

AN OUTLOOK ON DETERMINANTS OF PHYSICAL GOLD DEMAND IN EMERGING AND DEVELOPED COUNTRIES, 2000-2010¹

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Abstract

This study investigates the key determinants of physical gold demand across countries including emerging markets and developed economies for the period of 2000-2010. A major hypothesis to be investigated is whether financial and economic volatilities stimulate consumer demand for gold. The hypothesis is extended to examine the effects of these volatilities on gold consumption in developing and developed countries. The analysis here explores how consumers in emerging economies and developed countries vary in their perception of gold. Findings suggest that gold demand is driven by different determinants in emerging countries and developed economies. In general, volatile economic environment stimulates gold demand in developing countries indicating that consumers tend to purchase gold for precautionary motives. There is a negative relation between income per capita volatility and physical gold demand in developed economies implying that consumer in developed countries purchases gold as jewelry instead of a hedging instrument. Finally, results suggest that there is no significant change in gold demand after 2007 financial crises. However, there exists a notable shift in consumption of gold categories. People tend to consume less jewelry than ever, but they prefer to engage with more retail investment gold purchases. Incorporating proxies for socio-cultural factors will contribute better results for future research.

Keywords: Consumer demand, Gold, Financial volatility

JEL: D01, F01, G01

GELİŞMEKTE OLAN VE GELİŞMİŞ ÜLKELERDEKİ FİZİKSEL ALTIN TALEBİ BELİRLEYİCİLERİ ÜZERİNE BİR İNCELEME, 2000-2010

Öz

Bu çalışma gelişmekte olan ve gelişmiş ülkelerdeki fiziksel altın talebinin önemli belirleyicilerini 2000 ve 2010 yılları arasında incelemektedir. Finansal ve ekonomik belirsizlik tüketici altın talebini teşvik edip etmediği başlıca sorgulanan hipotezlerden biri olmakla beraber hipotez bu belirsizliklerin gelişmiş ve gelişmekte olan ülke tüketicilerini nasıl etkilediği yönüyle de incelenmiştir. Yapılan analizlerde her iki ülke grubundaki tüketicilerin altın algısı üzerindeki farklılıklar ortaya çıkartılmıştır. Bulgular, altın talebinin gelişmiş ve gelişmekte olan ülkelerdeki tüketicilerin farklı belirleyiciler tarafından açıklandığını göstermektedir. Genel itibariyle belirsiz ekonomik ortamların gelişmekte olan ülkelerde altın talebini arttırdığı dolayısıyla tüketicilerin ihtiyat amaçlı altın alımı yaptıkları sonucuna varılmıştır. Bununla beraber gelişmiş ülke tüketicilerinin altını ihtiyat amaçlı yatırımdan ziyade takı ve mücevherat maksatlı talep ettiği ve bu ülkelerdeki kişi başına düşen gelirdeki belirsizlikle altın talebi arasında zıt yönlü bir ilişkinin olduğu tespit edilmiştir. Son olarak 2007 küresel finansal krizinin fiziksel altın talebini önemli ölçüde etkilememesine rağmen insanların takıdan daha çok yatırım amaçlı altın tüketimine yöneldiği gözlemlenmiştir. Sosyo-kültürel faktörlerin gelecek araştırmalara eklenmesi daha iyi bulgular edinilmesine katkıda bulunacaktır.

Anahtar kelimeler: Tüketici talebi, Altın, Finansal belirsizlik

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Introduction

Gold, one of the major economic items in the financial markets, has been well studied in non-physical form of its demand. One of the main focuses in the economic and financial literature for critical functions of gold is the impacts of macroeconomic indicators on gold price mostly analyzed in terms of claims to gold. Ranson and Wainright (2005) concluded that the price of gold is among the superior predictor of the next year inflation. Capie and Mills (2005) investigated the exchange rate hedge of gold price and found that gold returns could be a hedge against U.S. dollar depreciation with changing degree of relationship overtime. Chua and Woodward (1982) also stated that gold serves as the hedge against changes in a currency's value both internally against inflation and externally against other currencies.

Meanwhile, physical gold demand (jewelry, coins, bars, medallions) receives less attention in the literature. Most studies on physical gold demand indicate that gold has different appeals on consumers, therefore; it has several functions and characteristics across the economies. Batchelor and Gulley (1995) examined the link between and gold price changes and jewelry demand in 6 developed countries (US, UK, Italy, Germany, France and Japan). They concluded jewelry demand is price inelastic. Haugom (1991) studied gold demand for both developing and developed country groups and found that two groups of countries have different determinants of physical gold demand. The author suggested that gold demand in emerging markets is mainly affected by global economic conditions, particularly US macroeconomic events. On the other hand, gold demand in developed countries is found to have a positive relationship with lagged demand and negatively correlated with the gold price.

Kannan and Dhal (2008) analyzed consumer demand for gold in India as the largest gold consumer country in the world. They showed that India's gold demand is significantly influenced by real income and macroeconomic variables such as interest rate, exchange rate, besides the relative price of gold³.

In a more recent and comprehensive study, Starr and Tran (2008) analyzed import demand for gold over 21 countries. They investigated the impact of key economic indicators such as inflation, real interest rates, exchange rates, GDP/Capita growth on gold imports per capita. The authors concluded that income per capita is not a significant determinant of gold imports, although gold demand is found to be negatively related with recent income growth and income volatility leads higher gold demands across nations.

This article investigates factors affecting physical gold demand in major gold consuming countries. A major hypothesis to be investigated is whether financial and economic volatilities stimulate consumer demand for gold. The hypothesis is extended to examine the effects of these volatilities on gold consumption in developing and developed countries. The analysis here explores how consumers in emerging economies and developed countries vary in their perception of gold. Findings indicate that there is persistent unobserved heterogeneity across countries in gold demand. In particular, gold demand is determined by different factors in emerging countries than the demand in developed economies. In general, volatile economic environment stimulates gold demand in developing countries indicating that consumers tend to purchase gold for precautionary motives.

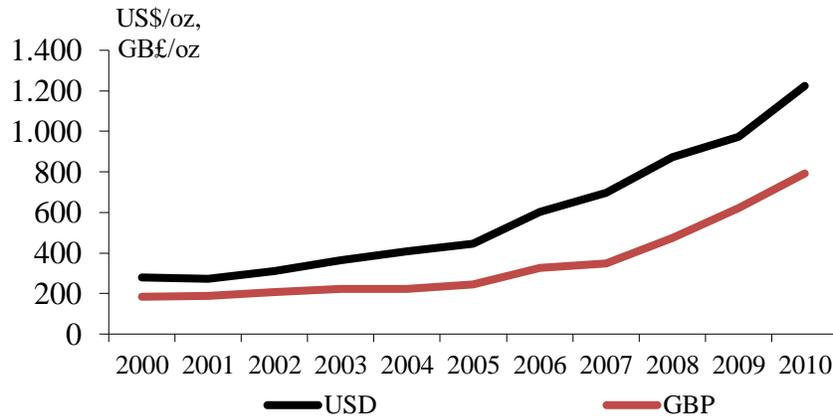
³ Vaidyanathan (1999) also confirmed that real income as a significant driver of gold demand in India.

The paper continues with an overview on global gold consumption. The following sections provide a detailed descriptions for data used and outline the empirical work employed to analyze the gold demand. After the estimation results are discussed, the paper concludes with recommendations and a summary of findings.

1. Global gold consumption

Despite dramatically increased prices (figure 1), global consumer demand for jewelry and retail investment gold (bars, coins, and medallions excluding central bank purchases and gold claims) followed relatively stable trend with an average of around three thousand tons per year during the first decade of the millennium (figure 2).

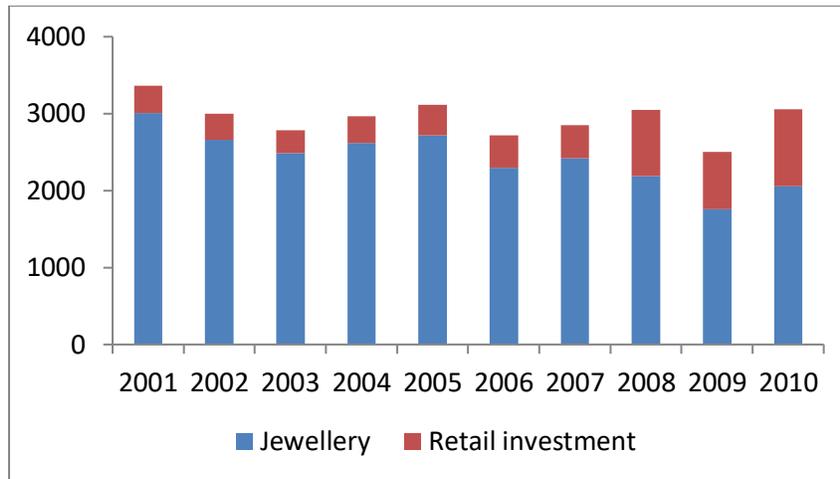
Figure 1: Average annual gold prices 2000-2010



Source: Reuters Datastream, World Gold Council

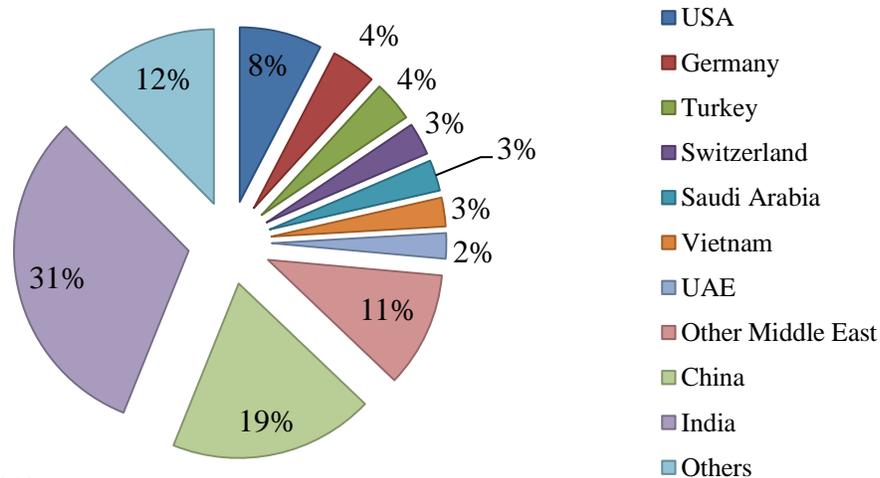
Retail investment gold consumption accounted less than a fifth of total consumer demand for physical gold before the financial crises which doubled the global demand for retail investment gold during the post-crises era.

Figure 2: Physical gold consumption in the world, 2000-2010 (in tons)



India and China were traditionally the leading nations in gold consumption accounted for approximately half of the global demand for gold in 2010. United States was the biggest gold consumer country among the developed economies (figure 3).

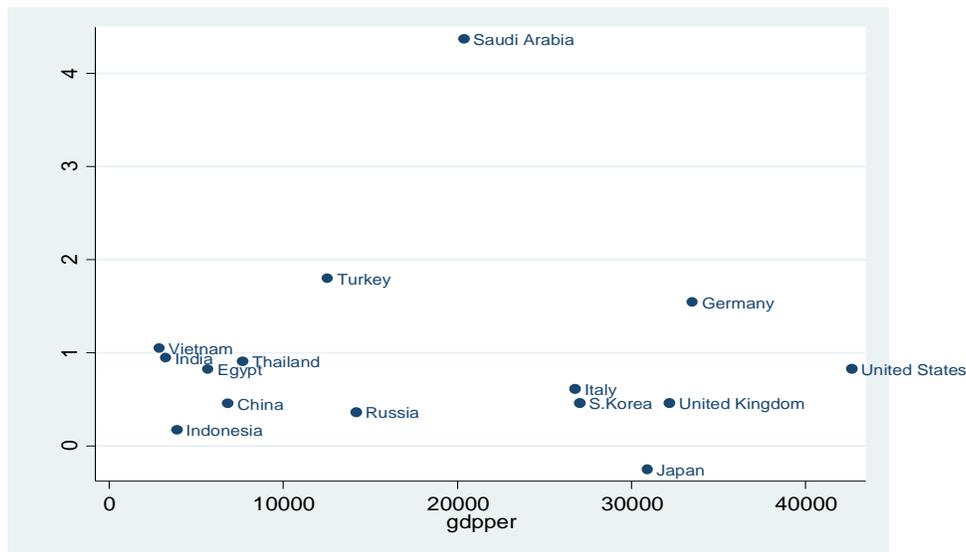
Figure 3: Major gold consuming countries (2010)



Source: WGC, 2010

However, figure 4 reveals that Saudi Arabia and Turkey had the most appetite for gold in terms of per capita consumption. Germany was the leading gold consuming developed country followed by the United States which had less than one gram gold consumption per person.

Figure 4: *Gold consumption per capita*



2. Data

Data for physical gold demand is obtained from the quarterly reports on “Gold Demand Trends” published by World Gold Council (WGC) (see www.gold.org). WGC categorized gold demand in for major groups of Jewelry, Retail Investment, Dental, and Industrial (also labeled as Technology). Jewelry and retail investment have the largest share of gold consumption, around 90% of total demand, and are analyzed in the present study. Industry & Dental demands presumably have different characteristic than consumer demand, thus they are not included in the analysis. Detailed definitions for each gold category are presented in Table 1. WGC releases the gold data excluding institutional investments and central banks gold purchases in order to identify the end-use consumption.

Table 1: *Categories of gold demand*

Category	Definition
Jewelry	All carat jewelry newly made from raw gold, including gem-set jewelry. It excludes jewelry of other metals clad or plated with gold as well as coins and bars used as jewelry. Second hand jewelry is also excluded (unless remelted and sold for cash). Purchases funded by the trading in of existing jewelry are not considered to add to demand. This is measured as close as feasible to purchases by the ultimate consumer.
Retail investment	Includes coins minted after 1800 which are not less than 900 fineness, are or have been legal tender in the country of origin and are not sold for more than 180 per cent of the value of their gold content; bars of one kilogram or less that are purchased by investors. It excludes second hand coins which have not been re-melted and sold for cash. Retail investment is measured as net purchases by the ultimate consumer.
Consumer Demand	Jewelry + Retail investment
Industrial	The first transformation of raw gold (e.g. fine gold kilobars) into intermediate products destined for industrial use such as gold potassium cyanide, gold bonding wire, sputtering targets. This includes gold destined for plating jewelry.
Dental	The first transformation of raw gold into intermediate products destined for dental applications such as dental alloys.

Source: World Gold Council

The econometric model is estimated using annual data for 11 emerging markets and 5 developed countries from 2000 – 2010 concerning gold per capita consumption quantity (in gr)⁴. The countries included in the study accounted for around 75% of total jewelry and retail demand in the world and may represent main characteristics of world gold market.

As for the explanatory variables, World Bank database is the main source for aggregate country data. GDP per capita (PPP constant 2005 US \$) and GDP per capita volatility are included for measuring individual income effect. Here, including GDP/capita, PPP is expected to measure the effects of real income and eliminate impenetrable impacts of differences of inflation and exchange rates across the countries. Besides, GDP per capita volatility would contribute to explain the effects of recent income changes on gold demand.

The inflation rate and inflation volatility data are also included in the regression. They are measured by consumer price index and by the standard deviation of inflation for the preceding 5 years, respectively. Exchange rate volatility is measured as the standard deviation of the previous five years nominal currencies compared to US dollar. Data for exchange rates is taken from Penn World Table 7.0 and from IRS for exchange rates in 2010 as well as US Trade Weighted Exchange Index: Broad for US⁵.

The London p.m. fix is the most preferred and reliable indicator for gold price,⁶ therefore the real price change in gold is derived from annual gold price issued by WGC in nominal US dollar. Here, nominal London p.m. fix gold prices in US dollar are converted into local currencies and finalized with real prices by using Penn Table 7.0 and World Bank database for inflation rates.

Market capitalization of listed companies in the countries' stock markets and domestic credit to private sector data are provided by World Development Indicators.

3. Empirical work

This paper examines characteristics of consumer gold demand and factors affecting physical gold demand across developed and developing countries. The general conceptual model for gold demand can be illustrated as $G_{it}=f(\text{income, gold price, price of substitutes, price of complements})$. Here price for complements are ignored in empirical studies due to the nature of gold (Starr and Tran, 2008). The econometric specification employed to analyze the factors affecting gold demand is as follows:

$$\ln G_{it} = \delta_0 + \delta_1 G_{it-1} + \delta_2 \ln GDPP_{it} + \delta_3 VGDPP_{it} + \delta_4 \ln PG_{it} + \delta_5 INF_{it} + \delta_6 VIN_{it} + \delta_7 RINT_{it} + \delta_8 CRED_{it} + \delta_9 STOCK_{it} + \delta_{10} VEXR_{it} + \delta_{11} D_i + \delta_{12} D_t + \gamma_i + \gamma_t + \varepsilon_{it} \quad (1)$$

G_{it} denotes consumer demand per capita in country i at time t and measured in grams in the logarithmic form. $\ln GDPP_{it}$ is the real gdp per capita, $VGDPP_{it}$ denotes gdp per capita volatility,

⁴ China, Egypt, Hong Kong, India, Indonesia, Russia, Saudi Arabia, South Korea, Thailand, Turkey, and Vietnam are the developing countries in the sample. Germany, Italy, Japan, United Kingdom, and United States are developed countries included in the analysis.

⁵ (<http://pwt.econ.upenn.edu/> , <http://research.stlouisfed.org/fred2/categories>)

⁶ See Starr and Tran(2008)

$\ln PG_{it}$ is the real gold price in logarithmic form, INF_{it} and $VINF_{it}$ are the consumer price index(CPI) and CPI volatility in country i at time t . γ_i and γ_t are country and time fixed effects. ε_{it} stands for random variations that are not captured by the model. Table 2 presents definitions of each variable used in the analysis.

Table 2. Variable Definitions and Data Sources

Variable	Definitions	Data Source
Ln Git	Log of gold consumption in tons. Includes jewellery, gold bars, coins, medallions and medals; excludes gold intended for dental and industrial uses	WGC ¹
Ln GDPP	Log of GDP/capita, in 2005 constant US dollars adjusted for PPP	WDI ²
VGDP	Standard deviation of growth rate for the previous five years	WDI
VEXR	Standard deviation of appreciation of against the US dollar in the previous five years the nominal exchange rate	PWT ³
INF	Consumer price index	WDI
VINF	Standard deviation of CPI in the previous five years	WDI
Ln PG	Log of world price of gold in constant domestic currency	WGC
RINT	Real interest rate	WDI
CRED	Private credit as a share of GDP (%)	WDI
STOCK	Market Capitalization of listed companies as a share of GDP (%)	WDI
D_i	Indicator variable which equals to 1 for developed countries.	
D_t	Indicator variable which equals to 1 for post-crises era.	

¹ World Gold Council, ² World Development Indicator, World Bank, ³ Penn World Tables 7.0

The empirical model is augmented by lagged dependent variable to identify whether gold demand has a dynamic structure. The econometric specification contains time and country fixed effects to control for the unobserved heterogeneity across countries over time. The augmented model is estimated with robust standard errors accounting for arbitrary patterns of heteroscedasticity.

The income factors are represented by real gdp per capita and gdp per capita volatility. Generally, income is expected to have positive correlation with quantity demanded. However, Ghosh et al., (2004) suggests an insignificant effect of real income on gold demand in advanced economies such as the US. Quantity demanded may also be associated with other factors such as socio-cultural elements or future price expectations which may be the case for gold demand.

Gold price is measured in real local currencies for each country obtained from WGC. Along with the economic theory, gold is expected to have negative price elasticity. Empirical studies show that current gold prices have negative relationship with quantity demanded. (e.g., Vaidyanathan 1999). However, increased price of gold may also imply an increase in future prices and may encourage consumer to buy more with investment motivation.

Exchange rate volatility is expressed with the lagged five years' standard deviation of nominal local currency changes compared to the US dollars. Since the domestic gold price is determined by global gold price, exchange rate is expected to play a key role in demand equations.

Inflation is measured by CPI and the volatility is calculated by the standard deviation of previous five years national inflation rates. Chua and Woodward (1982) and Capie and Mills (2005) suggest that gold claims serves a good hedging instrument against exchange rate changes and inflation. Although these findings derived from studies on gold claims, exchange rate and inflation volatility are expected to have positive correlation with physical gold demand, particularly in emerging markets.

The rest of the variables constitute possible substitutes for gold. They describe financial environment and investment opportunities across the countries. The real interest rates indicate an alternative saving instrument for gold. In a low interest rate environment, gold is expected to be a good investment tool against the possible increasing rates of inflation (Chua and Woodward, 1982). Availability and accessibility of borrowing is measured by the value of private sector credit outstanding as a share of GDP and is expected to decrease gold demand in highly and easily available environments especially in the emerging market context. Market capitalization of listed companies as a share of GDP can be considered as another possible substitute for gold. Higher shares of stock market to the GDP may cause decrease in gold demand.

Ordinary Least Squares method is used as a benchmark for panel fixed effects estimation which accounts for the unobserved heterogeneity problems due to country specific and historical factors. Missing observations in gold demand, real interest rates, stock market capitalization and gold price variables are aimed to be minimized by interpolating.

4. Results

This study examines factors affecting physical gold demand across countries including emerging markets and developed economies for the period of 2000-2010. The research is aimed to identify the effects of financial and economic volatility on consumer demand for jewelry and retail investment of gold.

Gold demand equation is estimated by OLS and Panel fixed effects methods to quantify the determinants of consumer demand for physical gold. Stationary test indicates that there exists significant serial correlation in the data. Thus, first difference is employed for further steps in the estimation. VIF and Breusch-Pagan tests show there are no significant multicollinearity and heteroskedasticity problem for the dataset, respectively. Hausmann test results suggested random effects is inconsistent with the gold demand data, therefore fixed effects is preferred in the model estimations.

Equation (1) is estimated for all countries. Then, it is estimated separately for both developing and developed country samples in order to illustrate potential differences in determinants of physical gold demand as well as different impact of 2007 global financial crisis on two country groups.

An important fact from Figure 4 is that gold consumption is not effected by income levels. High income level countries are consuming relatively less amount of gold compare to the emerging countries except the US. It can be interpreted as socio-cultural factors are playing more important role than income factors in gold consumption.

Figure 2 also suggesting that overall gold consumption trend significantly shifts from jewelry consumption to retail investment. Demand for retail investment was almost doubled in 2008 and stayed at high levels during the following years. That is, appeals for acquiring gold are more about investment purpose than ever. However, the historical jump in 2008 is not captured in the models since world total consumer demand (jewelry and retail investment) did not change significantly during the period.

The regression results for the full sample are presented in table 3. Fixed effects method preferred over OLS due to having a much smaller RMSE, a higher R^2 with more powerful coefficient estimates. The coefficient of the lagged demand is positive and statistically significant at a 1 percent level which indicates a dynamic demand structure for gold. Income and income volatility are statistically and economically significant determinants for gold demand. A 1 percent increase in income per capita leads to 0.3 percent increase in gold demand. Surprisingly, gold prices have an insignificant coefficient. Statistically significant and positive coefficients for inflation and inflation volatility suggest consumers demand more gold during the inflationary economic environment. Developing countries are more demanding gold than developed countries as the indicator variable for developed countries is negative and statistically significant at 10 percent level. Exchange rate volatility have a positive relationship with gold demand indicating that consumers tend to buy more gold as a hedging instrument against exchange rates. Finally the estimated coefficients for size of credit and stock exchange markets, real interest rates, and post-crises era are statistically insignificant.

Table 3: *Gold demand estimation, full sample (2000-2010)*

VARIABLES	OLS	Fixed Effects
	Gold/Capita	Gold/Capita
Lag (Gold Demand)	0.137 (0.33)	0.529*** (0.15)
Ln (GDPP)	1.518 (1.01)	0.287* (0.15)
GDPP Volatility	0.026 (0.02)	0.093** (0.04)
Ln (Gold price)	-0.018* (0.01)	-0.877 (0.54)
Inflation	0.365*** (0.13)	0.142** (0.07)
Inflation Volatility	0.059 (0.04)	0.019** (0.01)
Developed	-0.134** (0.06)	-0.044* (0.02)
Post-Crisis	0.042 (0.04)	0.054 (0.04)
Credit Market	-0.681 (0.45)	-0.032 (0.02)
Stock Market	-0.022 (0.02)	-0.048 (0.03)

Real interest rates	-0.088 (0.07)	-0.057 (0.05)
Exchange rate volatility	0.044 (0.03)	0.024* (0.01)
Constant	-6.70* (3.92)	-1.82*** (0.11)
Observations	174	174
R-squared	0.53	0.94
RMSE	0.224	0.105

*Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Table 4 reports estimation results for developing and developed country samples. Lagged demand is an important factor having positive and statistically significant coefficients in both estimations. A 1 percent increase in income per capita stimulates gold demand by 0.7 percent in developed countries while having an insignificant impact on emerging markets demand. However, income volatility significantly affects gold demand only in developing countries. The own price elasticity is elastic for developed markets suggesting gold being a luxury good. Inflation and inflation volatility have no significant impact on consumer demand in developed countries.

Table 4: *Gold demand model estimation, developing vs. developed country samples*

VARIABLES	Developing	Developed
	Gold/Capita	Gold/Capita
Lag (Gold Demand)	0.193*** (0.05)	0.237*** (0.09)
Ln (GDPP)	0.297 (0.17)	0.686** (0.34)
GDPP Volatility	0.116**	-0.084

	(0.06)	(0.05)
Ln (Gold price)	0.203	-1.104**
	(0.13)	(0.55)
Inflation	0.246**	0.237
	(0.13)	(0.14)
Inflation Volatility	0.092**	-0.018
	(0.05)	(0.23)
Post-Crisis	0.091	-0.049
	(0.08)	(0.10)
Credit Market	-0.056*	0.494
	(0.03)	(0.72)
Stock Market	-0.050	-0.087
	(0.11)	(0.06)
Real interest rates	-0.082**	-0.041
	(0.04)	(0.14)
Exchange rate volatility	0.031*	0.014
	(0.02)	(0.08)
Constant	-3.74***	-5.82***
	(1.02)	(2.11)
Observations	119	53
R-square	0.89	0.85
RMSE	0.113	0.121

*Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$*

Positive and statistically significant coefficients for inflation and inflation volatility in developing country sample estimation suggest consumers purchase more gold possibly as a hedging instrument against inflation. A 1 percent increase in the size of private credit rate decreases gold demand by 0.05 percent in emerging markets. Similarly, a 1 percent increase in real interest rates decreases gold demand by 0.08 percent in emerging markets. Finally, exchange rate volatility has a statistically significant impact on demand in developing countries.

Overall, findings suggest that gold consumption in emerging markets and developed countries have different determinants. Consumer in emerging markets are more affected by financial and economic volatilities implying that they are more investment oriented in gold consumption. However, developed country consumer seems to purchase gold mostly adornment and jewelry purposes.

5. Conclusions

This paper examines the determinants of consumer gold demand across the countries including emerging market as well as developed countries between 2000-2010 by using income factors, relative gold price, and a set of control variables consists of macroeconomic indicators for nations such as real interest rate, exchange rate and inflation.

The results suggest that there are significant differences between developing and developed countries. In general, gold demand affected by volatile economic environment in emerging markets indicating that consumers tend to purchase gold for precautionary motives. Income per capita has a positive impact on gold demand in developed countries, while income volatility highly associated with gold demand in emerging markets. Gold price is not a significant determinant for demand in emerging markets contrary to consumer demand in developed countries where gold is considered as a luxury good. Inflation, inflation and exchange rate volatility are important factors for developing country consumers' gold demand suggesting gold being a good hedge against inflation. Overall, gold demand affected by volatile economic environment in emerging markets indicating that consumers tend to purchase gold for precautionary motives.

Global financial crisis in 2007 has an insignificant impact on total consumer demand. Despite a dramatic increase in retail investment gold demand total world demand for gold did not change significantly during the post-crisis era. This fact might be an explanation for the insignificant impact of the crises on gold demand.

Findings also imply that the existence of uncontrolled heterogeneity problems presumably related with cultural backgrounds. Thus, incorporating more precise proxies for socio-cultural factors into the analysis may contribute better results for future studies. Moreover, acquiring separate data for consumer demand for jewelry and retail investment gold will capture the changing behaviors of gold consumption and have some plausible results on determinants of gold demand which may significantly improve estimates of the present models.

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