

Inter-sector GDP Substitutability in Macro-Money Demand: Novel Evidence for India

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Abstract The gross domestic product (GDP) as a scale variable in the macro-money demand function is justified only on the simplifying but verifiable assumption that the individual-sector GDPs have the same marginal money demand propensities. This assumption is easily verifiable by replacing the aggregate GDP with the services sector and commodity sector GDPs as two scale variables. The money demand propensities differ between these two sectors. To empirically verify this, a variable elasticity of substitution model is posited with these two sector GDPs as scale variables. This novel model permits us to estimate the parameter of elasticity of substitution between the two-sector GDPs. We expect the elasticity estimate to be greater than unity first and decrease towards unity later in the post-liberalization period 1992-2012 and this ensures a unitary income elasticity of demand for money for the aggregate GDP. For the pre-liberalization period (1971 to 1991) we expect the substitutability between the two sectors to be either less than unity or even negative. The policy implication of disparate sector-GDP growth rates for money demand should not be ignored in an emerging economy of India, where the GDP structure evolves towards invariance as in a developing economy.

Keywords Intersector GDP Substitutability, Macro-money Demand Function, 'Transcendental' Functional Specification

"Truth is never absolute because the basis of truth is a hypothesis".

--Anonymous

1. Introduction

1.1. Why a New Money Demand Study Again

It is well known that in a structurally evolving emerging market economy, inter-sector interactions may create disparate money-demand propensities and they are likely to create significant influence on the macro-money demand function. These very disparate sector money demand

propensities can be identified in three different ways; Firstly, changes in the sector composition —concentration or diversification — can show up as bias in the macro-money demand function [Ganti, 1996 and 2002] Secondly, these can end up as stored up information hidden behind the income elasticity of money demand [Ganti and Bhamidipati, 2011]; and [Ganti, Telidevara and Acharya, 2016]. Thirdly, these can also create substitutability or complementarity between the sectors so far as the demand for money is concerned. The rest of the study is organized as follows: Section2 provides brief explanation as to why distinguish between commodities and services for studying macro-money demand; section3 posits a variable elasticity of substitution model of money demand and derives the elasticity of substitution formulae between commodities and services; section 4 presents a discussion of the regression results and section 5 concludes with a summary and remarks.

2. Why Distinguish between Commodities and Services

Commodities are fungible and services are intangible. Commodities are off-the-shelf offerings and much easier to bid price. A bid is essentially a pricing quote for a known item. On the other hand a service is a 'proposal', consisting mainly, not only of identifying what needs to be delivered but also as to how that will be done. This is as it should be because the explanation is as important as the price. In case of a commodity, one knows from the outset, what needs to be delivered. In case of a service it, often, turns out to be a proposal or a solution as to what will be delivered as line items and also pricing them. Although experiences count with respect to both, those with services are more unique than those with commodities, because an experience is as real an offering as any commodity. In this sense, experiences are memorable too. Thus, the progression of pricing value from commodities to services is a journey from the impersonal market transactions to entirely personal and unique transactions. The distinction between goods and services has gained much more significance for predicting core inflation [Peach, Rich and Linder, 2013].

3. The Two Sector Model

Most econometric studies excluding those by [Ganti, 1996 and Ganti et al., 2016] relating to the macro-money demand function estimation have relied upon the GDP as the scale variable and interest rate as the opportunity cost variable in the specification. Our novel model posits the very well known 'transcendental' functional specification as in (1) below [Knox Lowell, 1968]. It not only allows the scale ($\alpha+\beta$) exponents of y_1 and y_2 in (1) to vary, but also the elasticity of substitution (σ) as in (5) below to vary over time. The sum of exponents of y_1 and y_2 here constitute the counterpart of 'm' elasticity with respect to real GDP in the standard macro-money demand function. Thus, in our function (1) the real GDP elasticity of 'm' can be greater than/ equal to/ or less than unity. Also, if is ' γ ' zero, then our transcendental function reduces to the simple Cobb-Douglas specification. There is no constraint placed upon the sign of ' γ '.

$$m = Ay_1^\alpha y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) \quad (1)$$

Where, $m=M/P$ is real money (nominal money supply deflated by the GDP deflator) y_1 = the real output in the commodity sector (y_1/p_1) and y_2 , the real output of the services sector (y_2/p_2). The marginal increase in the real money demand with respect to an increase in the real output of commodities y_1 is:

$$\begin{aligned} \frac{\partial m}{\partial y_1} &= A\alpha y_1^{\alpha-1} y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) + Ay_1^\alpha y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) \left(\frac{\gamma}{y_2}\right) \\ &= Ay_1^\alpha y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) \left(\frac{\alpha}{y_1} + \frac{\gamma}{y_2}\right) \\ &= m \left(\frac{\alpha}{y_1} + \frac{1}{y_2}\right) \\ &= m \left(\frac{\alpha y_2 + \gamma y_1}{y_1 y_2}\right) \end{aligned} \quad (2)$$

Similarly for real services output y_2 the marginal increase in the real money demand is:

$$\begin{aligned} \frac{\partial m}{\partial y_2} &= A\beta y_1^\alpha y_2^{\beta-1} \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) - Ay_1^\alpha y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) \left(\frac{\gamma y_1}{y_2^2}\right) \\ &= Ay_1^\alpha y_2^\beta \exp\left(\gamma \frac{y_1}{y_2} - \theta_i\right) \left(\frac{\beta}{y_2} + \frac{\gamma y_1}{y_2^2}\right) \\ &= m \left(\frac{\beta y_2 - \gamma y_1}{y_2^2}\right) \end{aligned} \quad (3)$$

The Marginal rate of Substitution (MRS) between commodities and services from (2) and (3) is:

$$\begin{aligned} \frac{dy_1}{dy_2} = \frac{\frac{dm}{dy_2}}{\frac{dm}{dy_1}} &= -\left(\frac{\beta y_2 - \gamma y_1}{y_2^2}\right) \left(\frac{y_1 y_2}{\alpha y_2 + \gamma y_1}\right) \\ &= -\left(\frac{\beta \frac{y_1}{y_2}}{\alpha + \frac{\gamma y_1}{y_2}}\right) \left(\frac{y_1}{y_2}\right) = -\frac{\beta - \gamma x}{\alpha + \gamma x} x \end{aligned} \quad (4)$$

Where $x = \frac{y_1}{y_2}$. An increase in the ratio of $x = \frac{y_1}{y_2}$ will lead to decrease in MRS only if $\beta > \gamma x$. The Elasticity of substitution between commodity and services outputs is

$$\sigma_{12} = \frac{d \ln\left(\frac{y_1}{y_2}\right)}{d \ln(\text{MRS})} = \frac{\left(\frac{\Delta x}{x}\right)}{\frac{\Delta \text{MRS}}{\text{MRS}}} = \frac{(\alpha + \gamma x)(\beta - \gamma x)}{\alpha \beta - 2\alpha \gamma x - \gamma^2 x^2} \quad (5)$$

Tables 1 and 2 present the results for the regression equation (7) which is the log-linear version of (6):

$$\left(\frac{M_1}{P}\right) = \left(\frac{\text{commodity-gdp}}{P}\right)^\alpha \left(\frac{\text{services-gdp}}{P}\right)^\beta \exp\left(\gamma \frac{\text{commodity-gdp}}{\text{services-gdp}} - \theta_i\right) \quad (6)$$

Or alternatively,

$$\ln\left(\frac{M_1}{P}\right) = \beta_0 + \alpha \left(\frac{\text{commodity-gdp}}{P}\right) + \beta \ln\left(\frac{\text{services-gdp}}{P}\right) + \gamma \left(\frac{\text{commodity-gdp}}{\text{service-gdp}}\right) + \theta_i + \epsilon \quad (7)$$

4. Econometric Results of (7)

Table 1 presents the OLS estimates of (7). For the opportunity cost variable we have used the one year deposit rate of interest. We experimented with the call money rate of the interbank market also. In view of very similar results and hence to save space, we have not reported them here. The OLS results are adjusted for first order autocorrelation of the residuals. The estimation of equation (7) refers to the post-liberalization period only and the time period covers 1992-2012. The parameter estimates of (7) clearly suggest that the transcendental function is more meaningful than the standard macro-money demand function in view of the GDP-structure change of the emerging Indian market economy. The sum of the exponents of the scale variables clearly tells us that the aggregate income elasticity of money demand is greater than unity. The negative but not significant- at- all estimate of the log (real commodity GDP) variable suggests that the distinction we have made in the GDP structure is relevant. Further, the positive but significant parameter estimates of the opportunity- cost variable (one year deposit rate) though a contradiction of the conventional negative sign need not be so in the Indian context. In separate studies [Ganti, 1997-98; Ganti, Telidevara and Acharya, 2014 and Ganti and Jangili, 2017] the empirical evidence suggests the presence of a perverse liquidity effect of the opportunity cost variable in the Indian economy.

Table 4.1. Regression Results of (7) (One-year Deposit Rate)

	1992-2012	1970-1991		
	coef	se	coef	se
log(Real Commodity GDP)	-1.633	1.043	-1.739	1.452
log (Real Services GDP)	3.115"	0.856	2.055	1.445
Commodity to Services GDP ratio	2.560"	1.280	1.279	1.161
Deposit rate	1.064"	0.536	-0.883	0.690
constant	-7.907'	1.737	49.072'	12.345
Number of observations	20		22	
Log-Likelihood	44.40		39.06	
rho	0.901		0.999	
dw 0	1.268		1.592	
dw	1.971		2.094	
R ²	0.832		0.237	
Adjusted R ²	0.784		0.047	

Note: xxx=significant at or better than 1%; xx= significant at 5% or better

4.1. The MRS and the Elasticity of Substitution Estimates

Using the parameter estimates from Table 4.1 and the formulae (4) and (5) we reported the MRS and the Elasticity of Substitution (a) estimates in Table 4.2 below. It is clear

from the time series of estimates of both the MRS and the elasticity both are decreasing over the time period 1992-2012. This is as they should be for the simple reason that the GDP structure is maturing towards a dominant services sector. As a result the elasticity of substitution converges to unity and the estimates reveal this trend. This can be easily verified by a simple regression of the elasticity on time as reported below (A):

Table 4.2. MRS and Substitution Elasticity Estimates (Deposit Rate: 192-2012)

Year	MRS	Elasticity
1992-93	3.3045	1.2450
1993-94	3.2662	1.2422
1994-95	3.2985	1.2446
1995-96	3.1908	1.2366
1996-97	3.2410	1.2403
1997-98	3.0099	1.2231
1998-99	2.9404	1.2179
1999-00	2.7859	1.2063
2000-01	2.7273	1.2019
2001-02	2.6763	1.1981
2002-03	2.5211	1.1864
2003-04	2.4967	1.1845
2004-05	2.3941	1.1768
2005-06	2.3159	1.1709
2006-07	2.2913	1.1690
2007-08	2.2439	1.1654
2008-09	2.1181	1.1559
2009-10	2.0518	1.1509
2010-11	2.0290	1.1492
2011-12	1.9501	1.1432

Note: MRS = Marginal rate of substitution of y_1 and y_2 ; Elasticity = Elasticity of substitution between y_1 and y_2

(A) Elasticity $a = 1.257 - 0.0059.time$; Adjusted R-square= 0.9831; F=1107.8

t-value(594.0) (-33.3) 1992-2012

It is clear from (A) that the elasticity estimate is not only showing declining trend, but also converging towards the unity value which is the intercept estimate 1.257. Though the estimate is significantly different from unity, it is closer to unity as it is supposed to be for a maturing GDP structure of an emerging economy of India. This feature is further verified and supported by the increasing trend in elasticity estimates for the earlier highly regulated economy of India. In fact, substitutability between the two sectors would be close to negligible. In an otherwise largely barter economy of India, especially of the large agricultural sector, zero substitutability between the two broad sectors becomes a reality. Monetization of an erstwhile barter economy alone can lead to release of otherwise barter- tied resources into a market economy and hence inter-sector interactions through

monetary exchanges and then substitutability between the sectors [Ganti and Cosimano, 1979]. Regression of the elasticity on time for the period 1970-1991 reported in (B) below vindicates our assertion:

(B) Elasticity $\sigma = -0.0862 + 0.0256 \cdot \text{time}$; Adjusted
R-square= 0.9135; F=222.9

t-value (-3.827) (14.93) 1970-1991

Table 4.3. MRS and Substitution Elasticity estimates (Deposit Rate: 1970-1991)

Year	MRS	Elasticity
1970-71	-5.7085	-0.0286
1971-72	-209.9733	-0.0012
1972-73	6.0549	0.0619
1973-74	46.8710	0.0056
1974-75	8.2972	0.0403
1975-76	20.3892	0.0137
1976-77	4.1003	0.1109
1977-78	5.4848	0.0713
1978-79	5.4531	0.0719
1979-80	2.5341	0.2472
1980-81	2.8862	0.1981
1981-82	3.0122	0.1842
1982-83	2.5918	0.2379
1983-84	3.1025	0.1752
1984-85	2.6648	0.2269
1985-86	2.1742	0.3195
1986-87	1.9224	0.3885
1987-88	1.7109	0.4602
1988-89	1.9638	0.3759
1989-90	1.7697	0.4390
1990-91	1.7214	0.4563
1991-92	1.5397	0.5273

Note: MRS= Marginal Rate of Substitution of y_1 and y_2 ; Elasticity= Elasticity of Substitution between y_1 and y_2

5. Some Concluding Remarks

Most macroeconomic money demand studies deploy the standard macro-money demand specification with GDP as the scale variable and an interest rate as the opportunity cost variable. For an evolving GDP sector structure and a gradual financial liberalization of an emerging market economy, the standard macro-money demand specification provides a biased function for monetary policy guidance. This happens to hold for the Indian economy as India is an emerging market economy. The first author of this study has verified this empirically in several reported studies published earlier in the Indian and in international journals.

The present study deploys a 'transcendental' functional

specification for the macro-money demand function with the commodities and services sectors as scale variables in place of the total GDP as the single scale variable. One year deposit rate is used as the opportunity cost variable. The nature of the transcendental specification is such that it enables us to verify the substitutability between the two scale variables in so far as the money demand is concerned. This is done by the time series estimates of the variable elasticity of substitution between y_1 and y_2 for the post (1992-2012) and pre-liberalization (1970-1991) periods. Further, the regression results provide empirical evidence in support of our assertion that the Indian economy is evolving towards a mature economy with one-to-one substitutability between the two sectors. At that mature stage, the standard macro-money demand function comes back into its own, unbiased, as a meaningful monetary policy framework.

One distinct direction of future research is to include electronic money in the money supply. Then the aggregate GDP elasticity of money demand may exceed unity even for an advanced economy with different policy implications.

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