An Analysis of 'Triangle Ordering' in Foreign Exchange Market (Forex): Simultaneous Ordering of Three Major Currency Pairs

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Seyyed Behshad Yassini
PhD Student in Financial Management, Department of Management and Economics, Science and Research branch, Islamic Azad University, Tehran, Iran
b.yassini@gmail.com

Abstract

With considering a 'triangle of three major currency pairs', there is a tiny difference between multiplication of exchange rate for the first two currency pairs and the third. To discover whether this little difference can lead to a neutral arbitrage or not, I took portfolios of 35 baskets of three major currency pairs(combinations of all 7 major currencies). There are eight approaches (different cases of short and long positions) in each basket; for example buying 1st currency pairs and selling two others, etc.

Historical monthly FX rates were gathered from January 1990 until July 2011. Profit or loss derived from eight approaches in all baskets has been calculated. Number of months with a profit has been compared with the months with a loss. Covariance's of all approaches of FX rates between growth rates were calculated.

I found that this 'triangle ordering' of three currency pairs will not always eventuate to a profit. In the other meaning, this is not a neutral strategy. The results showed that in 94% of 280 cases, the probability of gaining profit is almost equal to gaining loss. Also it was found that the most profitable approach is not the best in probability of profit.

Standard deviations of results (as indicators of risk of the approaches) were diagramed with the amount of profits. This figured 'efficient frontier' of approaches, the best combinations of risks and profits.

Covariance were often positive (in 70% of 280 cases), showing probability of simultaneous effectiveness of external factors on all currencies

Keywords: Forex, Currency Pairs, FX Rate, Arbitrage, Market-Neutral Strategy, Triangle Orders.

1- Introduction

By far the vast majority of currency trading volume is based on speculation — traders buying and selling for short-term gains based on minute-to-minute, hour-to-hour, and day-to-day price fluctuations. Estimates are that upwards of 90 percent of daily trading volume is derived from speculation (Galan & Dolan, Mark & Allen 2007)

In the simplest way, arbitrage is a risk-free type of trading where the same instrument is bought and sold simultaneously in two different markets in order to cash in on the difference between the markets. Second type of arbitrage occurs when two assets trade at different prices but have the same payoff (Alexander, C, 1999). Another type of arbitrage refers to the case where the two assets' payoffs may not be identical at the future date, possibly because of limits to arbitrage resulting from transaction costs, limits on capital or capacity constraints on trading (Liv & Timmermann, Jone & Allen, 2010).

In Forex, arbitrage is a financial operation in which currency pairs are bought and sold, either simultaneously or in minimum lapse of time, either in the same market or a different one, with the goal of obtaining a profit spread, product of the rate's price differentials. Arbitrageurs track the markets to making a decent size of money.Narrow spreads also limit the rate of return. This makes difficulties for an individual with limited resources (Canara Bank, 2008).

2- Literature review

Definitions

Major Currencies

Currencies are traded in pairs and exchanged one against the other. The majority of currencies are traded against the US dollar (USD). The four currencies traded most frequently after the US dollar are the euro (EUR), Japanese yen (JPY), the British pound sterling (GBP), and the Swiss franc (CHF). Some sources also include the Australian dollar (AUD) and the Canadian dollar (CAD) within the group of major currencies (Forex Hedye).

> The bulk of spot currency trading, about 75 percent by volume, takes place in the so-called "major currencies," which represented the world's largest and most developed economies (Galant & Dolan, Mark & Brian, 2007).

Spread

> It is the difference between BID and ASK.

Point

> Movements of exchange rates are usually in terms of points; Minimum fluctuation or smallest increment of price movements (Forex Hedye Accounting Treatment).

Short position

> That is the sale of a currency not owned by the seller at the time of the trade. Short position is usually made in expectation of a decline in the price. In forexmarkets, it

means you've sold a currency pair, meaning you've sold the base currency and bought the counter currency (Galant & Dolan, Mark & Brian, 2007).

Long position

A market position where the client has bought a currency not previously owned (Forex Hedye Accounting Treatment). A long position, or simply a long, refers to a market position in which you've bought a security. In FX, it refers to buy a currency pair (Galant & Dolan, Mark & Brian, 2007).

Basket

In this dissertation, it is a portfolio of three complementary major currency pairs

Triangle ordering

That is simultaneously ordering of three currency pairs, binary combinations of three major currencies

Triangle of three major currency pairs

It is the combination three complementary currency pairs (e.g. EURUSD, USDJY, and EURJPY)

Preface

One strategy in Forex is "Diversification". This strategy creates a complex portfolio of global currencies and adjusts its components daily. Diversification of currencies can lead to better risk-rewards for the combined portfolio. For example, in a portfolio comprised of three currency pairs, one position can be unprofitable at the moment, but the other two could show more profits of than compensatation for the losses incurred with the losing one (Hedye, 2007).

Without considering the spreads, in a specific time, conversion rates of three currencies (USD, EUR, and JPY) are as followed:

EURUSD: 1.40810

USDJPY: 76.777

EURJPY: 108.112

Multiplication of first two currency pairs is not equal to the third. There is a tinny difference:

$$\frac{\text{EUR}}{\text{USD}} \times \frac{\text{USD}}{\text{JPY}} \neq \frac{\text{EUR}}{\text{JPY}}$$

$$(1.40810 \times 76.777)\ 108.110 \neq 108.112$$

Can this little difference make a neutral arbitrage? Is this 'triangle' ordering of three currency pairs a suitable hedged portfolio?

Questions

Main

Can 'triangle' ordering of three major currency pairs make a market-neutral arbitrage strategy in Forex market?

Secondary

Do various baskets of three currency pairs have equal profit / loss?
Do various baskets of three currency pairs have equal risk?
How constant are different eight approaches in making profit in various baskets?
Which approach is the most profitable in each basket?
Is there any relationship between covariances and the proper approach?
Is a riskier approach a more profitable one?

Approach

If we consider all the seven major currencies (USD, EUR, JPY, GBP, CHF, CAD, and AUD) we will have 35 baskets of triangles of three currency pairs:

$$C_3^7 = 35$$

These baskets are listed in table 1.

Table 1 (35 baskets of triangle currency pairs)

	Currencies			Triangle currency pairs		
Basket 1	USD	EUR	JPY	USDEUR	USDJPY	EURJPY
Basket 2	USD	EUR	GBP	USDEUR	USDGBP	EURGBP
Basket 3	USD	EUR	CHF	USDEUR	USDCHF	EURCHF
Basket 4	USD	EUR	CAD	USDEUR	USDCAD	EURCAD
.	.			.		
.	.			.		
.	.			.		
Basket 35	CHF	CAD	AUD	CHFCAD	CHFAUD	CADAUD

I have gathered historical monthly exchange rate of these currency pairs (we call it FX rate) from January 1990 until July 2011 (259 months) in all baskets. A part of the collected data is shown in 'table 2'

Table 2 (historical monthly exchange rate of currency pairs in all 35 baskets)

Month	Basket 1			Basket 2			…	Basket 35		
	USDEUR	USDJPY	EURJPY	USDEUR	USDGBP	EURGBP	…	CHFCAD	CHFAUD	CADAUD
Jul-11	0.700473	79.417535	113.390000	0.700473	0.620136	0.885369	…	1.158490	1.124789	0.970924
Jun-11	0.695362	80.419243	115.661000	0.695362	0.616954	0.887265	…	1.162547	1.121241	0.964473
May-11	0.696667	81.122405	116.468710	0.696667	0.611548	0.877952	…	1.107527	1.071511	0.967527
Apr-11	0.692050	83.275929	120.336667	0.692050	0.610929	0.882825	…	1.066698	1.052601	0.986946
Mar-11	0.714571	81.756733	114.420000	0.714571	0.619412	0.866905	…	1.062943	1.078115	1.014249
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Jan-90	0.831905	144.949423	174.244173	0.831905	0.605995	0.728439	…	0.772312	0.842861	1.091315

Source: fxtop.com

We can have a short or a long position. Therefore there are 8 different 'approaches'. If we show the short position with "S" and the long position with "B", these approaches are: BBB, SSS, BSS, SBS, SSB, BBS, BSB, and SBB. For example, the first approach (BBB)in the first basket is buying EURUSD, JPYUSD, and JPYEUR. Or the second approach (SSS) is selling all these currency pairs. Monthly profit or loss derived from all of the available approaches in all 35 baskets was calculated. A part of the result is shown in 'table 3'.

Table 3 (Basket 1, profit / loss derived from 8 different approaches)

Month	BBB	SSS	SBB	BSB	BBS	BSS	SBS	SSB
Jul-11	-$33,908	$33,908	-$48,501	-$8,684	$23,277	$48,501	$8,684	-$23,277
Jun-11	-$20,663	$20,663	-$16,909	-$3,177	-$577	$16,909	$3,177	$577
May-11	-$67,584	$67,584	-$80,838	-$14,502	$27,757	$80,838	$14,502	-$27,757
Apr-11	$56,746	-$56,746	$121,831	$20,262	-$85,347	-$121,831	-$20,262	$85,347
Mar-11	-$15,574	$15,574	$35,719	$5,569	-$56,861	-$35,719	-$5,569	$56,861
Feb-11	$7,173	-$7,173	$49,542	$6,787	-$49,156	-$49,542	-$6,787	$49,156
Jan-11	-$17,281	$17,281	$4,498	$921	-$22,700	-$4,498	-$921	$22,700
Dec-10	$10,769	-$10,769	-$53,611	-$8,514	$72,894	$53,611	$8,514	-$72,894
Nov-10	$16,197	-$16,197	-$18,238	-$2,709	$37,144	$18,238	$2,709	-$37,144
Oct-10	-$56,155	$56,155	$74,449	$9,233	-$139,837	-$74,449	-$9,233	$139,837
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Apr-90	$75,636	-$75,636	$102,640	$9,333	-$36,336	-$102,640	-$9,333	$36,336
Mar-90	$104,963	-$104,963	$78,351	$7,662	$18,951	-$78,351	-$7,662	-$18,951
Feb-90	$11,651	-$11,651	$35,248	$3,222	-$26,820	-$35,248	-$3,222	$26,820
Jan-90	-	-	-	-	-	-	-	-
SUM	**-$1,606,877**	**$1,606,877**	**-$1,099,772**	**-$219,984**	**-$287,121**	**$1,099,772**	**$219,984**	**$287,121**

Monthly averages of profit / loss are calculated. This variable reflects the return of investment. Standard deviation between returns represents the risk of each approach. Returns and risks of all approaches in all baskets are shown in table 4. Column ‘Positive #’ shows the number of months with profit. Column ‘Negative #’ shows the number of months with loss. Columns ‘Positive %’ and ‘Negative %’ represent the present of months with profit / loss from all 258 months:

Table 4 (Monthly average of returns, Risks, Percent of months with profit / loss)

Basket	Approach	Profit	Monthly Profit	STDEV	Positive #	Negative #	Positive %	Negative %
1	1	-1,606,877	-6,204	57,548	130	128	50.4%	49.6%
	2	1,606,877	6,204	57,548	128	130	49.6%	50.4%
	3	-1,099,772	-4,246	63,857	128	130	49.6%	50.4%
	4	-219,984	-849	7,989	132	126	51.2%	48.8%
	5	-287,121	-1,109	54,036	129	129	50.0%	50.0%
	6	1,099,772	4,246	63,857	130	128	50.4%	49.6%
	7	219,984	849	7,989	126	132	48.8%	51.2%
	8	287,121	1,109	54,036	129	129	50.0%	50.0%
2	1	-20,724	-80	49,344	124	134	48.1%	51.9%
	2	20,724	80	49,344	134	124	51.9%	48.1%
	3	486,381	1,878	40,175	126	132	48.8%	51.2%
	4	79,456	307	5,008	134	124	51.9%	48.1%
	5	-586,561	-2,265	51,745	126	132	48.8%	51.2%
	6	-486,381	-1,878	40,175	132	126	51.2%	48.8%
	7	-79,456	-307	5,008	124	134	48.1%	51.9%
	8	586,561	2,265	51,745	132	126	51.2%	48.8%
3	1	-1,526,115	-5,892	55,178	120	138	46.5%	53.5%
	2	1,526,115	5,892	55,178	138	120	53.5%	46.5%
	3	-1,019,010	-3,934	25,919	127	131	49.2%	50.8%
	4	-120,817	-466	3,611	135	123	52.3%	47.7%
	5	-386,289	-1,491	50,591	130	128	50.4%	49.6%
	6	1,019,010	3,934	25,919	131	127	50.8%	49.2%
	7	120,817	466	3,611	123	135	47.7%	52.3%
	8	386,289	1,491	50,591	128	130	49.6%	50.4%
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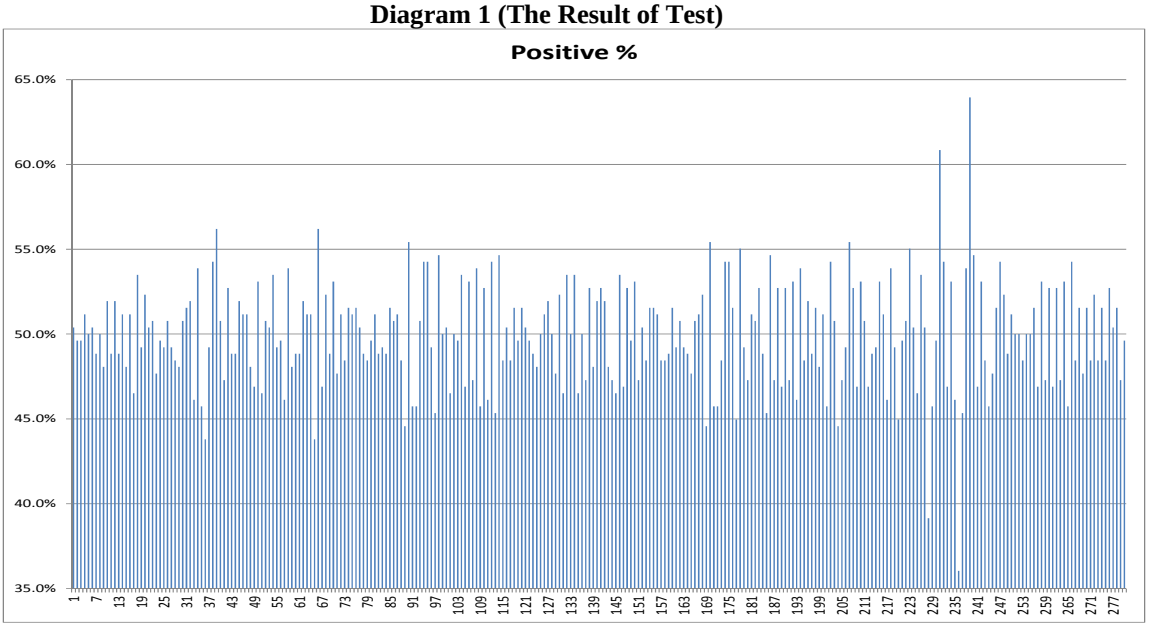
.	.	.	.	.	.	.	.	.
35	1	793,503	3,064	104,409	125	133	48.4%	51.6%
	2	-793,503	-3,064	104,409	133	125	51.6%	48.4%
	3	-320,936	-1,239	69,882	125	133	48.4%	51.6%
	4	49,176	190	3,360	136	122	52.7%	47.3%
	5	1,065,263	4,113	93,957	130	128	50.4%	49.6%
	6	320,936	1,239	69,882	133	125	51.6%	48.4%
	7	-49,176	-190	3,360	122	136	47.3%	52.7%
	8	-1,065,263	-4,113	93,957	128	130	49.6%	50.4%

Conclusions

1) There is not any triangle of three currency pairs that is profitable all the times.
2) Most of the 'Positive %'s (94% of results) are between 45% and 55% (as shown in diagram 1). This means that the probability of gaining profit is almost equal to gaining loss.

Diagram 1 (The Result of Test)



3) On the basis of profit percentage, the best and the worst state is in basket 30. In this basket, approach 4 (BSB with 64%) is the best one and approach 7 (SBS with 36%) is the worst. 'Table 5' shows descending order of percentages.

Table 5 (descending order of percentages)

Basket	Approach	Profit	Monthly Profit	STDEV	Positive #	Negative #	Positive %	Negative %
30	7	5,968	23	4,315	165	93	64.0%	36.0%
29	7	46,140	178	2,800	157	101	60.9%	39.1%
9	2	1,105,539	4,268	48,186	145	113	56.2%	43.8%
5	7	133,949	517	7,290	145	113	56.2%	43.8%
12	2	1,082,290	4,179	67,436	143	115	55.4%	44.6%
22	2	629,887	2,432	76,961	143	115	55.4%	44.6%
26	7	184,100	711	23,639	143	115	55.4%	44.6%
23	2	750,394	2,897	31,623	142	116	55.0%	45.0%
28	7	-169,321	-654	33,872	142	116	55.0%	45.0%
15	2	807,620	3,118	51,139	141	117	54.7%	45.3%
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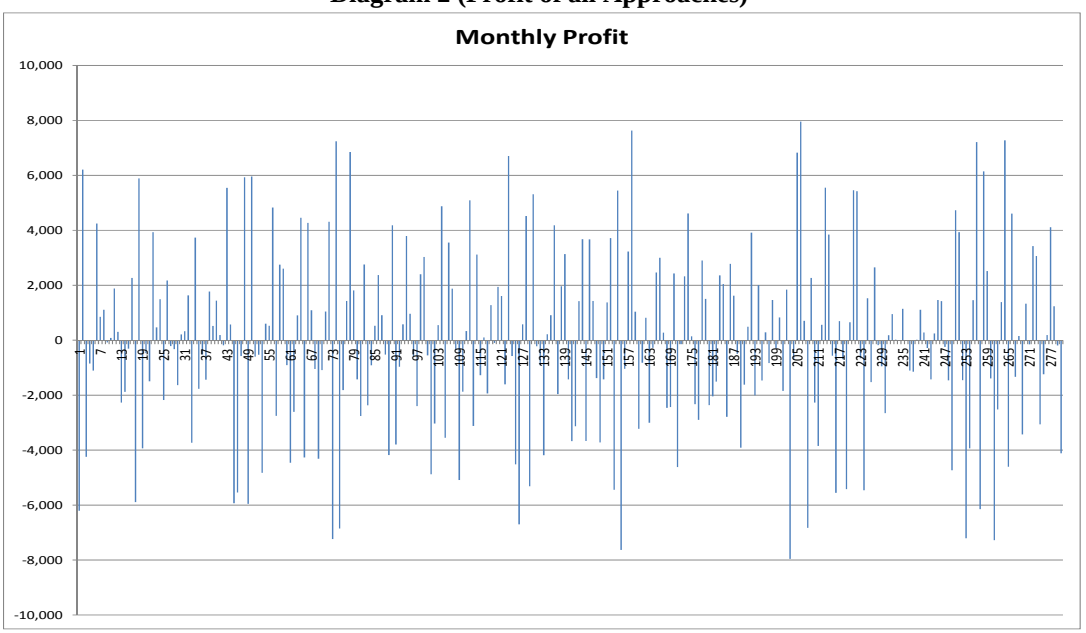
.	.	.	.	.	.	.	.	.
9	1	-1,105,539	-4,268	48,186	113	145	43.8%	56.2%
29	4	-46,140	-178	2,800	101	157	39.1%	60.9%
30	4	-5,968	-23	4,315	93	165	36.0%	64.0%

4) The most profitable state is in basket 26, approach 6 (BSS with $7954 profit per month) and the worst one is in the same basket, approach 3 (SBB with $7954 loss per month). 'Table 6' represents descending order of profits. 'Diagram 2' shows the profits of all approaches:

Table 6 (descending order of monthly profit)

Basket	Approach	Profit	Monthly	STDEV	Positive #	Negative #	Positive %	Negative %
26	6	2,060,113	7,954	69,377	127	131	49.2%	50.8%
20	6	1,975,206	7,626	61,298	125	133	48.4%	51.6%
33	8	1,883,852	7,274	61,781	137	121	53.1%	46.9%
10	2	1,874,580	7,238	62,235	133	125	51.6%	48.4%
32	8	1,867,516	7,210	59,977	133	125	51.6%	48.4%
10	6	1,774,385	6,851	55,665	126	132	48.8%	51.2%
26	5	1,767,768	6,825	86,915	122	136	47.3%	52.7%
16	3	1,736,301	6,704	90,947	126	132	48.8%	51.2%
1	2	1,606,877	6,204	57,548	128	130	49.6%	50.4%
33	2	1,591,686	6,146	73,805	137	121	53.1%	46.9%
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
33	5	-1,883,852	-7,274	61,781	121	137	46.9%	53.1%
20	3	-1,975,206	-7,626	61,298	133	125	51.6%	48.4%
26	3	-2,060,113	-7,954	69,377	131	127	50.8%	49.2%

Diagram 2 (Profit of all Approaches)



5) In about 39% (54 cases) of cases of loss, we have numbers upper than 50%. This means the ranking on the basis of profitability does not represent the ranking on the basis of percentages. For example basket 30, approach 7 is the best state in percentage, but it is the 139th best on the basis of profitability. And basket 26, approach 6 is the best on the basis of profitability, but it is in the rank of 159th on the basis of percentages.
6) Standard deviation between returns in each approach, represent the amount of risk. On this basis, 29-7 (basket 29 approach 7) has the lowest risk and 35-2 is the riskiest approach. Table 7 lists ascending amount of risks:

Table 7(ascending amount of standard deviation)

Basket	Approach	Profit	Monthly	STDEV	Positive #	Negative #	Positive %	Negative %
29	7	46,140	178	2,800	157	101	60.9%	39.1%
29	4	-46,140	-178	2,800	101	157	39.1%	60.9%
35	4	49,176	190	3,360	136	122	52.7%	47.3%
35	7	-49,176	-190	3,360	122	136	47.3%	52.7%
3	7	120,817	466	3,611	123	135	47.7%	52.3%
3	4	-120,817	-466	3,611	135	123	52.3%	47.7%
31	4	62,877	243	3,935	118	140	45.7%	54.3%
31	7	-62,877	-243	3,935	140	118	54.3%	45.7%
30	7	5,968	23	4,315	165	93	64.0%	36.0%
30	4	-5,968	-23	4,315	93	165	36.0%	64.0%
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
35	8	-1,065,263	-4,113	93,957	128	130	49.6%	50.4%
35	1	793,503	3,064	104,409	125	133	48.4%	51.6%
35	2	-793,503	-3,064	104,409	133	125	51.6%	48.4%

7) 'Diagram 3' shows the combination of profits and risks. Horizontal axis shows the amount of standard deviation of returns, vertical axis shows the amount of profit, and every dot represents an approach. There are 280 dots (35 basket x 8 approaches). All the red dots below the horizontal axis compromise loss and they are not suitable to adopt. There are 14 blue dots those contain most profit in a specific amount of risk, and lowest risk in a specific amount of return. These dots form a curve that is called 'efficient frontier'. These dots are listed in table 8.

Diagram 3 (profits and risks of various approaches in all baskets)

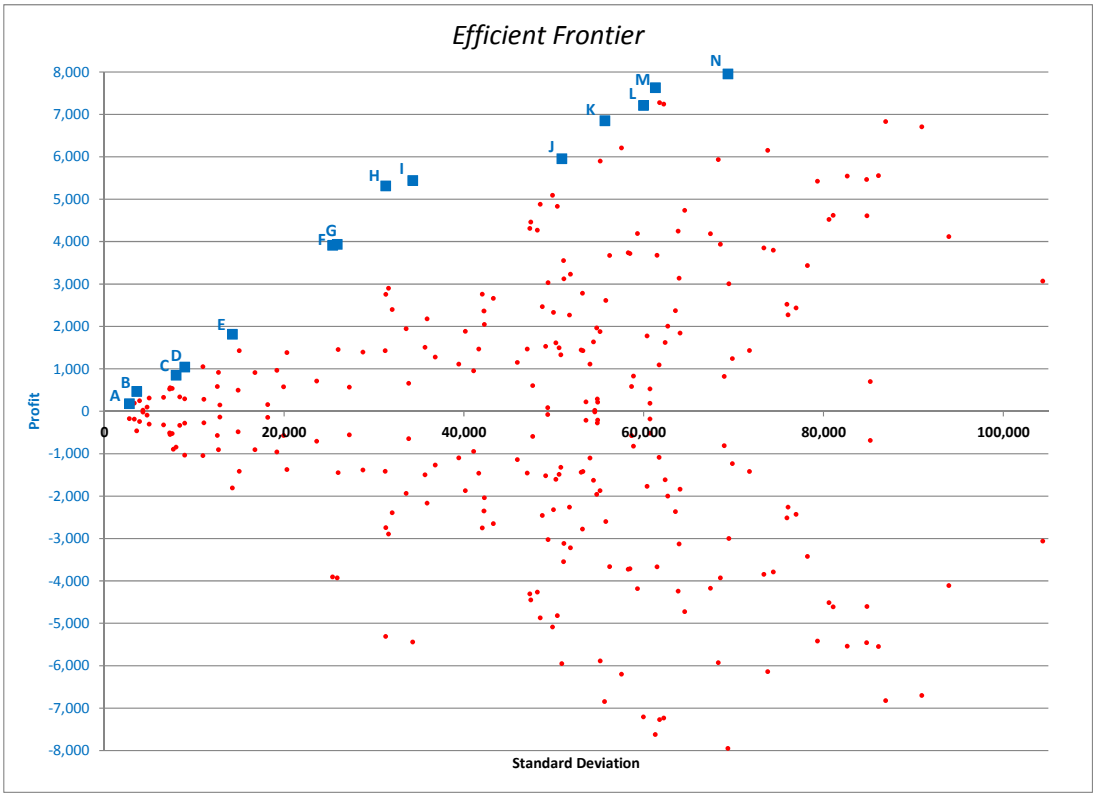


Table 8 (dots on the efficient frontier curve)

	Basket	Approach	Profit	STDEV	Positive	Currencies	Details
A	29	7	178	2,800	60.9%	JPY-CHF-CAD	BSS
B	3	7	466	3,611	47.7%	USD-EUR-CHF	SBS
C	1	7	849	7,989	48.8%	USD-EUR-JPY	SBS
D	20	7	1,041	8,952	48.8%	EUR-GBP-CHF	SBS
E	10	7	1,812	14,248	48.4%	USD-GBP-CHF	SBS
F	24	8	3,910	25,397	53.1%	EUR-CHF-AUD	SSB
G	3	6	3,934	25,919	50.8%	USD-EUR-CHF	BSS
H	17	2	5,311	31,303	52.3%	EUR-JPY-CHF	SSB
I	20	2	5,442	34,314	51.6%	EUR-GBP-CHF	SSS
J	7	2	5,955	50,893	53.1%	USD-JPY-CHF	SSB
K	10	6	6,851	55,665	48.8%	USD-GBP-CHF	BSS
L	32	8	7,210	59,977	51.6%	GBP-CHF-CAD	SSB
M	20	6	7,626	61,298	48.4%	EUR-GBP-CHF	BSS
N	26	6	7,954	69,377	49.2%	JPY-GBP-CHF	SBS

8) Rates of growth in each basket and related on each three currency pairs are calculated. Most of the covariance's between rates of growth are positive. This might means that there are external economical or other types of factors might affect all the currencies. This is shown in 'diagram 4'.'Table 9'. The most amount of covariance is in basket 2 between USDGBP and EURGBP. The lowest one is in basket 16 and between EURJPY and JPYGBP.

Diagram 4 (binaurally covariance's between growth rates of currency pairs)

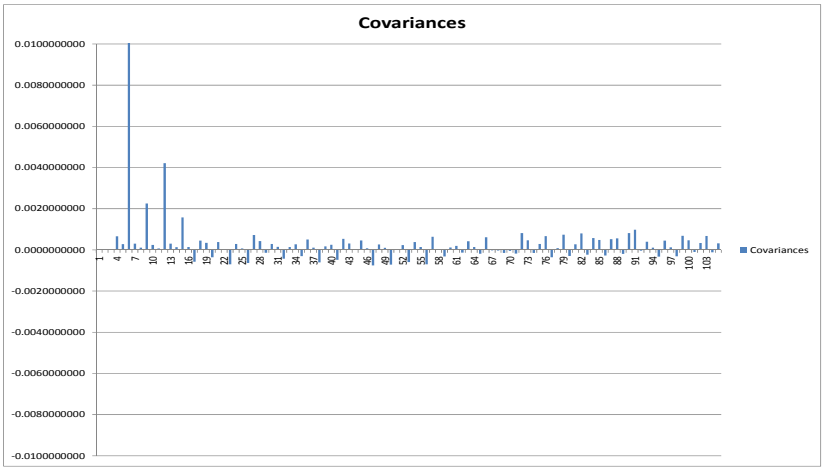


Table 9 (covariances ranking)

Basket	Currencies	Covariances
2	2 - 3	0.0403896204
4	2 - 3	0.0042109562
3	2 - 3	0.0022541728
5	2 - 3	0.0015795685
31	1 - 2	0.0009771837
30	2 - 3	0.0008124073
.	.	.
.	.	.
.	.	.
9	1 - 3	-0.0006346955
19	1 - 3	-0.0006990491
8	1 - 3	-0.0007008474
17	1 - 3	-0.0007162792
16	1 - 3	-0.0007522186

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