Estimating Elasticity of Import Demand for Gold in India

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ABSTRACT

The gold controversy in India is about how to curb import demand for gold as gold imports act as a huge burden on current account balance and a large part of it lies idle in the economy. But understanding gold demand is not simple as in India, gold is viewed not only as a consumption good, but also as a financial asset and it has a socio cultural dimension since ages. This paper tries to find out the price and income elasticities of physical import demand for gold in India in the recent past. It has two unique features which the previous studies did not focus. All the forms of gold imports which are used for different purposes (jewellery, bar etc.) are analysed separately; and the possibility of habit formation and inventory adjustment in determining the dynamics of India's import demand for gold is taken into consideration which is often missed by the existing studies. We apply a number of dynamic demand models based on distributed lags and the results are interesting. First, different motives play roles in shaping demand for different forms of gold, although investment behaviour dominates over habit persistence in aggregate. Second, given that the import demand for gold bars is inelastic with respect to real price, ceteris paribus, in both the short-run and the long-run, increment of tariff rates would not reduce import of other non-monetary unwrought forms of gold substantially. Third, change in tariff rates, however, can bring down gold jewellery demand more in the long-run than in the short-run. Fourth, expenditure effect is strong for gold jewellery demand while demand for gold bars responds little to any changes in import expenditure in the long-run and total gold demand is however moderately sensitive to expenditure movements. Thus the findings are able to contribute in formulating anti-inflationary and anti-cyclical policymaking since effective policy undertaking during an inflationary period require a knowledge of the immediate magnitude and speed of response of demand to changes in expenditure and prices.

Keywords: elasticity estimation, gold demand, gold import, habit formation, dynamic demand model

JEL Classification: D12, F13, F14

1 Introduction

India has been the largest consumer and importer of gold in the world for a long time. In fact, gold is India's second largest import content after petroleum products. Having a miniscule production of her mines[1], almost entire demand for this precious metal is met through imports. An obvious outcome of this massive accumulation of gold from centuries of trading is that approximately 22000 tonnes of gold hoarded by Indian households is lying idle in the economy (FICCI-WGC, 2014). This insatiable demand for gold leads to loss of opportunities in two ways, viz., diversion of household savings from productive assets and diversion of hard-earned foreign exchange resource which gives rise to chronic demand-supply imbalance on the foreign exchange market. Moreover, India's gold economy is entrapped in several other socio-economic problems such as illegal transaction of gold, black or parallel economy, tax evasion, under- and over-invoicing in exports and imports etc. Keynes (1913) argued that "if a time comes when Indians learn to leave off their unfertile habits and to divert their hoards into the channels of productive industry and to the enrichment of their field, they will have the money market of the world at their mercy". Following Keynesian arguments many including the government of India see this irresistible fascination towards gold as an illusion, a wasteful habit, and a remnant of the economic backwardness of the past. However, Chandavarkar (1961) refuted this view by claiming that gold holdings by Indians actually reflect practical considerations rather than unreasonable preferences, and a careful look at the data on holdings reveal "the actual extent of misdirection of resources involved is much less than is commonly supposed". Surprisingly, only few attempts had so far been made to understand India's gold demand sentiment and its sensitivity to any macroeconomic changes.

The present study looks at the three components of non-monetary gold imports in India which include non-monetary powder form of gold, other non-monetary semi-manufactured forms of gold and other non-monetary unwrought forms of gold[2]. The first two are linked with demand for gold jewellery and the latter demand for represents gold bars. Demand for each component is not only driven by economic motives, but also by socio-cultural and psychological factors. To Indian consumers, purchasing gold is a daily life affair since the precious metal is seen as a sign of prosperity and symbol of security. In Indian weddings gold jewellery is considered to be 'necessity' rather than 'luxury'. Again, gold is

[1] India produces only 0.5% of her annual gold consumption (WGC, 2010).
[2] This study does not include import of monetary gold which is held in reserve by the central bank.

treated as the fundamental asset for Indian households since it serves as a secure, tradable and liquid investment as well as a value preserver. Evidently, the economic logic for gold demand in India is not very straight forward from a long term perspective since it depends on a mixture of factors (Shetty, 2013). Along with the cultural and religious factors, demand for gold is driven by various macroeconomic conditions as well.

Significant shifts in the import of these non-monetary gold components by India in recent years have primarily motivated the present study to seek rationale for such changing demand pattern. Figure 1 shows that during the period of geo-political risks which were initiated in mid-2008 there was a spectacular rise in import of gold bars due to its appeal as 'safe haven'[3]. On the contrary, jewellery demand dropped in 2008 and 2009 and remained steady afterwards. Although the precautionary motive of gold absorption dominated over the consumption motive in the post-crisis period, Indian consumers exhibited resilience in jewellery absorption.

Figure 1

In order to reduce burden on current account balance, the government had increased import duty on gold bars from Rs.100/10gm to Rs.200/10gm, while duty on other forms of gold (excluding jewellery) was increased from Rs.250/10gm to Rs.500/10gm in 2009-10. But, it had minimal impact on buying. The government again raised the import duty on gold to 2 per cent of value in January 2012 and to 10 per cent in 2013. In July 2013, the Reserve Bank of India (RBI) introduced the 80:20 scheme, which required gold importers to re-export 20 per cent of the incoming gold to address the high current account deficit (CAD). The RBI had banned import of gold through star trading houses in August 2013. But this resultant shortfall in supply had led to a phenomenal rise in the premium on gold in the market and a spike in gold smuggling. In November 2014, the RBI had withdrawn the 80:20 scheme to remove distortions in shipments and curb smuggling.

This has prompted research on many aspects of gold demand, but the role of habits and stock adjustment effects in shaping gold demand has not been explored. The reason behind suspecting that habits shape gold demand is that many of the decisions concerning gold consumption take time and effort to adjust. These decisions include long-term commitments such as accumulating wealth for adverse financial situations or for wedding purpose, earning psychic income from possession of gold etc. Habits arising from such long-term decisions or ingrained behaviours link consumers' preferences over time. 'Habit', being

[3] Baur and Lucey (2010) defined a safe haven as "an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil."

essentially a loose expression, could include a variety of phenomena, viz., adjustment costs, psychic costs, reference group behaviour etc. On the other hand, stock adjustment effect takes place when demand for a gold increases following a reduction of its physical stock. Dynamic misspecification caused by omitted habit or stock adjustment effect will systematically mispredict the consumers' reaction to any policy. Hence, performing a demand analysis for disaggregated gold imports in India by considering its dynamic aspects is of utmost importance as it will not only throw light upon the sensitivity of gold imports to macroeconomic changes but also gauge the psychological adjustment in gold consumption that is often missed out by policy makers while prescribing measures on the basis of aggregate gold demand pattern.

Given this backdrop, the study attempts to capture the behavioural and investment decisions that determine the nature of dynamic adjustment in monthly import demand for gold in India by modeling gold as a habit-forming good. For this purpose, the econometric analysis has been performed using three dynamic demand models based on distributed lag specification. Throughout the study emphasis has been given upon disaggregated analysis of gold demand. The empirical results distinctly portray how response of demand for gold bars to price and expenditure changes differ substantially than that of gold jewellery demand, and how the aggregate demand analysis fails to capture the non-symmetric dynamic mechanisms operating on different components of gold import demand in India. The obtained estimates of expenditure and own-price elasticities of gold import demand suggest that Indian consumers care about the time-series process of gold prices and import expenditures in the short-run, but in the longer horizon they exhibit demand persistence. The study also unfolds how speed of adjustment from short-term deviation to long-run equilibrium vary significantly for jewellery demand and demand for bars. This provides empirical justification to the fact that Indian consumers' fetish for gold is not just an economic phenomenon, but it also has a deep-rooted psychological reason. To the best of our knowledge, this is the first attempt to empirically investigate dynamics of disaggregated gold import demand in India in a monthly set up.

The rest of the study is organized as follows. Section 2 provides the survey of literature. Section 3 identifies the role of habit formation in explaining gold demand inertia, outlines the methodological framework. Data descriptions are provided in section 4 followed by empirical findings reported in section 5. Chapter 6 concludes with policy discussions.

2 Literature Review

Gold demand being a fundamental economic variable has attracted attention of the researchers for ages. Several attempts have been made to identify the microeconomic as well as macroeconomic drivers of gold demand. Majority of these studies, with prime focus on inter-linkage between gold and other financial instruments, falls under investor behaviour strand of research related to gold. Recently, the collapse in the financial and economic conditions in the US and the European countries offered strong motivation to study the viability of gold as a safe haven from shortfall in financial markets (Baur and McDermott, 2010; Baur and Lucey, 2010). But, these studies are mostly based on developed economies, such as, the US and the European countries.

The present study, however, comes under a considerably less explored strand of gold demand related research which corresponds to physical demand for gold[4]. A significant part of this market reflects demand from emerging-market economies where gold has traditionally been store of value and symbol of wealth. Starr and Tran (2007) made first attempt to examine comprehensively the factors affecting physical demand for gold, using panel data covering 21 countries for the period from 1992 to 2003. They found that persistent heterogeneities in physical gold demand across nations are consistent with influence of socio-cultural aspects. The important implications of their results are that the determinants of physical demand of gold differ from those of portfolio demand of the same, and that they differ in cases of the developed and the developing economies. The present study is closely related to Batchelor and Gulley (1995) who examined the persistence in gold jewellery demand in the USA, Japan, the UK, Germany, Italy and France and measured the impact and long-run effects of price and income changes. They allowed forward looking and backward looking price expectations in the partial adjustment specification, while our study has employed traditional partial adjustment model (PAM) with static expectation, though allowed price dynamics in autoregressive distributed lag (ARDL) model.

In the Indian context, Patel (1950) made the pioneering effort to measure the responsiveness of the country's physical gold demand with respect to price and income based on the gold import data from 1925-26 to 1941-42. Patel (1958) addressed the issue of gold mobilization in an anonymous article in *Economic Weekly* entitled 'On Turning Gold into Base Metals'. Yet, after Patel, this apparently vital issue has failed to catch serious attention till economic reforms except few systematic studies, for example, studies by Rao and Nagabhushanam (1960), Chandavarkar (1961), Heston (1961), Sarma *et al.* (1992) among others. In an early work on gold demand in India during the period 1901–1913 (which was a sub-period of the gold standard era 1898-1914), Rao and Nagabhushanam (1960) empirically

[4] Physical demand for gold refers to the acquisitions of gold in physical forms such as jewellery, bars, coins, and medallions.

established that gold demand demonstrated higher income elasticity than silver and merchandise, also price elasticity for gold demand was negative. A probable reason for the lack of literature on India's gold economy could be unaccountability of gold supply that was almost entirely from smuggling before gold market deregulation. Nonetheless, the literature on this area is emerging in recent times.

The second-generation research on India's gold economy includes studies by Reddy (1996, 2002), Bhattacharya (2002), Vaidyanathan (1999), Vuyyuri and Mani (2005), Kannan and Dhal (2008), Karunagaran (2011), Mishra and Mohan (2012) and others. Again, majority of these studies have dealt with the asset demand of gold. Reddy (2002) in his address to the World Gold Council (WGC) outlined that gold has demand linkages with numerous macro aggregates. Kannan and Dhal (2008) identified the key determinants of physical demand for gold in India for the period 1980–2005, and their empirical findings suggest that gold demand in India is significantly price elastic both in the shorter and the longer terms, whereas income elasticity is less than unity in the longer run but close to unity in the short-run. In a similar vein, Kanjilal and Ghosh (2014) examined the long-run relationship among aggregate gold import demand, gold price and GDP in India for the period 1998-99 to 2012-13 in a quarterly setup. They observed that in the long-run gold import demand is moderately inelastic to unitary elastic with respect to gold price while highly elastic with respect to income, but in the shorter horizon, gold demand is highly price elastic. Although Kanjilal and Ghosh (2014) have employed ARDL and error correcting models (ECM), the paper neither analyzed the price and income dynamics that shape gold import demand nor discussed about the speed and process of adjustment. The current study attempts to fill this gap. In order to identify the underlying motives of gold hoarding by Indians, the Federation of Indian Chambers of Commerce and Industry and the World Gold Council surveyed a sample of 5000 households of India and found that 76.62 per cent of the surveyed households buy gold for safe investment and 52.54 per cent for adornment (FICCI-WGC, 2014). Although the WGC publishes extensive quarterly reports on gold demand trends and specifically studies the drivers of gold demand in India, the reports do not provide any econometric justification of persistent gold demand behaviour as exhibited by Indian households.

The present study differs largely from the earlier studies in terms of its scope, coverage and method of estimation and makes significant contribution to the existing literature. Firstly, this study provides insights to intra-year gold demand dynamics as it has used monthly gold import data while the existing analyses are mostly based on annual data. Only Kanjilal and Ghosh (2014) performed estimation based on quarterly data and RBI

(2013) conducted a short empirical estimation based on monthly data on gold imports from 2008-09 to 2011-12. Secondly, the empirical analysis is based on both aggregate and disaggregated data on gold import demand. Responsiveness of demand for gold jewellery and demand for gold bars are estimated along with that of total demand for gold. This is important because motives for purchasing these two forms of gold may be completely different. The only exception is Kannan and Dhal (2008) who attempted to measure elasticity of gold jewellery demand, whereas rest of the existing literature have considered aggregate gold demand. Finally and most importantly, price and expenditure dynamics and role of habit formation have received little attention in the gold demand literature despite their potential importance. The present study has attempted to empirically investigate whether the habitual nature of former choices and investment-driven behaviour help to explain sluggish adjustment of gold demand in the context of estimation of price and income dynamics.

3 Methodology

3.1 Theoretical Background

Following "characteristic approach" to demand theory propounded by Lancaster (1966, 1971), demand for gold can be essentially disaggregated into distinct characteristics viz. gold as a durable consumer good (ornaments), as a liquid asset and a store of value (bullion), as a hedge, as a vehicle for tax-evasion and as an industrial good. In essence, gold demand is driven by conceptually distinct motives, such as, psychic income accruing from gold jewellery, precautionary motive, expectation of capital gain from gold price rise etc. Due to wedding-related demand and rise of India's gems and jewellery export sector, a large part of the nation's gold demand consists of ornaments and jewellery. Hence, like most of the durable consumer goods, gold demand possesses certain features viz. due to presence of stocks past decisions affect present demand behaviour, adjustment costs may give rise to lagged adjustment of actual to desired stocks, habits play a role in linking past, present and future decisions, and purchasing decision can be advanced or postponed in the light of new information. Clearly, these features lack coherence which makes modelling of demand for gold in aggregate time-series data a difficult task (Deaton and Muellbauer, 1980). However, given the pervasiveness of habits, dynamic demand models are appropriate vehicles for treating the demand for durables since static approach assumes instantaneous adjustment to new equilibrium values when income or prices change. In reality, consumers very often react to income and price changes with certain delay by making the adjustment towards the new equilibrium situation to be distributed over several time periods. Hence, adjustment in each time period is partial.

In earlier studies, it was presumed that the reaction predicted by the static theory is spread over a number of time periods according to some ad hoc scheme. Later, Brown (1952) first estimated dynamic demand function with lagged demand and contemporaneous income as regressors which yielded a significant increase in explanatory power. Stone and Rowe (1957) applied this partial adjustment principle to analyze demand for consumer durables and provided economic rationale for introduction of lags into behavioural equations. But, this non-structural approach captures only some of the sluggish behaviour associated with myopic habit formation[5]. Houthakker and Taylor (1970) included explicit habit and durability effects in an empirical demand system. They explained higher demand for a particular good in the current period makes consumers more willing to purchase that good in the future periods through the force of habit, all other things being equal. Their model also incorporates short memory myopic habits by introducing one lag of consumption. These model specifications are essentially specific forms of distributed lag (DL) models. DL models are commonplace when an economic cause (such as change in price or change in expenditure) generates its effect (such as on the quantity of a good demanded) beyond the time period in which it occurred so that this effect is not felt all at a single point of time, but the effects are gradually felt over a period of time. Hence, DL models are found to be useful for analyzing demand for durable goods and capturing delayed response.

In general, habit models are categorized by the time scale over which habits linger. Preferences that depend only on current and one-lagged consumption yield short memory models, whereas preferences that hinges upon current and all previous consumption yield ‘habit-as-durables’ (HAD) models. Recent demand studies apply ARDL model to capture distant memory by allowing different lag structure to both the demand variable and its determinants. By similar kind of logic, psychological and institutional changes are incorporated in econometric models through introduction of time lags.

3.2 Model Specifications

In this section, we briefly discuss about the specifications of the three standard dynamic demand estimation models used to explore and analyze the price and income sensitivity of gold demand in India. The present study does not, by any means, conclude that

[5] When consumers have myopic outlook they consider their consumption history in order to plan present consumption, but do not recognize the impact of present consumption on future tastes.

one model is superior to the other, but focuses on the fitment of the models to the gold demand data in India.

3.2.1 Partial Adjustment Model

PAM is a fairly simple model in dynamic analysis of demand with the assumption of static expectations (Nerlove, 1958a, 1958b). The model is specified as follows:

$$q_{gt}^{*} = a_0 + a_1 m_t + a_2 p_{gt} \tag{1}$$

$$q_{gt} - q_{gt-1} = \gamma(q_{gt}^{*} - q_{gt-1}) \tag{2}$$

where q_{gt}^{*} is the long-run equilibrium quantity of gold import demand, m_t is real income, p_{gt} is relative price of gold, and q_{gt} is the actual quantity of gold imported. A partial adjustment mechanism describes how consumers adjust their current demand gradually towards the equilibrium level with speed of adjustment, γ, where $0 < \gamma \leq 1$. If habit of consumption persists, then current consumption will be weighted combination of the previous consumption and the present desired consumption, where the weight of the combination depends on γ. If $\gamma = 1$, then the consumers adjust their consumption instantaneously to the desired level. As $\gamma \rightarrow 0$, the consumption habits become increasingly persistent.

Substituting equation (1) into equation (2) and solving for q_{gt} yields a typical distributed lag equation:

$$q_{gt} = a_0\gamma + (1-\gamma)q_{gt-1} + a_1\gamma m_t + a_2\gamma p_{gt} \tag{3}$$

An addition of an error term to equation (3) yields the reduced form estimating equation. The short-run effects of income and price on demand are captured by $a_1\gamma$ and $a_2\gamma$ respectively, whereas the respective long-run effects are indicated by a_1 and a_2. These effects generate the elasticities when the variables of the model take natural logarithmic form. Clearly, the model imposes the restriction that the ratio of the short-run and long-run price elasticities equals to the ratio of the short-run and long-run income elasticities, i.e., the model restricts price and income to the same adjustment process. Since $0 < \gamma \leq 1$ the short-run elasticities are necessarily less that their long-run counterparts. In very short time period consumers can hardly react to changes in constraints which are not yet observed. When such phenomenon takes place over longer period, it is described as “habit persistence” or as “consumption inertia” as in Brown’s study. γ measures the inertia in consumption adjustment to the new equilibrium level. The length of the adjustment period, n, is obtained by solving $(1-\gamma)^n \leq 0.05$. Since full adjustment occurs only when $n = \infty$, the adjustment period derived is for 95 per cent or more adjustment.

3.2.2 Houthakker and Taylor State Adjustment Model

The basic postulate underlying the Houthakker and Taylor state adjustment model (H-T) is that past behaviour influences present consumption decision, and this past behavior is embodied in current value of a state variable which encompasses stocks held by the consumer as well as habits formed by past consumption. The basic demand function is specified as:

$$q_g(t) = \alpha + \beta s_g(t) + \gamma m(t) + \eta p_g(t) \tag{4}$$

The stock depreciating equation is given by:

$$\dot{s}_g(t) = q_g(t) - \delta s_g(t) \tag{5}$$

where, $q_g(t)$ is gold import quantity demanded during a time interval around time t, $m(t)$ is real income, $p_g(t)$ is relative price of gold, $s_g(t)$ is stock (physical or psychological) of gold at time t, δ is the rate of depreciation of stock (physical or psychological).[6] β is positive when habits predominate over inventory effect, i.e., when larger psychological stock results in greater demand at time t. In case of habit-forming commodity, current consumption is positively influenced by consumption in the recent past and it does not adjust immediately to changes in prices and income. Thus, the 'stock' or 'habit' parameter links past income and prices to current demand. A negative β, on the other hand, represents adjustment of current consumtion to the inventory of the commodity that is held. However, there is often no a priori basis for deciding whether habit formation or stock adjustment will predominate in the demand for the commodity.

The unobservable state variable in equation (4) can be eliminated using equation (5).

$$\dot{s}_g(t) = q_g(t) - \frac{\delta}{\beta}[\ q_g(t) - \alpha - \beta s_g(t) - \gamma m(t) - \eta p_g(t)] \tag{6}$$

Setting $\dot{s}_g(t) = 0$, the long-run or steady-state solution for the dynamic system is obtained.

$$\widehat{s_g} = \frac{\alpha}{\delta-\beta} + \frac{\gamma}{\delta-\beta}\widehat{m} + \frac{\eta}{\delta-\beta}\widehat{p_g} \tag{7}$$

Since, $\widehat{q_g} = \delta\widehat{s_g}$, hence

$$\widehat{q_g} = \frac{\alpha\delta}{\delta-\beta} + \frac{\gamma\delta}{\delta-\beta}\widehat{m} + \frac{\eta\delta}{\delta-\beta}\widehat{p_g} \tag{8}$$

$$q_g - \widehat{q_g} = \beta[s_g - \widehat{s_g}] \tag{9}$$

where β measures speed of adjustment.

Clearly, equation (9) is analogous to equation (2) of PAM as both the equations describe the adjustment process, i.e., the deviation of current demand from the long-run level is proportional to the deviation of the state variable from its long-run level. If β is negative, purchases of the commodity are larger than the long-term level when the inventory stays

[6] The state variable at any time is given by the sum of the discounted flows bought up to that time, i.e., $s_g(t) = \int_{-\infty}^{t} q_g(u)e^{\delta(u-t)}du$. This formula is applicable in cases of durables and habit-forming goods.

below its long-term level. But, if β is positive, changes in purchases and stock will occur in same direction.

The short-run (or instantaneous) effect on demand due to change in income and price that arises before there is any feedback on the state variable are captured by γ and η respectively, whereas the long-run (or steady-state) effect that reflects full adjustment in the state variable are captured by $\frac{\gamma\delta}{\delta-\beta}$ and $\frac{\eta\delta}{\delta-\beta}$. If log specification of the variables is utilized, these effects are interpreted as elasticities. In the state adjustment model, commodities subject to habit formation always have short-run elasticities lower than in the long-run, while the reverse holds for commodities subject to inventory or stock adjustment.

In order to estimate the coefficients of the model from time-series data, the continuous model ought to be approximated by involving discrete time intervals[7]. The estimating equation has the form:

$$q_{gt} = A_0 + A_1 q_{gt-1} + A_2 \Delta m_{gt} + A_3 m_{gt-1} + A_4 \Delta p_{gt} + A_5 p_{gt-1} + v_t \qquad (10)$$

where v_t is the random disturbance term, and the A's are the estimating coefficients from which the structural parameters are derived.

3.2.3 Autoregressive Distributed Lag Model

In recent times, ARDL models are widely used to test for presence of long-run relationship between economic variables and to estimate short-run and long-run dynamics. The basic form of an ARDL regression model is:

$$q_{gt} = a_0 + a_1 q_{gt-1} + \cdots + a_l q_{gt-l} + b_0 m_t + b_1 m_{t-1} + \ldots + b_m m_{t-1} + c_0 p_{gt} + c_1 p_{gt-1} + \ldots + c_n p_{gt-n} + \varepsilon_t \qquad (11)$$

where ε_t is a random disturbance term.

The model is autoregressive as a part of q_{gt} is explained by lagged values of itself. It has a distributed lag component in the form of successive lags of the explanatory variables (here m_t and p_{gt}).

Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001) introduced the bound test for cointegration within an ARDL dynamic specification for examining the existence of a long-run relationship among the variables. If long-run relationship is obtained, an error correction model (ECM) is established to examine the short-run dynamics of the relationship between the variables. ARDL(l,m,n) in ECM form for the log-linear specification of the long-run relationship between gold import demand, real price of gold and real income is:

[7] For a detailed discussion of the derivation, see Houthakker and Taylor (1970).

$$\Delta q_{gt} = \beta_0 + \sum_{i=1}^{l} \beta_i \Delta q_{gt-i} + \sum_{j=0}^{m} \gamma_j \Delta m_{t-j} + \sum_{k=0}^{n} \delta_k \Delta p_{gt-k} + \theta_0 q_{gt-1} + \theta_1 m_{t-1} + \theta_2 p_{gt-1} + e_t \quad (12)$$

Pesaran *et al.* (2001) call this a 'conditional ECM'. The ARDL method estimates $(p+1)^k$ number of regressions in order to obtain the optimal lag lengths for each variables, where p is the maximum number lags to be used and k is the number of variables in the equation. Maximum lags are determined by using one or more of the information criteria: Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) etc. The bound testing is to perform F-test of the null hypothesis of no cointegration $H_0: \theta_0 = \theta_1 = \theta_2 = 0$ against the alternative hypothesis that H_0 is not true. A rejection of H_0 implies that we have a long-run equilibrium relationship between the variables: $q_{gt}, m_{t,} p_{gt}$. Pesaran *et al.* (2001) reports two sets of critical values which provide critical values bounds for all classifications of the regressors, i.e., purely I(0), purely I(1), or mutually cointegrated. Cointegration is indicated when the calculated F-statistics lies above the upper level of the band, while if the computed F-statistics lies within the critical band a conclusive inference cannot be made without knowing the order of integration of the underlying regressors.

If bound test confirms that the variables are cointegarted, then long-run equilibrium relationship between the variables is estimated:

$$q_{gt} = \alpha_0 + \alpha_1 m_t + \alpha_2 p_{gt} + v_t \quad (13)$$

To extract the short-run dynamics, usual ECM is performed:

$$\Delta q_{gt} = \beta_0 + \sum_{i=1}^{l} \beta_i \Delta q_{gt-i} + \sum_{j=0}^{m} \gamma_j \Delta m_{t-j} + \sum_{k=0}^{n} \delta_k \Delta p_{gt-k} + \varphi z_{t-1} + \epsilon_t \quad (14)$$

where, z_{t-1} is the lag of error correcting term, and φ is the speed of adjustment.

ARDL bound testing methodology has numerous advantages over the conventional cointegration methods. First, the ARDL procedure can be performed with the mixture of I(0) and I(1) variables. Second, the ARDL procedure allows different variables to have different optimal lags; the model, thus, specifies myopic habit, but it allows for distant memory, if applicable. Third, the ARDL approach is statistically more significant in determining the cointegration relation in small samples. Finally, the ARDL technique employs a single reduced form equation.

Dynamic multipliers or dynamic elasticities of gold demand with respect to its own price or income are cumulative percentage responses of gold demand to a permanent percentage point change in price or income after certain periods. Using natural logarithm transformation of the variables, the short-run price elasticity is given by the coefficient on the contemporaneous price term, $\xi_p^{SR} = c_0$ and the long-run price elasticity is obtained as $\xi_p^{LR} =$

$\frac{\sum_{k=0}^{n} c_0}{1-\sum_{i=1}^{l} a_0}$. For the stability of the demand function, the denominator has to be positive, $1 - \sum_{i=1}^{l} a_0 > 0$. Similarly, the income elasticities for the short-run and the long-run are $\xi_m^{SR} = b_0$ and $\xi_m^{LR} = \frac{\sum_{j=0}^{m} b_0}{1-\sum_{i=1}^{l} a_0}$ respectively.

4 Data

4.1 Variables

The gold import demand equations are estimated with monthly data over the period April 1996 through March 2014[8]. Data on aggregate quantity of gold import by India (HS Code. 7108) and on its components viz. import of gold in non-monetary powder forms (HS Code. 710811), in non-monetary unwrought forms (HS Code. 710812), and in other non-monetary semi-manufactured forms (HS Code. 710813) are obtained from the Directorate General of Commercial Intelligence and Statistics (DGCIS) database[9]. Import demand for gold for jewellery is the sum of gold import in non-monetary powder form and that in other non-monetary semi-manufactured form, while gold import in non-monetary unwrought form corresponds to the gold import demand for bars. The quantities of gold imports are measured in kg. Monthly gold import data are seasonally adjusted using moving average technique.

Data for nominal price of gold in INR per troy ounce is sourced from the World Gold Council (WGC) database, while data for nominal price of silver in INR per troy ounce is obtained from the Reserve Bank of India (RBI) database[10]. Since monthly data for India's GDP at factor cost are not available, data for total merchandise import expenditure of India in INR billion from the Reserve Bank of India (RBI) database are used as a proxy for income[11]. Gold prices, silver prices and total merchandise expenditure are converted to real terms using inflation adjusting factor derived from Wholesale Price Index (WPI) with the base year 2004-2005. Data on WPI along with data on month-end yield of SGL transactions in government dated securities in per cent per annum for 10 years term to maturity, monthly average of BSE sensitivity index and monthly average of exchange rate of INR vis-à-vis USD are taken from the RBI database.

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[8] The choice of starting period from the first month of the financial year 1996-97 is justified on the basis of the fact that gold import in official terms increased significantly following liberalized gold policies in early 1990s. The financial year 1996-97 is not an outlier.

[9] DGCIS database is published by Ministry of Commerce and Industry, Government of India. The data on gold import provided by the DGCIS are reported with respect to importing countries, but in this study we have used India's import of gold from the world which is the sum of gold imports from all the importing countries.

[10] RBI reports silver price in INR per kg., but to maintain parity with gold price, silver price has been converted in INR per troy ounce.

[11] In the present study, expenditure elasticity is estimated instead of income elasticity.

For estimation returns of BSE sensitivity index and exchange rate are calculated. Natural logarithmic transformations of real aggregate gold import demand, real gold import demand for jewellery, real gold import demand for bars, real price of gold, real total merchandise import expenditure, real price of silver are denoted as *lqgt*, *lqgjt*, *lqgbt*, *lpgt*, *lmt* and *lpst* respectively, whereas bond yield, stock return and exchange rate return are denoted as *rlong*, *st* and *exrt* respectively.

4.2 Scope

The existing studies on gold demand in India with time series data has relied on annual data, except Kanjilal and Ghosh (2014) and RBI (2013). Using monthly data this paper has attempted to capture the short-run aspects of India's gold demand, which annual and even quarterly analysis fail to provide. Demand analysis based on monthly data also offers certain econometric advantages over annual data (Sexauer, 1976). Firstly, monthly data presents a larger sample of observations during a given period of time which is crucial for estimation of distributed lag models. Secondly, the structural stability of demand is greater with higher frequency of data. Hence, better forecasts can be obtained from monthly analysis as projections can be based on very recent period. Thirdly, recursive system which makes single-equation estimation to be theoretically defensible becomes more realistic when the time unit of analysis gets shorter. Moreover, an understanding of the structure of demand in an intra-year period leads to effective design of economic policies. The present study has analyzed the aforementioned monthly series to estimate the immediate magnitude and speed of the response of gold import demand to changes in expenditure and prices along with the full impact across a sequence of months. To the best of our knowledge, the study contributes to the literature by attempting to distinguish the dynamics operating on the different components of gold import demand, while the previous studies have based their analyses on aggregate gold demand, except Kannan and Dahl (2008) examining gold jewellery demand along with total gold import demand, but their study did not include demand for gold bars which surged in recent years.

Moreover, seasonality in India's gold import demand has been taken care of. It is important since seasonal demand for gold jewellery and gold bars differ substantially as can be seen from Figure 2 and 3.

<u>Figure 2, 3, 4</u>

The cause of this seasonality lies in religious, cultural, and traditional psyche. In India, purchase or gift gold during religious festivals, like Diwali (takes place in October or November) and Akshaya Thrithiya (falls in April or May), are considered auspicious to

Hindus. Wedding-related demand for gold generally occurs between October and January, and April and May. Figure 2 plots the seasonality in jewellery demand which gains momentum during wedding months. Figure 3 shows investment demand for gold is high during auspicious times as well as in the post-monsoon time. A good harvest following a good monsoon often boosts rural demand for the precious metal. Figure 4 gives a composite picture by marking the months of January, April, May, October and December with comparatively larger amount of total gold imports.

5 Empirical Results

5.1 Integration Analysis

It is essential to check each time series for stationarity prior to the estimation of the dynamic models, especially ARDL model. If a time series is non-stationary, the regression analysis performed in a traditional way will produce spurious results. Also, if the order of integration of any of the variables is greater than one, then the critical bounds provided by Pesaran *et al.* (2001) becomes invalid. Hence, before advancing to estimation stage the order of integration of the variables are checked using two types unit root tests, viz., without structural breaks and with structural breaks.

5.1.1 Unit Root Tests without a Structural Break

The study applies the Augmented Dickey-Fuller (ADF) unit root test. The result of the test as presented in Table 1 reveals that *lqgt*, *lqgjt*, *lqgbt*, *st* and *exrt* are stationary at their levels, while *lpgt*, *lmt* and *rlong* are non-stationary at their levels but are stationary after their first difference.

<u>Table 1</u>

5.1.2 Unit Root Tests in the Presence of Single Endogenous Structural Break

Structural breaks are of considerable importance in the analysis of macroeconomic time series data. Structural breaks can occur due to economic crises, regime change, changes in policy direction, changes in institutional arrangements, external shocks etc. If such structural changes exist in the data generating process, but not incorporated in the specification of an econometric model, results may be biased towards erroneous non-rejection of the non-stationarity hypothesis (Perron 1989; Perron 1997). The present study has performed Zivot and Andrews (1992) model which endogenously determine the time of the structural break.

<u>Table 2</u>

As can be seen from Table 2, *lqgt* and *lqgbt* are non-stationary while *lqgjt* is stationary. With both intercept and trend, *lqgjt* undergoes a structural break in October, 2008. The timing of the break coincides with the subprime lending crisis in 2008.

5.2 Parameter Estimates

The estimated equations for the three dynamic demand models are presented in this section. The estimated coefficients on one period lagged gold demand are small and positive with small standard errors in the three models for the total gold demand as well as for its components. This implies the presence of sluggish adjustment of gold demand. Moreover, the significant negative coefficients on contemporaneous own price and positive coefficients on contemporaneous import expenditure are consistent with demand theory. Since jewellery demand is subject to structural change during October, 2008, a dummy variable *break_j* has been constructed such that it takes value 1 on the break date, and zero otherwise. The coefficient on the break dummy is significant

Table 3, 4 and 5 report that following partial adjustment principle real price and real expenditure exhibit highly significant impact upon aggregate gold import demand and its components. Real silver prices have positive significant effect on total gold demand and jewellery demand which suggests silver appears as a substitute for gold purchase by Indians. Stock return and exchange rate return exert no significant upon on any of the gold demand components as well as on the aggregate gold demand. Bond yield affects jewellery demand negatively, but does not play role in explaining demand for gold bars and total gold demand. This gives insight to the investment motive lying under gold hoarding. When interest earning from government securities takes an upward turn, purchase of gold jewellery as a safe investment reduces.

Table 3, 4, 5

The partial adjustment parameter, γ, takes values within the ranges 0.51-0.53, 0.43-0.45, and 0.50-0.51 respectively for total gold demand, jewellery demand and demand for bars respectively. Since these values are less than unity, they indicate the presence of inertia in gold demand adjustment. It is obvious that adjustment occurs at a slower pace for jewellery demand while the rate of adjustment is similar for total gold demand and demand for gold bars. The adjusted R-square take values within the ranges 0.54-0.55 for total gold demand, 0.43-0.45 for gold jewellery demand and 0.45 for gold bars demand. This indicates moderate fit of the dataset under partial adjustment specification.

Coefficient estimates from H-T model are reported in Table 6. To overcome the problem of over-identification due to inclusion of a large number of explanatory variables, we have restricted our estimation by considering real gold price and total merchandise import expenditure as the regressors. In this specification, lagged real price has no significant effect on demand for gold bars, but change in real price exhibit significant negative impact on the same. Again, opposite effect is observed in case of jewellery demand, as it does not depend on fluctuation in price, but depends on past level of real gold price. However, both the lagged real price and change in real price have significant impact upon total gold demand. It is hence evident that the price dynamics operating on gold jewellery demand and gold bars demand differ significantly which fails to be captured in aggregate gold demand analysis.

Table 6

For total gold demand and demand for gold bars, the monthly stock adjustment coefficient, β, is negative. This indicates that investment behaviour dominates and inventory adjustment is a vital short-run feature of gold demand behaviour. However, positive β for jewellery demand suggests predominance of consumption habits and lower demand responsiveness in the short-run. In case of all three types of gold demand, H-T model exhibits moderate goodness of fit, as the adjusted R-square value ranges from 0.42 to 0.53.

In the first step of the ARDL analysis, presence of long-run relationships has been tested. The maximum number of lags in the ARDL has been set equal to 3, i.e., the model allows current demand decision to be explained by the values of its determinants in at most three previous months. The calculated F statistics are reported in Table 7, 8 and 9 along with the empirical results for each of the models in the long-run. The F-statistic of bound test yields evidence of long-run relationship between gold demand and its determinants at 1% significance level. The critical value bounds are obtained from Pesaran and Pesaran (1997). Lag lengths for the models are chosen using the Schwarz Bayesian Criterion (SBC). As can been seen from Table 7, 8 and 9, lag specifications selected in order to estimate dynamic effects of real gold price and real import expenditure on gold demand differ for total gold demand, jewellery demand and demand for bars.

Table 7, 8, 9

As we establish that long-run relationship exists, dynamic vector error correction model is utilized to determine short-run behaviour of gold import demand. The short-run dynamics are essential in testing for the stability of the long-run coefficients (Pesaran and Pesaran, 1997). Table 10, 11 and 12 present the empirical results for each of the models in the short-run in the ECM form. The error correcting term *ecm(-1)* in the short-run is negative and statistically significant in all the short-run ARDL models. The error correcting coefficients take values within the ranges -0.40 to -0.46, -0.45 to -0.54 and -0.46 to -0.51 for total gold demand, jewellery demand and gold bars demand respectively. This implies that once a shock occurs convergence to the steady state is sluggish with 40 to 46 per cent of the adjustment taking place in the first month for total gold demand. Similarly slow adjustments are observed in demand for gold jewellery and gold bars.

Table 10, 11, 12

Influence of past demand behaviour on current gold demand is evident from the coefficient of differenced lagged demand term. The fit of the dataset is however lower under ARDL specification than under the previous two dynamic demand models.

The cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive residuals square (CUSUMSQ) tests proposed by Brown *et al.* (1975) are performed to assess the parameter constancy. Since it has been found that the plots of the CUSUMSQ statistics are confined within the 5 per cent critical bounds of parameter stability, the absence of any instability of the coefficients are confirmed.

5.3 Elasticity Estimates

The estimated own-price and expenditure elasticities of India's gold import demand from the three dynamic models in both the short-run and the long-run are illustrated in Table 13. All of the expenditure elasticities are positive and all of the own-price elasticities are negative as expected. Due to specific formulation of partial adjustment model, elasticities in the short-run are lower than that in the long-run. Otherwise, the elasticity estimates are not restrictive. As can be seen from Table 13, elasticity estimates of aggregate as well as disaggregated gold demand are consistent in signs and magnitudes across the three dynamic specifications. Impacts on gold jewellery demand are highly elastic with respect to changes in price and expenditure, ceteris paribus. Sensitivity of jewellery demand in the short-run is lower than its long-run counterparts. This confirms habit formation and inertia operating on jewellery demand behaviour. On the other hand, demand for gold bars is inelastic or unitary elastic with respect to own price in both the short-run and long-run. The corresponding income elasticities are however not consistent in magnitude across these models: ARDL and H-T models indicate relatively elastic demand in shorter horizon but relatively inelastic demand when enough time has elapsed for full adjustment to occur, while PAM suggests the reverse. Also, ARDL and H-T specifications indicate that investment behaviour dominate over habit formation in shaping demand for gold bars, as the short-run elasticities exceed the corresponding long-run values.

Table 13

Noticeably, the magnitudes of elasticities of jewellery demand exceed from that of gold bars demand, while that of total gold demand take values between the corresponding values of the former two. However, elasticity estimates for total gold demand are closer to the corresponding estimates for gold bars demand and also exhibit investment behaviour. The results thus suggest that the response of aggregate import demand for gold to changed price and expenditure conditions differ substantially from that of its components. Hence, elasticity estimation considering only the aggregation of gold import demand data could potentially be biased and wrongly specify the dynamic relationships that exist between gold varieties and its determinants. Policy direction undertaken on the basis of such aggregate analysis is unlikely to bring the desired effect.

6 Conclusions

The present study explores the gold demand sentiment of India by employing dynamic demand models based on distributed lag framework. Although the models are moderate in terms of goodness of fit, the results obtained are compelling. The empirical findings highlight the difference in sensitivity of various components of gold import demand to changes in prices and expenditure. During the period studied, evidence of habit formation in shaping gold jewellery demand pattern has been found. This explains gold jewellery demand persistence in the post-crisis period.

Despite the approach undertaken in the present study being different from the existing literature, the obtained results are comparable to some of the previous studies. Empirical estimation in Kannan and Dhal (2008) suggest faster adjustment of gold demand from short-run deviation to long-run path as the error correcting terms of the estimated model lie within the range of -0.71 to -0.81 for aggregate demand and -0.68 to -0.78 for jewellery demand, but in the current analysis we find slower adjustment of monthly gold import demand with error correcting values within the range -0.40 to -0.46 and -0.45 to -0.54 for aggregate gold demand and jewellery demand respectively. In line with FICCI-WGC (2014) which concluded gold purchasing behaviour of Indian households is unlikely to change on the occasion of price changes, the present study has empirically showed that this household behaviour is reflected on the nation's gold import demand pattern as the demand for gold bars have price elasticity values less than unity in both the short-run and the long-run.

The analysis presented in this study emphasizes the role of habit formation and inventory adjustment in determining the dynamics of India's monthly import demand for gold. As traditionally measured elasticities do not take into account these dynamic adjustments, they can be misleading. The study also throws light on how dynamic responses of aggregate gold import to price and expenditure shocks are composite responses. First, as can be seen from H-T model estimates, different motives play roles in shaping demand for different types of gold, although investment behaviour dominates over habit persistence in aggregate. Second, in ARDL estimation, selection of different lag structure for different components of gold demand marks the distinction of adjustment processes. Third, the findings based on monthly gold import demand data are able to contribute in formulating anti-inflationary and anti-cyclical policymaking since effective policy undertaking during an inflationary period require a knowledge of the immediate magnitude and speed of response of gold import demand to changes in expenditure and prices. The empirical results thus provide policymakers a better understanding of India's gold demand pattern in order to formulate efficient gold policies for the country. Fourth, given that the import demand for gold bars inelastic with respect to real price, ceteris paribus, in both the short-run and the long-run, increment of tariff rates would not reduce import of other non-monetary unwrought forms of gold substantially. Fifth, change in tariff rates, however, can bring down gold jewellery demand more in the long-run than in the short-run. A strong evidence of such effects is found in the post-crisis period when gold jewellery demand was subdued following successive rise in tariff duty, but the total gold demand was virtually unaffected as demand for gold bars was resilient due to its safe haven characteristic. Sixth, expenditure effect is strong for gold jewellery demand while demand for gold bars responds little to any changes in import expenditure in the long-run, as per H-T and ARDL models. Total gold demand is however moderately sensitive to expenditure movements. Thus, non-responsiveness of gold bars demand to price and expenditure changes posit challenges before policymakers as price and income based policy tools are unable to exert desired impact on gold demand. A major reason behind such phenomenon is that gold still lacks a simple investment substitute in India's financial market. The centuries-old reliance on gold as a primary household financial savings instrument needs to be altered by creating financial awareness among the Indian households. Moreover, the findings of this study are also crucial from the viewpoint of the gold exporting nations which are developing marketing policies in order to position themselves in the gold market of India under recent changing macroeconomic conditions.

However, the obtained results are limited to backward looking behaviour as it has only considered effect of past decisions on current demand. Perhaps more general dynamic modelling techniques which incorporate both myopic and rational habits can provide additional insight into monthly demand for the yellow metal.

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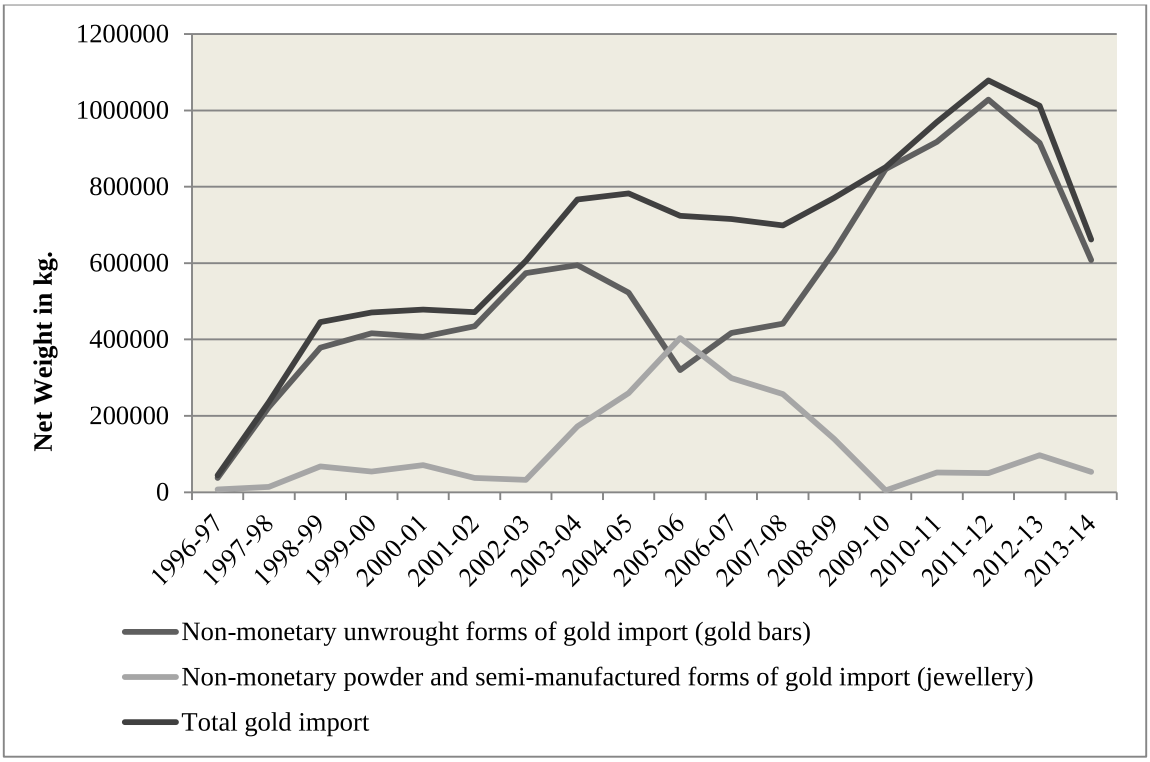
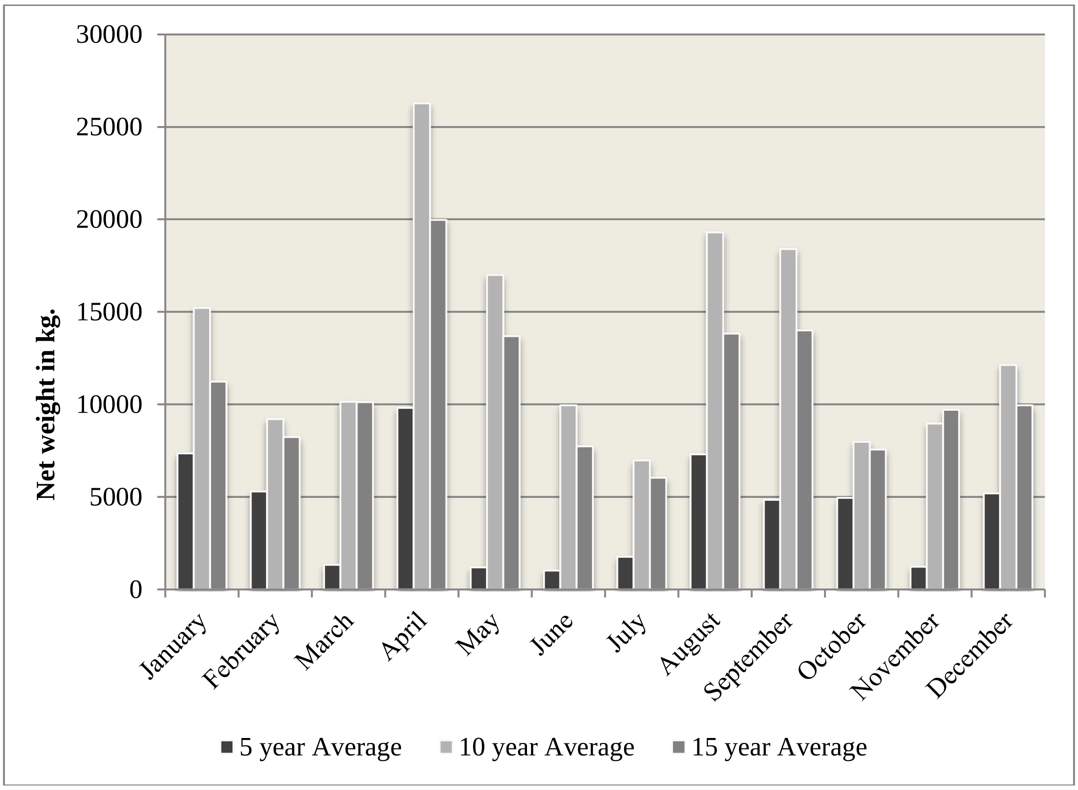
Figure 1. Movements in Gold Import Volume in India (Annual, 1996-97 to 2013-14)



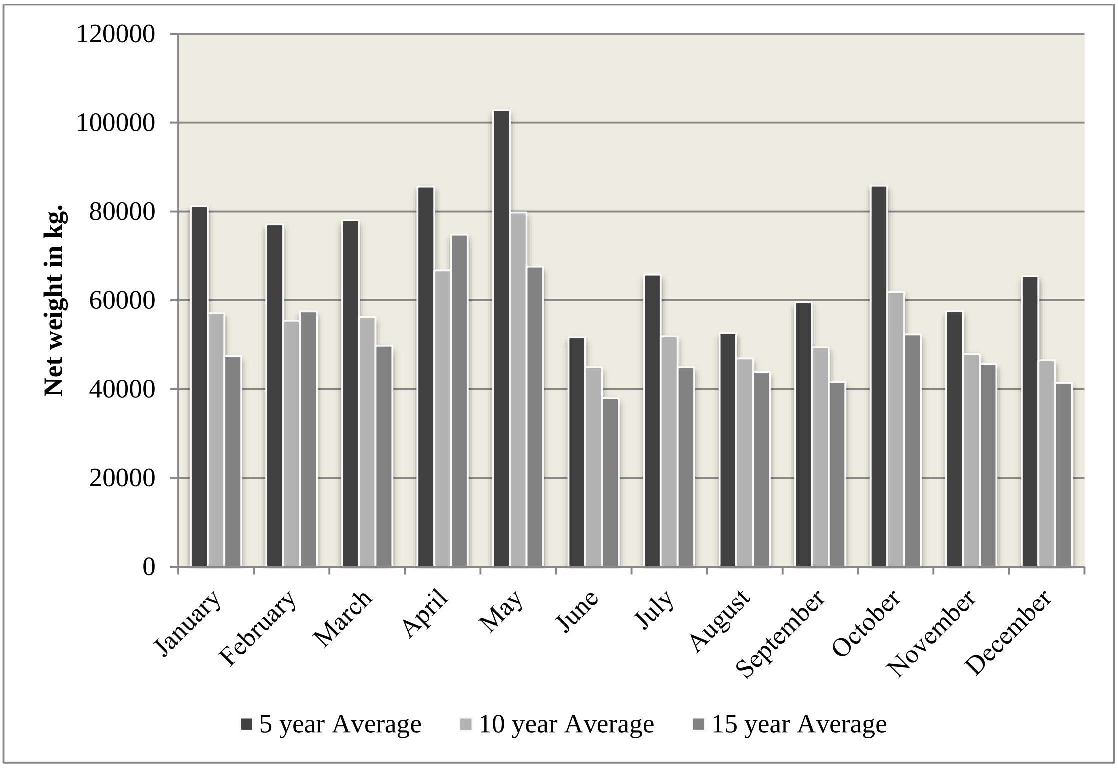
Source: DGCIS Database.

Figure 2. Seasonal Trend of Gold Jewellery Import in India (1999-2014)



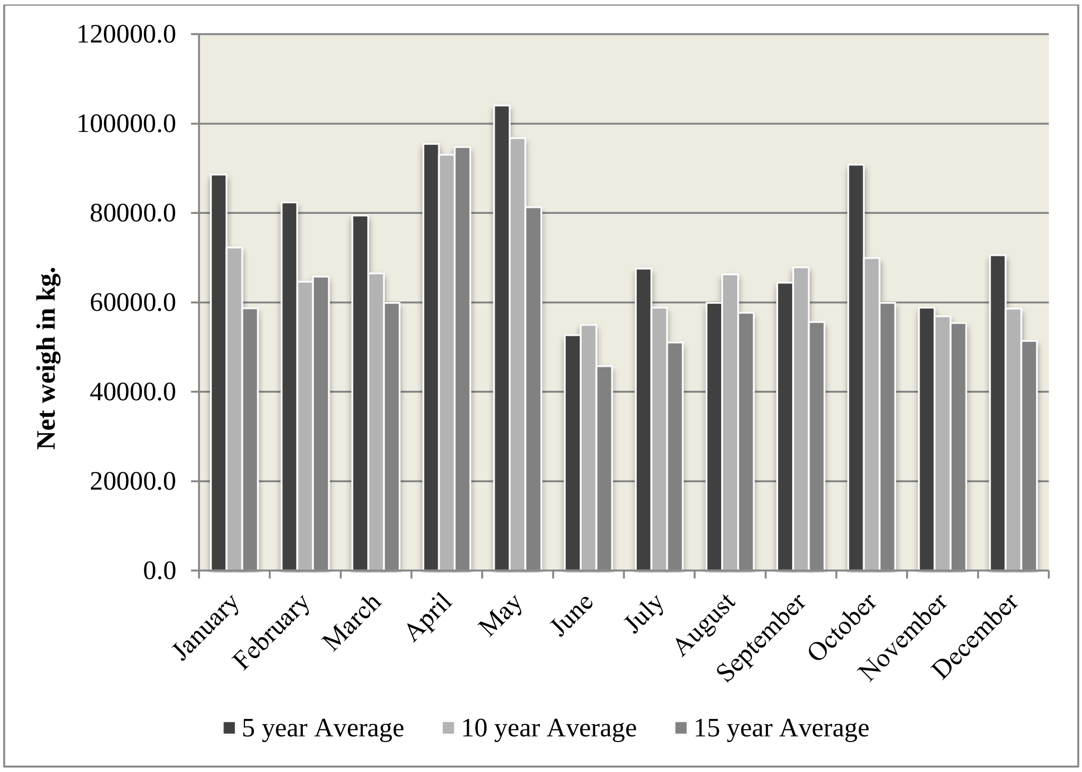
Source: Author’s Computation.

Figure 3. Seasonal Trend of Gold Bars Import in India (1999-2014)



Source: Author’s Computation.

Figure 4. Seasonal Trend of Total Gold Import in India (1999-2014)



Source: Author’s Computation.

Table 1. Unit Root Test Results without Structural Break

Series	ADF t-statistic	p-value	Lag Length Choice	Exogenous Specification
Level				
lqgt	-4.286	0.004	3	Constant, Linear Trend
lqgjt	-2.622	0.090	5	Constant
lqgbt	-4.584	0.001	3	Constant, Linear Trend
lpgt	-2.740	0.222	2	Constant, Linear Trend
lmt	-2.979	0.141	3	Constant, Linear Trend
lpst	-2.223	0.474	3	Constant, Linear Trend
rlong	-2.431	0.135	1	Constant
st	-9.391	0.000	1	Constant
exrt	-9.465	0.000	1	Constant
First Difference				
lpgt	-8.418	0.000	2	Constant, Linear Trend
lmt	-8.222	0.000	3	Constant, Linear Trend
lpst	-6.598	0.000	3	Constant, Linear Trend
rlong	-9.867	0.000	1	Constant

Source: Author's computation.

Table 2. Unit Root Test Results with an Endogenous Structural Break

Series	Zivot Andrews t-statistic	p-value	Chosen breakpoint	Lag Length Choice	Exogenous Specification
lqgt	-4.81	0.55	1999M11	2	Constant
lqgjt	-6.14	0.00	2008M10	3	Constant
lqgbt	-5.14	0.14	2005M03	2	Constant

Source: Author's computation.

Table 3. Parameter and Elasticity Estimates for PAM, Total Gold Demand

	Dependent Variable: lqgt					
Reduced Form Estimates	**Regression 1**		**Regression 2**		**Regression 3**	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
constant	12.25***	2.06	11.76***	1.83	9.31***	1.37
lqgt(-1)	0.47***	0.06	0.48***	0.06	0.49***	0.06
lpgt	-1.56***	0.4	-1.51***	0.37	-0.94***	0.24
lmt	0.75***	0.18	0.86***	0.16	0.84***	0.16
lpst	0.71**	0.35	0.53**	0.26		
rlong	-0.02	0.03				
st	-0.31	0.55				
exrt	-3.39	2.28				
LR Estimates						
γ	0.53		0.52		0.51	
a0	23.17		22.53		18.4	
a1	-2.96		-2.89		-1.86	
a2	1.42		1.64		1.65	
Goodness of Fit Statistic						
Adjusted R-sq	0.55		0.54		0.54	
S.E. of regression	0.50		0.50		0.51	
Elasticity Estimates						
SR Price Elasticity	-1.56		-1.51		-0.94	
SR Expenditure Elasticity	0.75		0.86		0.84	
LR Price Elasticity	-2.96		-2.89		-1.86	
LR Expenditure Elasticity	1.42		1.64		1.65	

Source: Author's computation.
Note: *,**,*** represent p<0.1, p<0.05, and p<0.01 respectively.
Residuals of the regressions are stationary.

Table 4. Parameter and Elasticity Estimates for PAM, Jewellery Demand

Reduced Form Estimates	Dependent Variable: lqgjt					
	Regression 1		Regression 2		Regression 3	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
constant	35.76***	6.16	37.38***	5.98	23.38***	3.97
lqgjt(-1)	0.37***	0.07	0.36***	0.07	0.42***	0.06
lpgt	-6.66***	1.29	-6.99***	1.26	-4.03***	0.80
lmt	1.80***	0.54	1.87***	0.54	2.22***	0.49
lpst	2.90***	1.00	3.08***	0.99		
rlong	-0.14*	0.08	-0.15*	0.08		
st	-2.17	1.58				
exrt	-8.98	6.59				
break_j	-2.78*	1.52	-2.76*	1.45	-3.43***	1.46
LR Estimates						
γ	0.63		0.64		0.58	
a0	56.79		58.04		40.26	
a1	-10.58		-10.86		-6.94	
a2	2.87		2.9		3.82	
Goodness of Fit Statistic						
Adjusted R-sq	0.45		0.45		0.43	
S.E. of regression	1.41		1.41		1.44	
Elasticity Estimates						
SR Price Elasticity	-6.66		-6.99		-4.03	
SR Expenditure Elasticity	1.80		1.87		2.22	
LR Price Elasticity	-10.58		-10.86		-6.94	
LR Expenditure Elasticity	2.87		2.9		3.82	

Source: Author's Computation

Note: *,**,*** represent p<0.1, p<0.05, and p<0.01 respectively.

Residuals of the regressions are stationary.

Table 5. Parameter and Elasticity Estimates for PAM, Gold Bars Demand

Reduced Form Estimates	Dependent Variable: lqgbt			
	Regression 1		Regression 2	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
constant	9.09***	2.13	7.02***	1.36
lqgbt(-1)	0.49***	0.06	0.50***	0.06
lpgt	-0.96**	0.44	-0.47**	0.27
lmt	0.54***	0.21	0.56***	0.17
lpst	0.51	0.40		
rlong	0.00	0.03		
st	-0.24	0.64		
exrt	-2.37	2.64		
LR Estimates				
γ	0.51		0.50	
a0	17.76		13.95	
a1	-1.88		-0.94	
a2	1.06		1.12	
Goodness of Fit Statistic				
Adjusted R-sq	0.45		0.45	
S.E. of regression	0.58		0.58	
Elasticity Estimates				
SR Price Elasticity	-0.96		-0.47	
SR Expenditure Elasticity	0.54		0.56	
LR Price Elasticity	-1.88		-0.94	
LR Expenditure Elasticity	1.06		1.12	

Source: Author's Computation
Note: *,**,*** represent p<0.1, p<0.05, and p<0.01 respectively.
Residuals of the regressions are stationary.

Table 6. Parameter Estimates for Houthakker-Taylor State Adjustment Model

Reduced Form Estimates	Dependent Variable					
	lqgt		**lqgjt**		**lqgbt**	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Constant	7.46***	1.42	22.48***	4.21	5.13***	1.38
lqgt(-1)	0.52***	0.06				
lqgjt(-1)			0.42***	0.07		
lqgbt(-1)					0.52***	0.06
d(lpgt)	-1.58**	0.70	-3.31	2.19	-1.62**	0.81
lpgt(-1)	-0.59**	0.25	-3.84***	0.85	-0.10	0.27
d(lmt)	1.71***	0.35	2.81***	1.05	1.58***	0.40
lmt(-1)	0.58***	0.17	2.08***	0.52	0.30*	0.18
break_j			-3.21**	1.52		
Structural Form Estimates						
α	23.83		26.69		32.46	
γ	1.86		2.48		1.89	
η	-1.89		-4.56		-0.63	
β	-0.21		0.37		-0.42	
δ	0.41		1.18		0.21	
Goodness of Fit Statistic						
Adjusted R-sq	0.53		0.42		0.45	
S.E. of regression	0.48		1.45		0.56	
Elasticity Estimates						
SR Price Elasticity	-1.89		-4.56		-0.63	
SR Expenditure Elasticity	1.86		2.48		1.89	
LR Price Elasticity	-1.24		-6.67		-0.21	
LR Expenditure Elasticity	1.22		3.62		0.62	

Source: Author's computation.

Note: ***,**,* indicate $p<0.01$, $p<0.05$, $p<0.10$ respectively.

Table 7. Long-run Parameter Estimates for ARDL Model, Total Gold Demand

Dependent Variable: lqgt									
Regressors	**Selected Model**	**Coefficient**	**Std. Error**	**Selected Model**	**Coefficient**	**Std. Error**	**Selected Model**	**Coefficient**	**Std. Error**
Constant		22.14	1.93		20.41	1.77		16.88	1.25
lpgt		-2.68	0.43		-2.41	0.41		-1.53	0.27
lmt		1.17	0.20		1.46	0.17		1.46	0.17
lpst	(2,1,1,1,1, 1,1)	1.43	0.39	(2,1,1,1)	0.84	0.30	(2,1,1)		
rlong		-0.08	0.03						
st		-0.14	0.64						
exrt		-1.75	2.62						
Bound Test									
F Wald Test Statistic		6.26***			10.12***			13.37***	

Source: Author's computation.

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 8. Long-run Parameter Estimates for ARDL Model, Gold Jewellery Demand

Dependent Variable: lqgjt									
Regressors	**Selected Model**	**Coefficient**	**Std. Error**	**Selected Model**	**Coefficient**	**Std. Error**	**Selected Model**	**Coefficient**	**Std. Error**
Constant		57.61	5.05		51.97	4.64		39.94	3.36
lpgt		-10.74	1.13		-9.85	1.08		-6.87	0.74
lmt		2.87	0.54		3.76	0.45		3.78	0.47
lpst	(1,1,2,1,1 ,1,1)	4.72	1.02	(1,1,1,1)	2.9	0.8	(1,1,1)		
rlong		-0.24	0.08						
st		-1.87	1.69						
exrt		-2.29	6.94						
break_j		-2.46	1.63		-2.62	1.56		-3.05	1.61
Bound Test									
F Wald Test Statistic		6.78***			9.51***			10.72***	

Source: Author's computation.

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 9. Long-run Parameter Estimates for ARDL Model, Gold Bars Demand

Dependent Variable: lqgbt						
Regressors	**Selected Model**	**Coefficient**	**Std. Error**	**Selected Model**	**Coefficient**	**Std. Error**
Constant		16.22	2.25		12.11	1.43
lpgt		-1.47	0.5		-0.54	0.31
lmt		0.72	0.24		0.88	0.2
lpst	(2,1,1,1,1,1,1)	1.07	0.45	(1,1,1)		
rlong		-0.04	0.04			
st		-0.17	0.74			
exrt		-0.96	3.05			
Bound Test						
F Wald Test Statistic		6.52***			22.16***	

Source: Author's Computation

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 10. Error Correction Representation for ARDL Model, Total Gold Demand

	Dependent Variable : Δlqgt					
	Regression 1		Regression 2		Regression 3	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Constant	0.04	0.03	0.04	0.03	0.05	0.03
Δlqgt(-1)	-0.07	0.07	-0.09	0.07	-0.14*	0.07
Δlqgt(-2)	-0.16**	0.06	-0.16**	0.06	-0.17***	0.06
Δlpgt(-1)	-3.65***	0.74	-3.81***	0.73	-3.50***	0.7
Δlmt(-1)	-0.76**	0.36	-0.76**	0.35	-0.71*	0.36
Δlps(-1)	1.37**	0.63	1.74***	0.62		
Δrlong(-1)	0.00	0.10				
Δst(-1)	0.62	0.44				
Δexrt(-1)	2.51	1.79				
ecm(-1)	-0.46***	0.07	-0.43***	0.07	-0.40***	0.07
Goodness of Fit Statistic						
Adjusted R-sq	0.39		0.35		0.38	
S.E. of regression	0.47		0.47		0.48	
Elasticity Estimates						
SR Price Elasticity	-0.87		-0.98		-1.57	
SR Expenditure Elasticity	1.33		1.59		1.71	
LR Price Elasticity	-2.39		-2.03		-1.24	
LR Expenditure Elasticity	0.67		1.11		1.22	

Source: Author's computation.

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 11. Error Correction Representation for ARDL Model, Gold Jewellery Demand

	Dependent Variable : Δlqgjt					
	Regression 1		Regression 2		Regression 3	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Constant	0.07	0.10	0.03	0.10	0.05	0.10
Δlqgjt(-1)	-0.16**	0.07	-0.17**	0.07	-0.19***	0.07
Δlpgt(-1)	-2.75	2.18	-2.66	2.16	-1.36	2.07
Δlmt(-1)	-2.67**	1.19	-1.33	1.00	-1.34	1.03
Δlmt(-2)	-2.38**	1.15				
Δlps(-1)	4.43**	1.85	5.66***	1.84		
Δrlong(-1)	0.27	0.29				
Δst(-1)	1.20	1.30				
Δexrt(-1)	-2.03	5.39				
ecm(-1)	-0.54***	0.08	-0.51***	0.08	-0.45***	0.08
break_j	-1.28	1.47	-2.07	1.45	-3.18**	1.46
Goodness of Fit Statistic						
Adjusted R-sq	0.36		0.35		0.31	
S.E. of regression	1.38		1.39		1.43	
Elasticity Estimates						
SR Price Elasticity	-4.40		-4.37		-3.31	
SR Expenditure Elasticity	1.80		2.81		2.81	
LR Price Elasticity	-10.79		-10.14		-6.67	
LR Expenditure Elasticity	2.65		3.73		3.62	

Source: Author's computation.

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 12. Error Correction Representation for ARDL Model, Gold Bars Demand

	Dependent Variable : Δlqgbt			
	Regression 1		**Regression 2**	
Regressors	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Constant	0.05	0.04	0.05	0.04
Δlqgbt(-1)	-0.12*	0.07	-0.08	0.07
Δlqgbt(-2)	-0.15**	0.06		
Δlpgt(-1)	-3.99***	0.84	-4.08***	0.8
Δlmt(-1)	-0.71*	0.4	-0.75**	0.4
Δlps(-1)	0.79	0.72		
Δrlong(-1)	-0.03	0.11		
Δst(-1)	0.54	0.5		
Δexrt(-1)	2.59	2.04		
ecm(-1)	-0.46***	0.07	-0.51***	0.07
Goodness of Fit Statistic				
Adjusted R-sq	0.38		0.35	
S.E. of regression	0.54		0.55	
Elasticity Estimates				
SR Price Elasticity	-0.73		-1.62	
SR Expenditure Elasticity	1.31		1.58	
LR Price Elasticity	-1.04		-0.21	
LR Expenditure Elasticity	0.20		0.62	

Source: Author's computation.

Note: ***,**,* indicate p<0.01, p<0.05, p<0.10 respectively.

Table 13. Range of Elasticity Estimates of the Three Dynamic Demand Models

	Model	Short-run		Long-run	
		Price	**Expenditure**	**Price**	**Expenditure**
lqgt	PAM	-0.94 to -1.56	0.75 to 0.84	-1.86 to -2.96	1.42 to 1.65
	H-T	-1.89	1.86	-1.24	1.22
	ARDL	-0.87 to -1.57	1.33 to 1.71	-1.24 to -2.39	0.67 to 1.22
lqgjt	PAM	-4.03 to -6.99	1.80 to 2.22	-6.94 to -10.86	2.87 to 3.82
	H-T	-4.56	2.48	-6.67	3.62
	ARDL	-3.31 to -4.40	1.80 to 2.81	-6.67 to -10.79	2.65 to 3.73
lqgbt	PAM	-0.47 to -0.96	0.54 to 0.56	-0.94 to -1.88	1.06 to 1.12
	H-T	-0.62	1.89	-0.21	0.62
	ARDL	-0.73 to -1.62	1.31 to 1.58	-0.21 to -1.04	0.20 to 0.62

Source: Author's computation.