A Timewise Specification Sensitive Look at Money Demand: An Analysis of US Data [1]

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Abstract: This paper analyses the money demand relationship with a clear distinction in the functional forms of short and long run. It is shown that there is a long run relationship between money and income, and that money demand declines after a certain level of income is achieved in the short run. Demand tends to converge to its long run levels. Credit has a negative but statistically insignificant impact on money demand.

Relevance for Practice: Ever since the discovery of the "missing money" by Goldfeld (1976) the empirical and theoretical modeling of money has been at odds. One might even argue that the inability to correctly identify the so-called relationship between money and income and/or interest rates led policy makers to shift their attention from money based policies such as money targeting to other ways of making monetary policy such as interest rate targeting. My findings in this paper suggest that if the money demand behavior is clearly distinguished in the short vs. the long run, the long lost monetary relations can come back to life. Therefore, policy makers as well as academics should refocus their research on considering monetary behavior within the framework of economic time periods. This has the potential to make monetary targeting feasible again.

Key Words: Non-linearity, TAR, Money demand

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1 Introduction

As one of the most important concepts in economics, money has been widely studied from both theoretical and empirical perspectives, producing a voluminous literature. Loosely speaking, those who follow the classical school believe that there is a positive relationship between a monetary aggregate, appropriately defined, and an income variable. Although this view of the money-income relationship is shared with the Keynesian school, albeit for very different reasons, the Keynesian school contends that interest rates, too, enter this equation to represent the opportunity cost of holding money over alternative assets. (See Laidler (1985) for a detailed discussion on the issue.) For the purposes of this paper, I call the former a long run analysis while the latter describes a short run phenomenon. This distinction, while crude, provides a useful short run-long run distinction.

Empirically speaking, the income elasticity of money demand found in a transactionary model such as those of Baumol (1952) and Tobin (1956) is ½ while a precautionary demand model like that of Miller and Orr (1966) finds it to be 1/3. The Friedman (1956)'s quantity theory of money demand puts income elasticity of money demand at unity.

Until the discovery of the famous missing money of Goldfeld (1976), the theoretical and empirical results on the issue were thought to be mutually consistent. Both theoretical and empirical developments since Goldfeld (1976) have failed to yield an agreed-upon solution to the problem raised by Goldfeld's observation. The whole saga even led some economists to totally reject the existence of a reliable money demand relationship (cf. Goldfeld and Sichel (1990)).

The bulk of the research concentrated on the impact of financial innovations on money demand. Examples include Dotsey (1984), Laidler (1985), Viren (1992), Zilberfarb (1989), Oh (2002) and Paroush and Ruthenberg (1986). Others (see, inter alia, Freedman (1983), Milbourne and Moore (1986), Guidotti (1993), Milbourne (1986), Marquis and Reffet (1992) and Ball (2001)) studied computerization of the payment systems which provide better cash management opportunities as a financial innovation. Their findings are supported by Santomero and Seater (1996) which observes a spread of new media of payment to even the sphere of small business with the help of technological advances. As another type of financial innovation, credit cards were brought under close scrutiny by many authors such as Ewis and Fisher (1984), Duca and Whitesell (1995), White (1976), Mandel (1972), Freedman (1983), White (1976), Dotsey (1984), Garcia (1977), Ausubel (1991, 1997, 1999, 2000), Brito and Hartley (1995), Calem (1992), Calem and Mester (1995), Canner and Fergus (1987), Daly (1994), DeMuth (1986), Duca and

Whitesell (1995), Durkin (2000), Mester (1994), Park (1997), Raskovich and Froeb (1992), Stango (2000), Goldfeld (1989), Gross and Souleles (1999), Bird et al. (1999), Genc and Bekmez (2004) and Castronova and Hagstrom (2004). Some researchers, on the other hand, concentrated their efforts more on the construct of monetary aggregates, thus leading to a huge literature on the so-called Divisia index. See, among others, in this genre, Hulten (1973), Barnett et al (1984), Barnett (1982), Diewert (1978), Serletis (1991), Serletis and Robb (1986), Anderson, Jones, and Nesmith (1997a, b, c), Barnett and Serletis (2000) and Aigner and Goldfeld (1974).

Although the applied work on money has estimated both short run and long run versions of the issue, usually the determinants as well as functional forms of both short run and long run estimations are the same. However, in a modern economy money may not serve the same purposes for the long run and short run needs of its holders. Economic agents may respond differently to various inputs of money demand. As it will be clearer later, the bottom line of this paper is that the way to allow income and interest rate to enter money demand relations in the short run and the long run may be the main cause of the recent troubles in the empirical work. This calls into question the functional forms of the estimated relations.

It is plausible to think that money will be used in the long run to settle all accounts (as the standard of deferred payments) in terms of purchase transactions and/or credit dealings. This yields the theoretical as well as empirical money demand functions commonly employed in the profession. Income appears linearly in this function, and interest may or may not find a place depending on the school of thought as alluded to above. On the other hand, in the short run alternative payment media may delay the use of money; hence generating an asynchronization between transactions and actual monetary payments to settle the accounts. Economic agents can use credit cards to postpone payments for several days even if they do not carry balance over periods. This earns them interest in the interim for the funds they keep in a bank account. Even governmental agencies tend to use alternative media to conduct their business, which is a growing trend in recent years (Geoffrey and Walton (2002)). This has come to being called the “plastification” of the US society. Sapsford (2004) offers a non-technical discussion on the issue.

As the economy grows or as the income of an agent increases the cost of carrying money around increases at the same time. The costs can vary from foregone interest earnings, and the difficulty of doing business over long distances, to such little things as a calculation error with money or simply the possibility of losing money. It is conceivable to demand more money as income increases to reflect the growing nature of the economy (or a person's purchasing power in line with a probably changing lifestyle), at least in relative terms, though, the growth in money would be reversed after a peak point where agents demand less money as their income grows compared to the size of their economic activities. This implies that the demand for money should have a negative relationship with income after a certain income level. This discussion points to a nonlinear treatment of income in short run money demand relations where interest rate is also a factor.

In this paper, I will look at the money demand relation with income and interest rate, by designing different short run and long run functions to estimate while taking into consideration the aforementioned discussion. The rest of the paper is as follows: In the next section, I will briefly discuss the data with their sources and applied transformations. The estimation methodology is also presented in this section. In Section, 3, I will present the empirical findings of the paper. A specific analysis of the impact of credit on money is analyzed in Section 4. Paper concludes with a summary in Section 5.

2 Data and Methodology

All data come from the Federal Reserve Bank of St. Louis' Fred II database. Seasonally adjusted GDP (1 decimal) and GDP Deflator are employed as the income and price variables, respectively. Monthly observations on the seasonally adjusted M2 aggregate and those of the non-revolving credit are converted into quarterly data by taking monthly averages of the quarters involved. The 3-Month Treasury Bill Rate at the Secondary Market represents the interest rate. It is calculated as the averages of business days. This variable, too, is converted to quarterly form in the same manner.

One might argue that the quarterly data are irrelevant for the study in question because if economic agents use credit for transactions during the period, and settle these transactions at the end of the period, then a more tractable frequency would be monthly. Although this argument is valid, one should not forget that there is still a sizable portion of debt which remains outstanding even after a quarter. For example, the median value of the "household debt service payments as a percent of disposable personal income" (TDSP data in FRED) is about 12% for the period of 1980.1-2004.4 on a quarterly basis. Also the median value of "household financial obligations as a percent of disposable personal income" (FODSP data in FRED) is approximately 17% for the same period. A ratio of these two variables can be interpreted as the household debt service as a ratio of its financial obligations. This yields a median value of about 69%. Since mid-1990s these statistics have an increasing trend. Yet, there is still above 30% of the debt remaining unpaid.

As a first step to the analysis, I search for the existence of a stable long run relationship among money and such variables as income and interest rates. However, I have to mention that the customary analysis which precedes the cointegration procedure such as the degree of integrity of the variables at levels and in first differences is carried out, but not reported here to save space. The cointegration method used is à la Johansen (1991 and 1995) and Johansen and Juselius (1990). There are four lags in the estimation process.

The traditional part of this endeavor is the scale variable such as income. In practice, there are many candidates for the scale variable such as consumption (Mankiw and Summers (1986) and Elyasiani and Nasseh (1994)) and wages. But the inclusion of interest is not free from debate as indicated above. Admittedly, there are far too many applications of cointegration methods in money demand estimation for our reference list to be exhaustive. However, the reader is encouraged to refer to a few well-known examples such as Hafer and Jansen (1991), Hoffman and Rasche (1991), Dickey et al (1991) and Hendry and Ericcson (1991). A general representation of the equation to estimate can be stated as

$$m2_t = \alpha_0 + \alpha_1 y_t + \alpha_2 R_t + ec_t \tag{1}$$

where m2 stands for the log of real M2 money, and y is the log of real income. R represents the nominal interest rate, and ec is the residual term. The interest rate may be dropped from the equation depending on the school of thought. I estimate the cointegration vectors of money demand with and without the interest rate, without siding with any school of thought a priori.

Once a cointegrating relationship is found for a given set of variables, an error correction model can be estimated to determine the short run dynamics of the system. I modify the error correction model to reflect the discussion on money-income relationship as mentioned above. The major significance of the model estimated here is to include the squared income along with the income and interest rates to the estimation equation to account for a possible reversal in money demand beyond a certain level of income. I also assume that income is exogenous to money in this estimation. One may argue that income should be considered endogenous here since the cointegration analysis used above does not make such a distinction. This is a valid argument. Thus, I estimated the short run relation by including 4 lags of income in one specification, and 4 lags of income and squared income in another. Qualitative results remain unchanged as reported in this paper. I further carried out a Hausman type specification test to detect the income endogeneity. Income is found marginally exogenous at 5% level of significance. Results are available upon request. Accessible references for this test are Davidson and MacKinnon (1993 and 2004) and Ruud (2000). On a related note, the direction of causality between money and income is another contentious issue in economics. That is to say, income determines money demand, but not vice versa.

Then, the equation to estimate becomes

$$\Delta m2_t = \sum_{j=1}^{J} \gamma_j \Delta m2_{t-j} + \beta_0 + \beta_1 ec_{t-1} + \beta_2 \Delta y_t + \beta_3 (\Delta y_t)^2 + \beta_4 \Delta R_t + \eta_t \qquad (2)$$

where Δ is the difference operator and η is the error term. The maximum number of the lags of the dependent variable, J, equals 4. The estimation method used incorporates the heteroskedasticity and autocorrelation consistent standard errors à la Newey and West (1987). It is well known that the first difference of the log of a variable approximately corresponds to the percentage change. This notion should be kept in mind when interpreting the results.

As an alternative estimation method, I employ the threshold autoregressive (TAR) models. The TAR(p) model can be formulated as:

$$\begin{aligned} \Delta m2_t = I_t &\left(\alpha_{00} + \sum_{i=1}^{p} \beta_{0i} \Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{0i} R_{t-i} + \sum_{i=1}^{p} \psi_{0i} ec_{t-i} \right) + \\ &(1 - I_t) \left(\alpha_{10} + \sum_{i=1}^{p} \beta_{1i} \Delta y_{t-i} + \sum_{i=1}^{p} \gamma_{1i} R_{t-i} + \sum_{i=1}^{p} \psi_{0i} ec_{t-i} \right) + \varepsilon_t \end{aligned} \qquad (3)$$

where the indicator variable, I_t, takes on the following values depending on the lagged value of Δm2 with respect to a threshold value, τ.

$$I_t = \begin{cases} 1 & if \quad \Delta m2_{t-d} > \tau \\ 0 & if \quad \Delta m2_{t-d} \le \tau \end{cases}. \qquad (4)$$

Here d is called the delay parameter showing how many periods Δm2 has to be lagged to compare to τ.

The interpretation of this model is pretty straightforward: For as long as $\Delta m2_{t-d}$ is above τ, the first component of equation is valid. I call this a "high money state." If $\Delta m2_{t-d}$ is less than (or equal to) the threshold value, the second term on the right of Equation 3, that is the "low money state" prevails. This helps us to determine if there are different behavioral states in demanding money based on some historical criterion.

One should notice that my equation differs from a traditional TAR model in that the latter is univariate while the former is multivariate. Moreover, I deliberately included the residuals from the long run model, ec, to account for the inherit long term relationship which exist in the data as the cointegration results show.

Chan (1993)'s method is used to obtain an optimum τ parameter. Enders (2004) is followed for the optimum delay parameter where $1 \leq d \leq 4$ as the possible values. Since this estimation is likely to generate several insignificant coefficients, a stepwise regression is run to select the statistically significant ones. This regression is run in all three formats as available in the literature, i.e. the full model, forward selection and backward elimination methods, with 0.10 significance value to enter and to stay in the model. As an option of estimation I "force" the intercepts into the regressions. In other words, α_{00} and α_{10} are not allowed to drop from the estimation even if they might be insignificant at the stated levels. A certain number of tests are conducted to determine the reliability of the results thus obtained, and also to distinguish the existence (or the lack thereof) of different states in money demand.

3 Estimation and Results

The estimation period covers quarterly data between 1959.1-1989.4. The starting date of the analysis is dictated by the availability of data from the source. The main reason why I chose pre-1990s as the closing date of my analysis is because of the rapidly internationalized nature of the US dollar especially after the collapse of the former Soviet Union. As a result, a large portion of the US currency is held abroad predominantly after this period. Porter and Judson (1996), Porter (1993), Feige (1994 and 1997), Obstfeld and Rogoff (1996), Jefferson (1998) and Rogoff (1998) and Genc and Bekmez (2004) suggest ways to re-generate the domestic monetary aggregates from the published data. This period might be called a "monetary abundance period" as opposed to Goldfeld's missing money phenomenon. Thus, unless carefully accounted for, one would estimate a money demand relation, which includes both domestic and international components as a function of domestic variables such as income and interest rates.

Table 1 presents the estimation results of Equation 1. Both Maximal Eigen Value test and the Trace test cannot reject r = 0 (that is, no cointegration) at 5% level of significance if interest rate is involved, but a single cointegration vector is found between the real money demand and real income without the interest rate. The estimated statistically significant cointegration vector after normalization is $m2_t = -0.228 + 0.92 y_t$. (The asymptotic standard error of the coefficient on income is 0.02.) This can be considered as the long run version of demand in accordance with the quantity theory of money. The income elasticity of money demand, so found, is close to unity as predicted by the quantity theory.

The results for Equation 2 are shown in Table 2. It is clear from the results that money converges to its long run equilibrium because of the negative statistically significant coefficient on the lagged error correction term, ec_{t-1}, as expected based on the discussion above. That is to say, all long run transactions must finally be settled with money. It is also clear that money is positively and significantly related to income, and negatively related to the interest rate. The negative interest rate coefficient is statistically significant.

Perhaps the more interesting matter is the negative coefficient on the squared income variable. Given its size in absolute value terms compared to other coefficients, not only is the coefficient on squared income statistically significant, but it is by far the most important economic variable contributing to the explanation of money demand. In a sense, exclusion of this variable from the regression would significantly bias the results from the economic standpoint. Squared variables are employed to detect the inflection points and paint the curvature of a function in practice. This brings about another interesting issue regarding the coefficient on the squared income: It is negative, mathematically speaking, $\Delta m2_t$ is concave with respect to Δy_t. In other words, one can say that up to a level, as the income growth increases the growth rate of demand for money increases; but after a certain threshold of income growth, growth rate of money demand starts dwindling. I conjecture that economic agents resort to non-monetary means to conduct transactions as income goes beyond a threshold level since the cost of dealing with money in economy increases for higher and higher levels of income. Besides, there are alternative ways of handling transactions without money thanks to the technological innovations.

Conversely, another possible reason for the concave relation between money growth and income growth could be that economic agents with low level of income cannot (or do not like to) bear the cost to employ non-monetary media, like credit, to do transactions. However, the necessity or willingness to employ non-monetary media increases when the agents possess high level of income. (I am indebted to a referee of this journal for bringing this point to my attention.)

Since $\Delta m2_t$ has a concave form with respect to Δy_t, it is easy to show that the impact of Δy_t on $\Delta m2_t$ is estimated to be maximized at $\Delta y_t \cong 1.61\%$, *ceteris paribus*. Putting it differently, if real income grows faster than 1.61%, the growth in money demand starts declining in the short run. The other two specifications of the short run money demand estimation mentioned above do not alter this finding. In the estimation period under consideration, the growth in real income tops the aforementioned extremum 31 times, which is met by a decline in the growth of real income 18 times. This corresponds to about 58.07% ‘success’ rate.

I test the significance of several coefficients as in

Table 3. As the first row shows, one fails to reject the relevance of the income variables in the estimation. The lags of the money demand variable can not be rejected as insignificant from the statistical standpoint, either. Also, by judging from the p-value of the F-statistics, one can say that it is not possible to conclude that the model, as a whole, is incapable of explaining the variation in the dependent variable. As a matter of fact, about 54.46% of the variation in the dependent variable is explained by this model as revealed by the adjusted R^2 from the estimation.

I conducted a battery of statistical tests for the robustness of the aforementioned results, which are all available from the author upon request. For example, with the help of Ljung-Box Q-statistics, I could not reject the null hypothesis of residuals being white noise. The same is true for the squared residuals, as well, which leads to the conclusion that the model errors are well-behaved according to the criteria set by these tests. Likewise, the null hypothesis of homoskedasticity as tested by the White method with the inclusion of cross terms, produced a t-statistics of 24.07 whose p–value is 0.99. This leads us to rule out the existence of heteroskedasticity in the estimation. I also find that the parameters are stable, that is to say, the estimated coefficients do not change as the sample size grows.

To strengthen the findings of this research, I used TAR(p) models as mentioned before. To comply with the requirements of this estimation method, the optimum delay parameter, d, in Equation 4 is determined with the help of Chan's method. It is thus found that d could be anywhere from 1 to 4. Therefore, I choose, d=1 for the sake of parsimony of estimation. The residual sum of squares, SSR, from this estimation is 0.0119036, yielding a threshold value, τ, of 0.011619. Next, I proceed wit the estimation of Equation 3 based on the found threshold value. As expected, this estimation produces several insignificant coefficients. The results are not reported here to save space, but available from the author.

To tackle this problem, the stepwise regression technique is used to eliminate the insignificant variable(s) in all three formats of this technique, i.e. the full model, forward selection and backward elimination methods, with 0.10 significance value to enter and to stay in the model. The intercepts are forced into the estimation. There is no outstanding difference among the formats, hence the results of full stepwise estimation are reported in Table 4.

As seen in Table 4, the coefficients on various lags of income are significant in both states. However, they are negative in high state and positive in low state suggesting that in high money state the higher the income the lower the demand for money, while a positive relationship is observed with income and money in the low state. These results support the findings of the first method employed above. Additionally, the interest rate contributes negatively to money demand in the high state due to high opportunity cost of money while it is found to be insignificant in the low state. The residuals from the long run estimation almost cancel each other out in the low state in absolute value, and they do not enter the high state estimation.

As before, a battery of statistical tests are run to maintain the robustness of the obtained results. These are not reported here to save space, yet available from the author upon request. Tests on serial correlation show that the residuals from this estimation is white noise. Likewise, no indication of ARCH-GARCH type errors are found in this estimation. A RESET test does not identify any specification problem with this model.

More specifically, I test to determine the statistical support for the switching regimes in this estimation. With a maximum of 4 lags in each state, I test the hypothesis of all coefficients except the intercepts being zero. The F statistics of this estimation is 18.71 with 8 and 167 degrees of freedom. Thus, the claim that all coefficients in this estimation are equal to zero is resoundly rejected. Next, I test the statistical similarity between intercept coefficients from each state. the F statistics is 4.7 with 1 and 167 degrees of freedom leading to the rejection of statistical indenticality of the intercepts from the two regimes.

4 Impact of Credit on Money Demand

Some studies have researched the impact of credit on money demand. Without the possibility of credit, there would be no non-synchronized transactions in the market, thus a cash-in-advance (CIA) type constraint or a barter type exchange would be required to conduct transactions in the economy.

I use a measure of non-revolving credit, which includes “secured and unsecured credit for automobiles, mobile homes, trailers, durable goods, vacations, and other purposes” (Durkin, 2000). To capture the mutual interaction between money and credit, I ran a vector autoregressive model of Δm2 and ΔCRD, where the latter is the first difference of the log value of real non-revolving credit. Income and interest rates are used as exogenous variables. (However, endogenizing them does not change the qualitative results.) Mathematically speaking,

$$DV_{jt} = \sum_{i=1}^{I} \tau_{ji} DV_{jt-i} + \psi_{j1}\Delta y_t + \psi_{j2}\left(\Delta y_t\right)^2 + \psi_{j3}\Delta R_t + \varepsilon_{jt} \qquad (5)$$

where DV represents the endogenous variables subscripted by j, i.e. Δm2 and ΔCRD. ε are innovations. The model involved four lags, i.e. I=4. Without presenting full results here, I find that money responds negatively for 3 periods to a one standard deviation in the non-revolving credit, and then positively but with ever smaller reactions. In other words, credit causes reductions in money demand first, but later on, its impact on money clears as the transactions need to be settled with money in the long run. However, it should be noted that statistically speaking the impulse responses are not found significant. Since my main interest is the impact of credit on money, but not vice versa, I omitted an impulse response function for credit in response to innovations in money demand. Additionally, a specification of the estimation equation which omits the squared income and interest yields almost identical impulse response function.

5 Conclusions

This paper looks into money demand estimation issue in the US context. My main point is that if the short run and long run versions of money are suitably defined by taking into consideration the impact of recent economic developments, which make money a rather costly media to conduct transactions, especially at higher income levels, a well-defined monetary relationship can be observed in the data. In empirical terms this necessitates a nonlinear specification of income in short run money demand estimation. The rationale to justify this can be briefly outlined as such: Even though in the long run, all accounts must be settled with money, the avoidance from money occurs in the short run to take advantage of less costly alternatives to money, thus necessitating different specifications of the short and long run monetary functions to estimate.

I show that there is a stable and theoretically expected relationship between money and income in the long run. Also shown is that less money is demanded when interest rates go up, and growth rate of demand for money is reversed from positive to negative at higher growth rate of income in the short run. Short run money demand function is found to converge to its long run equilibrium. Money is found to react negatively to positive shocks in credit, which is wiped out later on, when accounts are settled with money.

A threshold autoregressive (TAR) estimation technique is also incorporated in the study to confirm the findings of the standard methods employed in the analysis early on. Findings from both methods support each other giving credence to the claims of the paper. In that sense, the findings are tested for statistical as well as economical relevance with the help of several commonly used tests.

The study can be extended to a multi-country framework with the tools of both time series and panel data. The time series analysis would look at individual countries while panel data can analyze a combined cross section time series of multi-unit data in terms of testing for unit roots and cointegration. The possible candidates for study units could be G7 countries or OECD countries. This could be the subject matter of a future study to test the robustness of findings in the international context. The extended time series analysis of panel data is a developing field. However, there are well established papers in the field to test for unit root. See, for example, Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), Maddala and Wu (1999), Choi (2001) and Hadri (1999). Cointegration tests are presented in Kao (1999), McCoskey and Kao (1998), Pedroni (1995, 1997, 1999 and 2000) and Larsson, Lyhagen and Lothgren (1998). A well-rounded treatment of econometrics of panel data can be found in Wooldridge (2002) and Baltagi (2001). Additionally, on the theoretical end, a model can be worked out to produce the theoretical underpinnings of the empirical model of this paper.

Table 1

Cointegration Tests

	EV	Trace	5%CV	H0	MaxEV	5%CV	H0
m2, y, R	0.157750	26.67302	29.68	r=0	20.42969	20.97	r=0
	0.050450	6.24333	15.41	r<=1	6.16025	14.07	r=1
	0.000698	0.08308	3.76	r<=2	0.08308	3.76	r=2
m2, y	0.120931	16.33324	15.41	r=0	15.33809	14.07	r=0
	0.008328	0.99515	3.76	r<=1	0.99515	3.76	r=1

Notes: *EV* refers to Eigen value, *5%CV* to 5% critical value, *MaxEV* to Maxeigen value test, and *H0* to the null hypothesis. The critical values are from Osterwald-Lenum (1992).

Table 2

The Short Run Model Estimation

Variable	Coefficient	t-Stat	p-Value.
β_0	0.015387	2.982936	0.0035
β_1	-0.001917	-2.659882	0.0090
γ_1	0.734701	7.882920	0.0000
γ_2	-0.277394	-3.278528	0.0014
γ_3	0.215377	2.081739	0.0397
γ_4	-0.144583	-1.738751	0.0849
β_2	0.358956	2.476573	0.0148
β_3	-11.14024	-2.226299	0.0280
β_4	-0.003349	-4.653131	0.0000
Adj. R^2	0.544632		
F	18.64136	p of F	0.000000

"p of F" stands for the p-value of the F statistics. Please, see Equation 2 for the coefficients.

Table 3

Joint Significance Tests

H0	Chi-Square	p-Value
$\beta_2=\beta_3=0$	6.135706	0.046521
$\gamma_1=\gamma_2=\gamma_3=\gamma_4=0$	74.39602	0.000000

"H0" stands for the null hypothesis for the test. Please, see Equation 2 for the coefficients.

Table 4

Full Stepwise Estimation Results

Variable	Coefficient	t-Stat	p-Value.
α_{00}	0.028988	2.472776	0.0144
α_{10}	0.003118	1.399385	0.1636
β_{01}	-0.436499	-1.924574	0.0560
γ_{01}	-0.004696	-8.672221	0.0000
γ_{03}	0.004260	7.526914	0.0000
β_{11}	0.303254	3.766535	0.0002
β_{12}	0.182083	2.249498	0.0258
β_{13}	0.254782	2.873134	0.0046
ψ_{01}	0.502565	4.297621	0.0000
ψ_{02}	-0.506551	-4.345030	0.0000
Adj. R^2	0.396818		
AIC	-6.965042		
BIC	-6.785598		

"AIC" and "BIC" refer to Akaike Information Criterion and Schwarz Information Criterion, respectively. Please, see Equation 3 for the coefficients.

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