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Corporate Finance

Market Efficiency

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Playing poker

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Summary

Poker

There is an old saying among poker players:

If you've been in the game half an hour and you haven't figured out who the patsy is, you're the patsy.

This is the main lesson of

financial market efficiency

(except that in financial markets, you can't afford to wait half an hour)

What is market efficiency?

Market efficiency is about how financial market prices react to new information,

including cases where some people are better-informed than others (“private information,” “asymmetric information,”)

as well as cases where everybody has the same information (“public info,” “symmetric info”).

Market efficiency is also about the possibility (or rather, the impossibility) of arbitrage opportunities or profitable trading opportunities.

Importance for corporate finance.

Why does information move asset prices?

Here are some examples of how information can affect financial market prices:

1) Newspaper articles on Bank of England MPC

→ interest rates

→ bond prices

2) Rumours of a takeover bid

→ share prices of target company

3) Concerns about economic prospects for a sector

→ share prices in that sector

(e.g. internet stocks, regulated utilities, etc.)

4) Earnings announcement

→ shares of the company

5) Political events in Russia or Balkans

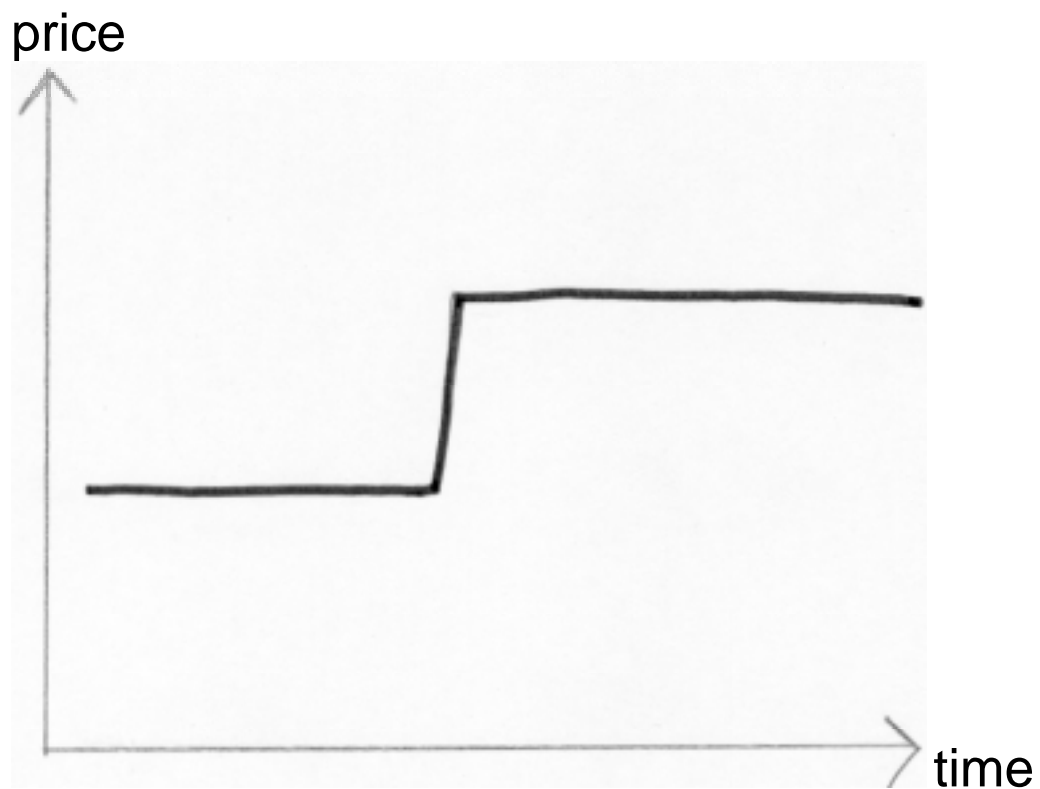
→ Euro/US \$ exchange rate

Key idea (1):

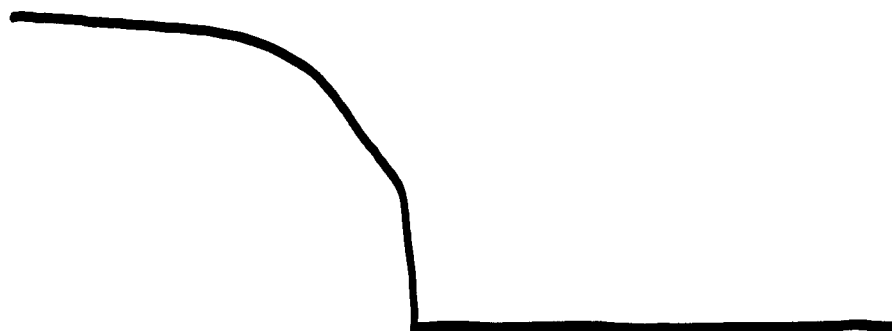
asset prices move in response to news

Some examples of how news affects prices:

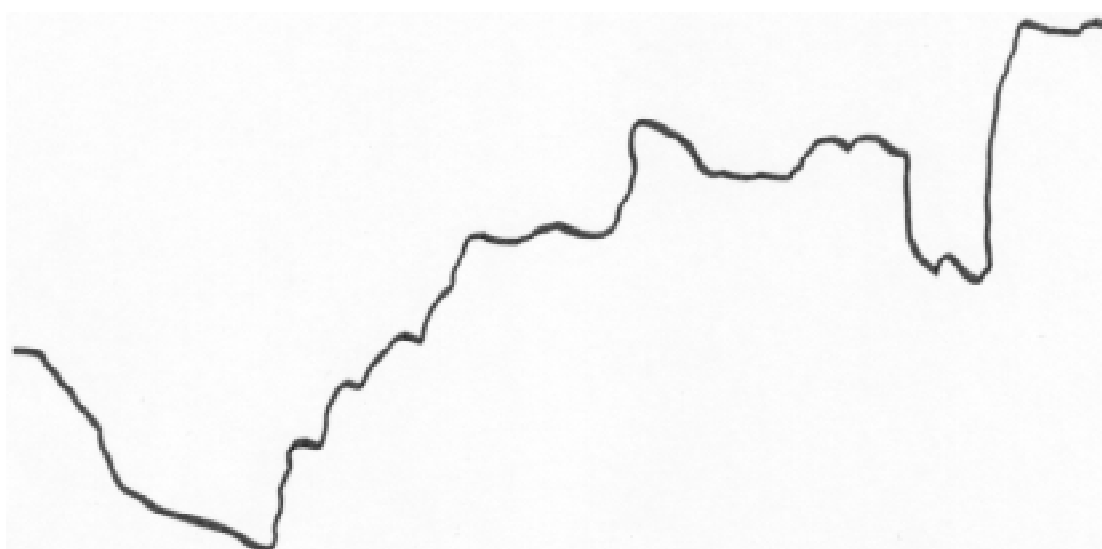
(a) good news, all of a sudden:



(b) bad news, anticipated



(c) generally, news arrives all the time,
some of it good, some of it bad,
sometimes anticipated, sometimes not:



Note: if you didn't know the information and just looked at the graph, you might think that prices just moved about in a random way. This idea of "randomness" can cause confusion. We will return to it later.

Key idea (2):

Some patterns of price movement are unlikely:

Would you expect to see this?



Or this?



(fluctuation around a trend)

both of these are examples of **mean reversion**.

Arbitrage opportunities

Patterns such as mean reversion would give rise to extremely profitable trading opportunities, such as:

Buy low, Sell high

Profitable trading opportunities are called

“arbitrage” opportunities

In the extreme case there are **pure arbitrages** (no risk whatsoever).

Normally, all trading opportunities of this kind involve at least some risk, but **“arbitrage”** is also used to describe any kind of trading where:

the expected profits are very large compared to the risk

the risks would average out to zero over a large number of such trades (**“diversification”**).

Since transaction costs are low in financial markets, and since there are large numbers of traders constantly on the lookout for arbitrage opportunities, we would expect not to find any (at least, hardly ever).

Absence of arbitrage and martingales

The lack of arbitrage opportunities →

$E(\text{future price}) = \text{today's price}$

(+ maybe a suitable risk premium)

(for the time being, we will ignore risk premia)

A **martingale** is a price path with

$$E(p_{t+1}) = p_t$$

The bottom line is that risk-adjusted prices should follow a martingale.

Random Walk

We have concluded that (risk adjusted) prices should follow a martingale:

$$E(p_{t+1}) = p_t$$

This is often called a “random walk.” I used the word martingale because:

(less important reason) strictly speaking, a random walk is something slightly different.

(important reason) “random walk” is a **misleading** term because it conveys the impression that prices move for no good reason, because of random factors.

In a rational world (whether or not we live in one) asset prices should move in response to information.

If you don't know the information, then the price path would look random. The “random walk” or “martingale” hypotheses are theories about **what kind** of (apparently random) patterns we would expect to see.

They are not statements that prices really do move for arbitrary, random reasons.

Confusion about “random walks”

Here are some examples of how easy it is to be confused:

Brealey and Myers, p354: “price changes are random.”

Paul Samuelson, “Proof that properly discounted present values of assets vibrate (sic.!) randomly,” title of article

Paul Cootner (editor), “The random character of stock market prices,” title of book published by MIT press in 1964.

The **correct interpretation** is that, unless you have private information that the rest of the market does not have,

you cannot predict price **changes** in advance

by using information such as past prices, etc. A time-series of prices should look like:

“a ‘wandering one,’ almost as if once a week the Demon of Chance drew a random number ... and added it to the current price to determine the next week’s price.”

(Maurice Kendall, on discovering this in the data)

Three kinds of market efficiency

1) weak-form efficiency:

you cannot make excessive trading profits by looking at past patterns in security prices

2) semi-strong-form efficiency

you cannot make excessive trading profits by looking at public information

also...

3) strong-form efficiency

you cannot ever make excessive trading profits even if you have private information (perhaps because as soon as you start to trade, the market will figure it out and the adjust instantly)

Most finance researchers do not take (3) too seriously. We will ignore it from now on.

The empirical evidence, as well, as the theory, very strongly supports (1) and (2).

Are markets really efficient?

i.e. is it really true that you can't use past prices to predict the future?

answer:

(1) by and large, yes, prices are efficient. Many careful studies have been carried out on different possible inefficiencies. They **virtually all reject inefficiency.**

e.g. serial correlation is very close to zero (no **mean reversion.**)

(2) there are some "**anomalies**" however, some of which are **controversial**. Some have also apparently disappeared.

e.g. the "small company effect."
long-run underperformance of IPO's

(3) there are **a few** anomalies that seem persistent

e.g. failure of uncovered interest parity

Although we will discuss UIP, the main message is that **markets are efficient**. UIP is an interesting **exception** that will teach us to look at evidence as well as theory (story about dollar bill on ground).

Uncovered Interest Parity

At present the (1-year) interest rate on sterling is about 6.5%; the interest rate on Euro is about 5%

Uncovered interest parity

→ this difference equals the expected depreciation rate of sterling

$$E(p_{t+1}) = p_t (1 + r_{\text{€}}) / (1 + r_{\text{£}})$$

where p_t = exchange rate at time t , and the exchange rate is the number of € for £1.

In this example, since the exchange rate is 1.62, the expected exchange rate next year using UIP would be:

$$1.62 \times (1.05/1.065) = 1.597$$

(this is an expected value. There is plenty of variance around the expectation)

UIP is a basically an **expectations hypothesis** (similar to expectations hypothesis of term structure).

If it fails then it is, on average, systematically cheaper to borrow in one currency rather than another.

Reference for previous example

EXCHANGE CROSS RATES

May 24	SPH	DM	FF	DM	£	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	
Belgium* (BF)	106	18.48	16.28	4.848	1.952	4900	5.483	20.53	487.8	412.5	20.66	3.678	1.528	3.391	2.248	241.4	2.479		
Denmark (DK)	54.00	10	8.794	2.622	1.059	2396	2.854	11.10	268.8	223.1	11.18	2.007	0.828	1.834	1.217	130.5	1.341		
France** (FF)	61.50	11.37	10	2.982	1.281	2952	3.560	12.82	305.0	253.7	12.72	2.395	0.938	2.085	1.383	148.4	1.525		
Germany** (DM)	20.83	3.814	3.354	1	0.403	990.0	1.127	4.234	102.5	85.07	4.265	0.800	0.315	0.699	0.484	48.79	0.511		
Ireland** (₹)	51.22	9.471	8.329	2.483	1	2459	2.798	16.51	254.6	211.3	16.59	1.886	0.782	1.737	1.152	123.8	1.270		
Italy** (₹)	2.083	6.368	5.339	0.191	0.041	100	0.114	0.429	18.35	15.53	0.421	0.061	0.032	0.071	0.047	44.19	0.454		
Netherlands* (₹)	18.31	3.365	2.917	0.888	0.357	878.6	1	3.757	90.97	75.50	3.785	0.710	0.280	0.621	0.412	44.19	0.454		
Norway (Nkr)	48.72	9.938	7.922	2.562	0.951	2338	2.661	10	242.1	200.9	10.67	1.889	0.744	1.652	1.096	117.6	1.208		
Portugal** (₹)	20.12	3.720	3.272	0.970	0.382	965.8	1.099	4.130	793	67.99	4.161	0.788	0.307	0.682	0.453	48.57	0.499		
Spain** (₹)	24.24	4.483	3.942	1.175	0.479	1164	1.324	4.976	129.5	100	5.013	0.940	0.370	0.822	0.545	58.52	0.601		
Sweden (Skr)	48.36	8.942	7.864	2.345	0.844	2321	2.642	9.829	240.3	199.5	10	1.870	0.738	1.643	1.088	118.7	1.222		
Switzerland (Sfr)	25.79	4.708	4.160	1.250	0.583	1238	1.408	5.283	126.2	106.4	3.332	1	0.394	0.874	0.580	62.3	0.636		
UK (₹)	65.47	12.10	10.65	3.174	1.278	3142	3.570	13.44	325.4	270.0	13.54	2.539	1	2.220	1.473	158.0	1.625		
Canada (Cdn)	28.48	5.454	4.796	1.430	0.576	1416	1.611	6.054	148.8	121.8	6.099	1.144	0.451	1	1.507	1	107.3	1.102	
USA (₹)	44.66	8.220	7.229	2.155	0.805	2134	2.428	9.125	228.9	183.4	9.193	1.724	0.679	1.507	1	107.3	1.102		
Japan (₹)	41.43	7.690	6.737	2.008	0.829	1989	2.263	8.553	205.9	175.9	8.586	1.907	0.633	1.406	0.932	100	1.037		
Euro (₹)	43.34	7.459	6.560	1.926	0.788	1936	2.204	8.280	203.5	166.4	8.342	1.564	0.616	1.368	0.907	97.37	1		

Source: Reuters, French Press, Bloomberg News, and Swedish Kroner per 100, Belgian Francs, Yen, Swiss, Lira and Pesetas per 100. * IMF member.

WORLD INTEREST RATES

DOMESTIC MONEY RATES

May 24	Over night	One month	Three months	Six months	One year	Local inter.	Dis. rate	Repo rate
Euro-zone	4 1/2	4 1/2	4 1/2	4 1/4	4 1/2	-	-	3.75
Switzerland	1 1/2	2 1/4	3 1/2	3 1/4	3 1/4	-	0.50	-
US	6 1/2	6 1/2	6 1/4	7 1/4	7 1/4	-	6.00	-
Japan	6	6	6	6	6	-	0.50	-
5 Libor BSA fixing*	-	6 1/2	6 1/2	7 1/4	7 1/4	-	-	-
Interbank Fixing	-	6.46	6.70	6.83	7.31	-	-	-
US Dollar CDs	-	4 1/2	4 1/2	4 1/4	4 1/4	-	-	-
Euro Linked Ds	-	3 1/4	3 1/2	3 1/2	4 1/2	-	-	-
SDR Linked Ds	-	4 1/4	4 1/2	4 1/2	4 1/2	-	-	-
BSA Euro Libor	-	4.250	4.440	4.630	4.842	-	-	-
Euro Euribor	-	4.06	-	-	-	-	-	-
EDMA	4.06	-	-	-	-	-	-	-
EURONIA	4.0618	-	-	-	-	-	-	-

* London interbank fixing rate (LIBOR) is the BSA London rate, fixed at 11am London time. All rates are shown for the domestic money rates, US CDs, Euro & SDR Linked Deposits etc.

UK INTEREST RATES

LONDON MONEY RATES

May 24	Over night	7 days notice	One month	Three months	Six months	One year
Interbank Sterling	6 1/4 - 6 1/4	6 1/4 - 6 1/4	6 1/2 - 6 1/2	6 1/2 - 6 1/2	6 1/2 - 6 1/2	6 1/2 - 6 1/2
BSA Sterling LIBOR	-	5 1/2	6 1/4	6 1/2 - 6 1/2	6 1/2 - 6 1/2	6 1/2 - 6 1/2
Sterling CDs	-	-	5 1/2 - 6 1/4	6 1/2 - 6 1/2	6 1/2 - 6 1/2	6 1/2 - 6 1/2
Treasury bills	-	-	5 1/2 - 5 1/2	6 1/4 - 6 1/4	-	-
Bank bills	-	-	5 1/2 - 5 1/2	6 1/4 - 6 1/4	-	-
Local authority dep.	6 1/4 - 6 1/4	6 1/2 - 6 1/2	6 1/4 - 6 1/4	6 1/4 - 6 1/4	6 1/4 - 6 1/4	6 1/4 - 6 1/4
Discount Market dep.	6 1/4 - 6 1/4	6 1/2 - 6 1/2	6 1/4 - 6 1/4	6 1/4 - 6 1/4	6 1/4 - 6 1/4	6 1/4 - 6 1/4
UK clearing bank base lending rate 8 per cent from Feb 18, 2000	-	-	-	-	-	-
	Up to 1 month	1-3 months	3-6 months	6-9 months	9-12 months	1-2 years
Certs of Tax Dep. (£100,000)	2 1/4	5	5	5	5	5 1/4

Certs of Tax Dep. under £100,000 to 2 1/4%. Deposits withdrawn for cash 1 1/4%.
Av. base rate of discount May 24, 2000 to Jun 20, 2000, Scheme B 7.54%. Reference rate for period Apr 1, 2000 to Apr 23, 2000, Scheme B & V 6.288%. Finance House Base Rate 8% for May 2000. EDMA May 24 4.0600.

Evidence on UIP

Evidence → UIP is completely wrong.

The expected exchange rate is approximately the same as today's exchange rate.

(the exchange rate in the future is a random variable with mean equal to today's rate and a variance about that mean.)

Reference: Rogoff, "Perspectives on exchange rate volatility," 1998.

Implications:

- it is cheaper, on average, to borrow in the currency with the lowest interest rate.
- similarly it is better, on average, to invest in the currency with the highest rate.
- there is enormous exchange rate risk around these averages → can you afford to take that risk?
- this is not a **riskless arbitrage** opportunity.
Covered interest parity does hold (covered interest parity is a relationship between the exchange rate, interest rates, and the **forward** exchange rate.)

A stronger interpretation of market efficiency:

prices “**reflect information.**”

So far we have said that prices must move often, because of information arrival, and that absence of arbitrage opportunities imply these movements should have particular forms.

One can go further and say that prices must at all times reflect relevant information in a rational way:

- (a) weak-form efficiency means that the current price reflects all information contained in past prices
- (b) semi-strong form efficiency means that the price reflects all public information
 - e.g. if you play roulette, your wealth will follow a random walk (approximately)
 - however, this does not mean that the roulette wheel reflects any important economic information.

Are financial prices efficient in this stronger sense?

The question is not easy to answer empirically.

Orange Juice

Are financial prices efficient in the sense of reflecting all relevant information?

Although the question is very difficult to investigate conclusively, Richard Roll has carried out an interesting study of the market for orange juice concentrate futures. (article published in the *American Economic Review* 1984).

Futures contracts in frozen concentrated orange juice are traded by the Citrus Associates of the New York Cotton Exchange. Data were obtained for the sample period October 1975-December 1981, a total of 1,564 trading days.

The weather is the most obvious influence on the orange crop and is the most frequent topic of stories concerning oranges in the financial press, but weather surprises explain only a small portion of the variability in futures prices. (Other newspaper topics are associated with even less price variability than is weather).

Possible sources of orange juice demand and supply movements - including substitute product prices, general demand, export demand, and production costs - are also investigated. Again, no factor is found that can explain more than a small fraction of the daily price movement.

Summary

By and large financial markets are highly efficient, in the sense that it is difficult to make money trading.

Companies are used to finding positive NPV projects in their main business activities.

They should not expect to find positive NPV projects in the financial markets.