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Analyses on Gold and US Dollar in Vietnam's Transitional Economy

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JEL Classifications: C12; C22

Keywords: Vietnam; Financial economy; U.S. Dollar; Gold.

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This paper looks into properties of two other *financial assets* that are popular in Vietnam's economy, the United State Dollar (USD) as a major, liquid, and familiar foreign currency; and gold, a traditioormedal saving vehicle.

These financial assets have been so popular that people usually buy them for the purposes of savings, payments, and sometimes hedging against the depreciation of the local currency value. The trades of these assets are also natural and happen as part of daily economic life, therefore have grown up to be liquid markets. For this sole reason, understanding these assets and markets is an integral part of studying Vietnam's financial markets.

The content of this paper consists of two main parts, one on the gold factor in Vietnam's economy, the other empirical analysis on the USD. Each main part is organized in sequential subsections of (i) background; (ii) literature, data, and methods that enable the studying process; and (iii) main analyses and insights drawn upon the study. The last section of the paper sums up key results from two main parts of study.

1 An analysis of the gold factor

1.1 Background on the gold factor

Gold has long been a symbol of wealth since ancient civilization of Egypt or Iraq, *ca.* 5000 B.C. In Asia, large countries such as India and China have also been major importers of gold. This part of study is about gold and the gold market in Vietnam, a country that has been influenced a great deal by the neighboring China.

1.1.1 Functions of gold in Vietnam's economy

The basic uses of gold in Vietnam are: (i) Jewelry frabiration; (ii) Central bank's reserve; (iii) Private investment; and (iv) Industrial applications. Besides these, we consider a number of economic functions of gold in Vietnam's economy that are widely accepted. Some of these functions are related to the low level of economic development in the closed-door times, and have still been retained due to the public habits. Some are related to new concepts of financial assets. The main functions are

1. Payment currency for commercial deals, such as real estates, automobiles, and commercial settlement among individuals;

2. Savings in kind, including interest-bearing gold certificate of deposit;

3. Commercial calculations for financing and obligations, although real-world transactions are not realized by gold itself;

4. A hedge against other financial assets' depreciation in value; and

5. A notion of guarantee.

In Vietnam, until mid-1990s, gold was still used extensively as payment currency for commercial transactions, such as real estates, home applicances (tivi set, radio,...), and

automobiles. Before that, it had been used to even pay for furniture and high-valued apparels. There was no statistics on how much actual value of commercial transaction had been done through gold exchange in the past. Today, this habit is still kept by a portion of the population, although not so frequently as in the past.

Gold hoarding has also been very common. The practice is considered one type of savings, although not very productive. Understanding this practice, several banks in Vietnam also try to mobilize gold money from the public by offering some interest for gold deposits. The Tuoi Tre Newspaper reported on 18-May-2004 that in Ho Chi Minh City, the largest commercial center of Vietnam, the trend of gold deposit increased in the first quarter of 2004, with the growth rate of 15.6%, compared to end of 2003, accounting for 2.1% of total city's deposits at banks. The second growth rate belong to USD, 13.9%, and the lowest was the local currency (VND) 10.8%. Also according to this report, the local currency deposition still accounts for the largest share of total mobilization from the public, 66.5%. However, whenever the national economy shows a sign of possibly higher inflation, such as 5% in the first quarter of 2004, people tend to shift their assets holding to USD and gold.

By a separate online survey, performed by TintucVietnam.com by 7-Apr-2004, we observe that during the period of increasing inflation, surging gold and USD prices in Vietnam, the reaction of the public to the situation is summarized by table (1).

Table 1: Survey result of public opinions about gold and USD

Question: *What will you do having experienced rocketing prices of gold and USD in Vietnam?*		
Options	Percentage	No. of votes
Buy U.S. Dollar	18%	2271
Buy gold	9%	1131
Still keep VND	7%	941
Have no money to consider	35%	4561
Wait-and-see	14%	1788
Don't care	17%	2190

Gold carries with it the notion of guarantee 'as good as gold'. In the financial market, sometimes even the government had to revert to gold as a guarantee for selling government financial products (Vuong 2000 [27] and 2004 [28]).

1.1.2 Gold: regulations, production and trading in Vietnam

Regulations and the authority The major authority that governs gold businesses in Vietnam is the central bank, State Bank of Vietnam (SBV). There are many legal documents related to the gold business in the nation, but some documents listed below are considered of greater importance:

1. Decree No. 174/1999/ND-CP passed on 9-Sept-1999 by the government;

2. Decree No. 64/2003/ND-CP passed on 11-Jun-2003 by the government;

3. Circular No. 10/2003/TT-NHNN passed on 16-Sept-2003 by SBV.

Besides legulatory and operational details, the main spirit of these documents, that has influenced the gold business and market in Vietnam, can be summarized as follows:

1. They remove the requirement for minimum of statutory capital for enterprises that want to be engaged in gold fabrication, trading, jewelry, and gold fine-art works;

2. Legal gold businesses must be authorized by SBV, including the subfields like pressing gold bar, import and export of gold material, gold ore, bar, pieces, bars, pellets, or grain;

3. Trading of gold has to be in line with granted quota. Application for gold import/export quota must be submitted to and authorized by SBV.

Gold mine production There is no official statistics about gold mining in Vietnam. However, the gold deposit in the country is estimated small. It has been estimated that every year Vietnam produced less than 2 tonnes of gold. This is far below the consumption level estimated by the World Gold Council, by which Vietnam consumed approximately 58 tonnes of gold in 2003. The negligible production of gold mines inside Vietnam is an important reason for gold import businesses.

Gold trading There is no statistics available from SBV about situation of gold trading in Vietnam. However, the situation of gold smuggling has been considered active. For example, SBV granted total quota of 10 tonnes of gold for import in 2003, but estimate of actual gold consumption inside Vietnam by the World Gold Council (WGC) was standing at a fairly high level, 58.8 tonnes. A large portion of this statistical discrepancy could be explained by gold smuggling. The smuggling of gold into, sometimes out of, Vietnam could be done in a variety of ways, such undeclared luggages of airline passenger, through land borders with Laos, China, Cambodia, etc.

While Thailand has scrapped their import tariff on gold import (0%), there still exists a tariff on importing gold into Vietnam. Current gold import tax rate applicable for Vietnam's importers is 0.5%. Before 1-Apr-2004, the tarriff rate had been 1%. One of reasons that the government slashed the rate is to channel gold imports through official channels and to stamp out illegal smuggling.

Thus far in 2004, it has been estimated that SBV granted import quotas of approximately 18 tonnes of gold, although SBV itself did not reveal the any figure. Given this quote restriction, there has been no free movement of gold in and out of Vietnam. The trading of gold into and within Vietnam is fairly active, and this point has been confirmed by the WGC in its press release on the event of Vietnam lowering tariffs on gold imports on 31-Mar-2004. The WGC estimates that Vietnam's gold market grew by approximately 5.1% per annum during the period from 1995 to 2003, becoming the second largest gold market within South East Asia, behind only Indonesia. The WGC cites the reason for the rapid growth to be increasing jewelery and investment demands. It also appreciates the fact that real properties in Vietnam are still priced according to their value in gold, in line with our previous mention of gold functions in the economy.

The above has discussed the background of the gold market in Vietnam, based on this information, the subsequent discussions will focus mainly on the market's situation, properties, through gold price, return, and related data.

1.2 Related literature, data and methods

1.2.1 The literature of gold

The literature on gold is not as large as those of other topics in relation to financial and capital markets such as stock, bonds, market properties, etc. Many of the important works on gold date back to early of the XXth century, such as the work of Whittlesey (1937:[31]), Machlup (1941:[21]), Zauberman (1951:[34]), Chandavarkar (1961:[8]), Carter (1963:[7]), Brown (1941:[5]) etc.

Although there are other papers, too, discussing issues around the gold and its roles at central banks, in the economic system, and population's saving modality, but this discussion focuses mainly on those works as they adopt a fairly intuitive approach and discuss some relevant issues to Vietnam's gold market. Below, this brief review will be constructed by relevant issues of the selected literature mentioned above.

Roles of gold in the economy as money The role of gold as money in the economy had been established for a long history. But full gold standard era only started in 1821, when Britain became the first nation to switch to it. Before that most nations had adopted the bimetallic regime of gold and silver. Following Britain, in 1870s North America and all over European regions also switched to the gold standard. In the period, the discoveries of large gold deposits in the American West served as a stimulus for this widespread move. So, the period from 1870 to 1914 witnessed the world operating under a unified gold standard, known as Gilded Age, a fairly short period in the history of monetary systems.

However, the gold standard was much criticized in early XXth century, due largely to problems of bank panics and deflationary gap caused by shortfall and lateness of monetary expansion. The famous mainstream economist John Maynard Keynes once called it 'the barbarous relic' of the old monetary system, and suggest it should never return. After all, there were changes in the notion of gold in the first half of the XXth century, with the birth of IMF/WB in 1944, and the relaxing of gold reserve for the purpose of money value preservation by the Roosevelt administration in 1933, where gold price jumped to USD 32.32/ounce from a stable level of USD 20.50/ounce for many years. The importance of gold was unquestionable in the past, when the gold standard prevailed. Its eminent role leads to a critical analysis of Whittlesey (1937:[31]) on the dilemma: *a. If the USA continue its present policy of purchasing and sterilizing gold a badly unbalanced national budget will be driven still further out of equilibrium; and b. If they abandon the policy they are certain to experience losses, through a fall in the value of stocks of gold, worth billions of dollars.*

Its importance is also stressed in Machlup (1941:[21]), in which the economist takes a retrospective view on the devaluation of the USD in 1933-34, i.e. the raising of the price of gold. Another question is whether large imports of gold constitute a sacrifice

of wealth or income. The debates around these topics among academics and between academics and the policy makers never end; the fact that further stresses the role of gold as money in developed economies. In addition, [31] discusses the dishoarding of gold from the population for the chiefly monetary purposes used to be one of the main task in economic downturn. This happened in both North America and the European economies. A single figure of USD 1.633.5 million dishoarding of gold for supporting monetary value of local currencies in Europe in 1936, just out of the Great Depression, emphasizes the role of gold in the gold standard monetary system. We notice that this amount of USD equivalent is worth 32% of the total world output of new gold production in that year (*op.cit.*[31], p. 587).

Another work by Brown (1941:[5]) provides us with some contemporary concerns in regard to the role of gold in the monetary system. [5] quotes the scholar Hardy as saying: "*The new gold standard of the twenties was not identical with the gold standard which was destroyed by the World War, but the differences were in general technical and did not greatly impair the capacity of the gold standard to perform its primary function.*" These classical analyses were done in the context of likely expanding World War II, where a major ally to the American, the Great Britain, faced the escalated war with Germany. Most economies underwent economic large-scaled economic disorders at the time, and the role of gold was a pertinent issue in many policy and scholarly discussions.

However, we also notice the general perception that on the one hand, the myth of gold standard as better monetary system still exists, on the other departure from the gold standard and using 'paper money' do provide central bank and financial authorities a weapon to fight against deflationary gap and economic recession/depression in many cases, such as the flexible and expansionary policy by the US Federal Reserve dealing with 1987 stock meltdown, which many economists appreciated its danger as much as 1929 depression.

Gold demand and supply In the first half of the XXth century, majority of research papers on gold were centered around the issue of demand and supply of gold as money to the economy. Until this time, the gold standard prevailed in all world major economies, such as the United States, the United Kingdom, France, etc. Most studies in this period excluded the economic impacts of gold flow from the Soviet Union (USSR), and China, two large nations, due to lack of both data and relevance of world economic integration([31, 34]), although both the former USSR and China, P.R. were then large gold mine producers.

The gold demand by world economies, especially the most important ones such as the USA, Britain, France,... had placed a great pressure on the supply side. [7] discussed the issue of gold production and supply in details, in which the author analyzed the evolving situation of gold supply over the time, citing to the work of Charles Hardy *Is there enough gold?*. In his analysis, the devaluation legislation that permitted the US President F.D. Roosevelt to decrease the gold content of one US Dollar from 23.22 fine grains to 13.7 had made the US gold supply increase to USD 6.85 billion from USD 4.0 billion. In the 1936-41 period, the monetary gold stocks of the USA went up to USD 22.74 billion. These happened while the appearance of gold standard in the monetary system had vanished

quickly. In [7], the statistics of gold production in 1962 in total was USD 1,295 million, excluding the Sino-Soviet bloc, compared to the level of USD 848 million in 1953. Africa is the part of the world that produced a majority of newly mined gold USD 969 million in 1962, or 74.8%. North America, the USA and Canada, collectively produced 14.8% of the year total.

Carter (1993, [7]) discusses that the supply of gold consists of three parts: (1) accumulated gold in artistic, ornamental, and industrial forms; (2) monetary gold stocks; and (3) natural resources. The supply of gold is therefore quite complex to be estimated correctly. The analysis shows a picture that about 55% of newly mined gold had gone into the monetary deposits each year, and much of the rest to industrial and artistic uses. In the world financial authorities practices, much of gold production is used for the purpose of credit control in the main form of gold reserves at central banks. In general, the exact gold demand from the public and not for the monetary purpose is a difficult estimate.

Relevance of gold in Soviet-styled and less developed economies In many developing countries, the relevance of gold in the daily economic life is eminent. We have mentioned India, China, Vietnam, Indonesia, and other developing economies in the Asia-Pacific region as an example. The consensus in keeping gold has been analyzed in the work of Chandavarkar (cf.[8]), in which the author focuses on the nature and effects of gold hoarding in less developed countries, with an elaborate discussion of India as one of the world largest gold consumer. Many of his issues and points are relevant to Vietnam. In the survey [8], the author establishes some formal similarities of gold and money such as liquidity and non-interest yielding. However, the situation in Vietnam is different as gold C.D. and gold deposit at several banks do yield interest for the depositors. Through [8] we learn that in the period from 1950-58, the gold proportion of the household sector's savings is low in general 3.6/1.7% p.a. The analysis indicates that the role of gold as a savings medium in both India and many other under-developed economies is comparatively insignificant. This work also raises an interesting point that although there is no doubt that agriculturists in less developed economies could sell gold to meet fixed monetary costs of doing business, but the actual distress sales of this type are "*not normally of an appreciable magnitude because the esteem value attached to gold, particularly ornaments, being very high, its outright sale to meet current or capital outlays is only resorted to in exceptional circumstances such as acute depression.*"

In the analysis of [8], the issue of mobilizing private gold hoards is raised as a type of foreign exchange, and *gold bonds*. We have seen that both of these vehicles exist in Vietnam, in the preceding discussion. However, as a function of bridging the foreign exchange gap, the mobilizing of gold hoards does not necessarily mean a release of of internal real economic resources (*op.cit.*[8], p. 146).

Whittlessey (1937, [31]) also points to gold hoards and the importance of gold flow into and out of private hoards since the 1929 world Great Depression, with a notice on large release of from India, Hong Kong and China. The statistics is between 1931 and 1936, these two released an amount of USD 1.5 billion. European hoards at the time were also not small, through the release of USD 325 million, much of this came from France. And

the estimated gold hoards of French in the 1931-36 period were standing at as much as USD 493 million. So we know that gold hoarding is not a unique situation in less developed countries, particularly East Asia, but also more developed countries such as the US, UK and France (ibid.[31],p. 587).

Zauberman (1951, [34]) extended the study to gold doctrines and practices in the former Soviet Union to find some interesting points. The Soviet rouble was also put on a '*gold basis*', which required some gold content for a rouble. There were controversies in the practices and theories, as in theories, money should die away in the post-revolution society, giving way to a primitve barter economy. Vietnam also followed this model in 1950, and only dropped following the launching of *Doi Moi*. Soviet economists were also divergent on economic concepts of gold. Jurowskij advocated the reformers and suggested to follow a push of the forces of the economy which by 1922 restored gold to wide circulation in the Soviet Union. But chief Soviet monetary economist of the opposite school of thought, i.e. anti-money, Strumilin, branded this advocacy as anti-Marxist. In fact, Lenin lately advocated and prepared a resolution vote by the 9th All Russian Congress of Soviets approving the restoration of '*rational money circulation on the basis of a gold currency*' with utmost effort and urgency (cf.[34], p. 880). However, the striking character of the Soviet styled economy is its money-free calculus, focusing on the kinds, revealing the nature of a barter economy. The motive for putting Soviet rouble on gold was somewhat political, with Koslov's statement (*op.cit.*[34], p. 887): "*USA tries to impose the whole world the paper dollar as the foundation of international settlements, as an international currency. But it is well known that it is gold only which can fulfill the role of international money.... Placing the rouble on the gold basis means that the rouble is the only currency in the world with a hard, gold content.*"

Gold price and return properties The author of [8], *op.cit.* p. 140, stresses that in fact the value of gold has no relation to the growth and development of the economy. Unlike the equities and real properties, gold does not share in the fruits of economic progress. The common point in gold hoarding between the context of this analysis and Vietnam's current situation is that gold in the form of ornaments cannot be a good hedge because of the a peculiarity of this market: '*their sale usually involves a capital loss in so far as the seller cannot get value for the cost of workmanship.*' One point in [8], which we can observe to validify later on is that internal price of gold tends to be higher in under-developed economies than its international price. This leads to the situation where its utility tends to depend on the internal market, apart from statutory restrictions on export.

Using a different approach [25] examines the efficiency of the gold and silver market, with supporting evidence on international market's informational efficiency. Serial dependences are also found, a common issue to stock prices and returns. The examination of [25] is performed on daily price differences and log-differences (returns). The work also presents the evidence that return distribution of international gold departs significantly from Gauss distribution, exhibiting leptokurtosis and fat-tailedness through Kolmogorov-Smirnov's tests.

We have discussed several important aspects of literature on gold, and will move on to describe the data and methods used in subsequent analyses.

1.2.2 Data sets

Because our analyses on the Vietnamese gold market in connection to the world consists of several different aspects, some different data sets will be used. They are described in what follow.

Data sets used and sources A data set on daily gold prices and returns will be used for analysis. The gold prices for use are in fact the daily average between bid/ask prices. The daily gold prices cover the period from the beginning of 1998 until early May-2004 for London Fix Gold Price series, while it is a bit longer series for Vietnam, from Jan-1996 to the same end date. Daily price of London Fix is provided by the Global Financial Data, Inc., at the gold information portal www.onlygold.com. Price of Vietnam's gold market has been collected and updated by the Mezon Finance Co. The main sources for updating Vietnam gold price data are the Bulletin of Market Prices issued on a daily basis, archive of the Ministry of Finance, free market daily quotes by major private gold traders in Hanoi and Saigon. We notice that daily gold quotes for Vietnam's gold market are in the local currency, VND, while the data provided by onlygold.com is ready-made in USD.

Another set of data is average annual international by onlygold.com for showing the long-term trend of the gold price. This data set spans over about 200 years.

We also extract from the original daily price monthy gold prices, for both London Fix and Vietnam's. This will add to our analysis of gold returns, so that we do not have to only stick to the daily series. Monthly returns can also give additional understanding of the market changes over time. Another set extracted from the daily price set is the Bid-Ask spread based on daily gold transactions. This is only applicable to Vietnam's market where the data are available to us.

Data on Vietnam's gold demand are from the estimates of the World Gold Council, from 1994 until 2002, on a quarterly basis.

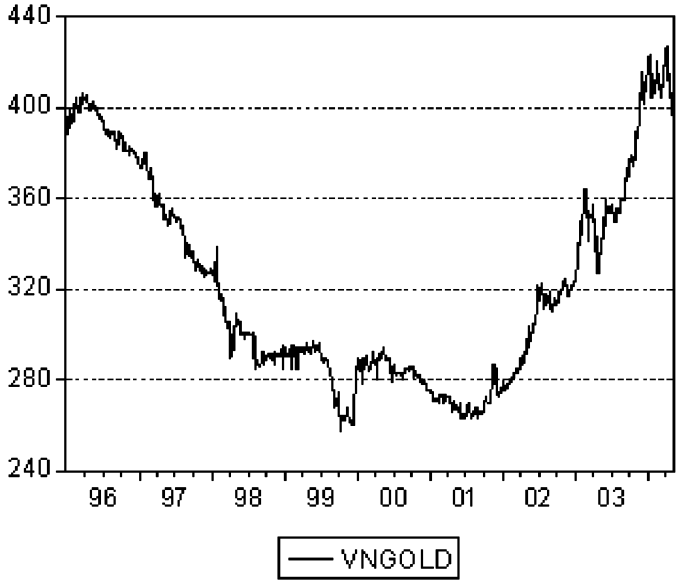
Data and conversion procedures Data conversion is an important task due to the following reasons:

- To be comparable, the buy and sell prices are averaged as international data are all averages.
- Daily gold price in Vietnam is quoted in the local currency, so it should be converted to USD for a better comparison to international prices;
- Vietnam market uses the weight measure system of China, with the rule is different from the standard weight metric system, as well as the English measures. The rule for conversion is 1.0 Troy ounce is equivalent to 31.1034768 grams of gold as in the English measure. In Vietnam measure the standard weight is the Chinese *tael* and

1/10 of a *tael*. A tael is equivalent to 37.4485861 grams. So the idea is 6.02 Troy ounces is equivalent to 5 taels.[1]

Figure (1) below shows us the movement of gold price in Vietnam's market in the period from 1996 to 2004 after these treatments.

Figure 1: Daily average gold price in Vietnam's market



1.2.3 Methods

In the upcoming analyses, we will use simple statistical consideration, and rely more on the intuitive approach. Basic statistical properties of gold returns will be looked at, the same way as we do with the paper on Vietnam Stock Market.

In one consideration, the gold return properties will be analyzed using the same method of $GARCH$ that has been verified by international evidence in the world markets. the detailed discussion of this method can be referred to the preceding paper, so that we save the space here. In addition, a simple test on other properties and hypothesis of efficient market will be performed to gain more insights.

More details will be offered in relevant discussions of empirical results.

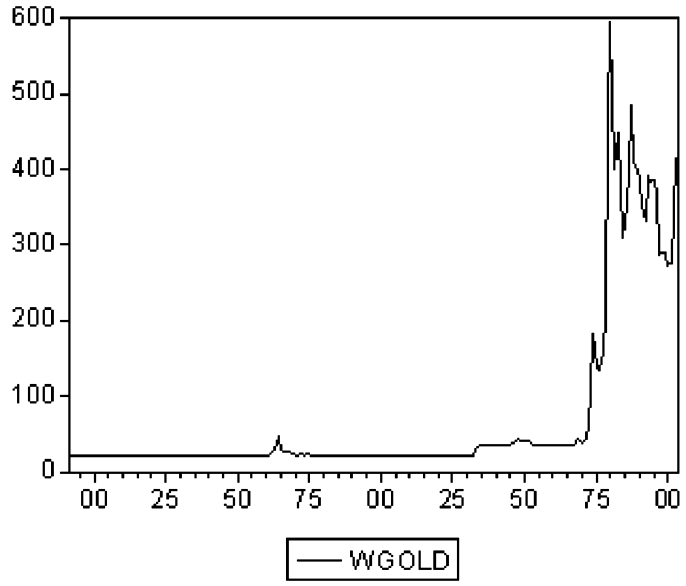
1.3 Analyses of gold in Vietnam

Before specific considerations of Vietnam gold market in the contemporary time, it is worthwhile to look at the degree of changes of world gold market in terms of price over a long horizon. Figure (2) shows the gold price on annual average basis for the period from 1792 to 2003. The price is quoted in USD, so that we can see it has increased drastically in the 1970s, following the move that the United States totally scrapped the gold standard

[1]Details of gold weight measures are: 1 Troy ounce=1.097 ordinary ounce; 32.15 Troy ounces is equal to 1 kg.

and floated its money. After some slow business time, gold price has returned in the recent years and been highly volatile in 2003 and early 2004.

Figure 2: World gold price 1792-2003



The following analyses will discuss several aspects of Vietnam's gold market. Firstly, we look at the domestic gold demand in the past. Secondly, we examine the pattern of monthly gold return, and establish some comparison with the world market. Thirdly, the daily gold return in Vietnam will be estimated using the $GARCH$ specification in our purpose to try to capture further statistical properties. Finally, we look at possible connection of the domestic to world gold market.

1.3.1 Historical gold demands and the trend

Given our rough knowledge about Vietnam's gold mining capacity of less than 2 metric tonnes per annum, we need an indication of domestic gold demand. However, actual demand figures have been not available, estimates by the World Gold Council will be used. Figure (3) will give us an idea of the domestic gold demand in recent reforming period of Vietnam from 1994 to 2002.

What we can see is the upward trend in recent years. The gold demand usually picks up in the fourth and first quarter of the year. The reason for increase in demand in the last quarter and first quarter of the year is because of the habit to generate savings by the year-end after a business cycle. Also the first quarter is the time of Tet (new lunar year) holidays in China, Vietnam, Korea, savings and payments in cash usually increase before and after the days.

The upward trend can be checked by using the ADF paradigm with time trend for the period 1994-2002. We report brief results of such a test below.

$$\begin{array}{lccccccc} \Delta d_t & = & +15.60 & +0.43t & -2.02d_{t-1} & +0.96\Delta d_{t-1} & +0.60\Delta d_{t-2} & +0.22\Delta d_{t-3} & +0.39\Delta d_{t-4} \\ & & (3.66)^{\star} & (3.63)^{\star} & (-3.81)^{\star} & (2.05)^{\star\star\star} & (1.63) & (0.85) & (2.23)^{\star\star} \end{array}$$

where *,** ,*** denote coefficients significant at 1, 5, 10%, respectively. This regression has min. AIC=4.927, and fairly good fit with $\overline{R}^2 = 0.7743$.

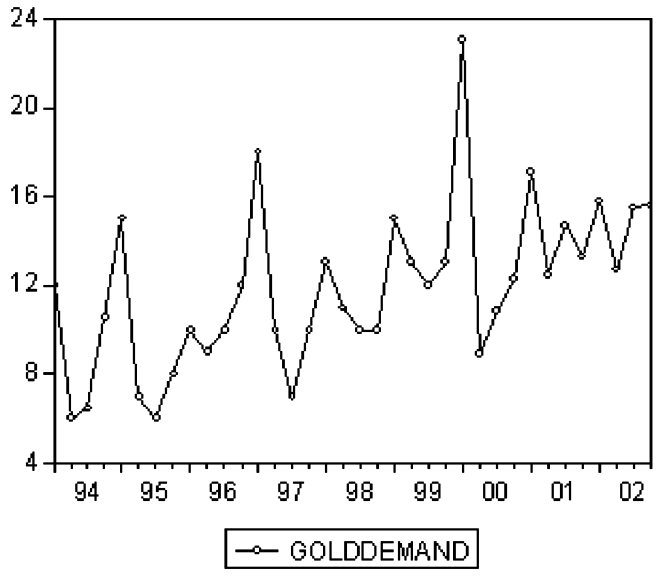
The results show that change in quarterly gold demand is time-trend stationary, with positive time coefficient being highly significant at 1%. Other important coefficients are the constant and AR(1) coefficient. Both coefficients are highly significant, with AR(1) carrying a negative sign. By these, we learn that the gold demand in Vietnam has increased steadily in recent years, and the degree of growth in demand is positively related to the time factor.

As we know already that the actual amount of import by officially granted quotas is a fraction of the actual consumption, it is highly likely that a large amount of gold has been smuggled into the country, and a fraction of the amount of money could go to private hoards. As payments and gold deposits are negligible in the economy, we could think of increasing private hoards despite the fact that other financial assets have already become more familiar to the public in recent years. Thus, the gold hoarding habit is persistent. This situation can also imply that private households are still concerned of uncertain economic conditions, in which case private hoards can serve as a safety net.

1.3.2 Monthly gold returns

We now move to examining the month gold return and making some comparison between the domestic and world markets. Because this assessment has one objective to compare

Figure 3: Quarterly gold demand in Vietnam



possible differences between the two, monthly returns on gold are summarized for a common sample, running from Jan-1998 to May-2004.

Table 2: Comparative monthly gold returns

	London	Vietnam
Mean	0.00394	0.00279
Median	-0.00075	0.00087
Max	0.234081	0.10223
Min	-0.09959	-0.07710
Std.Dev.	0.04657	0.02937
Skewness	1.56782	0.50206
Kurtosis	9.86095	5.11438
JB	180.20*	17.35*
Proba.	0.00000	0.00017

We notice that the two return series that are used here are computed directly from the normal return defition, which is the difference of logarithmic value of gold price this month and the preceding, and not annualized. The statistics show some differences. The highest return jump in London for the period is 23.4%, while it is only about 10% in Vietnam. Excess kurtosis in London gold return is much larger than Vietnam's, so are standard deviation and skewness indication. However, both reject the possibility of following normal distribution, with large and highly significant JB values.

We also see that in this period, the correlation coefficient among the two returns is highly positive, standing at 76.84%. As to monthly gold returns we check the property of serial correlation through table (3). The autocorrelations (AC), Q' and corresponding probability are reported for each lag k from 1 to 12. We learn from the result that for monthly returns of gold, serial correlations are negligible in the case of London market, weakly significant until $k = 6$, insignificant from $k = 7$ onward, and decisively rejected for Vietnam.

Table 3: Monthly gold returns serial correlations

	London			Vietnam		
k	AC	Q'	Prob.	AC	Q'	Prob.
1	-0.254	5.107**	0.024	0.000	0.000	0.998
2	-0.169	7.405**	0.025	-0.070	0.389	0.823
3	0.038	7.522***	0.057	0.098	1.175	0.759
4	0.153	9.446***	0.051	0.088	1.806	0.771
5	-0.106	10.387***	0.065	-0.078	2.309	0.805
6	-0.062	10.709***	0.098	-0.037	2.428	0.876
7	0.048	10.904	0.143	0.043	2.588	0.920
8	0.085	11.538	0.173	0.076	3.094	0.928
9	-0.026	11.600	0.237	0.050	3.317	0.950
10	0.000	11.600	0.313	0.070	3.762	0.957
11	0.055	11.875	0.373	-0.012	3.775	0.976
12	-0.063	12.239	0.427	-0.018	3.804	0.987

We realize some difference with respect to the issue of serial correlations for monthly gold returns, but in general, both series do not seem to have been affected greatly by this phenomenon.

To continue, table (4) will report annualized average monthly gold returns for both markets. We note that the period from 1998 to May-2004 is marked by 11 time points, with increments in time are equal, 7 months. The average is then computed for the period indicated by the corresponding row of the first column for each market. For example, the annualized monthly return of London gold running from s.1 to s.4 is about -0.48% per annum, that is the average for the time span from Jan-1998 to May-2000.

Table 4: Annualized monthly gold returns through expanding periods

London Monthly Ret. Breakdown											
	s.1	s.2	s.3	s.4	s.5	s.6	s.7	s.8	s.9	s.10	s.11
s.1	0.0262	0.0062	-0.0646	-0.0048	-0.0202	-0.0313	-0.0106	0.0240	0.0394	0.0494	0.0473
s.2		-0.0109	-0.1035	-0.0137	-0.0301	-0.0411	-0.0159	0.0238	0.0409	0.0517	0.0491
s.3			-0.1962	-0.0151	-0.0365	-0.0487	-0.0168	0.0296	0.0483	0.0595	0.0557
s.4				0.1660	0.0433	0.0004	0.0280	0.0747	0.0890	0.0960	0.0872
s.5					-0.0794	-0.0824	-0.0180	0.0519	0.0736	0.0843	0.0760
s.6						-0.0853	0.0127	0.0956	0.1118	0.1171	0.1019
s.7							0.1106	0.1861	0.1775	0.1677	0.1393
s.8								0.2616	0.2110	0.1867	0.1464
s.9									0.1605	0.1492	0.1081
s.10										0.1380	0.0819
s.11											0.0258

Vietnam Monthly Ret. Breakdown											
	s.1	s.2	s.3	s.4	s.5	s.6	s.7	s.8	s.9	s.10	s.11
s.1	-0.1304	-0.0778	-0.0928	-0.0474	-0.0469	-0.0507	-0.0354	-0.0032	0.0221	0.0287	0.0335
s.2		-0.0326	-0.0767	-0.0237	-0.029	-0.0371	-0.0219	0.0124	0.0384	0.0439	0.0475
s.3			-0.1208	-0.0192	-0.0278	-0.0382	-0.0197	0.0198	0.0485	0.0535	0.0564
s.4				-0.4904	0.01867	-0.0106	0.00555	0.0480	0.0768	0.0784	0.0786
s.5					-0.0452	-0.0572	-0.0201	0.0394	0.0756	0.0777	0.0781
s.6						-0.0692	-0.0076	0.0675	0.1058	0.1022	0.0986
s.7							0.0541	0.1359	0.1642	0.1451	0.1322
s.8								0.2177	0.2192	0.1754	0.1517
s.9									0.2207	0.1543	0.1296
s.10										0.0879	0.0841
s.11											0.0803

The recent return trends for both are upward, and we can see that annualized Vietnam's gold return is in general similar to the world's. However, the actual degree of return is different. For instance, in the most recent 7 months, the annualized average monthly return of gold in Vietnam has been much higher than London's quote, about 3.11 times, although on average the monthly returns for the most recent 14 months of both markets are quite close, 8.19% and 8.41% in London and Vietnam, respectively.

We also note that in the down times of the international gold price, the domestic gold price in Vietnam is also affected, so that minus returns for slow gold business are almost corresponding the world, although the magnitude of change can be different. The situation leads us to a valid question of any possible link of the domestic gold market to the world

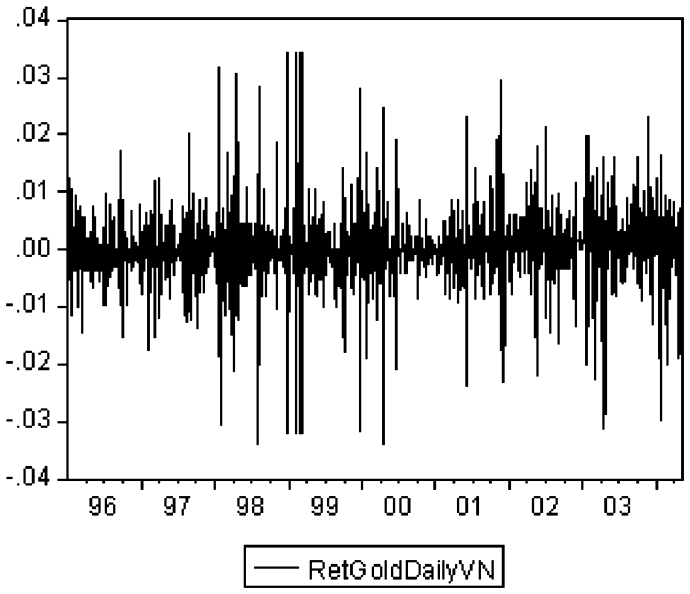
in the recent reform period.

1.3.3 High-frequency gold return

We continue to examine the properties of Vietnam's gold market in comparison to the world's in what follow, but on a daily basis. The discussion concentrates on a few points: firstly, if there is evidence of the gold market informational efficiency; secondly, the statistical properties of the daily gold return for comparative markets; and finally, a look at the bid-ask spread in domestic gold market.

Properties of daily returns and market efficiency We have the following graphs showing the gold returns of Vietnam and London markets. Changes in daily return of London market appear to have been larger at critical times, while Vietnam's daily return changes in much smaller magnitudes as shown in figures (4) and (5).

Figure 4: Daily gold return of Vietnam



In our daily analysis, Vietnam's return runs from Jan-1996 to May-2004, and London from Jan-1998 to the same end date. Thus, we consider the individual samples, instead of common. Table (5) summarizes key statistics of daily gold returns of these markets based on individual samples available to this study.

What we know from the foregoing table is the Vietnam's domestic gold market shows less fluctuating situation in general. Its daily return maximum and minimum are only about 1/5 of the London in absolute value. Mean level of return is also smaller by the similar magnitude. Both daily returns exhibit large excess kurtosis in their distribution, but London's is much larger. Both show significant departure from Gauss distribution in daily returns through very large JB values.

In table (6), we also report the autocorrelations and Q' for daily returns of both markets, for the first 12 (near) lags, 9 other far lags from 20 to 100, together with the corresponding

Figure 5: Daily gold return of London

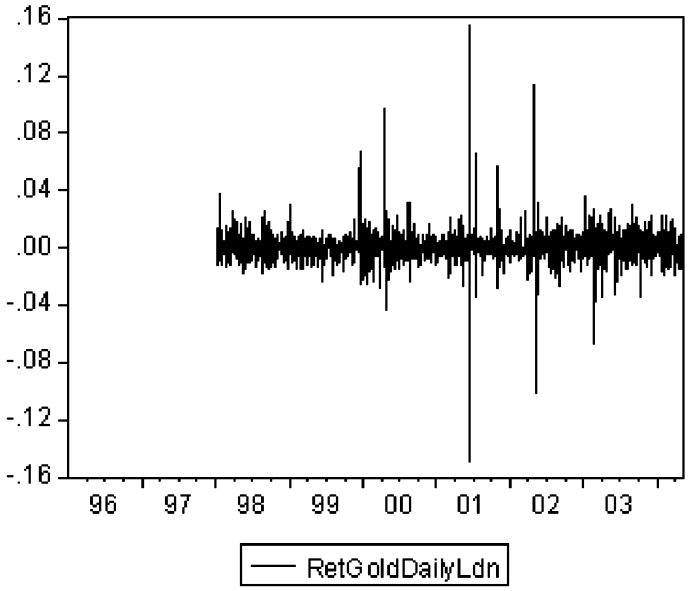


Table 5: London and Vietnam's daily gold returns

	London	Vietnam
Mean	0.000246	0.000011
Median	0.000000	0.000000
Maximum	0.154949	0.034183
Minimum	-0.149947	-0.033985
σ	0.011538	0.005860
Skewness	0.81	-0.14
Kurtosis	53.10	12.50
JB	173027.20	8182.47
Prob.	0.0000	0.0000
Observations	1653	2176

p-Value. Unlike the results of monthly returns provided in table (3), where serial correlations do not appear to be severe, the daily returns of both exhibit highly significant autocorrelations, all at 1% level. We observe that Q's are quite large even in near lags for both series, rendering all p-Value straight 0.

Table 6: Serial correlations in daily returns

	Vietnam			London		
k	AC	Q'	Prob.	AC	Q'	Prob.
1	-0.160	55.45	0.00	-0.189	59.26	0.00
2	0.010	55.69	0.00	0.010	59.42	0.00
3	0.023	56.87	0.00	0.008	59.53	0.00
4	-0.003	56.89	0.00	0.038	61.88	0.00
5	-0.001	56.89	0.00	-0.037	64.14	0.00
6	-0.009	57.05	0.00	0.014	64.49	0.00
7	0.036	59.92	0.00	-0.046	68.04	0.00
8	-0.015	60.44	0.00	0.060	74.11	0.00
9	0.049	65.63	0.00	-0.035	76.17	0.00
10	0.007	65.72	0.00	0.022	77.01	0.00
11	0.017	66.37	0.00	-0.046	80.52	0.00
12	-0.037	69.40	0.00	0.012	80.76	0.00
20	-0.011	71.01	0.00	0.010	94.32	0.00
30	-0.023	83.99	0.00	0.011	112.41	0.00
40	0.016	114.34	0.00	0.023	116.41	0.00
50	-0.034	123.64	0.00	-0.003	121.52	0.00
60	-0.013	135.99	0.00	0.031	131.87	0.00
70	0.031	147.58	0.00	-0.013	141.35	0.00
80	0.055	160.92	0.00	0.030	146.74	0.00
90	0.009	170.46	0.00	0.037	152.82	0.00
100	0.013	175.77	0.00	0.062	166.48	0.00

The results shown in table (6) reveal strong serial dependence in return series of both, leading us to disbelief in the market efficiency for gold. Next, in a look at the efficiency of the gold market through a parametric estimation, we use specification provided by eq.(**??**) of the preceding paper. Results are summarized below, both using 1652 observations after adjustments over the common sample from Jan-1998 to May-2004.

$$\begin{array}{rcll} r_t & = & +1.04 \times 10^{-5} & -0.159638 r_{t-1} \\ & & (0.0967) & (-3.8304)^{\star} \end{array} \tag{1}$$

where * denotes coefficients significant at 1% level. This regression has min. AIC$=-7.4652$, and $\overline{R}^2 = 0.0250$. No further serial correlations are found in residuals of the regression, with $BG = 1.69$, $k = 2$.

$$\begin{array}{rcll} r_t & = & +25.3 \times 10^{-5} & -0.189162 r_{t-1} \\ & & (1.0775) & (-1.8498)^{***} \end{array} \tag{2}$$

where *** denotes coefficients significant at 10% level. This regression has min. AIC$=-6.1211$, $\overline{R}^2 = 0.0352$. No further serial correlations are found in residuals of the regression, with BG$=1.59$, $k = 2$.

It is also noteworthy that large JB's reject the Gaussian distribution of the residuals for both estimations, too. We also note that Engle's LM statistic in both cases is very large at $k = 2$, showing the relevance of GARCH effect in the daily gold returns, which we will capture in the subsequent discussion.

Through the estimation results, we know that both AR(1) coefficients in the equations are highly significant and negative, while constants are insignificantly different from 0. Statistically significant β_1s in these estimations indicate that past prices of gold carry significant explaining power for the current price. And this rejects the weak-form efficiency of the gold market in both London and Vietnam in the period from 1998 to 2004, through established trend in returns. Naturally, the result of our study is different from the support of efficient market in [25], where results do support market efficiency, althought not overwhelmingly. We also point to the fact that AR(1) coefficient in the London gold return estimation is significant but not highly. But for the Vietnam market, the coefficient is significant at any level. Thus, we make it clear here that we decisively reject market efficiency with Vietnam gold market, and do not make such statement with London.

A word on the bid-ask spread Here we add a few more words about the Vietnam's gold bid-ask spread. As we mention in the foregoing discussion of the data, the study uses average gold price in analysis. Clearly, in the marketplace the gold traders/shops have different levels of bid and ask prices. It is of interest to have an idea of how large the bid-ask spread for gold transaction. Figure (6) shows the spread over time, and calculated in dollar term, the same way the gold price itself is calculated in our study.

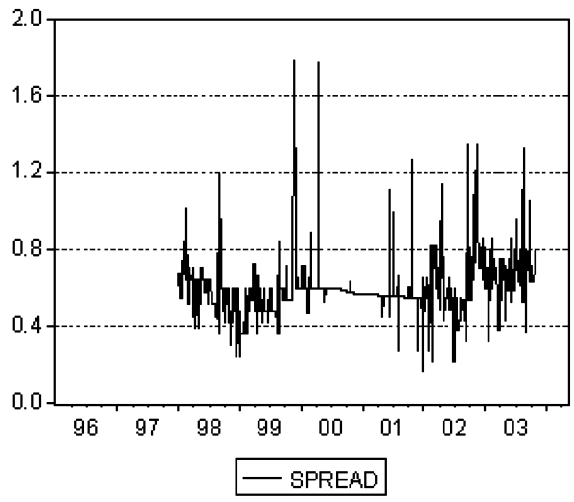
What we see is the spread in dollar term gold spread changes over time, but almost center around USD 0.4 to 0.8/ounce difference. Sometimes it can jump to higher levels such as USD 1.78/ounce, or drop to USD 0.16/ounce. Besides the reason of USD fluctuation itself, there is one important reason for explaining this. The bid-ask spread has much to deal with activeness of trading in the market, as well as anticipation of future market changes. Most of the times, when the market is in stable condition, and no expected changes in price level in the near future, the spread stays in a low range from 0.4 to 0.8, subject to fluctuation of the USD itself.

However, the situation changes when the market expects future changes through rumors, news arrival. For instance, when the market is uncertain about near future gold price in the world, which would likely affect the domestic price (we will examine this relation in the next part), the gold shops/traders may hold back gold or request larger spread to absorb possible risk due to price uncertainty. This practice is common in the domestic market, and a reason for peaks in the spread graph we have seen. This point is valid when checking the correlation between the domestic price and the price spread shows a positive correlation of +0.2469. The interpretation of this positive relation is that the spread has the tendency to go up, when the price shows such a likelihood. It is also useful to indicate here that the Granger causality statistic can reject the null hypothesis that the price does not Granger-cause price spread at $k = 4$, through F-stat. of 2.16, at 10% significant level. In contrast, in reverse, the alternative that spread Granger-causes price is rejected decisively.

1.3.4 Domestic and world markets

The following will investigate some possible evidence of the linkage of the domestic gold market to the world, in line with the financial market reform.

Figure 6: Gold bid-ask spread in USD term



Correlation coefficients: a return trend We have noticed in figures (4) and (5) above that comparatively, the return scales are a wider for the London Fix graph because, as expected, its price fluctuates much more than that of Vietnam. Also another difference is the number of peaks, positive or negative, is greater than in Vietnam situation.

Thus, it is of interest to see them behave in pair of returns the 2-dimensional graph, or a scatter diagram $r(x, y)$. The following figure (7) will represent such a view. Naturally, we notice that except a few outlying pairs of data that scatter around the value of one axis of an absolute value greather than 5%, most of the datapoints cluster in around the $r(0, 0)$ with some radius $d(r(x, y), r(0, 0)) \leq 0.04$.

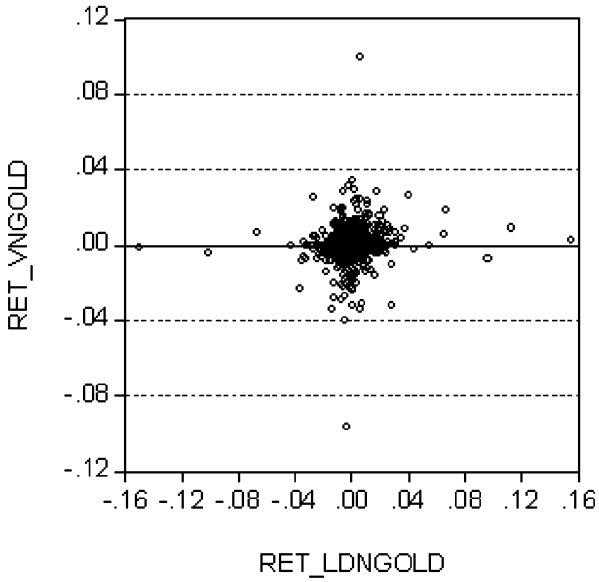


Figure 7: Scatter diagram: London Fix and Vietnam daily returns 1998-2004

Investigating further into the return variables, the co-moving trend has been clear. Given the whole sample of 1653 return observations, with much deviation in place, we easily see the positive correlation coefficient in returns of over 13.1%. A closer look into different subsamples below show another interesting features of the co-moving properties between the two daily returns.

Table 7: $\rho(x, y)$ behavior through changing subsamples

Subsample	Cardinality	$\rho(x, y)$
1/2/1998-5/5/2004	1653	+13.1059%
1/2/1999-5/5/2004	1394	+14.0891%
1/2/2000-5/5/2004	1134	+15.8836%
1/2/2001-5/5/2004	872	+16.3095%
1/2/2002-5/5/2004	611	+18.6501
1/2/2003-5/5/2004	350	+20.6829
1/2/2004-5/5/2004	89	+27.6719

The general trend is when we reduce the cardinality of subsample, with the end is the

cutoff data point, the correlation coefficient increases gradually, without any exception. This finding is important we know that the more the trade liberalization and commitments of Vietnam to the re-integation into the internationl economy, price and return trends' differences have gradually been removed.

We can also notice that in the recent period of time, the positive correlation becomes stronger, especially the most recent period of gold price chaos, from the beginning of 2004. The domestic gold market also mimics the international market to a large extent, although in different magnitude of change as we have discussed earlier. This leads to a leap in correlation coefficient of the larger subsample Jan-03:May-04 to from around +20.7% to 27.7% in the recent 5 months. This insight is crucial, advocating the decision by the central bank to be willing to grant quotas for importers to stabilize the domestic gold price early 2004.

The foregoing discussion gives us an insight that the gold market has been fairly exposed to the international market, despite some barrier cause by the imposition of import quotas and existence of tariffs (although small, 0.5%, but still existent). To this end, the domestic gold market has established some apparent link, and stronger over time, to the international market, an encouraging sign of the financial economy's integration into the world and neighboring regions.

AR-GARCH feedback and distributed lags of an external factor Throughout this work, we have seen substantial presence of the different autoregressive feedback specifications that help explain the interrelation of variables in dynamical systems in discrete time. We also verified the significance of AR(1) in the domestic gold returns, together with the presence of ARCH(1) and GARCH(1) terms in the preceding estimation outputs.

However, we do note that apart from the finding of conditional heteroskedasticity in the situation (which does happen empirically), it is far from satisfactory to our inquiry into the dynamical change of price. In light of this, besides the use of a larger sample of daily data for Vietnam, we have an intent to look into the following possible dynamics.

$$r_{i,t} = C + \Sigma_{k=1}^{m} \alpha_k r_{i,(t-k)} + \Sigma_{l=0}^{n} \beta_l r_{j,(t-l)} + u_t \tag{3}$$

where u_t represents a GARCH$(1,1)$ process as found empirically significant in the table (**??**); i denotes the Vietnam series, and j London Fix.

The following table (8) summarizes the outcome of this estimation strategy.

Our careful checks for the misspecification risk also show satisfactory results. Ljung-Box Q' is not significant at even near-lags, for example $Q'(4) = 1.85 \Rightarrow$ p-Val.=0.63 in the given sample. Engle's ARCH LM statistic for testing further conditional heteroskedastic residuals is quite small, 0.4772 rejecting the null hypothesis of further ARCH effect, with p-Val=0.49.

We have seen clearly that dynamical system shows better influences of the world gold price/returns to the Vietnam domestic gold returns. In other words, technically speaking, effects of the past changes in world prices have been quite eminent on the situation of Vietnam, with some lags (this estimation supports the influential past values of up to lag length equal 4).

The above ARMA-GARCH specification for the domestic gold return variable has closed our discussion on the factor of gold in Vietnam's financial economy. Several key insights are summed up in the end section of this paper, where major results of the paper studies will be offered.

2 An analysis of U.S. Dollar

We now move to the second main content of this paper, discussing the role and properties of USD in Vietnam. This part is organized as follows. It starts with a section about the USD and the foreign currency market, as an overview on roles of foreign currencies, regulatory framework that governs the trading and transactions, and market organization. This first discussion is followed by a section of literature, data and methods. The results are then provided in the subsequent section of empirical analysis.

2.1 Background on USD in Vietnam

Vietnam has gradually abandoned the previously opted old-styled centrally planned economy since mid-1980s. The drop of this long-standing economic structure had its root in chaotic economic position in early 1980s. In late 1980s, following the concept of *Doi Moi* a broader recognition of the private economy has helped simulate investment both from outside and within.

Besides the existence and operation of formal economic units in the financial system, private households operating financial services within the population also mushroom, especially in the urban areas. Given the revival of a crucial financial sector inside the economy, inhabitants also shift their economic interests toward investment problems and

Table 8: Estimation of Vietnam gold returns with London as external factor

	Mean Equation				
	Coeff.		Std.Error	z-Statistic	Prob.
β_0	0.000119		0.000131	0.91	0.36
$r_{j,(t-1))}$	-0.153447	*	0.037301	-4.11	0.00
$r_{i,t)}$	0.070764	*	0.013127	5.39	0.00
$r_{i,(t-1)}$	0.097186	*	0.015111	6.43	0.00
$r_{i,(t-2)}$	0.090994	*	0.017675	5.15	0.00
$r_{i,(t-3)}$	0.054021	*	0.015944	3.39	0.00
$r_{i,(t-4)}$	0.032318	**	0.013898	2.33	0.02
	Variance Equation				
κ	0.000003	**	0.000001	2.56	0.01
γ_1	0.269210	*	0.060537	4.45	0.00
α_1	0.710160	*	0.059746	11.89	0.00
$\gamma_1 + \alpha_1$	0.979370				
$\overline{R}^2$	0.088715				
$L(\theta)$	6326.895				
AIC	-7.666134				

new value-generating financial assets, for instance hard currencies, *inter alia*. The USD plays a crucial role mong these assets.

In this discussion we will name the USD as an increasingly important item in households' savings portfolio. USD savings and land ownership currently represent those most important assets in every Vietnamese family. In fact, private land ownership is not legalized by law in Vietnam, only land-use-right. We will examine the role of USD in Vietnam's economy below.

2.1.1 The role of USD and foreign exchange market in Vietnam's economy

Public interest in the USD Unlike before 1990s, when the average income level and savings were generally very low, the economic reform has improved living standards and savings of the population substantially. Businesses that deal with foreign currencies and problem of economic exposure caused by exchange rate ups and downs are also increasing, due largely to the lifting of international trade barriers to domestic trading firms. This situation, plus the importance of hard currencies in households' savings proportion, have made the public much more aware of the exchange rate issues and interested of understanding about what has happened with exchange rates of currencies.

From fixed to more flexible exchange rate regime During the closed-door period, Vietnam's foreign trade was modest. Most of the trade was done with former socialist economies, namely the former Soviet Union, East Europe (East Germany, Czechoslovakia, Poland, etc.), and China. The Soviet rouble therefore was the single most important currency, and played a critical role of payment and calculation in trades. Sometimes, trade activities with countries other than the said group of economies happened, and the USD was used instead of the rouble. However, the major character of this period is the country applied a fixed exchange rate regime, by which any currency rate was predetermined by a governmental administration agency, which is still existent today, the Government Pricing Committee. This was expected because under a strict centrally planned mechanism, almost all goods in the economy, including currencies, were supposed to be priced *fixedly*. The fixed regime never counted the actual output growth, the need of money, and purchasing power, because when it prevailed, there was no notion of supplies and demands existent, which had been replaced by plans and direct distributions by the State totally.

However, the regime was pushed to change when the country started trading with other countries than the traditional ones. Economic shakeouts took place in late 1980s and early 1990s, where economic aids to Vietnam dropped suddenly following political sweeping changes, and many conventional European markets fell out of domestic producers' reach. As the needs for goods and services from the world markets remained, the country had to look up for new trading partners. The reforming of trading activities represented one of the most imperative needs of Vietnam in early days of the reform. Then, the word 'hard currencies' emerged to be one of the most frequent words one could read from newspapers. Since the time, the USD gradually popped up as a familiar money, replacing the rouble.

Naturally, the exchange rate regime had little choice but to have adopted necessary changes to reflect a new economic structure of the nation.

The USD as the payment and calculation currency During the period of frequent USD reserve shortfall, which is unsafe for settling debts and trade payments, the government usually has to intervene in different ways. An example of such interventions is on 20-Dec-2003, the central bank sold USD 20 million to commercial banks to import gold during the domestic gold price hike, reaching 25% increase over a year, to facilitate the import of 2 tonnes. It is because the availability of USD plays a very important in the economic transaction, safety of the economy. The US Dollar is widely accepted as the means of both international and domestic payments. In many circumstances, even when the USD is not used as the actual payment currency, it is still used as the currency for calculation, with which participating sides of a deal fix the actual amount of payment to a certain amount in USD terms, at some agreed-on exchange rate.

In fact, the practice of using the USD as calculation currency for financial obligations among enterprises, individuals represents a simplest way of hedging, with which the final index of value is the USD amount that one will receive or have to settle. This is caused by the continous depreciation of the local currency against the USD over the past 10 years, leading to an uncertainty of local currency value preservation, in which case the holding of USD is always on the safe side, comparatively.

Popularity and liquidity of the USD Issues in relation to exchange rates, especially the USD against the VND, have become increasingly familiar within the eocnomic community, as well as the populace. As to businesses, the problem is generally to find ways to hedge against economic exposures caused by currency risks. As to the population, whose primary concern is about the efficiency of savings vehicle, a puzzle is the consideration among preferences of value preservation, asset price appreciation and interest. The popularity of the USD within the economy is so large that has caused, since 1994, a conundrum of USD-denominated deposits and under-pillow holdings by both enterprises and households. The amount of USD holdings within the populace and by enterprises is unpredictable, and there is no such statistics available. The amount can be very large, by Vietnamese standards, due to a large amount of foreign exchange (FX) in USD transferred from abroad to individuals and enterprises in Vietnam. The estimated FX amount tranferred through bank services in 2003 alone is about USD 2.7 billion from USD 2.25 billion in 2002. Bankers also predict the flow of foreign exchange in this way in 2004 could reach USD 3.5 billion, an amount equivalent to approximately 10% of Vietnam's GDP. An indicative ratio of foreign exchange transfer to enterprises and populace is roughly 55:45. Thus, we understand that a large amount of USD money has been hoarded by the populace over years, helping increase the popularity of the USD itself among the households.

The popularity of USD money to the public has much helped increase the liquidity. Through a vast system of private gold shops, anyone can easily buy or sell USD money. The volume of USD trades through this large system is unknown. However, the liquidity is very high, and transaction takes no cost, except the bid/ask difference. The same

situation happens with commercial banks. The largest FX transmission service bank is Ho Chi Minh City-based East Asia Bank, indicates clearly that if the recipient of transferred money wishes to sell the amount to the bank, he or she is not subject to any fee. And this becomes a precedent to other players in the field.

However, on the buyer side, the buying of legal USD, which can be used to settle USD-denominated debts or international payment settlements, is not always straightforward because it will be subject to the availability of foreign currency reserve of commercial banks. We will look at this issue when dealing with the regulation system administering foreign exchanges. Most of the transaction in this way happen on the interbank FX market, the single most important market.

2.1.2 Regulations

We now look at regulations that govern transactions of USD in the economy. Vietnam is considered a country that governs foreign exchange, especially USD strictly. This has a root in many problems of international payment, and frequent shortfalls of hard currencies in the economy.

Selected legal documents regarding FX There have been a number of legal documents passed by either the government or the central bank regarding FX transaction, such as buy/sell FX for debt settlement, profits repatriation, international payment. We briefly review them below.

1. Decision No.679/2002/QD-NHNN, dated 1-Jul-2002 by the SBV (the central bank) governor on the issuing regulations on transaction of foreign currencies of commercial banks, which are authorized to undertake FX business.

2. Decree No.63/1998/ND-CP on the management of foreign exchange, passed on 17-Aug-1998, by the government.

3. Decision No.37/1998/QD-TTG, dated 14-Feb-1998 by the Prime Minister, on critical measures of managing foreign currencies positions. This was effective almost immediately, only two days after the document date.

4. Circular No.01/1999/TT-NHNN on elaboration of the above-mentioned Dec.63. passed on 16-Apr-1999 by SBV.

5. Decree No.12/1997/ND-CP on 18-Feb-1997, regarding foreign exchange management with respect to FDI enterprises FX needs by the government.

6. Circular No.02/1997/TT-NHNN on 28-Jun-1997 by SBV on elaboration of the Dec.12 above.

7. Decision No.203/NH-QD on 20-Sept-1994 by the SBV governor regarding the establishment of the interbank FX market for member commercial banks.

8. Decision No.207/NH-QD on 16-Aug-1991 by the SBV governor on the establishment of the FX transaction center as a market.

Although the above enumerates only a few important documents, it is observable that foreign currencies and their related transactions have been controled strictly by the government and its currency authority, SBV. The administration keeps producing new documents and/or changing the preceding ones over the time to cope with market changes.

Major implications These documents are lengthy legal papers that has enforcibility on businesses operating in Vietnam. Implications of them are different, but still focusing on restricting the unnecessary outflow of FX from Vietnam, and trying to retain the FX reserve for international payments and debt settlements. We offer below some key implications from the implementation of these legal documents, towards the actual FX business in the market.

1. FX businesses, both private shops and commerbank bank transaction counters are strictly governed by both market administraters and specifically devised regulations. These are called *authorized FX dealers*, provided in Decree No.63/1998/ND-CP and Decision No.679/ 2002/QD-NHNN, as most updated regulatory framework.

2. Eligible enterprises are subject to a set of rules in order to be able to buy legal USD money for settlements and repatriation overseas. The process of acquiring FX for eligible enterprises are highly conditional on availability of the hard currency proceeds at banks and legal procedures.

3. Individuals can purchase hard currencies in the free market, *de facto*. However, these dollars are used for hoarding and interest-bearing private deposits purposes only. These dollars cannot be legalized for commercial settlements although legally acknowledged by the authorities as personal financial assets.

4. From time to time, the government could intervene in the market in big ways, such as request of FX expropriation measures, e.g. Decision No.37/1998/QD-TTG, by which all FX-generating enterprises are obligated to re-sell part or all of the FX revenues to authorized commercial banks.

5. The single most important and powerful FX market in the interbank FX market, established in 1994 by Decision No.203/NH-QD, superceding its ancestor, the FX transaction center established by Decision No.207/NH-QD.

6. Unauthorized FX deals are strictly prohibited. FX speculators are even subject to fellony. These are highly regulated by Decree No.63/1998/ND-CP.

7. Other less strict regulations on obtaining and uses of FX include purchases of small items using credit cards, and encouraged payments such as overseas education tuitions and living expenditures.

The above implications show one important point that obtaining large FX should be done through the official channel of interbank market transactions. The following discusses more insights about this important market in Vietnam's financial economy.

2.1.3 Organization of the market

Vietnam FX Transaction Center was established in 1991 following Decision No.207/NH-QD by SBV governor, which operated as an FX market to fulfill the following major objectives:

1. Establishing connection and FX market between commercial banks and economic organizations operating lawfully in Vietnam.

2. Evaluating and measuring the supply and demand of foreign currencies with Vietnam's financial economy.

3. Assisting in forming appropriate exchange rate of the USD against the local currency, VND, through the equilibrium price prevailing on the market.

4. Being a preparation step for the future formation of official money market in Vietnam.

This Center had operated for over three years, with two trading sessions occuring every week on Tuesday and Friday, in both Hanoi and Ho Chi Minh City. This preparation exercise was put to and end in late 1994, giving way for the birth of the currently operational interbank FX market.

Vietnam Interbank FX Market was born following the above-mentioned SBV Governor Decision No. 203/NH-QD, issued on 20-Sept-1994, to replace the transitional Vietnam FX Transaction Center. The major objective of this market is:

1. To fully establish an organized market for foreign exchange needs among commercial banks to aim at a full-fledged forex market market in the future.

2. To serve as a channel of interventions when they become needed for the central bank to stabilize important foreign currency price, aiming at the USD to pursue pre-determined national currency policies.

Currently, statistics revealed by SBV indicates that the interbank FX market accounts for approximately 90% of all forex transactions by banks and enterprises in Vietnam. Before 1998, when the need for foreign currencies, e.g. USD, JPY, etc., was fairly unsophisticated the interbank FX market only offered spot transactions, which was defined as transactions that delivered within two working days from the deal date. Since 1998, after the famous Asian financial crisis, the FX needs became more sophisticated to hedge against uncertain supply/demand relations, the market has also offered forward and swap transactions.

Currently daily FX spot transactions are subject to a daily price limit, which is $\pm 0.25\%$ per day, from the previous closing price (referenced). This limit was set following the Decision 679/2002/QD-NHNN on 1-Jul-2002, which relaxed the former highly regulated limit of $\pm 0.1\%$ per day. As to commercial banks that are authorized FX dealers, the bid/ask spread is up to the bank general manager to decide.

Due to the lower level of sophistication of Vietnam financial markets in general, new types of financial products and transactions usually require new *legal corridor* and in

the Vietnam FX market, Decision 679/2002/QD-NHNN serves as such legal foundation for forward and swap transactions. The term of both forward and swap transactions is shortest at seven days, and longest period of 180 days. The daily price variation limit of $\pm 0.25\%$ is still applicable, with a relaxation that some risk premia can be added to the calculation above the normal daily cap: 7-30 days, 0.5%; 31-60 days, 1.2%; 61-90 days, 1.5%, and 91-180 days, 2.5%.

Thus, it is possible to make these transactions but the actual happenings are only handful as these products have been new to both bankers and corporates. Spot transactions still dominate the market by all means. In subsequent empirical analyses we concentrate on the spot exchange rate of the USD against the VND as the most important one.

2.2 Related literature, data and methods

This section provides a brief literature review followed by further dicussion on the data sets and methods used in the analyses of the USD in Vietnam.

2.2.1 A literature review

The general literature of foreign exchange and exchange rates is enormous in the financial literature. This review will only embark briefly on part of it, and later provides some relevant directions, of which our analyses can take advantage.

Exchange rate return properties, role of information, and volatility Return properties of exchange rates are almost always documented in empirical studies. This practice is similar to what is done with stock market time series, as they exhibit similar properties, although are quite different in nature. Exchange return properties are reported in different ways: (i) either basic statistics or specific ones following estimating specifications of particular studies; (ii) the same rates across several countries; (iii) spot versus forward rates, or nominal versus real rates; (iv) across different frequencies, such as intraday, daily, weekly, monthly or annual.

For instance, [9] reports set of statistics on seven different daily spot currency rates, both basic and model-based derived statistics. In this work, the author adopts the Engle-Lee component model with an extension to Poisson jumps. [10] concentrates on statistical properties of real exchange rates of several European currency against the Japanese Yen (JPY-based). Their derived statistics showing real FX rate properties are based on a test of long memory and nonlinear mean reversion model, with a PDL parameterization $B(L)(1-L)^d y_t = D(L)\epsilon_t$, where d represents the fractional order parameter, and L the lag operator. [26, 13] stresses on the distributional properties of daily returns, and its volatility, focusing on non-linear component existent, following ARFIMA specifications.

Schotman *et al.* [18] uses intraday quotes by Reuters to explore dynamic relations between the quotes of JPY:DEM and the rates implied by JPY:USD and DEM:USD, and find the technical problems arising in computing autocorrelations, cross-correlations, that substantial price discovery takes place through the direct JPY:DEM market, during the most busy intervals of a typical trading day. Malik (2003, [22]) studies the abrupt changes

in volatility as well as the role of exchange rate shocks in determining persistence frequently found in volatility for exchange rates of several major currencies against USD, namely JPY, GBP, FFR, CAD, and DEM, for the period 1990-2000, on a weekly basis. Such statistical consideration indicates three abrupt change points for JPY and GBP, and two for the rest, corresponding to major economic and political events. It also shows some significant increase in volatility in GBP around Sept-1992, the time when Britain announced its abandonment of Exchange Rate Mechanism (ERM) being a target of speculative attacks; a major currency event of Europe during 1990s. The study is combined with $GARCH$ effect and finds that there is a considerable reduction in the valid estimate of volatility persistence when controls for sudden changes in variance are included. When regime shifts are accounted for, the results show that persistence of volatility shocks decreases in most cases.

From another aspect, Hocking *et al.* [23] examines impacts of information sources, news arrival and rumors on foreign exchange market, through questionnaire survey with 321 traders and 63 financial journalists from leading banks and financial news providers in the collective European foreign exchange market. It finds that trading participants and financial news services form an independent relationship, although both forex traders and journalists are engaged in a circular pattern of market information processing. Strikingly, the result indicates that traders rate the speed of news and its *anticipated impacts* as more important than its perceived accuracy. Edmonds *et.al* [14] looks into the issues of exchange rates with three hypotheses (i) no difference from other assets; (ii) unaffected by the level of temporal aggregation; and (iii) the time path of shocks to exchange rates and other asset prices is characterized neither by ARCH processes nor by persistence of shock in mean (AR). The study works with unconditional and conditional volatility in weekly and monthly series of exchange rates and other asset prices for seven countries for a 15-year period. The similarity between exchange rates and other speculative prices is found. The difference by model frequency is quite remarkable between monthly and weekly series.

Towards the properties of exchange return, Hwang (2001, [16]) considers the use of asymmetric fractional integrated GARCH stochastic process, named as FIFGARCH$(1, d, 1)$. Estimations are performed for Canadian Dollar and ECU against US Dollar, from 1973 to 1998, with over 6,000 daily returns. The result shows that full-fledged asymmetric FIFGARCH has a good capacity to capture the statistical properties of these rates during the considered study sample. Beine *et al.* [2] also represents another investigation to capture long memory properties of exchange returns. From a more theoretical view, Zaffaroni (2003, [33]) extends the class of long memory volatility model focusing on Gaussian inference on long-range dependent volatility, and applies it to foreign exchange rates. It shows that the exchange rates appears to be better captured by nonlinear MA in terms of goodness-of-fit during the estimations, than stock indexes.

We notice that there exist a large number of highly sophisticated estimation models for exchange rates in efforts to capture complex properties of exchange rates both in level and returns. However, given the low degree of sophistication of the market existing in Vietnam, and its thin trading volume, simple statistics would likely be appropriate while

still serving as good indications of the exchange rate properties.

Central banks' interventions Central bank interventions on the market have been common in world money market. Even sophisticated and large market such as Tokyo, interventions take place quite frequently, and even in large amount. In Vietnam, where the State's will represents a genuine power, interventions are a sharp tool in many situations. A number of works document this practice and its impacts on both volatility and market reactions, such as, *inter alia*, [2, 1, 4, 3].

Among these works, Beine *et al.* (2002:[2]) uses a long-memory model FIGARCH consideration to investigate effects of official interventions on the short-run evolution and volatility of exchange rates. Besides showing the outperformance of the paradigm, the study finds empirical evidences that central bank interventions exert an incorrectly signed effect on the levels of exchange rates and tend to increase their volatility in the short run.

Baine and Laurent (2003, [3]) examine several major exchange rates using dynamical processes characterized by ARFIMA-FIGARCH specifications,

$$\Psi(L)(1-L)^{\varsigma}(y_t-\mu)=\Theta(L)\epsilon_t, \quad \epsilon_t=\sigma_t z_t \tag{4}$$

$$\sigma_t^2(\omega,\beta,\phi,d)=\omega+\{1-[1-\beta(L)]^{-1}\phi(L)(1-L)^d\}\epsilon_t^2 \tag{5}$$

which the authors call a double long memory specification. Their estimations for four major exchange rate returns DEM, GBP, FFR, and JPY against US Dollar over the period from 1980 to 1996. Many outliers are documented, which are responsible for the rejection of the normality assumption. The study finds that a significant part of these outliers are related to the direct central bank interventions in foreign exchange markets. In brief, the central bank interventions appear to have produced impact on increasing exchange rate volatility.

Foreign exchange market efficiency The concept of foreign exchange market efficiency is similar to that of stock markets. Smoluk *et al.*(1998:[24]) studies the exchange of GBP agaisnt USD. They find that although the pound/dollar annual rate follows the random walk due to frequent and strong shocks to the nominal rate, using variance ratio test $VR(q)$, initiated by Lo and MacKinlay (1988:[20]. Another work by Wu and Chen (1998:[32]) looks into foreign exchange market efficieny of several industrialized countries, including most important ones of Western Europe, North America and Japan, employing panel unit-root test towards forward exchange rate premium. The results reject the null and support market efficiency hypothesis.

Lee *et al.* (2001:[19]) examine nine foreign exchange rates for the pre-crisis period from 1988 to 1995, including most important currencies except JPY. The researchers employs a joint variance ratio test $VR(q)$, and technical trading rules to find evidence of random walk pattern of these rates. The result supports the random walk hypothesis, thus verifying market efficiency for this period.

Emerging and transitional economies, and the Asian financial crisis A number of studies extend efforts to investigate exchange rates in emerging Desai (1998:[11]) studies the interaction between the exchange rate regime and macroeconomic stabilization in several transition economies in Eastern Europe during 1990-96. The work finds a high degree of persistence of inflation and initial disequilibria between highly undervalued nominal exchange rates in relation to their purchasing power parity (PPP) estimates. The work's insights are relevant in the Vietnamese exchange rate problems in early 1990s, when the inflation used to reach nearly 800% at some point.

Another interesting and useful work is provided by Guijun and Schramm (2003:[15]), studying solely China's foreign exchange policies since its extensive economic reform kick-off. Their insights are relevant to Vietnam due largely to similarity of economic models and management mechanism between the two, although the nation has been about 15 years ahead of Vietnam. The work also offers a unique opportunity to have insights about a Sino-Soviet foreign exchange policies in transitional period. [15] shows that Vietnam is similar to China in the sense that the reform process is characterized by substantial trade liberalization, shifting exchange rate regimes, exchange market developments, easing restrictions on international transactions in gradualism. The difference is China has now moved to the last frontier of its exchange reform, while Vietnam still has some way to go.

In light of the recent Asian currency crisis 1997-98, researchers also consider shift in exchange rate behavior in Asian emerging economies. Jeon and Seo (2003:[17]) studies such impacts on the foreign exchange market efficiency in four Asian economies adversely affected by the crisis. They use the cointegration paradigm for high-frequency data from Jan-1996 to Feb-2001 and find the result consistent with market efficiency hypothesis across four East Asian markets. There is some evidence that market efficiency became weaker in the immediate period after the 1997 crisis, but recovered fairly quickly afterwards.

As to Latin American emerging markets, [12] examines the PPP theory from a long-run perspective in the presence of a parallel (black) market for USD in a number of Latin Amercian emerging economies, e.g. Brazil, Argentina, Chile, and Mexico. This study uses a joint structure of PPP and long-run informational market efficiency and finds that the hypothesis could not be rejected for these economies. The results also indicate that *black* market rate shows an appropriate error-correction mechanism to eliminate significant shocks that deviate the real rate from long-run PPP.

While the world literature on foreign exchange market documents a huge number of studies, only a handful of studies on Vietnam's exchange rates exist, with some pioneering works such as [29, 30]. Unlike the public attention on exchange rate issues, the Vietnamese academics do not appear to look seriously into the market. As the market grows and gets more complicated over time, the domestic literature shows an inadequacy. The analysis of this section, thus, looks forward to bring up more insights and issues in relation to Vietnam's foreign exchange market.

We have gone over some areas of exchange rate literature, and will now move to the main analysis, starting with a discussion of the data and methods used in the subsequent empirical studies.

2.2.2 Data sets and methods of study

Before examining empirical aspects of USD market in Vietnam, the subsequent discussion provides some description of data and methods that will be used in analyses.

Data set Data availability represents a difficult problem in Vietnam, all the times, no exception to anyone, including large multilaterals like WB or IMF. Such data like the central bank interventions, reserves, and so on are kept secret, even at request of WB/IMF, sometimes triggering disputes.[2]

In this study, the data set comprises of different time series by frequency, and data sample. The followings are used:

1. Daily spot exchange rate of USD against VND, and the derived daily return series as log-differenced. These time series span the period from 8-May-1995 to 20-May-2004, a substantial period of Vietnam's exchange market reform.

2. Weekly spot exchange rate and the derived weekly return series as first-order log-differenced. These time series span the period from 8-May-1995 to 24-May-2004, taking all Mondays in this period.

3. Monthly spot exchange rate over the period from Jan-1988 to Jun-2004, representing the entire reform period of Vietnam from the date of *Doi Moi* kick-off.

Daily data are collected from various sources, mainly from the daily Market Prices Bulletion, published by the Government Pricing Committee since 1990. However, the data are fragmented as no database exists, so the update of daily data since 2001 has been organized and maintained by Mezfin data team, and now representing one of the most comprehensive database in Vietnam. Weekly data are extracted directly from the daily series. However, the monthly data are composed from sources of Ministry of Finance, and the central bank. We have the data series shown in the figures below.

We can realize from fig.(8) that the local currency constantly depreciates against USD over the past 9 years. There were periods when exchange rates remained almost unchanged, and points in time, when exchange rates were adjusted abruptly. For a longer-horizon and lower frequency, i.e. monthly, figure (9) shows a smooth line. However, the abrupt changes can still be observed easily.

Basically, in this section, we deal mainly with time series of exchange rates.

Methods The methods for studying USD exchange rates are quite simple in this discussion. Basic and descriptive statistics will be used to provide for understanding about the returns of USD exchange rates for several frequencies, daily, weekly, and monthly. Qualitative discussions on these statistics are also useful to obtain more insights about the foreign exchange market.

Other econometric methods for checking common problems, such as serial correlations will also be used in a standard way. Its use has been mentioned in preceding papers.

[2] We have mentioned this problem when discussing the banking sector in Vietnam in paper 2.

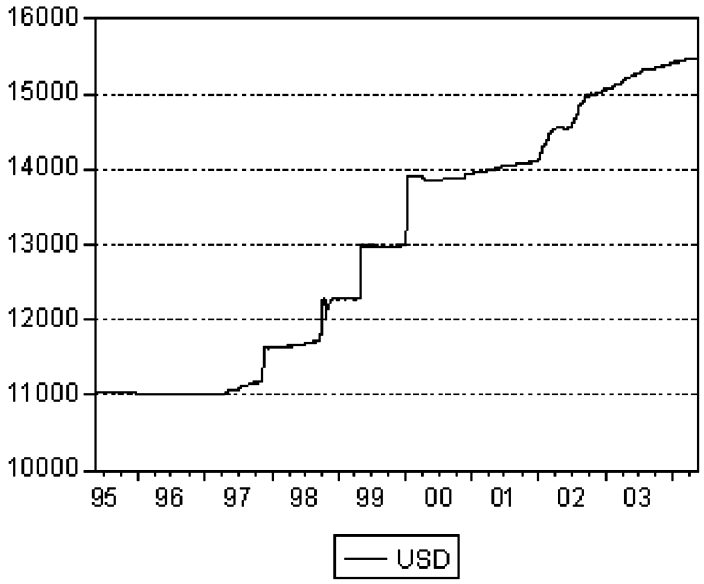


Figure 8: Daily USD exchange rate from 1995 to 2004

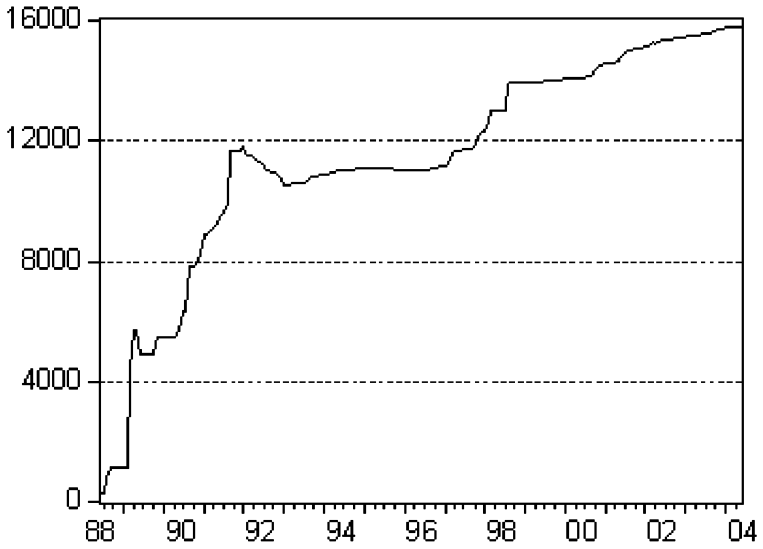


Figure 9: Monthly USD exchange rate from 1988 to 2004

Q'-statistic will be reported alongside the autocorrelations of time series of different frequencies.

Two main discussions of empirical results will require methods for

- The efficient market hypothesis (EMH); with specific emphasis on the Lo-MacKinlay variance ratio specification test; and
- The GARCH effect in the daily USD exchange return of Vietnam market.

As the elaborations on these parts can become more lengthy, they will precede the specific empirical results are supplied. Discussions in relation to USD exchange rate returns use the definition of returns as first-order difference of logarithm of price in level, provided in eq.(6)

$$y_t \equiv \ln(P_t) - \ln(P_{t-1}) \tag{6}$$

where P_t, P_{t-1} denote average prices of USD on day $t, t-1$, respectively. This price means the average between selling and buying prices of USD of the day.

2.3 The empirical analysis

In what follow, we extend the analysis to properties of USD exchange rate returns, examination of the presence of the foreign exchange market in Vietnam, and capturing the major property of the conditional variance on exchange rate returns. The flow of analysis and provision of empirical results also follow this sequence.

2.3.1 Basic indications on returns

Returns of USD exchange rates play an important role in the decision of the population on holding USD in the portfolio. When the return increases, we understand that the local currency has the tendency to depreciate against the greenback. The higher the appreciation of USD against VND, the stronger the switching from local currency to USD becomes.

Figures (8 and 9) show that the trend of local currency depreciating against USD persists, although there exist some periods, in which the exchange rate remains stable. We provide detailed examination of returns in different frequencies and horizons in the following.

Returns in different frequencies and time spans The monthly return is used extensively in reports by media and the agency due to the ease of data collection. We show below figure (10) for the period from Jun-1988 until very recently, Jun-2004, representing almost the whole economic reform timeline in Vietnam.

We have two other time spans for weekly and daily returns as shown in the figures (11) and (12), respectively. Weekly return series runs from May-1995 to Jun-2004, and daily from Dec-1995 to May-2004.

What we can realize from the retuns of different frequencies are as follows.

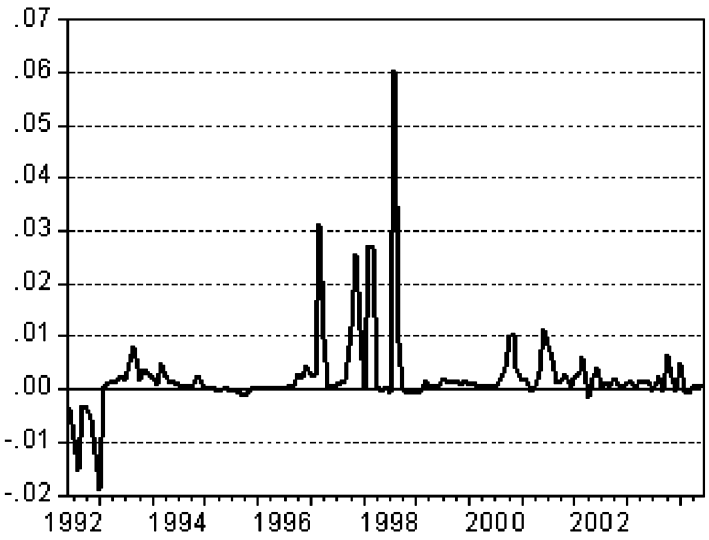


Figure 10: Monthly USD exchange rate return from 1988 to 2004

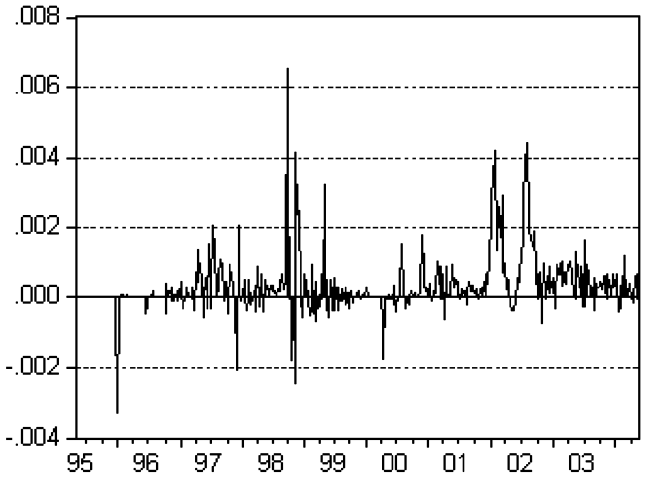


Figure 11: Weekly USD exchange rate return from May-1995 to May-2004

- Scales for fluctuations of monthly and weekly returns are very similar, so that the jumps within a week of USD spot exchange rates typically represent by the week ups and downs.
- Comparatively, the daily fluctuation is also quite sizable and cluster thickly within the range of -0.1 to $+0.1\%$.
- Two periods that we can see larger jumps in returns are 1998-99 and 2002-03.

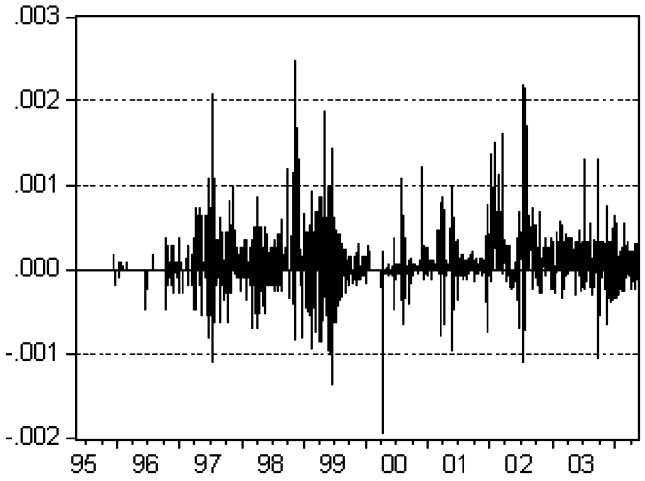


Figure 12: Daily USD exchange rate return from Dec-1995 to May-2004

Comparative basic statistics The next table (9) indicates some basic descriptive statistics on USD returns in question. What we learn is the fluctuation of USD returns is not large, by whatever frequency. For example, the largest is monthly return represents 6% per month, and the downside is even much smaller in magnitude. However, since the appreciation of USD against VND keeps going on, we end up with a large cumulative return for the period of reform.

Table 9: Basic descriptive statistics of USD returns

	Monthly	Weekly	Daily
Mean	0.002284	0.000311	0.000070
Median	0.000943	0.000088	0.000000
Maximum	0.060561	0.006550	0.002468
Minimum	-0.019080	-0.003312	-0.001946
Std. Dev.	0.007593	0.000791	0.000290
Skewness	3.95	2.44	1.38
Kurtosis	28.84	17.29	14.16
J-B	4412.54	4484.89	12124.76
Proba.	0.00	0.00	0.00
Obs.	145	472	2200

In table (10) we study the weekly return of USD over different subsamples. We can see that starting from 1997, year of the financial crisis in Asia, no subsamples show negative average weekly return in USD. In other words, USD on average increases continuously. If we select the most recent period, which runs from Jan-2002 to May-2004, the average rate of growth in USD price represents the highest among all computations.

Table 10: Weekly USD returns over expanding subsamples 1995-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1995	-0.000097	-0.000037	0.000100	0.000178	0.000159	0.000140	0.000159	0.000297	0.000314	0.000311
1996		0.000002	0.000164	0.000237	0.000201	0.000171	0.000187	0.000334	0.000348	0.000343
1997			0.000323	0.000350	0.000265	0.000214	0.000232	0.000389	0.000398	0.000389
1998				0.000378	0.000235	0.000177	0.000222	0.000399	0.000410	0.000399
1999					0.000101	0.000080	0.000154	0.000407	0.000415	0.000403
2000						0.000057	0.000182	0.000509	0.000494	0.000471
2001							0.000303	0.000732	0.000638	0.000593
2002								0.001202	0.000826	0.000733
2003									0.000449	0.000390
2004										0.000239

Looking closely at the first row of table (10), which exhausts the whole sample in consideration. We notice that the first subsample in 1995 starts in May, and the last, in 2004, ends in May. Each subsample of this row runs from May-1995 to the last day of the year indicated by the table. Therefore, we consider the pattern of the weekly USD return over expanding timeline until we cover the whole data series. The statistics show that in the second half of 1995 the USD value depreciated against the VND. This is the time when FDI flow to Vietnam surged abruptly, and the availability of USD in the market became much more abundant. However, the second row of (10) shows in its first data cell that 1996 saw USD regain its value, with slightly positive weekly return over the whole year. Thus, we learn that USD lost its value only in the second half of 1995, and gained in all other subsamples. In general, USD gained much value in two year 1998 and 2003, $+0.0378\%$ and $+0.0449\%$ per week on average.

Next, we examine the situation of autocorrelations for the three returns in near lags, from 1 to 10, and each additional 5 lags in the following table (11). The table reports also $Q'(k)$, alongside the autocorrelation coefficients (AC columns).

The results from table (11) show large $Q'(k)$ values at even near lags. These values become much larger with further lags in the returns. The large values indicate the fact that even the monthly return exhibits strong serial correlations, at far lags such as 30. Weekly and daily returns, as expected, show highly significant $Q'(k)$ at any conventional levels. Therefore, we obtain an insight that these returns, no matter how we scale them and choose the frequency, should not show uncorrelatedness, even with far lags. This insight is in line with literature documented for asset returns in many world markets, and also with insights about Vietnam Stock Market returns, considered in the previous paper.

2.3.2 Foreign exchange market efficiency revisited

We have documented the serial correlations through statistically significant autocorrelations of table (11), this indicates that without parametric specifications, the hypothesis of uncorrelated increments is nullified, and return sequences have not exhibited what we consider a 'fair game' property.

Next, we will be using a semiparametric test initiated by Lo and MacKinlay (1988:[20]), which is now usually referred to as *variance ratio test.* In this particular empirical analysis, a brief description of the method will follow immediately, then the empirical results from such test implementation for USD exchange rate returns.

Lo-MacKinlay's variance ratio test Besides the original work [20], the method is also presented with clarity and further elaboration in [6], p. 44–58. The method is shown briefly in the following. The hypothesis is exactly the same as what we consider in analyzing capital market efficiency in the preceding paper. Using the set of notations by Lo and MacKinlay 7.

$$X_t = \mu + X_{t-1} + \epsilon_t \tag{7}$$

where, μ is a drift parameter and ϵ_t is the random term of the system. Our standard assumptions are as usual:

1. $\forall t,\ E(\epsilon_t) = 0$ and $E(\epsilon_t \epsilon_{t-\tau}) = 0\ \forall \tau \neq 0$, where $E(\cdot)$ denotes the expectation operator.

2. $\lim_{nq} \frac{1}{nq} \sum_{t=1}^{nq} E(\epsilon_t^2) = \sigma_0^2 < \infty$, where nq represents the number of observed past price, and q a parameter that will be presented below.

Table 11: Autocorrelations (AC) and $Q'(k)$ on USD returns

	Monthly		Weekly		Daily	
$k =$	AC	$Q'(k)$	AC	$Q'(k)$	AC	$Q'(k)$
1	0.320′	15.20	0.393′	73.24	-0.120′	31.67
2	0.072′	15.97	0.427′	160.09	0.199′	118.64
3	0.116″	17.98	0.286′	199.12	0.134′	158.06
4	0.111″	19.86	0.224′	223.11	0.183′	231.79
5	0.230′	27.91	0.249′	252.71	0.145′	277.92
6	0.214′	34.92	0.146′	262.97	0.147′	325.75
7	0.055′	35.39	0.283′	301.53	0.156′	379.18
8	0.110′	37.27	0.211′	322.96	0.112′	407.04
9	0.168′	41.67	0.125′	330.57	0.141′	451.18
10	0.062′	42.28	0.066′	332.68	0.110′	478.01
15	-0.074′	46.05	0.000′	334.27	0.077′	642.99
20	-0.049′	51.60	0.088′	342.40	0.069′	736.81
25	-0.053′	55.40	0.177′	418.74	0.086′	815.87
30	-0.054′	57.16	0.158′	521.16	0.108′	882.71

(′,″) denote coefficients statistically significant at 1 and 5%, respectively.

3. $\forall t, E(\epsilon_t \epsilon_{t-j} \epsilon_t \epsilon_{t-k}) = 0$, with $j, k > 0,\ j \neq k$.

These conditions are necessary for constructing a variance ratio test that is valid for accounting for the heteroskedastic increments in exchange rate prices. We next present the statistic itself, together with several important properties.

The construction of the variance ratio has a number of components as follows. Assuming that we have $nq + 1$ observations $X_0, X_1, \ldots, X_{nq}$, where q is any integer greater than 1. We define a number of estimators as follows:

$$\hat{\mu} \equiv \frac{1}{nq} \sum_{k=1}^{nq} (X_k - X_{k-1}) = \frac{1}{nq}(X_{nq} - X_0) \tag{8}$$

$$\hat{\sigma}_a^2 \equiv \frac{1}{nq} \sum_{k=1}^{nq} (X_k - X_{k-1} - \hat{\mu})^2 \tag{9}$$

$$\hat{\sigma}_b^2(q) \equiv \frac{1}{nq} \sum_{k=1}^{n} (X_{qk} - X_{qk-q} - q\hat{\mu})^2 \tag{10}$$

$$J_r(q) \equiv \frac{\hat{\sigma}_b^2(q)}{\hat{\sigma}_a^2} - 1 \tag{11}$$

MacKinlay (1988, [20]) points out that under the null hypothesis:

$$\sqrt{nq} J_r(q) \sim N(0, 2(q-1)) \tag{12}$$

Also, [20] shows that by approximations, we can construct the following statistic:

$$M_r(q) \simeq 2 \sum_{j=1}^{q-j} \frac{q-j}{q} \hat{\rho}(j) \tag{13}$$

where $\hat{\rho}(j)$ denotes the lth order autocorrelations coefficient estimator of the return ($\equiv (X_t - X_{t-1})$).

The way to account for heteroskedasticity in USD price increments is as follows:

$$\hat{\delta}(j) = \frac{\sum_{k=j+1}^{nq} (X_k - X_{k-1} - \hat{\mu})^2 (X_{k-j} - X_{k-j-1} - \hat{\mu})^2}{[(X_k - X_{k-1} - \hat{\mu})^2]^2} \tag{14}$$

$$\hat{\theta}(q) \equiv \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q} \right]^2 \hat{\delta}(j) \tag{15}$$

The computation leads to the following heteroskedastic-consistent standardized test statistic, with the property:

$$z^*(q) \equiv \frac{\sqrt{nq} M_r(q)}{\sqrt{\hat{\theta}}} \overset{a}{\sim} N(0,1) \tag{16}$$

We will be using $z^*(q)$ to implement the test on foreign exchange market efficiency in the weak form.

Empirical results Following the strategy of testing foreign exchange market using Lo-MacKinlay variance ratio, qs are given integer values from 2 to 8. The implementation of the test paradigm has been done with two return sequences, weekly and monthly. In fact, [20] suggests the implement the variance ratio test on the weekly return to avoid biases of daily trading return due to (i) nontrading; (ii) asynchronous prices. So we will give priority to weekly return, but test outcome for the daily return is also reported in this discussion.

The computation of the variance ratio heteroskedasticity-consistent test statistic is straightforward, utilizing eq.(16). With respect to the weekly return, the sample from 25-Dec-1995 to 24-May-2004 is selected for the computations, yielding 440 observations. The weekly return is computed as the first-order log-difference between this Monday and the preceding. Below are some components of intermediate results during the computing process.

We obtain the vector of first 7 autocorrelations, from lag of 2 to 8 from the following:

$$\rho(j)_{(7\times 1)} = \begin{pmatrix} 0.024191827 \\ 0.031072883 \\ 0.046921251 \\ 0.041611121 \\ 0.030454606 \\ 0.023931347 \\ 0.032912386 \end{pmatrix} \tag{17}$$

For approximating $M_r(q)$ from autocorrelations of both weekly and daily returns, the loading factors in the sum are provided in the table (18), with q running from 2 to 8, and corresponding j from 1 to 7.

$$A = \begin{pmatrix} 1.0000 & 1.7778 & 2.2500 & 2.5600 & 2.7778 & 2.9388 & 3.0625 \\ & 0.4444 & 1.0000 & 1.4400 & 1.7778 & 2.0408 & 2.2500 \\ & & 0.2500 & 0.6400 & 1.0000 & 1.3061 & 1.5625 \\ & & & 0.1600 & 0.4444 & 0.7347 & 1.0000 \\ & & & & 0.1111 & 0.3265 & 0.5625 \\ & & & & & 0.0816 & 0.2500 \\ & & & & & & 0.6250 \end{pmatrix} \tag{18}$$

The computations result in the following vector of $\hat{\delta}(j)_{7\times 1}$ for the weekly return series by eq.(19).

$$\hat{\delta}(j)_{(7\times 1)} = \begin{pmatrix} 0.024191827 \\ 0.01143054 \\ 0.013085669 \\ 0.004524031 \\ 0.000560878 \\ 0.000529654 \\ 0.000320668 \end{pmatrix} \tag{19}$$

For computing heteroskedasticity-consistent estimator $\hat{\theta}(q)$, the loading factors in the sum for both weekly and daily returns are provided in the table (20), with q running from 2 to 8, and corresponding j, from 1 to 7.

$$B = \begin{pmatrix} 1.0000 & 1.3333 & 1.5000 & 1.6000 & 1.6667 & 1.7143 & 1.7500 \\ & 0.6667 & 1.0000 & 1.2000 & 1.3333 & 1.4286 & 1.5000 \\ & & 0.5000 & 0.8000 & 1.0000 & 1.1429 & 1.2500 \\ & & & 0.4000 & 0.6667 & 0.8571 & 1.0000 \\ & & & & 0.3333 & 0.5714 & 0.7500 \\ & & & & & 0.2857 & 0.5000 \\ & & & & & & 0.2500 \end{pmatrix} \tag{20}$$

The results of variance ratios and test statistic values following Lo-MacKinlay paradigm are provided in table (12).

Table 12: Variance ratio test results on the USD weekly return

q	2	3	4	5	6	7	8
$1 + M_r(q)$	1.02	1.03	1.05	1.04	1.03	1.02	1.03
$z^*(q)$	$(52.02)^\star$	$(96.72)^\star$	$(98.84)^\star$	$(118.72)^\star$	$(162.94)^\star$	$(188.38)^\star$	$(195.42)^\star$

We notice two points as follows:

1. The magnitude of variance ratios themselves are around $+1$, and smaller than those reported by [20]. They all yield correct sign $(+)$.

2. However, all $z^*(q)$ test statistics show very large values, which increase when we increase the value of q.

It has been proved that $z^*(q)$ statistic asymptotic behavior will follow $N(0,1)$. Values of $z^*(q)$, taking 5% significant level as applied by [20], become significant if $|z^*(q)| > 1.95$. Our test statistic values shown in tab.(12) help verify the significance of all $M_r(q)$. These have the meaning that these $M_r(q)$s, although not large, are significant different from 0, and thus $1 + M_r(q)$s are statistically different from 1, with the weekly USD return and q running from 2 to 8.

Clearly, these results reject the null hypothesis that eq.(7) represents the dynamics of the USD weekly price.

Similarly, the daily USD return is examined using the sample period from 15-Jan-1996 to 20-May-2004, yielding a large number of daily observation, 2180. This is the largest data set for USD spot rate available in Vietnam thus far that we can access. We report some intermediate (23), (24) in the Appendix 1 of this paper. The results of variance ratio tests on the daily return are reported in table (13).

We notice the same insights as in the case of daily return series, and that values of $z^*(q)$ even gets much larger than the case of weekly return. The results also decisively reject the null hypothesis.

2.3.3 Changing volatility and persistence

The upcoming analysis will examine the degree of volatility persistence in the daily USD return through a consideration of the ARMA-GARCH$(1,1)$ specification. The motivation has been given in paper 3, plus some further event study presented in the subsequent discussion. In this specific study, we use 1940 daily observations from Dec-1996, about 6 months before the Asian financial crisis, to May-2004. The sample is quite good for a GARCH specification estimation, and spanning a good period of reform in Vietnam. The results of this estimation is provided in table (14).

The estimation of this specification show that only constant term of the variance equation is statistically insignificant, while the rest of coefficients are statistically significant at any conventional level. We notice that $\alpha_1 + \gamma_1 \simeq 0.981$ indicates that the volatility is quite persistent, and the sum close to 1 unveils the fact that the current shock will have influence to almost all forecast horizons, with respect to the conditional variance. Due to $\alpha_1 + \gamma_1 < 1$, we learn that the unconditional variance, σ^2, is equal to:

$$\sigma^2 = E(\sigma_t^2) = \omega/(1 - \alpha_1 - \gamma_1) = 4.06 \times 10^{-5}$$

Estimating the above specification also yields satisfactory stability and appropriate properties. We check the further serial correlations in residual and squared residuals in the following.

We find that no further serial correlations are found in the residuals of the estimation. In addition, other test statistic such as Engle's LM statistic shows that no further ARCH

Table 13: Variance ratio test results on the USD daily return

q	2	3	4	5	6	7	8
$1 + M_r(q)$	1.0003007	1.0000062	1.0000037	1.0000024	1.0000017	1.0000014	1.0000012
$z^*(q)$	(-331.74)*	(462.54)*	(4599.33)*	(17,013.55)*	(28,550.53)*	(16,165.89)*	(24,480.08)*

Table 14: Daily USD return GARCH(1,1) specification

	Coefficient	Std. Error	z-Statistic
ω	$3.98\times10^{-5}{}^\star$	1.21×10^{-5}	3.279526
AR(1)	0.660208*	0.043681	15.11414
AR(2)	0.293024*	0.041184	7.114976
MA(1)	-0.87932*	0.022014	-39.9437
	Variance Equation		
κ	3.64×10^{-9}	3.15×10^{-9}	1.154245
ARCH(1)	0.211249*	0.046039	4.588479
GARCH(1)	0.76944*	0.041796	18.40925
R^2	0.1508	$L(\theta)$	13487.62
$\overline{R}^2$	0.1482	AIC	-13.90

effect left after the estimation, with small values of 0.0695 and 0.1769, for lag $k = 1$ and 2, respectively. These show no significance at any conventional levels, indicating satisfactor model specification.

We have noticed that the GARCH specification can help model the USD return well enough. $\alpha + \gamma < 1$ but quite close to 1 indicates that the volatility persistence is quite strong. By this specific estimation, with highly significant AR(1), AR(2) terms, we notice that the parametric estimation also rejects the hypothesis of random walk of USD spot exchange rate, in line with the result of the Lo-MacKinlay variance ratio test. The predictability components are shown clearly through first- and second-autoregressive coefficients of the dynamics. Figure (13) below presents the picture of changing conditional variance following the preceding estimation using GARCH specification for empirical data of daily USD return in Vietnam over a reasonably long period.

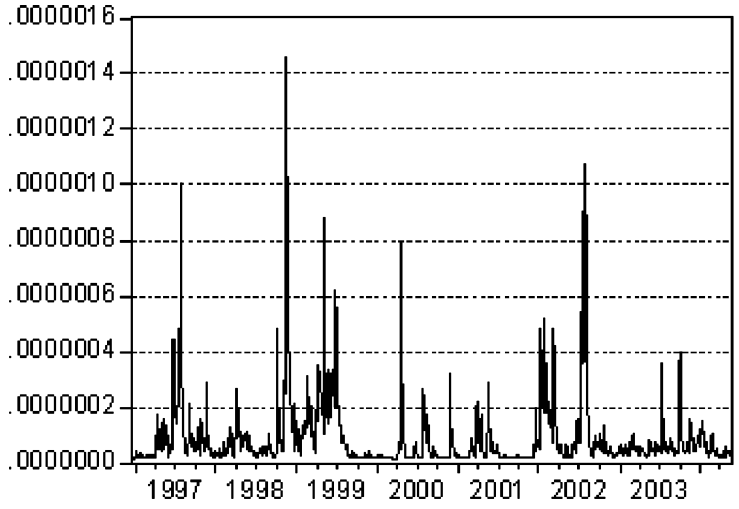


Figure 13: Daily USD return changing volatility

2.3.4 Possible dummy variable modeling

An important implication that one may have when looking at Vietnam's exchange rate situation is about whether or not restrictions and recent Asian financial problem carry

Table 15: Further serial correlations test and reported Q'

k		Q'			$Q^{2\prime}$	
5	-0.001	3.59	0.17	-0.007	1.71	0.43
10	0.003	6.08	0.53	-0.005	3.35	0.85
15	-0.008	8.71	0.73	0.001	3.57	0.99
20	0.014	12.88	0.74	-0.001	4.34	1.00
25	-0.013	18.82	0.66	0	4.62	1.00
30	0.046	26.95	0.47	-0.019	6.40	1.00
35	0.03	39.74	0.16	0.009	7.38	1.00

any substantial impacts on either the return or the changing levels of conditional variance of USD return. This question is quite essential to our understanding, and to this end, the question is somewhat similar to the interest in paper 3. For this specific consideration, we use the subsample of USD return from the beginning of 1998 until end of 2003, large enough to cover possible effect of the past crisis.

To update further information with regards to these events, three dummy variables are entered into the original dataset as follow.

1. AFC1 is the dummy variable, receiving 1 when we consider the remaining effect of the crisis, and 0, otherwise. Thus, this series has value 1 from observation 1 till observation 149, on about mid-July 1998, the period considered most critical to East and Southeast Asian nations during the turbulence;

2. BANDTO25, the effective period of USD price variation limit of 2.5% per transaction day. This series, thus, contains values 1 from observation 968 till 1344; and,

3. BANDTO10, the effective period of USD price variation limit is strictly monitored and capped at 1% per transaction day. The period covers observation 236 until 967. This series, thus, contains values 1 from observation 968 till 1344.

The actual empirical estimation uses the following specification:

$$y_t = \beta_0 + \delta_2 D_{2,t} + \delta_3 D_{3,t} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \epsilon_t - \theta_1 \epsilon_{t-1} \quad (21)$$

$$\sigma_t^2 = \omega + \phi_1 D_{1,t} + \phi_2 D_{2,t} + \phi_3 D_{3,t} + \alpha_1 \sigma_{t-1}^2 + \gamma_1 \epsilon_{t-1}^2 + \gamma_2 \epsilon_{t-2}^2 \quad (22)$$

We summarize the examination of possible impacts of the dummy variables on daily returns of the time series in table (16).

Table 16: Possible impacts of dummy variables

	Coefficient	Std. Error	z-Statistic
β_0	2.47×10^{-5}	3.18×10^{-5}	0.7773
δ_2	7.77×10^{-5} **	4.35E-05	1.7867
δ_3	2.59×10^{-5}	3.59×10^{-5}	0.7217
β_1	0.813903*	0.04272	19.0520
β_2	0.139306*	0.036613	3.8049
θ_1	-0.87882*	0.025156	-34.9344
	Variance Equation		
ω	6.94×10^{-8}	1.40×10^{-7}	0.4948
γ_1	0.398186*	0.111357	3.5758
γ_2	-0.280222*	0.094267	-2.9726
α_1	0.785764*	0.060676	12.9502
ϕ_1	-6.59×10^{-8}	1.39×10^{-7}	-0.4730
ϕ_2	-6.31×10^{-8}	1.38×10^{-7}	-0.4570
ϕ_3	-6.46×10^{-8}	1.38×10^{-7}	-0.4665
R^2	0.1280	AIC	-14.04
$\overline{R}^2$	0.1201	$L(\theta)$	9425.22
$\sum_i \gamma_i + \sum_j \alpha_j$	0.9037		

We note that δ_2 coefficient is significant at 5% level, and the rest of the dummy variables show no significance. All autoregressive/moving average and ARCH/GARCH coefficients are highly significant, similar to the previous specification without the dummy variables. The persistence of volatility shock is still quite high, around 0.90, although slightly lower than the previous level of 0.98.

We do not find the significance of the Asian financial turmoil's impact on the Vietnamese foreign exchange market through the daily USD return. This is in line with the argument that strict forex regulations and half-closed financial economy of Vietnam play a critical role in the situation. An illustration of the time-varying variance following table (16) results is provided in the Appendix 2.

3 Concluding Remarks

We have obtained a number of insights about the gold and foreign exchange markets in Vietnam in the reform period. Below some major remarks are offerred.

3.1 On the gold market

3.1.1 Functions and roles of gold in the economy

Gold with high purity has still played an important role in Vietnam's population as a payment, value-preserving measure. The use of gold for these purposes, as well as hoarding, has been increasing over the recent years of the reform.

There exists in Vietnam the method of gold deposition at authorized commercial banks, through which the gold holding can yield the depositors some interest. In the time of local currency depreciation concern, the population tend to switch their liquidity assets to either gold or USD, or both. And the price of gold has a link to the real property market in Vietnam since the population has the habit of indexing land and houses to gold.

3.1.2 Gold businesses are heavily regulated

Gold mining in Vietnam has been almost negligible, approximately 2 tonnes p.a. compared to the estimated consumption of 59 tonnes in 2003, leaving much of the demand to the gold import business. Import tax on gold is still applicable, and becomes a risk of smuggling. About 49 tonnes of gold was channeled to Vietnam through unofficial methods, representing such a large risk of smuggling. The current tariff is 0.5%, reduced from 1.0% on 1-Apr-2004, a move that has been hailed by the WGC as positive change in gold regulation issues and fighting smuggling. However, in general, the gold businesses are heavily regulated by the main authority, the central bank SBV.

The quotas granting process can be sometimes difficult and possible to only a number of authorized commercial banks, thus the free movement of gold into and out of Vietnam is impossible, as stipulated by the Government Decree No. 64/2003/ND-CP.

3.1.3 Major empirical results on the gold factor

Increasing gold demand in Vietnam One result of this has shown that the gold demand in Vietnam has been a time-trend stationary process during the recent years of the reform, using the ADF paradigm. In other words, the growth rate of gold demand for this particular is positively related to the time factor. This leads to an insight that the official quota system can be inappropriate since the authority underestimates or is not willing to fully appreciate the domestic need for gold. This can be a good cause for smuggling that makes the market less transparent and uncontrollable. The recent gap between official import of gold and estimated consumption offers such suspicion.

Properties of gold return The monthly gold return in Vietnam does not show significant serial correlation, for the period 1998 to 2004. In terms of changing return level, the recent trend for gold price in Vietnam is quite strong, and more stable than international gold prices, in comparison to London Fix indicator. In general, the fluctuation of domestic gold market is less than that of international market.

Using the large sample of daily gold return from 1996 to May-2004, nearly 2200 daily observations, with a comparison to London market, the results show that the max and min fluctuations on a daily basis of Vietnam gold market are only 1/5 of London price in value. The empirical distribution of daily return departs significantly from the normality. Huge excess kurtosis and JB values are reported. Strong serial correlations are found in daily returns, both Vietnam and London, with highly significant Q's, until very far lag, such as $k = 100$.

Additional results also indicate that high-frequency gold return for Vietnam exhibits sign of time-varying volatility, represented by the GARCH phenomenon.

Gold market efficiency The gold market efficiency to information is rejected by confirming the predictable component of past prices. This result is in line with our previous finding of strong serial dependence in past prices of gold in Vietnam, without parametric estimation. The significance of AR(1) is our estimation for the Vietnam gold market is much stronger than the London market, using a common subsample sample of more than 1600 observations, running from 1998 to 2004.

Connection of domestic to world gold market Through different subsamples of data, the connection of the domestic market to the world is checked using the correlation coefficient. What has been found is the more recent the subsample is selected, the stronger the positive correlation between Vietnam and London markets becomes. The strongest represents the most recent subsample from Jan to May-2004, with $\rho = 27.67\%$, highly positively correlated indication. This already represents a significant jump in we compare to a larger subsample with the first observation dates back to early 2003, where $\rho = 20.68\%$. When we move the first date back to 1998, ρ gets smaller, standing at a mere 13.11%, although still positive, but in magnitude only half of the Jan-May, 2004 period.

The re-integrating process and liberalized trade have contributed to gradually remove the price difference between the domestic and international markets. The connection even

becomes clearer when we examine the degree of dependence of domestic gold return on the London return, using PDL specification capturing the time-varying volatility effect. All coefficients of distributed lags of London returns until $k = 4$ are highly significant, as well as AR(1) coefficient of Vietnam's return. The changing volatility of this specification is captured well, showing a high degree of persistence, with $\gamma + \alpha = 0.9794$, indicating the current shocks to the system may carry influence to a large number of future variances. This problem is also found in many other gold market, thus not a surprising result for the Vietnam market.

3.2 On the foreign exchange market

A qualitative discussion on the role of USD in Vietnam foreign exchange market is provided in the paper. A number of tests are performed on different returns of USD exchange rates in this paper as well. We summarize below some key results.

3.2.1 Roles and hoards of USD

We show that USD has an important role in the local economy, through the public acknowledgement of it as widely accepted payment and calculation currency, and the noticeable popularity and liquidity of USD itself. Population, excluding enterprises, is estimated to hold a large amount of USD in their savings. An indicative ratio is 45% of the forex channeled through banks held by households. The transfer in 2003 alone is estimated at USD 2.7 billion. Thus, we know that USD hoarding is as strong as gold.

For its popularity and the trend of USD hoarding, the hard currency is subject to a set of heavy regulations by the central bank. The current most important forex market is the Vietnam Interbank FX Market, established in 1994 that accounts for currently about 90% of total FX transactions for business demand. Transactions are simple, mostly spot, although forward and swap are allowed.

3.2.2 Properties of USD returns

The study uses three different return frequency, monthly, weekly and daily. In general, fluctuation of returns is not large, but comparatively, among the three returns, daily return appears to have fluctuated the most, although in absolute magnitude the scale for the daily return is only 1/3 of monthly and weekly. The daily return point have clustered around the two points -0.1 and $+0.1\%$.

Large jumps in returns of all types are seen in 1998-99 and 2002-03 periods. Looking more closely into the weekly returns of USD exchange rates, over the sample period from May-1995 to May-2004, with nearly 500 observations, the study constructs different subsamples to observe the change of the mean return over time. It reveals that 1998 and 2003 are the two years that USD gains most of its value against the local currency, 0.0378/Recent trend of upward USD returns is clear, showing the continuous depreciation of the local currency, although it has been hard to see large shocks.

A thorough check on serial correlations using $Q'(k)$ with k running from 1 to 10, and several other longer lags, until 30. All three returns exhibit strong serial correlations at

all lags examined, rejecting the hypothesis of uncorrelatedness in these return series. One strange point is the strong serial correlation of the monthly return, which we have seen documented in regional literature, although weekly and daily serial correlations are found quite common.

3.2.3 A test on foreign exchange market efficiency

Our study employs the Lo-MacKinlay (1988:[20]) variance ratio test paradigm to test the market efficiency. The tests have been performed on both weekly and daily returns of USD, and for integer values of q from 2 to 8. The test results show that although the actual $M_r(q)$ values for both weekly and daily returns are small in magnitude, they are all highly significant, with huge $z^*(q)$ values.

These results imply clearly that $1+M_r(q)$s are significantly different from 1, in our tests with q upto 8 they are larger than 1, more specifically, as hypothesized by the random walk theory, thus strongly reject the null hypothesis of market efficiency for USD prices.

3.2.4 The time-varying volatility

The work also looks into the phenomenon of time-varying volatility and persistence by capturing the GARCH effects in the daily USD return. The specification is modeled as ARMA-GARCH(1,1), and estimated using 1940 observations for the period from 1996 to 2004. We find that variance equation's main coefficents are highly significant, at any significant levels, and the persistence is quite strong with $\alpha + \gamma = 0.9807$, leading to a comparatively small unconditional variance of the system $\sigma^2 = 4.06 \times 10^{-5}$.

3.2.5 Impacts of the Asian crisis, and daily price limits

The last specification test is employed on the daily USD return in pursuing any possible effects of the Asian financial crisis and daily limits on the dynamics of the daily USD exchange rate return.

Three dummy variables to represent the crisis period, the limit of 0.1% and the limit of 0.25% are introduced into both mean and variance equations. The estimation outcomes are also highly significant for AR, MA, (G)ARCH terms, but do not unveil the strong effects of these limits and the Asian crisis on Vietnam return. There are two points in the rejections of these examined effects. First off, the daily limits do not show that they can help reduce the variance, although they are devised to reduce the risk of large jumps. Second, the Asian crisis has had little impact on the domestic exchange rate return can be attributed to the half-closedness of the domestic foreign exchange market, and perhaps strong measures taken by the government during the critical time.

4 Appendixes

4.1 Appendix 1

Additional intermediate results of Lo-MacKinlay (1988:[20]) variance ratios for daily USD return, with q running from 2 to 8.

$$\rho(j)_{(7\times1)} = \begin{pmatrix} -0.120497618 \\ 0.183980864 \\ 0.337836482 \\ 0.562146608 \\ 0.70868773 \\ 0.859019415 \\ 1.02306521 \end{pmatrix} \tag{23}$$

$$\hat{\delta}(j)_{(7\times1)} = \begin{pmatrix} 3.00672 \times 10^{-4} \\ 3.60565 \times 10^{-4} \\ 1.22961 \times 10^{-5} \\ 2.48802 \times 10^{-6} \\ 1.40419 \times 10^{-6} \\ 6.43504 \times 10^{-6} \\ 3.98039 \times 10^{-6} \end{pmatrix} \tag{24}$$

4.2 Appendix 2

Illustration of the changing conditional variance of USD daily return for the period 1998-2003, capturing the effects of dummy variables of Asian financial crisis, relaxing daily USD price limit.

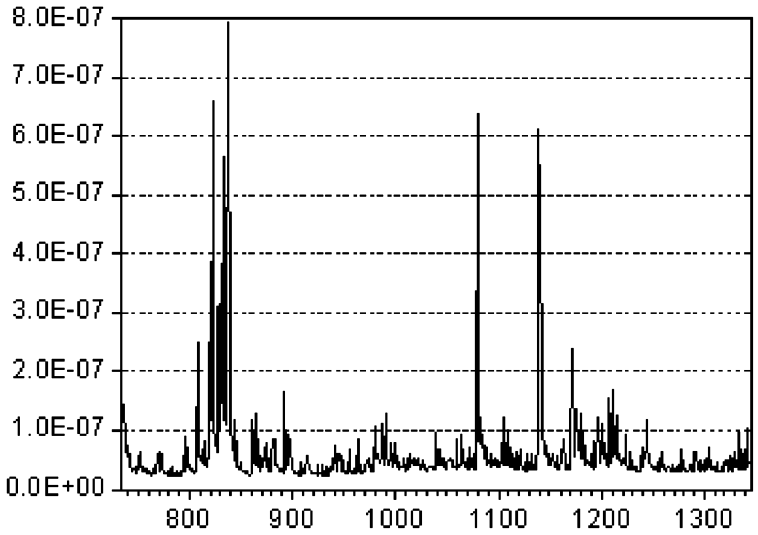


Figure 14: Daily USD return changing volatility with dummy variables

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