

Financial Arbitrage and Information Technology

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I. Introduction and Motivation

In his 2003 controversial article entitled "IT does not matter", Nickolas G. Carr argued that Information Technology (IT) has lost its magical power to provide competitive advantages and that corporations would be better off focusing on the risk of IT rather than looking at IT as a strategic asset that can provide opportunities.

His reasoning is similar to what took place a century ago with electricity, when utility companies became able to centralize power generation in big utilities and were able to distribute electricity over a network of electrical grid systems. At first, many electric producing/providing companies resisted the change, but lower costs, freed-up capital, more flexibility, and fewer problems made even the larger companies to change their strategies and switch. This transformation helped smaller companies, which before had to stand on the sidelines and just watch bigger companies, to buy electricity over the public electrical grid and sell it to their customers. In a similar fashion, advances in computer networking, hardware sharing, grid computing, and internet services are all making IT utilities possible, in which IT has become more accessible, affordable, and ubiquitous.

In the past, building or buying new IT systems required a large amount of investments, and only the largest and best funded companies could afford cutting-edge technology. Smaller companies did not have any choice to just wait for costs to come down, and by then, they would have been many years behind the other big companies.

Further, it is hypothesized that over time, centralizing control over the basic IT infrastructure will ultimately increase the level of security and make network grid more reliable, which in turn make the utility model much more successful.

Another important fact about computing technology is that today, due to free open-source software, utility and application services provided over the internet, and the more affordable computers of today, most customers are small to midsize organizations without a large IT budget. These organizations vary from small businesses, to schools, and to non-profit organizations, and can all have and benefit from the same state-of-the-art systems that used to be only available to large companies with astronomical IT budgets. Thus, this new trend in business-computing - that is the era of inexpensive, affordable, reliable, and ubiquitous hardware and software is leading the way into the future.

On the other hand, IT guru, Robert M. Metcalfe, views IT investment as a source of competitive advantage. He further argues that it determines the path of sustainable excellence for a corporation.

Obviously, Carr and Metcalfe are at polar opposites. Carr's beliefs are that IT and IT investments are not sources of competitive advantage, and they do not give a company an edge over its competitors. However, Metcalfe believes that IT innovation and those who adopt IT early can get a competitive advantage.

We believe that, like any heated debate, the truth may lie in the blend of both views. In this paper we will find out whether the reality supports IT as a strategic asset or infrastructural asset in the financial services industry or both. In case of both, it will indicate that there is an optimal level of investment in IT beyond which it will cease to be a strategic asset.

II. Review of the Literature

In this section we review the works of leading researchers and practitioners in the area of information technology on strategic values of information technology and their views on Carr's argument of IT no longer is the source of competitive advantage.

According to George Stalk (1998) competitive advantage is a constantly moving target like the competition itself. For any company in any industry, the key is not to get stuck with a single simple notion of its source of advantage. Innovation represents the most powerful new sources of competitive advantage.

Piccoli & Ives (2005) in a survey of the IT literature surmise that the sustainability of IT-dependent competitive advantage can be obtained through efficiency improvements, differentiation, and channel domination.

Kohli and Grover (2008) observe that the information technology has now become an essential part of today's modern organizations, but still have difficulty measuring its contribution to business performance. They maintain that the innate logic of Carr's argument implies that if IT does not matter, then all IT research does not matter. A very tough notion to accept.

According to Clemons and Row (1991) as business value of IT has been difficult to measure, many have classified IT as a strategic necessity. They further observe that IT is necessary but not sufficient for sustainable competitive advantage. They believe information systems are strategic business tools, frequently essential to a firm and central to its competitive strategy.

Clemons and Kimbrough (1986) believe that because IT can improve the cost, timing, and quality of information flows and decision processes, it can radically change the transaction economics with far-reaching strategic results. Monitoring costs and, hence, uncertainty can be decreased.

Nevo and Wade (2010) emphasize that IT assets derive their business value from the impact they make on the organizational resources with which they interact. Thus, they maintain, that the intrinsic capabilities of the IT assets should not be used alone to measure their business value; the emergent capabilities arising from their synergistic relationships with organizational resources should be part of valuation metric.

According to Barua, Mani, and Mukherjee (2010) conducted a study of over 150 Fortune 1000 firms from every major industry. They illustrate that small and even marginal investments in information technology such as effective and quality data can have a large positive impact on key financial measures. They show, among others, the slight investment in IT can increase the return on Equity (ROE) of the average Fortune 1000 by 16%, the Return on Invested Capital

(ROIC) by 1.4%, resulting in net income increase of \$5.4 million, and the Return on Asset (ROA) by 0.7%, resulting in additional income of \$2.87 million.

Marcus Heidmann (2010) indicates that a core-banking-system replacement can close more than 50% of the cost gap with competitors for one bank. A core-banking-system project can yield strong returns over ten years.

In summary, many IT professional and practitioners believe that as technology becomes more affordable, reliable, and wide-spread, the potential for competitive advantage increasingly depends on how organizations make use of acquired technology and the how they adapt their organizations and business processes to make the best use of that technology.

As evidenced above, Nicholas Carr's argument that affordable and accessible IT will no longer offer strategic values to companies as scarcity—not ubiquity—makes a business resource essentially strategic, stands out in sharp contrast with others' views of IT's capability. He believes that much of the over \$1 trillion invested globally on IT every year is wasted, and it is not efficient for an organization to invest and create its own computing infrastructure, because this will lead to massively redundant investment and will result in extraordinarily low levels of asset utilization.

III. Empirical Testing of the Arguments

We will test the arguments by looking into financial services industry. We chose to look at financial arbitrage as this involves not only strategic thinking but also quick execution to make an abnormal profit. We will test whether the companies who execute covered interest arbitrage as strategic activity, value technology as a competitive advantage or as a commodity.

a. Covered Interest Arbitrage

Let us start by explaining why covered interest arbitrage involves strategic applications. The Covered Interest Rate Parity (IRP) states that

$$F_0^{IRP} = S_0 \left[\frac{1+i_{\$}}{1+i_{\pounds}} \right] \text{ where } i_{\$} = \text{annual money market rate in US, } i_{\pounds} = \text{annual money market rate in}$$

UK, S_0 = Spot Price defined as price of foreign currency, F_0^{MKT} = Forward market price of foreign currency, and F_0^{IRP} = Forward IRP price of foreign currency.

The left hand side of the above equation is the forward rate for delivering one unit of foreign exchange in future. The right hand side gives the cost of delivering one unit of foreign exchange through money market. If the market is competitive then the costs of forward and money market should be equal. Companies like Wachovia looks at the above equation and looks to take advantage of disparity. If both sides are equal then the foreign exchange is fair valued. However, arbitrage opportunities present themselves if the following happen. 1) If the forward market is overvalued then one should sell or lend the foreign currency and buy or borrow the domestic currency to take advantage of mispricing. 2) On the other hand if the foreign exchange is undervalued, then one will go for the foreign exchange. The case of overvalued £ is presented.

Scenario: Overvalued £

$i_{\$} = 3\%$ $i_{£} = 5\%$ $S_0 = \$2.00/£$ $F_0^{MKT} = \$2.05/£$ where variables are as defined above.

Test 1: Cost of Borrowing

$(1+.03) < 2.05/2.00 * (1+.03)/1+.05$ - Borrow in US, Lend/Invest in UK

Test 2: Mispricing

$F_0^{IRP} = 2 * [1.03/1.05] = \$1.9619/£ < F_0^{Mkt} = \$2.05/£$ - £ is overvalued.

Borrow \$ and sell £.

Actions	ICF (\$)	FCF (\$)
Convert into £,		
Invest in UK	-\$1	+£0.50(1.05) S_1 =+£0.525 S_1
Sell £, Go short £0.525 @		
$F_0^{Mkt} = \$2.05/£$	0	£0.525(\$2.05/£- S_1) =\$1.0763-£0.525 S_1
Borrow \$1 in US	+\$1	-\$1(1+.03) =-\$1.03
	-----	-----
	0	1.0763-1.03=+.0463

There will be arbitrage where \$ is demanded and £ is sold bringing $F_0^{Mkt} = \$2.05/£$ **down** to $F_0^{IRP} = \$1.9619/£$. Market corrects itself because of self-interest or invisible hand. Here sustainable greed is at work

b. *Cross Rate Arbitrage*

$S^{HM} (€£) = S^{HM} (\$/£) \div S^{HM} (\$/€)$ where

$S^{HM} (€£)$ is homemade cross rate as obtained from market data on respective country's spot rate. On the other hand the market provides a direct spot cross rate, $S^{MKT} (€£)$. If $S^{MKT} (€£) \neq S^{HM} (€£)$, then there is an unexploited profit opportunity (UPO_{SCR}) and will be cross rate arbitrage.

Scenario: £ is undervalued

Citi $S^b(\$/\text{£})=1.9712$; Chase $S^b(\text{€}\$)=.6783$; Wells $S^a(\text{€}\text{£})=1.3310$

With the given data, we get homemade cross rate as follows:

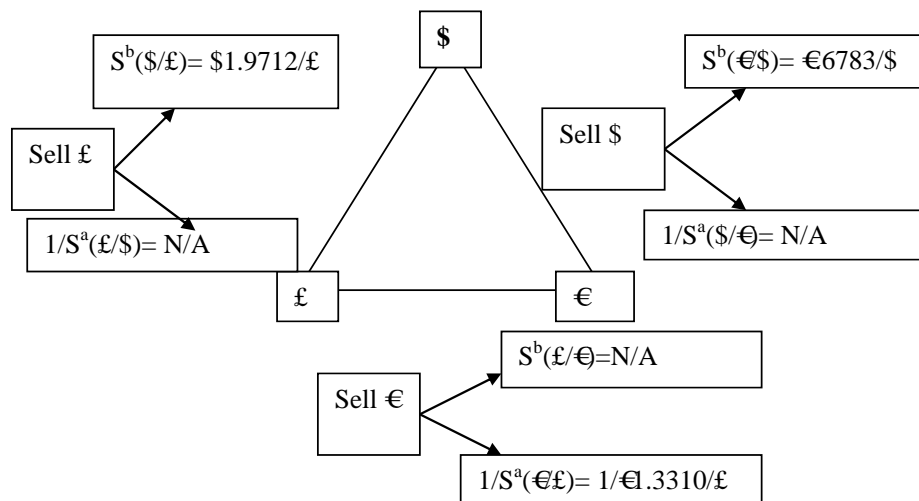
Homemade Cross Rate $S^{\text{HM}}(\text{€}\text{£})$: $S^b(\text{€}\text{£})=S^b(\$/\text{£}) \times S^b(\text{€}\$)=\text{Sell } \text{£} \text{ to get } \$ \times \text{Sell } \$ \text{ to buy } \text{€} - \text{£ Investor.}$

Market Cross Rate $S^{\text{MKT}}(\text{€}\text{£})$: $S^b(\text{€}\text{£})=S^b(\$/\text{£}) \times S^b(\text{€}\$)=1.9712 \times .6783 = \text{€}1.3371/\text{£}.$

Since $S^{\text{HM}}(\text{€}\text{£}) - S^{\text{MKT}}(\text{€}\text{£}) \neq 0$, there is unexploited profit opportunity for Spot Cross Rate.

The Homemade bid cross rate is higher than market ask cross rate. Hence, £ is undervalued. An arbitrageur will go for £ and a triangular arbitrage will ensue.

Cross Rate Arbitrage



Riskless Profit = $.6783 \times 1/1.3310 \times 1.9712 \times 5,000,000 = 5,022,783$ or 22,783 profit.

Implications

The implications of the above arbitrage process are as follows. Whenever a mispricing is detected, three sets of activities are generated – two money market activities and one forward market activity in covered interest arbitrage. The large banks carry out these activities as Spot Forward Swap accompanied by borrowing or lending activity. This trading entails strategic placement of orders. The size and reputation of players and quick access to order books are essential. Similarly, in cross rate arbitrage triangular activities are generated. As we look into the

executions of the players in reality, we will find out whether technology gets the prominence as Metcalfe contends or whether the technology is no longer a strategic asset as all competitors have the similar technology. Further, if we find out that the players emphasize co-locations as their strategy; this will mean that technology is no longer a strategic advantage. The competitors are seeking elsewhere to get strategic advantage. This will support Carr's view. In either case, we will be successfully bringing the debate to the empirical realm of financial arbitrage.

IV. Data, Methodology, and Empirical Findings

We test the following two hypotheses on the linkage between financial arbitrage and information technology.

Hypothesis 1: Covered Interest Arbitrage is affected by comparative advantage in information technology.

Hypothesis 2: Cross Rate Arbitrage is affected by comparative advantage in information technology.

a. Data

1. The data is obtained through hand collection. To test the hypotheses and investigate the relationship between UPOs and IT investments, yearly data from 1999 to 2010 for the Euro (exchange, spot, forward, interest rates), yearly data from 1989 to 2010 for the British Pound and US Dollar (exchange, spot, forward, interest rates), and yearly expenditures from 1980 to 2010 for IT investments were tabulated. The starting point of the sample period was determined by the availability of data.
2. To obtain data on interest rates on notes we have used the Federal Reserve and Federal Reserve Bank of St. Louis Federal databases. We have used data from Bank of England and European Central Bank for Exchange rates, Spot and Forward on Euros and Pounds. And to obtain data for Euros & Pounds Cross rates, Spot and Forward Rates, we have used databases from the University of British Columbia - Sauder school of Business and Institute of Chartered Accountants in England and Wales.

Hypothesis 1: Covered Interest Arbitrage is affected by comparative advantage in information technology. We define,

$$UPO = f - (i_s - i_f) \neq \text{where UPO is unexploited profit opportunities.}$$

We have analyzed the relationship between UPOs and technology investments and level of investment (high and low) for the following scenarios for Euro and British Pounds.

- $UPO_f(UPO_{\text{€}}) = \alpha + \beta (\text{Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 1
- $UPO_f(UPO_{\text{€}}) = \alpha + \beta (\text{LN Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 2
- $UPO_f(UPO_{\text{€}}) = \beta (\text{Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 3
- $UPO_f(UPO_{\text{€}}) = \beta (\text{LN Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 4

In equations 1 and 3, we are looking at the level of technological expenditure, and equations 2 and 4 deal with natural log of technological expenditure. We are using dummy variable regression to find out the impact of high or low levels of technological expenditure.

Initially, we used a t-test with the assumption of unequal variances to test our hypothesis. We used multiple regressions to investigate the relationship between technology expenditure, level of IT investment and UPOs. We analyzed the relationship for both absolute values of UPOs and squared values of UPOs. The analysis revealed that with respect to the Euro (see Table 1 for data summary), there was a significant difference, with P-value of $.009 < .05$, between the two means. We further ran regression to study the relationship between absolute value of UPOs and IT investments and level of IT investments. Our analysis showed that indeed there was a strong relationship between UPOs and investments in IT with multiple R of almost 85% for scenarios 3 and 4, but for scenarios 1 and 2, the relationship was weak with multiple R of around 35% (Table 2). Also, the regression analysis further showed that except for the scenario 3, the level (high or low) of IT expenditure was not an influential variable. The regression analysis almost showed the same results, however with smaller multiple R, when we used squared values of UPOs instead of absolute values (Table 3). We concluded that even the small sum of money spent on IT can have an impact on UPOs, as does the large amount of IT investments. Therefore, our analyses show greater support for the Metcalfe's views and full support for hypothesis 1. However, as far as the British Pound (see Table 4 for data summary) was concerned, the t-test showed that there was not a significant difference between the two means, with P-value of $.89 > .05$. Furthermore, the regression analyses (Tables 5 & 6) also showed that although there was a relationship between UPOs, for both absolute and squared values and the IT investments, but the relationship was not as high as the Euro's was. Overall, our analyses showed greater support for the Carr's views of IT with partial to no support for hypothesis one.

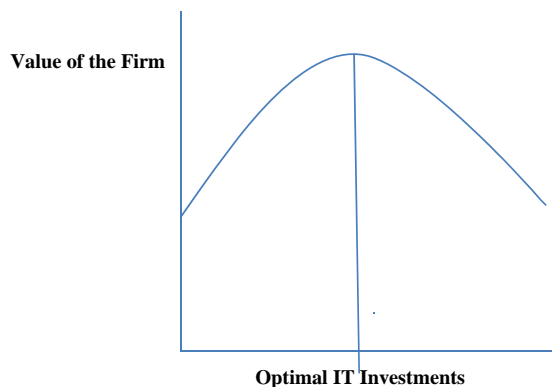
Hypothesis 2: Cross Rate Arbitrage is affected by comparative advantage in information technology. We define:

- $UPO_{SCR} = S^{HM} (\text{€£}) - S^{MKT} (\text{€£}) \neq 0$ if there is unexploited profit opportunity for Spot Cross Rate (UPO_{SCR}) where $S^{HM} (\text{€£})$ is homemade spot cross rate and $S^{MKT} (\text{€£})$ is market spot cross rate. Similarly, we define for forward market,
- $UPO_{FCR} = F^{HM} (\text{€£}) - F^{MKT} (\text{€£}) \neq 0$ if there is unexploited profit opportunity for Forward Cross Rate (UPO_{FCR}) where $F^{HM} (\text{€£})$ is homemade forward cross rate and $F^{MKT} (\text{€£})$ is market forward cross rate.

We have analyzed the relationship between UPOs and technology investments, and the level of investment (high and low) for the following scenarios for both Spot and Forward Cross Rate:

- $UPO_{SCR} (UPO_{FCR}) = \alpha + \beta (\text{Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 5
- $UPO_{SCR} (UPO_{FCR}) = \alpha + \beta (\text{LN Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 6
- $UPO_{SCR} (UPO_{FCR}) = \beta (\text{Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 7
- $UPO_{SCR} (UPO_{FCR}) = \beta (\text{LN Tech. Exp.}) + \gamma (\text{High or Low Tech. Exp}) + \varepsilon$ 8

We used t-test for two sample with unequal variances to investigate the hypothesis two. We also used multiple regression to analyze the relationship between IT investments, high or low level of investment and UPOs for both absolute values and squared values of UPOs. The t-test analysis for the Spot Cross Rate (€£) (see Table 7 for data summary) showed that there was not a significant difference between the two means with a P-value of $.93 > .05$. We further ran regression to study the relationship between absolute value of UPO_{SCR} , the IT investments, and the level of IT investments. Our analysis showed that there was a relationship between UPO_{SCR} and investments in IT with multiple R of almost 83% for scenarios 7 and 8, but for scenarios 5 and 6, the multiple R of around 14% (Table 8), and the regression analysis further showed that generally, the level of IT expenditure was not an influential variable. The regression analysis almost showed the same results, however, with smaller multiple R when we used squared values of UPO_{SCR} instead of the absolute values (Table 9). We concluded that even the small investment in IT can have an impact on UPO_{SCR} . The analysis showed mixed results and therefore, we believed it leaned more towards the Metcalfe's views of IT with partial support for hypothesis one. Similarly, The t-test analysis for the Forward Cross Rate (€£) (see Table 10 for data summary) showed that there was not a significant difference between the two means with the P-value of $.82 > .05$. We further ran regression to study the relationship between absolute value of UPO_{FCR} , IT investments, and the level of investments. Our analysis showed that there was a relationship between UPO_{FCR} and investments in IT with multiple R of almost 75% for scenarios 7 and 8, but for scenarios 5 and 6, the multiple R of around 60% (Table 11). The regression analysis also showed that, in general, the level of IT expenditure was not an influential variable. The regression analysis almost showed the same results, however, with smaller multiple R, when we used squared values of UPO_{FCR} instead of the absolute values (Table 12). We concluded that there was a relationship between UPO_{FCR} and the IT investments, though not very strong, however, even the small investment in IT can have an impact on UPO_{FCR} . The analysis showed mixed results, but we believed it leaned more towards the Metcalfe's views of IT with partial support for hypothesis 2. Our results indicate that there is optimality of IT investments. The following graph explains it well, and the optimal level will maximize the value of the firm.



V. Concluding Remarks

In the introduction we posited that truth may lie in the middle. That is, it is neither 'IT does not matter at all' nor it is 'IT matters all the time'. Our empirical findings indicate such a result

when we linked financial arbitrage and information technology. Our data show that IT investment matters sometime and not always. The implications of our findings suggest that there is an optimal IT investment level. At the beginning stage, the strategic benefits from IT investments far exceeds the risk of IT investments. At some point the role reverses and the risk and mis-utilization of IT investments outweigh the independent and interactive strategic benefits of IT. The challenge is to find the optimal level of IT investments. That will be our next endeavor.

Table 1 - Euro Data Summary

	Data 1 Forward US & EUR	Data 2 US Interest	Data 3 EUR Interest	Data 4 US EUR	Data 5 - F - (US - EUR)	Data 6 IT Exp	Data 7 NL Exp	IT
Mean	0.45	2.64	2.89	-0.23	0.69	559.15	6.32	
Standard Error	0.13	0.56	0.37	0.45	0.50	20.20	0.04	
Median	0.57	2.38	2.88	-0.62	0.97	547.88	6.31	
Mode	#N/A	1.37	#N/A	#N/A	#N/A	#N/A	#N/A	
Standard Deviation	0.45	1.95	1.27	1.56	1.74	69.99	0.12	
Sample Variance	0.20	3.79	1.63	2.43	3.04	4898.78	0.01	
Kurtosis	-1.31	-1.43	-1.08	-0.30	0.68	-1.82	-1.78	
Skewness	-0.14	0.20	-0.16	-0.21	0.42	0.03	-0.05	
IT - Information Technology NL - Natural Logarithm				F - Forward EUR - Euro				

Table 2 - Euro Absolute value of UPO

	R	F	α	β	γ	P-value A	IT \$	Hi/Lo IT \$	NL IT \$
UPO € = $\alpha + \beta$ (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.35	.55	-4.38	.01	-1.10	.47	.32	.49	-
UPO € = $\alpha + \beta$ (LN Tech. Exp.) + γ (Hi or Low Tech. Exp) + ϵ	.33	.53	-34.52	5.77	-.96	.40	-	.39	.55
UPO € = β (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.85	.002*	0	.002	-.05	-	.008	.93	-
UPO € = β (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.84	.002*	0	.22	.26	-	-	.68	.01*
R - linear correlation coefficient F - Significance F α - Intercept, Regression Coefficient β - Regression Coefficient * shows overall significant relationship between UPO and IT investments @5%				γ - Regression Coefficient UPO - unexploited profit opportunity IT - Information Technology NL - Natural Logarithm					

Table 3 - Euro Square value of UPO

	R	F	α	β	γ	P-value A	IT \$	Hi/Lo IT \$	NL IT \$
UPO $\epsilon = \alpha + \beta$ (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.35	.56	-20.07	.04	-2.89	.51	.47	.72	-
UPO $\epsilon = \alpha + \beta$ (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.33	.59	-135.85	22.20	-2.35	.52	-	.77	.51
UPO $\epsilon = \beta$ (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.59	.12	0	.004	1.91	-	.35	.59	-
UPO $\epsilon = \beta$ (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.58	.13	0	.32	2.46	-	-	.45	.38

R - linear correlation coefficient
 F - Significance F
 α - Intercept, Regression Coefficient
 β - Regression Coefficient
 γ - Regression Coefficient

UPO - unexploited profit opportunity
 IT - Information Technology
 NL - Natural Logarithm

Table 4 - British Pound Data Summary

	Data 1 Forward US & UK	Data 2 US Interest	Data 3 UK Interest	Data 4 US - UK	Data 5 F - (US - UK)	Data 6 IT Exp	Data 7 NL IT Exp
Mean	-0.01	5.43	7.90	-2.47	2.46	320.99	5.51
Standard Error	0.00	0.59	0.72	0.36	0.36	36.75	0.14
Median	-0.01	5.04	6.56	-2.06	2.04	267.43	5.59
Mode	#N/A	1.37	5.88	#N/A	#N/A	#N/A	#N/A
Standard Deviation	0.02	3.36	4.06	2.06	2.05	207.90	0.77
Sample Variance	0.00	11.26	16.44	4.26	4.20	43223.55	0.60
Kurtosis	0.35	0.14	-0.71	-0.52	-0.50	-1.52	-1.38
Skewness	-0.38	0.55	0.26	-0.58	0.59	0.29	-0.28

IT - Information Technology
 NL - Natural Logarithm

Table 5 - GBP Absolute value of UPO

	R	F	α	β	γ	P-value A	IT \$	Hi/Lo IT \$	NL IT \$
UPO_£ = α + β (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.47	.027	3.79	-.003	-.53	0	.42	.75	
UPO_£ = α + β (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.45	.04*	4.06	-.16	-1.55	.35		.25	.85
UPO_£ = β (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.67	.00*	0	.01	-5.58	-	.00*	.00**	-
UPO_£ = β (LN Tech. Exp) + γ (High or Low Tech. Exp) + ϵ	.83	.00*	0	.66	-2.60	-	-	.00**	.00*

R - linear correlation coefficient
F - Significance F
 α - Intercept, Regression Coefficient
* shows overall significant relationship between UPO and IT investments @5%
** shows significant relationship between UPO and IT investment level @5%

β - Regression Coefficient
 γ - Regression Coefficient
GBP - British Pound Sterling

Table 6 - GBP Square value of UPO

	R	F	α	β	γ	P-value A	IT \$	Hi/Lo IT \$	NL IT \$
UPO_t = α + β (Tech. Exp.) + γ (Hi or Lo Tech. exp) + ϵ	.46	.03*	16.50	-0	-8.98	.002	.77	.41	
UPO_t = α + β (LN tech. exp.) + γ(Hi Lo tech. exp)+ϵ	.46	.03*	7.81	1.52	-13.92	.78	-	.79	.12
UPO_t= β (Tech. Exp.) + γ (Hi or Low Tech. Exp) + ϵ	.57	.00*	.00	.06	-30.99	-	.00	.00**	-
UPO_t = β (LN Tech. exp.) + γ (Hi or Lo Tech. exp) + ϵ	.71	.00*	.00	3.09	-15.94	-	-	.00**	.00

R - linear correlation coefficient
 F - Significance F
 α - Intercept, Regression Coefficient
 β - Regression Coefficient
 γ - Regression Coefficient
 GBP - British Pound Sterling

* shows overall significant relationship between UPO and IT investments @5%
 ** shows significant relationship between UPO and IT investment level @5%

Table 7 - Spot Cross Rate Data Summary

	Data 1	Data 2	Data 3 = Data 1 / Data 2	Data 4	Data 5	Data 6	Data 7
	SCR US/GBP	SCR US/EUR	SCR EUR/GBP	(HM) SCR EUR/GBP	(Mkt) UPO	IT Exp	NL IT Exp
Mean	0.61	0.88	0.70	0.71	0.00	567.63	6.34
Standard Error	0.03	0.06	0.03	0.03	0.01	20.09	0.04
Median	0.57	0.83	0.68	0.67	0.01	563.77	6.33
Mode	0.71	0.83	#N/A	0.67	#N/A	#N/A	#N/A
SD	0.09	0.18	0.10	0.09	0.03	66.63	0.12
Sample Variance	0.01	0.03	0.01	0.01	0.00	4439.01	0.01
Kurtosis	-1.64	-0.48	-0.39	-0.03	0.50	-1.84	-1.77
Skewness	0.12	0.66	0.89	1.22	-0.90	-0.10	-0.18

SCR (HM) - Spot Cross Rate – Homemade
 SCR (Mkt) - Spot Cross Rate - Market
 IT - Information Technology
 NL - Natural Logarithm

Table 8 - Spot Cross Rate Euro/GBP - Absolute value of UPO

	R	F	α	β	γ	P-value α	IT \$	Hi/Lo IT \$	NL IT \$
UPO_{SCR} = α + β (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.14	.92	.03	.00	.00	.83	.99	.88	
UPO_{SCR} = α + β (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.14	.92	.07	-.007	.00	.93		.92	.96
UPO_{SCR} = β (Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.82	.00*	.00	.00	-.01	-	.006*	.41	
UPO_{SCR} = β (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.82	.00*	.00	.004	-.005	-	-	.006**	.64

R - linear correlation coefficient
F - Significance F
 α - Intercept, Regression Coefficient
* shows overall significant relationship between UPO and IT investments @5%
** shows significant relationship between UPO and IT investment level @5%

β - Regression Coefficient
 γ - Regression Coefficient
GBP - British Pound Sterling

Table 9 - Spot Cross Rate Euro/GBP - Square value of UPO

	R	F	α	β	γ	P-value α	IT \$	Hi/Lo IT \$	NL IT \$
UPO_{SCR} = $\alpha + \beta$ (Tech. Exp.) + γ (Hi or Low Tech Exp) + ϵ	.22	.81	.005	.00	.00	.63	.71	.88	-
UPO_{SCR} = $\alpha + \beta$ (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ϵ	.23	.81	.03	.00	.00	.68	-	.87	.69
UPO_{SCR} = β (Tech. Exp.) + γ (Hi or Lo Tech. Exp) + ϵ	.57	.17	.00	.00	.00	-	.10	.48	-
UPO_{SCR} = β (LN Tech. Exp.) + γ (Hi or Lo Tech. Exp) + ϵ	.58	.16	.00	.00	.00	-	-	.09	.57

R - linear correlation coefficient
 F - Significance F
 α - Intercept, Regression Coefficient

β - Regression Coefficient
 γ - Regression Coefficient
 GBP - British Pound Sterling

Table 10 - Forward Cross Rate Data Summary

	Data 1	Data 2	Data 3 = Data 1 / Data 2	Data 4	Data 5	Data 6	Data 7
	FR US & GBP	FR US & EUR	FCR EUR/GBP	(HM) FCR (Mkt) EUR/GBP	UPO	IT Exp	NL IT Exp
Mean	0.60	0.86	0.72	0.71	0.01	559.15	6.32
Standard Error	0.02	0.04	0.03	0.03	0.01	20.20	0.04
Median	0.61	0.80	0.68	0.68	0.01	547.88	6.31
Mode	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
SD	0.06	0.15	0.09	0.09	0.02	69.99	0.13
Sample Variance	0.00	0.02	0.01	0.01	0.00	4898.7	8
Kurtosis	-1.24	-1.35	0.02	0.24	1.34	-1.82	-1.78
Skewness	-0.04	0.59	1.09	1.16	-0.11	0.03	-0.06

FCR (HM) - Forward Cross Rate - Homemade
 FCR (Mkt) - Forward Cross Rate - Market

Table 11 - Forward Cross Rate Euro/GBP - Absolute value of UPO

	R	F	α	β	γ	P-value			
						A	IT \$	Hi/Lo IT \$	NL IT \$
UPO_{FCR} = $\alpha + \beta$ (Tech. Exp.) + γ (High or Low Tech. Exp) + ε	.63	.10	.17	.00	.03	.03	.05	.17	-
UPO_{FCR} = $\alpha + \beta$ (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ε	.60	.13	1.02	-.16	.03	.07	-	.18	.07
UPO_{FCR} = β (Tech. Exp.) + γ (High or Low Tech. Exp) + ε	.74	.02*	.00	.00	-.01	-	.02*	.31	-
UPO_{FCR} = β (LN Tech. Exp.) + γ (High or Low Tech. Exp) + ε	.76	.02*	.00	.003	.00	-	-	.39	.01*

R - linear correlation coefficient
F - Significance F
 α - Intercept, Regression Coefficient
 β - Regression Coefficient
 γ - Regression Coefficient
GBP - British Pound Sterling
* shows overall significant relationship between UPO and IT investments @5%

Table 12 - Forward Cross Rate Euro/GBP - Square value of UPO

	R	F	A	β	γ	P-value			
						A	IT \$	Hi/Lo IT \$	NL IT \$
UPO_{FCR} = $\alpha + \beta$ (techexp) + γ (Hi or Lo techexp) + ε	.62	.12	.00	.00	.001	.03	.04	.08	
UPO_{FCR} = $\alpha + \beta$ (LN tech exp) + γ (Hi or Lo techexp) + ε	.57	.16	.05	-.007	.001	.06		.11	.07
UPO_{FCR} = β (Tech Exp) + γ (Hi or Lotech. exp) + ε	.57	.18	.00	.00	.00	-	.14	.67	
UPO_{FCR} = β (LN Tech. Exp.) + γ (Hi or Lo techexp) + ε	.57	.14	.00	.00	.00	-		.72	.11

R - linear correlation coefficient
F - Significance F
 α - Intercept, Regression Coefficient
 β - Regression Coefficient
 γ - Regression Coefficient
GBP - British Pound Sterling

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