the overshooting of the crude oil price is brought about by the interaction between news-based trading and technical trading in oil futures markets.

In addition to that, the wide fluctuations of oil prices are often inversely affected by the long swings in the dollar exchange rate: Since the dollar serves as global key currency crude oil is priced in dollars (like all other commodities). As a consequence, any dollar depreciation devalues real oil export earnings. This valuation effect in turn strengthens the incentive for oil-producing countries to increase the price of their most important export good. If their market power is strong, oil exporters are able to put through oil price increases which by far overcompensate them for the losses due to the preceding dollar depreciation. The oil price "shocks" 1973/74, 1978/80 and 2002/2007 are the most impressing examples for the inverse relationship between dollar depreciations and subsequent oil price movements (see figure 3 and Schulmeister, 2000).

*Figure 3: Dollar exchange rate and oil price fluctuations*



1) Vis-a-vis DM, Franc, Pfund, Yen. - Source OECD, WIFO.

Equilibrium economics under rational expectations cannot account for wide fluctuations of asset prices around their fundamental equilibrium. This is so because conventional theory can only explain two types of equilibrium paths, either convergence towards the fundamental equilibrium or a bubble. Hence, exactly that phenomenon which can most easily be observed in real life and which practitioners call sequences of "bulls" and "bears" remains unexplained in mainstream economics.

Empirical exchange rate studies, e.g., conceive the "purchasing power parity puzzle" primarily as the (unexplained) low speed at which an over- or undervalued exchange rate returns to its fundamental equilibrium. The preceding process of "overshooting" is simply attributed to "shocks" and, remains unexplained (Rogoff 1995; Sarno/Taylor 2002; Taylor/Taylor 2004). This kind of perception prevents conventional economists from looking at the dependence of between persistent upward trends and downward trends in asset price dynamics.

Empirical stock market studies focus in most cases on specific "anomalies" like the "momentum effect" (caused by the "trending" of stock prices) or the "reversal effect" (caused by trend reversals). However, these phenomena are not analyzed in the context of the irregular cyclicity of asset prices (for surveys of empirical stock market studies see Campbell 2000; Cochrane 1999; Lo-MacKinlay 1999; Shiller 1999). An important reason for this "myopic" perception lies in the fact that the relatively new and popular school of "behavioral finance" uses equilibrium concepts as the reference or benchmark models, too. As a consequence, observations which contradict equilibrium models can only be perceived as "anomalies".<sup>2)</sup>

## **Expansion of trading activities in financial markets**

In the following I shed some light on the development and the level of transaction volumes in global financial markets. To grasp the importance of the size of trading volumes in economic terms the data are expressed as multiples of the nominal world GDP (the absolute numbers in dollars are just too big to be meaningfully interpreted).

In 2006 overall financial transactions in the global economy were 68.0 times higher than nominal world GDP (figure 4). In 1990, this ratio amounted to 15.3% only. Hence, since then financial transactions have been growing 4.4 times faster than GDP. This difference has increased considerably since 2000, i.e., the expansion of trading activities has significantly accelerated in comparison to economic growth.

Spot transactions of stocks, bonds and foreign exchange have expanded roughly in tandem with nominal world GDP. The overall increase in financial trading is thus exclusively due to the spectacular boom of derivatives markets (figure 5). Out of the latter, futures and options

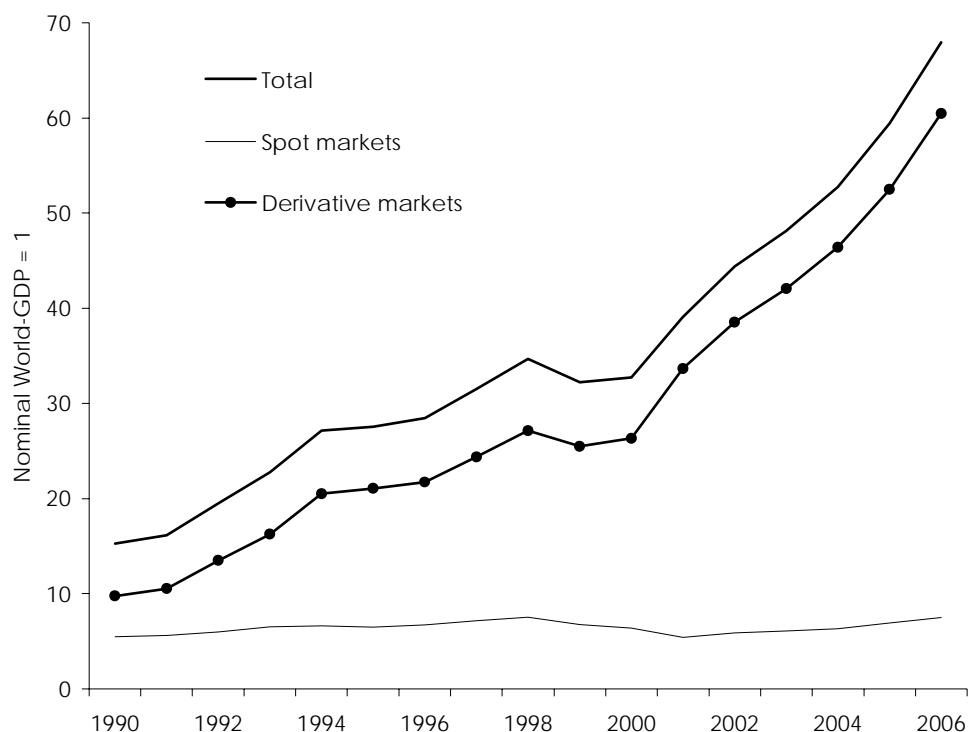
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<sup>2)</sup> Schulmeister (1987) and Frydman – Goldberg (2007) offer models which explain asset price dynamics as a sequence of systematically overshooting upward and downward trends ("bulls" and "bears"). For the "long swings" of the dollar exchange rate see Engel – Hamilton, 1990.

trading on exchanges – where also amateur investors can participate – has expanded much stronger than "over-the-counter" (OTC) trading which is exclusively carried out by professionals.

*Figure 4: Financial transactions in the world economy*

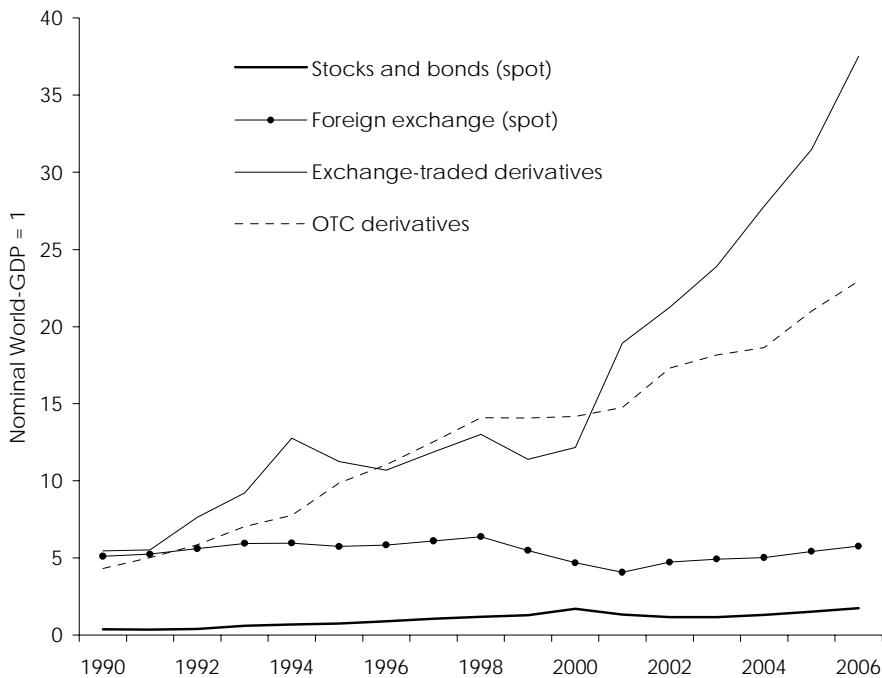
*Notional values in \$*



Source: BIS, WFE, OECD, OEF.

These observations about price dynamics and trading activities in financial markets beg the following questions: How does the increasingly short-term oriented trading bring about long-term asset price trends? More specifically: Are persistent upward (downward) trends of asset prices ("bulls/bears") caused by short-term price runs being steeper than counter-movements, or are these trends caused by upward (downward) runs lasting longer than counter-movements?

*Figure 5: Financial transactions in the world economy by instruments  
Notional values in \$*



Source: BIS, WFE, OECD, OEF.

These questions are addressed in the following part which deals with the interaction between short-term runs and long-term trends of asset prices, taking the dollar/euro exchange rate as example.

### **Interaction between short-term runs and long-term trends**

The cycle of the dollar/euro exchange rate between 1999 and 2005 was shaped by two pronounced trends, a downward trend lasting from January 1999 to October 2000, and an upward trend lasting from January 2002 to December 2004 (marked by A and C in figure 6).

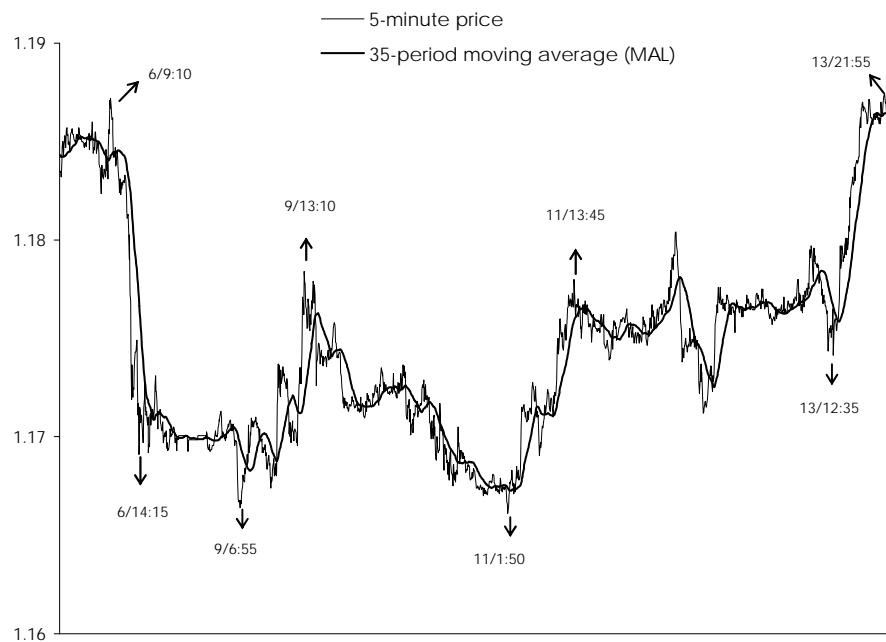
Both long-term trends were realized in a sequence of shorter (medium-term) trends. For example, the euro depreciation over period A was brought about in three downward trends which were interrupted by only small counter-movements (figure 6). In a similar manner the euro appreciation during period C was realized in a sequence of several trends, each lasting some months. Only between October 2000 and January 2002 did the trending behavior of the dollar/euro exchange rate not result in a long-term appreciation or depreciation (the two upward and downward trends - each lasting several months - roughly "compensated" each other).

Figure 6: Cycle of the \$/€ exchange rate 1999/2005



Quelle: Federal Reserve System, WIFO

Figure 7: Technical trading signals based on intraday dollar/euro exchange rates, June, 6-13, 2003



Quelle: Federal Reserve System, WIFO.

The pattern of exchange rate dynamics as a sequence of trends, interrupted by counter-movements and – comparatively seldom - by non-directional movements ("whipsaws"), seems to repeat itself across different time scales. Figure 7 displays exchange rate movements based on five-minute data over six business days in June 2003 (this sample covers roughly the same amount of data points as the seven-year period displayed in figure 6). Closer inspection reveals that the exchange rate also fluctuates also over the very short run in a sequence of trends, sometimes interrupted by "whipsaws" as during afternoon trading (GMT) on June, 6, and on June, 11.

In order to elaborate some characteristics of the pattern of exchange rate dynamics, the path of the daily \$/€ exchange rate movements as depicted in figure 6 is measured (Table 1).<sup>3)</sup>

*Table 1: Path of the \$/€ exchange rate 1999/2005*

*Daily data*

Period	Duration in days	Change in price in cents	Length of price path in cents 1)	Change in price per day in Cents (slope)	Length of actual price path per day in cents	Change in price per change in actual path
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*Based on Original data*

A	471	-34.4	226.0	-0.07	0.480	-0.15
B	324	2.8	156.4	0.01	0.483	0.02
C	755	50.1	405.3	0.07	0.537	0.12
D	224	-18.7	123.0	-0.08	0.549	-0.15

*Based on 5 day moving average*

A	467	-33.5	110.0	-0.07	0.236	-0.30
B	320	2.1	70.2	0.01	0.219	0.03
C	751	49.3	183.0	0.07	0.244	0.27
D	210	-12.5	30.1	-0.06	0.144	-0.41

Source: WIFO. - Cumulative absolute value of the daily changes in exchange rate levels.

Note: Period A: 1/1/1999 bis 25/10/2005, Period B: 26/10/2000 bis 31/1/2002,  
Period C: 3/1/2002 bis 30/12/2004, Period D: 31/12/2004 bis 14/11/2005.

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<sup>3)</sup> The following „stylized facts“ are derived from a still ongoing research project on the dynamics of exchange rate dynamics. The final study will be published in 2008 under the title “Technical Trading and Trends in the Euro Exchange Rate” (this project got financial support from the Anniversary Fund of the Austrian National Bank under the project number 11 989).

In period A the euro depreciated in 471 (trading) days by 34.4 (dollar) cents. This translates into a depreciation "speed" of 0.07 cents per day (column 5 in table 1). As there were many ups and downs, the path of the cumulated movements was several times longer than the change in level, namely, 226.0 cents (column 4) or 0.48 cents per day (column 6).

The ratio of column 3 and column 4 measures the degree of monotonicity (column 7). There are two extreme values. A value of one would indicate a pure monotonic path like a (deterministic) bubble. A value of zero would indicate "whipsaws", i.e., price oscillations around a constant level. Hence, this ratio indicates the importance of counter-movements during a price trend.

If one carries out the same measurement exercise based on the \$/€ series smoothed by a 5-days moving average, then the length of the actual price path shrinks in all four periods to less than half of the original price path. There are two reasons for that result. First, most fluctuations of the daily \$/€ exchange rate are small in size and last only one day. Second, and more important, the exchange rate fluctuates most of the time around an "underlying" trend (this is even true for period B).

As next step, I explore how the accumulation of monotonic movements ("runs") of the daily exchange rate brings about exchange rate trends lasting several years (as during period A and C). As table 2 shows, the euro depreciation in period A was primarily due to downward runs lasting by one third longer than upward runs (2.4 days versus 1.8 days), the average slope of upward and downward runs was approximately the same.

This pattern is particularly pronounced on the basis of 5 days moving averages of the original price series (table 2): The long-term appreciation (depreciation) trend of the \$/€ exchange rate in period A (C) is primarily brought about by upward (downward) runs lasting longer than "counter-runs" - the differences in the slopes of upward and downward runs play only a minor role. This result was already obtained in a study which elaborated the pattern of exchange rate dynamics by measuring the path of the daily deutschemark/dollar exchange rate between 1980 and 1986 (Schulmeister, 1987).

I will now document the distribution of the single upward and downward runs according to their length for two periods, first, for the period of a long-term depreciation trend of the euro (period A), and, second, for the period of an appreciating euro (period B).

Over the depreciation phase A, short upward runs occurred more frequently than short downward runs (93 runs compared to 69 runs; short runs are defined as lasting up to 2 days). By contrast, within the set of medium runs (between 3 and 6 days) and long runs (longer than 6 days), downward runs occurred more frequently than upward runs (table 3).

By the same token, short downward runs occurred more frequently than short upward runs over the appreciation phase C, however, medium and long runs were more often upward directed than downward directed (table 3).

*Table 2: Runs of the \$/€ exchange rate 1999/2005*

*Daily data*

Period	Number	Upward runs			Downward runs		
		Average duration in days	Average slope 1)	Number	Average duration in days	Average slope 1)	
<i>Based on original data</i>							
A	113	1.8	0.47	113	2.4	- 0.48	
B	79	2.0	0.51	79	2.1	- 0.46	
C	210	1.9	0.56	209	1.7	- 0.51	
D	57	1.7	0.53	58	2.2	- 0.57	
<i>Based on 5 days moving average</i>							
A	44	3.8	0.23	45	6.6	- 0.24	
B	37	4.0	0.25	36	4.8	- 0.20	
C	70	6.8	0.24	68	4.1	- 0.24	
D	9	8.4	0.12	10	13.4	- 0.16	

Source: WIFO. - 1) Average change in exchange rate level per day in cents.

Note: Period A: 1/1/1999 bis 25/10/2005, period B: 26/10/2000 bis 31/1/ 2002,  
 Period C: 3/1/2002 bis 30/12/2004, period D: 31/12/2004 bis 14/11/2005.

In order to test for the robustness of these results I generate 1000 random series ("random walks without drift"). I then compare the observed distribution of monotonic price movements to the expected distribution under the random walk hypothesis (RWH). This comparison shall reveal in which class of runs (by length) and based on which smoothing parameter (length of moving average = MA) does the observed number of runs deviate (most) significantly from the expected number according to the RWH.

Based on the original data (MA = 1), there occurred significantly more short runs than under the RWH over the appreciation period C (this holds to a larger extent true for short downward runs as compared to short upward runs). At the same time there occurred significantly less medium and long downward runs (table 3). Over the depreciation period A, by contrast, there occurred significantly less short downward runs, but significantly more medium downward runs, and less medium and long upward runs than under the RWH (table 3).

Based on smoothed series (both, the observed exchange rate series as well as the random series are smoothed by a 5 days and 20 days moving average), the most significant deviations of the observed number of runs from their expected values under the RWH concern the most persistent runs (lasting longer than 14 days in the case of a 5 days MA, and

longer than 34 days in the case of a 20 days MA – table 3). Over the depreciation period A, e.g, there occurred many "abnormally" long lasting monotonic downward movements (many more than upward movements). In an analogous way, over the appreciation period C there occurred many "abnormally" long lasting upward movements (many more than downward movements).

*Table 3: Non-random components in the duration of exchange rate runs  
Daily data*

	Upward runs		Downward runs		Upward runs		Downward runs	
	observed	RWH	observed	RWH	observed	RWH	observed	RWH
Period A: 1/1/1999 bis 25/10/2000								
<i>Original data</i>	1-2	93	88.7	69 ***	88.8	163 **	141.9	177 ***
	3-6	20 **	27.7	42 ***	27.5	43	44.3	32 ***
	≥ 7	0 *	1.8	2	1.8	4	2.9	0 **
	All	113	118.2	113	118.2	210 ***	189.0	209 ***
Period C: 1/2/2002 bis 30/12/2004								
<i>5 days</i>	1-6	37	35.9	27 *	36.0	44 **	57.2	53
<i>moving average 1)</i>	7-14	5 **	10.4	11	10.4	18	16.6	15
	≥ 15	2	2.0	7 ***	2.0	8 ***	3.3	0 **
	All	44	48.4	45	48.4	70	77.1	68 *
<i>20 days</i>	1-14	16	18.0	11 *	18.0	29	28.7	31
<i>moving average 1)</i>	15-34	3	4.1	5	4.1	4	6.5	6
	≥ 35	0 *	1.4	4 ***	1.4	5 **	2.4	0 **
	All	19	23.5	20	23.5	38	37.5	37
								37.5

Notes: The table compares the observed numbers of exchange rate runs by duration to their expected means under the random-walk-hypothesis (RWH). These means are derived from a Monte-Carlo-simulation based on 1000 random walk series (without drift).. The random walks were constructed with an expected zero mean of the first differences and with an expected standard deviation of the first differences as observed in the original exchange rate series over the respective period. \* (\*\*, \*\*\*) indicate the significance of the difference between the observed means and the expected means under the random-walk-hypothesis at the 10% (5%, 1%) level.

Finally, I show the results of the same exercise based on 30 minutes data. The frequency of these data is by a factor of 48 higher than the frequency of daily data since the data base comprise 24 hours of trading per day (except for weekends). Hence, the length of the moving averages is much longer than in the case of daily data.

Table 4 displays the non-random components in the duration of monotonic exchange rate movements during the depreciation period of the euro (period A) as well as during the appreciation period C. The most important results for the original (unsmoothed) 30 minutes exchange rates are as follows (table 4):

- Short lasting exchange rate runs occurred significantly more frequently than expected under the RWH. At the same time, persistent runs i.e., monotonic exchange rate movements lasting longer than nine 30 minutes intervals, occurred less often than under the RWH. Both results hold true for the depreciation period as well as for the appreciation period.
- The overall number of observed exchange rate runs is significantly higher than is to be expected if 30 minutes exchange rates followed a random walk.

When the 30 minutes data are smoothed by a 50 period MA and by a 100 period MA, respectively, a very different picture emerges (table 4):

- Over the depreciation period A there occurred (insignificantly) less short exchange rate runs than under the RWH. At the same time, there occurred significantly more long downward runs, but significantly less upward runs than under the RWH (long lasting runs are defined as those lasting more than 34 periods).
- Also over the appreciation period C the number of short lasting runs is smaller than expected under the RWH (this result is significant for the 50 period MA but insignificant for the 100 period MA). In an analogous way to the depreciation period A, there occurred significantly more long lasting upward runs than under the RWH. At the same time there occurred less persistent downward runs (this result is significant for the 100 period MA but insignificant for the 50 period MA).
- The overall number of upward and downward runs is in all but one case (period A/50 period MA) lower than expected under the RWH (in the case of period C/50 period MA, this result is significant).

One can conclude from these results that the short-term volatility of exchange rates based on intraday data, i.e., the frequency of short lasting ups and downs, is even higher when measured on the basis of intraday data than on daily data. In both cases the observed short-term volatility is higher than in the case of a random walk. However, in both cases the exchange rate fluctuates around an "underlying" trend. As a consequence, there occur less short lasting runs and more long lasting (persistent) runs when the exchange rate series is smoothed by moving averages. Persistent upward (downward) runs last longer during an appreciation (depreciation) phase than the counter-movements. Hence, the sequence of these runs results in a stepwise appreciation (depreciation) process, i.e., in long-term exchange rate trends.

*Table 4: Non-random components in duration and slope of exchange rate runs  
30-Minutes data*

		Upward runs		Downward runs		Upward runs		Downward runs	
		observed	RWH	observed	RWH	observed	RWH	observed	RWH
Period A: 1/1/1999/01/01bis 25/10/2000									
<i>Original data</i>	1-2	4571 ***	4037	4611 ***	4037	7105 ***	6594	7203 ***	6594
	3-9	1234 ***	1325	1196 ***	1324	2118 *	2164	2019 ***	2162
	$\geq 10$	3 ***	10	2 ***	11	6 ***	16	6 ***	18
	All	5808 ***	5372	5809 ***	5372	9229 ***	8773	9228 ***	8773
Period C: 1/2/2002 bis 30/12/2004									
<i>5 days</i>	1-6	1907 ***	1631	1863 ***	1631	3040 ***	2664	3054 ***	2664
<i>moving</i>	7-14	468	477	495	479	789	779	788	782
<i>average 1)</i>	$\geq 15$	52 ***	93	69 ***	92	101 ***	152	88 ***	150
	All	2427 ***	2202	2427 ***	2202	3930 ***	3596	3930 ***	3596
<i>50 days</i>	1-14	492	516	488	515	772 **	843	785 *	841
<i>moving</i>	15-34	85 **	69	63	70	87 ***	112	114	115
<i>average 1)</i>	$\geq 35$	91 **	103	117 ***	102	205 ***	169	164	167
	All	668	688	668	688	1064 *	1124	1063 *	1124
<i>100 days</i>	1-14	350	363	330	364	559	595	575	596
<i>moving</i>	15-34	41	46	36 *	47	63 *	75	77	77
<i>average 1)</i>	$\geq 35$	70 *	78	95 ***	76	145 ***	128	114 *	125
	All	461	488	461	488	767	798	766	798

Notes: The table compares the observed numbers of exchange rate runs by duration to their expected means under the random-walk-hypothesis (RWH). These means are derived from a Monte-Carlo-simulation based on 1000 random walk series (without drift).. The random walks were constructed with an expected zero mean of the first differences and with an expected standard deviation of the first differences as observed in the original exchange rate series over the respective period. \* (\*\*, \*\*\*) indicate the significance of the difference between the observed means and the expected means under the random-walk-hypothesis at the 10% (5%, 1%) level.respective period. \* (\*\*, \*\*\*) indicate the significance of the difference between the observed means and the expected means under the random-walk-hypothesis at the 10% (5%, 1%) level.

This pattern in the dynamics of speculative prices conflicts with the most fundamental assumption of the "efficient market hypothesis". According to this concept any asset price reflects the fundamental equilibrium value of the respective asset (rational market participants permanently keep the price at this level). If new information arrives, actors will

drive the price instantaneously to its new equilibrium. This (rational) behavior assures that asset prices follow a random walk which in turn implies "weak market efficiency". This concept means that one cannot systematically make trading profits from exploiting just the information contained in past prices (as do the popular trading rules of technical analysis).<sup>4)</sup>

In contrast to efficient market theory the empirical analysis presented above shows that the dynamics of exchange rates (and most probably of asset prices in general) is characterized by price fluctuations around underlying trends.<sup>5)</sup> This phenomenon of "trending" can be observed on the basis of daily data as well as of intraday data. This phenomenon is not only typical for asset price dynamics over the short run but also over the long run since short-term price runs accumulate to long-term trends. Hence, the abnormally frequent occurrence of persistent asset price movements represents the most important link between the short run and the long run in the dynamics of asset prices.

Since the most popular trading technique in financial markets, the so called "technical analysis", is based on the (assumed) exploitability of asset price trends, I shall finally sketch the interaction between this trading practice and asset price dynamics.

## **Technical analysis and the trending of asset prices**

Technical analysis tries to exploit price trends which "technicians" consider the most typical feature of asset price dynamics ("the trend is your friend"). Hence, these trading techniques derive buy and sell signals from the most recent price movements which (purportedly) indicate the continuation of a trend or its reversal (trend-following or contrarian models).<sup>6)</sup> Since technical analysts believe that the pattern of asset price dynamics as a sequence of trends interrupted by "whipsaws" repeats itself across different time scales, they apply technical models to price data of almost any frequency, ranging from daily data to tick data.

According to the timing of trading signals, one can distinguish between trend-following strategies and contrarian models. Trend-following systems produce buy (sell) signals in the early stage of an upward (downward) trend, whereas contrarian strategies produce sell (buy) signals at the end of an upward (downward) trend, e. g., contrarian models try to identify "overbought" ("oversold") situations.

Technical analysis is omnipresent in financial markets. In the foreign exchange market, e. g., technical analysis is the most widely used trading technique (for recent survey studies see

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<sup>4)</sup> Recent contributions to the debate about the efficiency of asset markets are Le Roy, 1989; Shiller, 2003; Lo, 2004.

<sup>5)</sup> First calculations concerning the interaction between short-term runs and long-term trends of stock index futures prices and crude oil futures prices gave similar results as those for the \$/€ exchange rate.

<sup>6)</sup> Kaufman (1987) provides an excellent treatment of the different methods of technical analysis. For a short description of the most important trading rules see Schulmeister, 2007A).

Cheung – Chinn - Marsh, 2004; Gehrig - Menkhoff, 2006; Menkhoff - Taylor, 2007). It seems highly plausible that technical analysis plays a similar role in stock markets, particularly in short-term trading in stock index futures (Irwin-Holt, 2004, provide evidence about the popularity of technical analysis in futures markets).

Many factors have contributed to the popularity of technical trading systems among practitioners. First, these systems can be "universally" used, i.e., they can be applied to any kind of price data frequency. Second, these price data have become easily available (at ever falling costs). Third, computer software has been continuously improved (and got cheaper at the same time). Fourth, the internet has enabled traders (professionals as well as amateurs) to trade in real time on all important market places in the world.

Figure 6 shows how a particularly simple trading system works in the \$/€ market based on daily exchange rates: Whenever the current price crosses the 50 days MA from below (above) a buy (sell) signal is given. One has to keep in mind, however, that it is much more difficult to make profits following technical trading systems than it seems to be the case when looking at price movements ex post. This is so because the essential non-randomness in asset prices dynamics, i.e., the "abnormally" frequent occurrence of trends on different time scales, is itself not stable over time. This means with respect to MA models that the length of the moving averages which would optimally exploit asset price trends, changes over time and can at best be approximated ex ante.

In addition to that, there often occur "whipsaws", i.e., sideways movements, during which technical models usually produce a sequence of losses. This problem is particularly pronounced in the case of high frequency data (see, e.g., figure 7). Hence, when technical trading is based on intraday data, more sophisticated models are used in practice than simple MA models (as depicted in figure 7).

There is one universal property of the performance of technical trading systems in asset markets of all kinds: These models produce more often single losses than single profits, however, profitable positions last on average three to four times longer than unprofitable positions (due to "riding" trends) which causes the models to often produce an overall profit (Schulmeister, 2007A, 2008).

The "trending" of asset prices and the specific "construction" of all kinds of technical models (being focused on the exploitation of price trends) implies that technical trading systems provide a chance to make speculative profits and an incentive to use those models in practice. At the same time, however, following such models can easily cause not experienced (amateur) traders to incur losses, mainly because of optimizing model parameters based on past price movements (Schulmeister, 2007A, 2008).

There operates an interaction between the "trending" of asset prices and the use of technical models in practice. On the one hand, many different models are used by individual traders aiming at a profitable exploitation of asset price trends, on the other hand the aggregate

behavior of all models strengthen and lengthen price trends (this interaction is analyzed by Schulmeister, 2007B, 2006).

## Concluding remarks

The central message of this paper is the following. Asset prices develop in a sequence of "underlying" runs (monotonic movements on the basis of smoothed data), sometimes interrupted by sideways movements ("whipsaws"). Over a long period of time, these runs last in one direction longer than the "counter-runs". The accumulation of these price movements result in upward or downward trends, i.e., "bull markets" and "bear markets". The sequence of these trends adds up to long-term irregular cycles of asset prices around its fundamental equilibrium without any tendency to converge towards this level.

These "manic-depressive" fluctuations of important prices like exchange rates, stock prices or commodities prices (in particular the crude oil price) dampen activities in the "real economy", especially via two channels. First, turbulences in financial markets are important causes of recessions (e.g., the fall of stock prices and the rise of oil prices contributed to the recession 2001; in the euro area, this development was significantly aggravated by the strong rise of the euro exchange rate). Second, during phases of "business as usual", the striving for profits of entrepreneurs shifts from real investment and production to financial investment and speculation. This slow, yet persistent change in the framework conditions from a "real capitalistic regime" to a "finance capitalistic regime" has become – in my mind - the most important cause of the sluggish growth of production and employment since the early 1970s (in particular in comparison to the 1950s and 1960s - Schulmeister, 2007C).

In spite of the empirical evidence concerning the wide fluctuations of asset prices since the liberalization of financial markets in the 1970s the subsequent creation of many financial innovations (in particular all kinds of derivative instruments), one has to state the following: Neither the neo-classical "mainstream" in economics nor "behavioral finance" or the Post-Keynesian school have comprehensively analyzed the hypothesis that asset prices fluctuate systematically around their fundamental equilibrium without any tendency of convergence (the latter serving as a "center of gravity" or an "attractor" rather than as an equilibrium).

As regards the "mainstream" in economics, this negligence is understandable. A neo-classical economist would have to suffer intensively from "cognitive dissonance" when looking closely at expectations formation, trading behavior and price dynamics in modern asset markets: If those markets which come closest to the optimal market of economic theory (as regards transaction costs and the diffusion of information) produce systematically wrong price signals, then the whole theoretical construction collapses.

However, exactly for that reason it should be attractive for "heterodox" economists to investigate deeper trading behavior and price dynamics in asset markets and their impact on the real side of the economy. Keynes gave a lot of hints how to better understand the role

of financial speculation in mature capitalism. However, he had no time to give his observations and reflections about the role of emotions in financial markets, the mentality of rentiers, the "dominance of speculation over enterprise" and its consequences for employment and prosperity a theoretical fundament. Over the 1950s and 1960s, this part of Keynes' writings has progressively been forgotten, in part because financial markets were regulated and, hence, narcotized at that time. Nowadays, the time has come again to rediscover this part of the heritage of Keynes.

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