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Measuring substitution in China's monetary-assets demand system

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ABSTRACT

This paper examines China's money demand using a Normalized Quadratic function in the search for global flexibility and easing of the degree of freedom. I impose the theoretical regularity conditions in the model that much of the previous literature ignores. I provide the robust estimates of the Morishima elasticities of substitution among currency, demand deposits and time deposits. I find that currency and demand deposits are elastic substitutes in use, while time deposits are inelastic substitutes with the former two. Time deposits are distant from a medium of exchange, and agents treat them as a saving asset, separable from the composite of currency and demand deposits. The results imply that the narrow money M1 is well-defined, while the broad money M2, which assumes perfect substitution of the component assets, is problematic. A monetary aggregate that internalizes the substitution effects should be adopted in China.

1. Introduction

Understanding money demand is important for economists, particularly under the current environment with ever developing payment systems and enriching financial instruments in China. This paper uses the elasticity of substitution to investigate China's money demand as well as the monetary aggregates. Specifically, I estimate the elasticities of substitution among three primary monetary assets - currency, demand deposits and time deposits - with a particular focus on the elasticity of time deposits with the other two assets. Time deposits are the influential component assets of the popular M2 aggregate of money. A weak substitution effect of time deposits will result in misleading M2 and a strong case for abandoning the simple-sum approach to monetary aggregation.

A well-regarded estimation of elasticity is the premise of accurate interpretations of money demand and monetary aggregate. In this paper, I estimate the Morishima elasticity of substitution using the Normalized Quadratic (NQ) expenditure function, introduced by [Diewert and Wales \(1988\)](#). The NQ functional is preferred due to its simplicity and global flexibility, and the latter guarantees the desired properties of the demand function. This paper contributes to the literature by paying explicit attention to the regularity conditions of neoclassical consumer theory that the previous studies shy away from. I build the regularity directly into the NQ model. Without imposing the regularity conditions, empirical evidence shows that there will be significant violations of the curvature, which lead to wild volatility of elasticities and thus impede the model's ability to produce stable output.

The degree of substitution across monetary assets has been thoroughly examined in developed economies, such as US and UK ([Davis & Gauger, 1996](#); [Drake, Fleissig, & Swofford, 2003](#); [Fisher, 1992](#); [Jones, Fleissig, Elger, & Dutkowsky, 2008](#)). However, to the best of my knowledge, there is little evidence from China, which is the second largest economy in the world. This paper fills the gap in the literature by exploring the money demand and substitutability of monetary assets in China. The People's Bank of China (PBC, the central bank of China) designed three monetary aggregates, M0, M1 and M2, to measure the aggregated stock of money. M0 is the

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quantity of currency in circulation or cash. The narrow money M1 is the simple sum of currency and demand deposits. The broad money M2 is the simple sum of M1 and time deposits. [Chen \(1989\)](#) investigates the causal relationship between the three monetary aggregates and the key macroeconomic variables over the period 1951–1985. A causal relationship is detected only when M0 enters the model, and thus he believes M0 is the best target for monetary policy during that historical period. In later years, M0 is no longer appropriate for China thanks to the emergence of new financial intermediaries and the development of the financial market. In the year of 1998, PBC announced M2 as the nominal anchor and adopted it as the intermediate target of the monetary policy. Unfortunately, ever since then, few empirical studies have examined M2 in spite of its importance.

This paper examines China's M2 by estimating the money demand system, as well as the Morishima elasticity of substitution over the period 1999 to 2014. In that sense, this paper is closely related to plenty of important topics, such as monetary aggregates, money demand and monetary policy. I find that demand deposits have a high degree of moneyness as they preserve elastic substitution with currency. A rich literature has indicated that money demand is far from stable, because of technological, institutional, and regulatory changes in the banking sector. This paper contributes to the literature by taking a closer look at China's demand deposits after the current rise of mobile payment, such as Alipay and Webchat pay. I find demand deposits are gradually substituting cash, which might be the result of the revolutionary change in method of payment and behavior of consumption. This might lead to an industrial transfer that businesses advance in e-payment prosper.

On the contrary, I find that time deposits exhibit extremely low substitutability with both currency and demand deposits. The explanation is that households in China treat time deposits as a saving asset instead of a transaction asset. As a result, time deposits may not be an effective substitute of money and should not be included in the monetary aggregate M2 with a simple-sum approach. The low substitutability of time deposits is not rare in the literature. [Saqib, Khan, and Malik \(1988\)](#) estimate the elasticities of substitution of Pakistan's monetary assets from 1971 to 1985, and find that the time deposits are not close substitutes of currency and demand deposits. [Timberlake and Fortson \(1967\)](#) analyze the role of time deposits with US data from 1897 to 1965, and find that monetary aggregates are no longer significantly correlated with the key macroeconomic variables if time deposits are included.

In terms of aggregation algorithm, the literature has never stopped debating the validity of the simple-sum approach used by PBC to calculate monetary aggregates. Some macroeconomists are in favor of the weighted average aggregation, such as the Divisia Index and the Monetary Service Index (MSI), which have been advocated by the central banks of US and UK. Divisia and MSI distribute different weights to the component assets based on the elasticities of substitution. Do Divisia or MSI indeed work better than the simple sum for China? Should China follow the lead of the Federal Reserve to adopt the Divisia monetary aggregate? This paper sheds some light on the above questions and contributes to the debate of aggregation approaches. According to my results, the simple-sum method is sufficiently appropriate for M1, which only includes two assets with equivalent cross price elasticities (or equal weights), and it may not be appropriate for M2 due to the low substitutability of time deposits with the other assets.

This paper also demonstrates the importance of estimating a flexible demand function with the regularity conditions imposed. By comparing the estimates from my model with those from some alternative models, I find that a flexible functional form without regularity constraints may fail to generate stable estimates of elasticities. The remainder of this paper proceeds as follows. [Section 2](#) discusses the NQ expenditure function, the simultaneous need of the economic and econometric regularity, and the Morishima elasticity of substitution. [Section 3](#) describes the data and the user costs of monetary assets. [Section 4](#) presents the estimated money demand and the Morishima elasticities. To check the robustness of the estimators, I also model the NQ expenditure system with alternative specifications and proxies. A separability test and a hypothesis test of elasticity are also conducted to examine the monetary aggregates. [Section 5](#) concludes the paper.

2. Model

2.1. Flexible functional form and regularity condition

The 2015 Nobel Prize laureate of Economics, Angus Deaton, was first known for his work on the flexible functional form. Over the years, the flexible functional form has been the major approach used to investigate the demand and substitutability of monetary assets ([Banks, Blundell, & Lewbel, 1997](#); [Barnett & Lee, 1985](#); [Fisher, Fleissig, & Serletis, 2001](#)). It is a functional form that has enough parameters so that it can approximate an arbitrary twice continuously differentiable function to the second order at any point. According to the Shephard's Lemma, the demand function is the first-order derivative of the expenditure function and the price elasticity relies on the second-order derivative of the expenditure function ([Shephard, 1953](#)). If the expenditure function is not flexible, both the demand and elasticity will be a priori restricted in some arbitrary way and mis-specified.

Flexibility is one of many desired properties of the money demand function. In fact, the literature tends to ignore another important attribute of the demand function, regularity. Some of the frequently used functional forms are only locally flexible with a small regularity region, such as the Translog Model ([Christensen, Jorgenson, & Lau, 1975](#)), the Generalized Leontief Model ([Diewert, 1971](#)), and the Almost Ideal Demand System ([Deaton & Muellbauer, 1980](#)). Without the global satisfaction of the regularity conditions (positive, monotonicity and curvature), the second-order condition for optimization fails, and the duality theory fails. The resulting first-order condition, the demand function and the elasticity of substitution become invalid. [Guilkey and Knox Lovell \(1980\)](#) find that the Translog model fails to approximate the true data-generating function from time to time, and the estimated elasticities of substitution are volatile. Goods that are actually complements might be classified as substitutes. Those imperfections of the estimated models may be explained by the failure of regularity.

In the following years, the flexible functional forms with larger (yet not global) regularity regions are advocated by economists and econometricians, such as the semi-nonparametric globally flexible function forms (SNP) ([Gallant, 1981](#)) and Asymptotically Ideal

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