Journal of the History of Economic Thought, 2026

ECONOMETRIC MODELS OF THE SAVINGS DEPOSIT MARKET: DEVELOPMENT AND DEMAND AMONG US RETAIL BANKS, 1970S AND 1980S

BY

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From the 1960s, the rising volatility of financial markets in the US troubled econometricians and bank managers alike. Both found it increasingly difficult to forecast savings deposit flows. This article explores these challenges by focusing on two developments. First, it analyzes the adjustment process among econometric models of the savings deposit market. I combine the analysis of the FMP model used by the Fed since 1970 and the deposit model of the Philadelphia Saving Fund Society (PSFS), thereby pioneering the historical analysis of econometric models built by private financial institutions. I find that economists failed to discover timeless determinants for deposit flows. Second, I explore how the conditions of the savings deposit market shaped the demand for macroeconomic forecast models, using the PSFS as a case study. I show that while the rising volatility led bank managers to seek sophisticated tools to predict deposit flows, the deregulation of the banking industry put the forecasting quality of macroeconomic models for individual banks to the test.

I. INTRODUCTION

In the late 1960s, the economist Franco Modigliani was working on an econometric model of the US economy for the Federal Reserve Board—the FMP model (named after the three involved institutions: the Federal Reserve Board, the MIT, and the University of Pennsylvania)—when he found a strong increase in the interest elasticity of savings

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ISSN 1053-8372 print; ISSN 1469-9656 online/26/000001-19
doi:10.1017/S1053837225101041

deposits around the year 1962 in the data. He acknowledged this finding by including a dummy time variable that changed all major parameters of his model from that year until the end of the period. In a publication two years later, Modigliani's colleagues Edward Gramlich and Dwight Jaffee criticized his use of this statistical tool. Gramlich, who had designed a separate deposit model for the Fed, explained his refusal to include similar statistical methods from a rather fundamental standpoint:

> To the extent that the switch in interest elasticities really did occur, which question in some fundamental sense we can never answer, the Gramlich–Hulett version has been remiss in not capturing it. But precisely because we can never tell whether the switch really did occur, we cannot make accurate goodness-of-fit comparisons between the two sectors, for it is always possible to introduce constant and slope dummies in periods that would otherwise have large errors and make apparent improvements fit. (Gramlich and Jaffee 1972b, p. 246)

With this statement, Gramlich and Jaffee set specific standards for the use of statistical tools like dummy variables. To them, the mere improvement of results in empirical tests was not a sufficient justification, and neither was Modigliani's explanation that the introduction of Certificates of Deposits (CDs) by large commercial banks in the early 1960s had caused a shift in investor behavior. From their point of view, Modigliani's argumentation was speculative because it lacked a theoretical foundation. If interest elasticities did change over time, but there was no sound mechanism to predict these changes, superior results in tests against historical data did not guarantee superior results in actual forecasts. Hence, the goodness-of-fit comparison based on historical data was no proof of the superiority of Modigliani's model in general. Instead, Modigliani's model was *messier* (see Backhouse and Cherrier 2019) in the sense that it contained built-in subjective judgments on the effect of historical events. Whether this choice improved or affected the forecast performance of his model depended on the endurance of this effect.

A few years later, in a different historical context, Charles Gibson was leading a team of economists at the Philadelphia Saving Fund Society (PSFS), the oldest and largest savings bank in the United States.[1] Here, he developed and administered the bank's econometric deposit forecast model. In 1981, he explained the rationale behind the use of macroeconomic modeling in retail banking: "The old, stable world of banking is gone, and with it the once-comfortable world of bank decision-making. In its place, we have exploding bank technology, regulatory uncertainty and economic instability. New problems demand new tools" (Gibson 1981, p. 39).

Until the 1970s, deposit forecasts of retail banks in the United States were not unlike weather proverbs and usually confined to predictions of seasonal variations. Yet by 1979, most large commercial banks in the US had introduced some kind of formal economic forecasting technique (Giroux 1979). The PSFS introduced their first full-scale model in 1978. This raises the question of what made econometric models superior to the old forecast techniques.

[1] Charles W. Gibson joined the PSFS in 1971 and worked on its econometric models until its liquidation in 1992. He started in the comptroller's department and later led the newly founded economics department. In 1988, he was transferred to the treasury department. He acquired the title of assistant vice-president in 1975 and that of vice-president in 1980. Sadly, his educational background is unknown.

These two seemingly independent instances are connected by the overarching question of how to make economic forecasts of financial flows in the presence of fundamental institutional change. Both instances point to the increasing volatility and unpredictability of deposit flows in the US. Most scholars dealing with the postwar history of the American banking industry agree that in the mid-1960s, a period of rapid transformation and volatility began, which lasted at least until the early 1990s (Walker 2017; Hendrickson 2011; Mason 2004; Berger et al. 1995). During this period, the American banking industry changed almost beyond recognition. Most scholars conceptualize this change as the transformation of a bank monopsony into a competitive market (Berger et al. 1995; Nocera 1994).

This article aims at bringing together the above two instances in a historical analysis. First, I explore how the fundamental change in the US banking industry provoked changes in the macroeconomic models that simulated the market for savings deposits. These changes produced a learning curve inside the economics departments of the Fed as well as those at retail banks. Both had to adjust their expectations of deposit flows to their changing experience. Second, I describe how the same changes in the market affected the utility of these models for their users. Naturally, retail banks had a different interest from the Fed's in the econometric modeling of deposit flows. It is not the aim of this article to assess the accuracy of the models. Instead, I look at the contemporary assessment and critique of the quality of the forecast as a possible source for change.

To achieve the aim of this article, I analyze econometric models in their historical appearance. The repeated revisions of the models make them an excellent historical source for tracking the learning process of banks with regard to changes in the determinants of deposit flows. First, I introduce two models of the deposit market that were integrated into the 1970 version of the FMP model of the Federal Reserve Board. In a second step, I turn to the econometric forecasting methods of retail banks. In this context, I present the deposit-forecasting model of the PSFS. This case study explains the changes to the PSFS model in the historical context of a large savings bank struggling to survive a period of extreme uncertainty. Moreover, PSFS is used as a case study to explore the changing utility of macroeconomic forecast models for retail bank managers. Finally, I look at the 1985 version of the FMP model to find out if the changes made since the 1970 version reflect the experiences that are contained in the various versions of the PSFS model.

To the best of my knowledge, this article is the first to examine the history of an econometric model of a private enterprise in such depth. The pioneering work on the relations between business and econometric analysis by Thomas Stapleford (2017) does not cover the postwar period. The article of Pedro Duarte and Francesco Sergi (2023) on the practices of economic forecasting at Data Resources Inc. (DRI) is not interested in the specifications of DRI's or their clients' models. By integrating the business perspective with the academic and government perspectives, the article gives new insights into one of the most discussed issues in the history of macroeconomic modeling: the trade-off between empirical accuracy and theoretical stringency. This issue was first raised by Mary Morgan (Morgan and Butter 2000; Morgan and Morrison 1999) and discussed more broadly in the recent literature (see Boumans and Duarte 2019). Like this literature, the article profits from earlier work of former practitioners or employees of central banks (Webb 1999; Brayton et al. 1997; Bodkin et al. 1991).

II. SAVINGS DEPOSITS IN THE FMP MODEL IN 1970

In the 1960s, several institutions throughout the United States developed large-scale macroeconometric models aimed at simulating the entire US economy. Contrary to the take of standard histories of macroeconomics, these first large macroeconomic models had a strong focus on the role of banks in the economy (Acosta and Rubin 2019, pp. 471ff; Rancan 2019, pp. 454–456). The financial sector of the two most important models, the Brookings model and the FMP, was based on Frank de Leeuw's earlier work on models of the financial sector. De Leeuw later continued his work at the Fed's Division of Research and Statistics (DRS) and cooperated with Edward Gramlich, Franco Modigliani (MIT), and Albert Ando (University of Pennsylvania) in creating the FMP model (Acosta and Cherrier 2021).

Savings deposits entered the FMP model rather late in the development process. They were introduced in 1969 as a restraint on housing starts. This is due to the fact that, at the time, houses were financed primarily by savings institutions, such as savings and loan associations and mutual savings banks. In the model, savings deposits represented the main proxy for credit rationing, because the relative availability of savings deposits determined the availability of mortgages (Acosta and Rubin 2019, pp. 486ff). The integration of savings deposits into the model was complicated by the fact that two separate groups had worked on this task. On the one hand, Edward Gramlich and David Hulett (1972) created a comprehensive model of supply and demand for savings deposits.[2] On the other hand, Franco Modigliani (1972) had worked on another deposit demand model with Myron Slovin (1972), using his findings to create a model that could predict deposit rate settings.[3] The following portrayal of both models is based on a publication of Edward Gramlich and Dwight Jaffee (1972a).[4] Both models differentiated between the supply side and the demand side of savings deposits.

The supply side of the deposit market was represented by Gramlich–Hulett and Myron Slovin in an almost identical way. The central question was how banks set deposit interest rates. In both models, the setting of the own rate mainly depended on a generic competitive rate that was composed of the weighted average of the yields of competing assets. The empirical tests confirmed the significance of the competitive rate as a determinant of all deposit rates in both models.

The quantity of savings deposits was determined by household demand. Both models were informed by portfolio selection theory as proposed by Harry Markowitz and James Tobin in the 1950s (Markowitz 1952; Tobin 1956, 1958). Thus, at the heart of both models is the premise that the demand for any asset is determined by its elasticity to rate differentials between its own rate and that of competing assets. A rise in the return of the respective asset should increase demand, if the return of all other assets does not rise. The coefficients that represent the rate of substitution between assets were determined empirically based on quarterly data from the US from 1954 to 1969.

[2] David T. Hulett received his PhD from Stanford University in 1966. He worked for the Fed from 1967 to 1970 and then switched to the Office of Management and Budget.

[3] At the time, Slovin was a staff member of the Fed while also working on his dissertation. He received his PhD from Princeton in 1972. See Gramlich and Jaffee (1972a, p. 310).

[4] This publication provides the only detailed description of that part of the FMP model that deals with the market for savings deposits.

The main dependent variables of the model constituted the deposit market: passbook savings deposits at commercial banks, savings and loan shares (passbooks), and mutual savings bank deposits.[5] For all other assets, both models used proxies. The opportunity costs of short-term assets were approximated by the three-month Treasury bill rate (T-bill rate). The corporate bond rate represented long-term assets. The expected rate of inflation entered the equation as a measurement for the opportunity cost of holding financial versus real assets during inflationary periods.

While both models were based on the portfolio selection approach, they came to significantly different results regarding the interest elasticity of household demand. Gramlich and Hulett found that rates of competing assets had no significant influence on the demand for deposits. Instead, non-rate variables like disposable income or capital gains were more accurate in predicting deposit flows. The authors suspected the existing regulation of interest rates—known as *Regulation Q*—to be responsible for this lack of elasticity because it made all deposit rates almost perfectly collinear (Gramlich and Hulett 1972, p. 25).

In contrast, Modigliani found a significant elasticity among competing interest rates, at least in the long run. These conflictive findings resulted from the specific way Modigliani integrated household expectations into his model. According to portfolio selection theory, investors decided upon expected, not current, returns. Thus, both teams had to integrate expectations into their models. The Gramlich–Hulett model used a simple lag structure for all interest rates that distributes the impact of a change in one interest rate on all expected rates evenly over six quarters (Gramlich and Hulett 1972, pp. 19–23). Modigliani, however, assumed that the response of households to changes in interest rates was much slower than six quarters. He assumed the existence of a *learning-expectational lag* that had two sources. First, households show significant inertia in habits and thus do not change their investment patterns over longer periods, even though price changes would suggest a rebalancing to be efficient. Second, households hold interest rate expectations that are informed not just by the current rate of return but also by past rates (Modigliani 1972, pp. 64–66). The learning-expectational lag significantly delayed the adjustment of household portfolios. Modigliani estimated that it could take an investor many years to adjust the share of savings deposits to the optimum ratio (Modigliani 1972, pp. 80ff).

Additionally, Modigliani assumed that the learning-expectational lag had significantly shortened during the period under consideration. He identified the introduction of Certificates of Deposits by commercial banks in 1962 as the defining watershed moment. From that year, bank customers appeared much more responsive to price differentials among the distinct banking groups and were more ready to adjust their portfolio. This assumption had profound consequences for his model. While Gramlich and Hulett treated the entire postwar period in one block, Modigliani set a clear break in 1962 by including a time dummy variable that changed all major parameters of his model. The increased interbank competition also increased the responsiveness of deposits at savings institutions to changes in the money market rate. Before 1962, deposits at savings institutions were oriented only towards the capital market. From 1962, the money market

[5] The 1970 versions of both models also included insurance reserves as a fourth kind of deposit. However, they will not be discussed here as they are not relevant for my analysis. Later versions of the FMP model do not include insurance reserves any more.

became a bit more influential to deposit flows at savings institutions (Modigliani 1972, pp. 73–75).

In the last chapter of their book, Gramlich and Jaffee compared the two models by looking at their performance during simulation tests. Here, the combined Modigliani–Slovin model proved to be superior in almost all aspects mainly because of the functional periodization (Gramlich and Jaffee 1972b, pp. 245ff). This fact led to Gramlich and Jaffee's criticism of Modigliani as illustrated in the introduction to this article. The Gramlich–Hulett model opted for stringency, while Modigliani chose empirical accuracy. At first sight, this finding seems contrary to that of Juan Acosta and Goulven Rubin (2019, pp. 478ff) and Roger Backhouse and Beatrice Cherrier (2019, pp. 434–436), who found Modigliani repeatedly pleading for theoretical stringency or transparency vis-à-vis his more pragmatic colleagues from the Fed team during the creation of the model. Here, however, the dispute was not about theoretical issues but about the question of how to deal with fundamental institutional change. In this sense, Modigliani allowed his model to be *messier* than that of his colleagues. As the next section will show, this pragmatic strategy was also preferred by a fast-growing group of macroeconometric model users: retail banks.

III. THE DEPOSIT FORECAST MODEL OF THE PHILADELPHIA SAVINGS FUND SOCIETY

The increasing dynamic of the deposit market troubled not only the creators of sophisticated macroeconomic models at the Fed but also the fast-growing group of economists working in the retail banking industry. In the early 1970s, large retail banks began to introduce econometric models for forecasting purposes. By the end of the decade, the practice had become widespread at least for large and medium-sized banks. In 1979, a dissertation by Gary Giroux presented the results of a nationwide survey on forecasting techniques of commercial banks (Giroux 1979). Giroux differentiated between *sophisticated* and *non-sophisticated* forecasting methods. Multiple regressions, econometric models, and input-output analysis were among the *sophisticated* methods, while techniques such as expert panels, exponential smoothing of time series, and individual judgment were considered *non-sophisticated* (Giroux 1979, p. 61).

Among larger banks (more than $500 million worth of deposits), sophisticated techniques were quite common. About two-thirds used at least one of them for forecasting purposes. However, the vast majority of small and medium-sized commercial banks still relied solely on individual judgment as the only forecasting method. Thus, econometric methods had entered the retail banking sector by 1979, but they had not rooted deep. Regarding deposit forecasting, more than 20% of large banks used regression analysis and almost 20% full-scale econometric models to forecast time deposits.

Giroux explained the common utilization of these techniques in this area with the potentially strong correlation of deposits with specific economic variables such as personal income (Giroux 1979, pp. 78ff). Correspondingly, the rising demand for sophisticated forecast techniques among the banking industry was driven by the macroeconomic volatility, especially the strong fluctuations of interest rates. This is why the main users of model-based forecasting were departments for strategic planning and asset-liability management.[6] However, the rise in the application of econometric models among financial institutions was also due to the emergence of a professional model-based forecasting industry in the 1970s. In 1981, the *American Banking Journal* published a buyer's guide to financial modeling that included twenty-three service providers, three of which supported full-scale macroeconomic models. The largest one—Data Resources Inc. or DRI—had more than 100 customers in the financial industry.[7] These service providers offered tailor-made solutions for banks from access to their macroeconomic models and large databases to aid in building the banks' own models and provision of computer capacity via time-sharing agreements.[8] Thus, banks were able to use econometric models without employing an expensive staff of economists and data analysts themselves.

In order to understand the dynamic relationship between model predictions, experience, and model modification, I now turn to the case of the Philadelphia Savings Fund Society, the oldest and largest savings bank in the US. Some general information about forecasting at PSFS has been published by Charles Gibson (1981), who was in charge of the Deposit Forecast Model that the bank started to develop in late 1976. It was part of a larger effort to use econometric models for forecasting money flows at PSFS. In 1977, the first version of the deposit model was ready for testing (Gibson 1981, p. 41). In April 1978, the financial planning unit that was responsible for the development of the model made an effort to explain to a largely ignorant board the nature of econometric forecasting: "A model is not a crystal ball, but rather a tool, which can order and analyze experience, and simulate a range of future occurrences. … This model enables PSFS to look to the future with more assurance than has formerly been possible."[9]

The prime cause for the introduction of the deposit forecast model at PSFS was to optimize its liquidity management system.[10] Initially, PSFS used a rule-of-thumb approach to liquidity provision. The deposit forecast model was introduced to help develop a more efficient liquidity strategy.[11] The other main purpose of the model was to provide long-term forecasts for strategic planning. In 1977, PSFS had begun its first comprehensive strategic planning effort, which resulted in its first business plan in 1978. Here, the deposit model contributed forecasts for the three following years.[12] In short, the PSFS used the model for similar purposes as most commercial banks (see above).

During the time of its existence, the PSFS deposit model was repeatedly adjusted and extended with one major revision occurring in 1980. The full-grown PSFS deposit forecast model in its 1980 version featured forty-nine equations with sixty dependent and eighty independent variables.[13] While PSFS had neither the means nor the ambition

[6] *American Banking Journal* (September 1981): 88–101; *American Banking Journal* (July 1984): 92–104.
[7] DRI was founded by Harvard economist Otto Eckstein in 1969 and expanded fast throughout the 1970s. See Duarte and Sergi (2023) for more details.
[8] *American Banking Journal* (September 1981): 88–101.
[9] PSFS Deposit and Cash Flow Model, Agenda of Board Meeting of April 14, 1978, in Hagley Museum and Library (Accession 2062: Philadelphia Saving Fund Society Archive) [henceforth Hagley 2062], Record Group I, Subgroup 2, Series B [henceforth RG I/2-B], Box 13.
[10] Report of the Liquidity Task Force, June 14, 1980, p. 14, in Hagley 2062, RG XX/3, Box 137.
[11] Report of the Liquidity Task Force, June 14, 1980, pp. 16ff, in Hagley 2062, RG XX/3, Box 137.
[12] PSFS Business Plan 1979–1981, in Hagley 2062, RG V/2-B, Box 68.
[13] PSFS Deposit Forecast Model—1980 Version, Attachment to the Report of the Liquidity Task Force of the PSFS as of July 14, 1980, in Hagley 2062, RG XX/3, Box 137.

to employ their own macroeconomic model, their deposit model in many ways resembled the FMP deposit models. Both used overwhelmingly macroeconomic indicators to forecast deposit flows. However, there were two important differences. First, while the FMP models predicted deposit flows on a macroeconomic scale, the PSFS model forecasted deposit flows at the firm level. Second, the PSFS model lacked any measurement that implemented the impact of expectations on deposit demand. Instead, the model featured a large number of dummy variables for seasonal or one-time variations of deposit flows.

The construction and maintenance of a stand-alone macroeconometric deposit model was possible only because PSFS bought data, computing power, and expertise from an external client. From the beginning in 1976, Gibson and his team closely cooperated with DRI. DRI personnel advised Gibson during the process of building and revising the model, and provided the computer power via a time-sharing arrangement as well as the macroeconomic data used in the PSFS model. The package included historical data but, even more important, also forecasts for most external independent variables in the PSFS model. DRI derived these forecasts by using their own macroeconometric model, one of the most sophisticated models of the period.[14] While the DRI model differed from the FMP model in some areas, the financial sectors of both models including the deposit models were similar (Duarte and Sergi 2023, p. 736). To their clients, DRI offered specific scenarios like a recession scenario or an inflation scenario. Thus, the macroeconomic variables used in the PSFS model were not forecast independently from each other but instead came as an interdependent set. PSFS itself provided only the historical data of their own deposit flows and interest rates as well as those of their regional competitors.

The PSFS deposit model consisted of two main sectors: a small and simple model for the flow of passbook deposits at PSFS and a much more complex model for the market for savings certificates. As for the latter sector, it is impossible to describe its features before the 1980s revision in any meaningful way due to a lack of sources.[15] Thus, I largely focus the analysis on the first sector, while pointing to a few important features of the second sector.

Concerning passbook accounts, the initial version of the PSFS model used only four independent variables to predict flows: the differential between the ninety-day T-bill rate and the PSFS passbook rate, the level of personal income in Pennsylvania, the unemployment rate in Pennsylvania, and the differential between the PSFS passbook rate and the rates at competing commercial banks.[16] The use of rate differentials to explain deposit flows is in line with the general assumption of the FMP model. While income and rates of competing banking groups are important features in both models, the T-bill rate had not been an important predictor of mutual savings deposits under the original FMP model. The unemployment rate did not occur at all. Under the PSFS model, however, these two new variables were key to explaining savings deposit flows at PSFS.

[14] "Model for Success. PSFS and Economic Models," *On-Line Extra* 2, 4 (August/September 1983): 2, in Hagley 2062, RG V/1-C, Box 65.

[15] We know of its existence prior to 1980 because of the specific goals set in 1980 to improve it. Minutes of the January 18, 1980, meeting, Corporate Planning Committee 1979–1980, in Hagley 2062, RG I/2-B, Box 29.

[16] See PSFS Business Plan 1979–1981, p. 6, in Hagley 2062, RG V/2-B, Box 68.

The strong negative relationship between the T-bill rate and PSFS passbook flows is compatible with portfolio theory and draws directly on the experience of *disintermediation.* This term was coined to describe the phenomenon of strong outflows of deposits into the money and capital markets that first occurred in 1966 (Woelfel 1994, p. 306). The flows were caused by large interest spreads between money market and deposit rates. These large spreads were the result of the fight against inflation in the presence of mandatory interest rate ceilings on deposits (Walker 2017; Mason 2004; Gilbert and Lovati 1979; Erdevig 1978). The original FMP model in 1970 did not account for this phenomenon, since it happened too recently to have a major influence over the entire data period. The authors of the model only hinted at the effects of disintermediation in their articles (Gramlich and Huett 1972, p. 34; Slovin 1972, pp. 122ff). In the PSFS model, the effect of disintermediation is represented by the linear negative relationship between the ninety-day T-bill rate and deposit flows.

While disintermediation was a well-known reality by the mid-'70s, the positive relationship between the unemployment rate and deposit flows was a new insight to the economists at PSFS. In 1978, the financial planning unit felt the need to explain to the board why unemployment correlated positively with deposit flows. The underlying link was understood to be the increased uncertainty among households during times of recession that prompted those still employed to increase their liquid assets. This effect overcompensated the withdrawal of savings deposits by the newly unemployed.[17] In an interview for an employee newsletter in 1983, Gibson later claimed that he personally found the positive correlation between deposits and the unemployment rate while working on the PSFS model: "You wouldn't think that a rising unemployment rate is good for anybody. Actually, it's fairly good for savings banks. … We found that out when we were building our first deposit model seven years ago."[18]

It is not clear if Gibson and his team were the first to integrate the unemployment rate into a deposit model. The 1970 version of the FMP model did not feature this variable. This is not surprising, since unemployment had been low throughout the entire postwar period and did not seem to have an effect on portfolio selection. At least the creators of the FMP model did not find evidence for it to be significant. Only in 1974 did the unemployment rate rise above 7% for the first time since the war.[19] The notion that unemployment explained a good part of the flows of savings deposits at PSFS hints at the fact that rising unemployment changed the income-risk perception of households and therefore increased demand for liquid assets such as savings deposits. The 1980s editions of the DRI macroeconomic model put a strong emphasis on the unemployment rate, when determining the level of consumption and hence saving (Eckstein 1983, pp. 95ff). It is not clear, however, if the unemployment rate was directly linked to savings flows in the model. Since PSFS and DRI closely cooperated in the creation of the bank's model, it is at least possible that the work on the PSFS deposit model contributed to the discovery of the unemployment rate as an important predictor of savings flows.

[17] PSFS Business Plan 1979–1981, p. 6, in Hagley 2062, RG V/2-B, Box 68.

[18] "Model for Success. PSFS and Economic Models," *On-Line Extra* 2, 4 (August–September 1983): 2, in Hagley 2062, RG V/1-C, Box 65.

[19] US Bureau of Labor Statistics online Database, Series LNS14000000, Online-Resource, URL: https://data.bls.gov/pdq/SurveyOutputServlet.

In sum, PSFS's initial model integrated two relatively recent findings concerning the main influences on deposit flows: the experience of disintermediation and the return of income uncertainty that followed the recession of 1974–75.

The Impact of the Money Market Certificate and the Revision of the PSFS Model, 1978–80

From 1978, short-term interest rates in the US started to rise substantially. This was mainly a consequence of renewed attempts of the Federal Reserve to fight a persistently high inflation rate. The Fed Fund Rate reached 20% in early 1980 and remained in double digits for several years, with money markets closely following its lead (Goodfriend and King 2005; Clarida et al. 1999). The large spreads between the money markets and the still regulated interest rates on bank deposits led to a widespread fear of a recurrence of disintermediation (Godfrey 1978).

This fear is key for understanding the rationale behind the nationwide introduction of the money market certificate (MMC) in June 1978 (Gilbert and Lovati 1979, pp. 10ff). The MMC was a savings certificate with a six-month maturity and a fixed interest rate that was tied to the interest rate of six-month Treasury bills. Thus, the rate on MMCs—while still regulated—was competitive against money market investments.

By January 1980, the MMC had fundamentally disrupted the flow of deposits in the US. Banks and savings institutions desperately searched for ways to adjust their forecasting techniques to this new reality, strongly increasing the demand for and use of models. In a 1980 survey, 15% of Savings & Loan associations stated that they planned to use models for financial planning in 1981, up from only 5% that planned to use them in 1979.[20] At the PSFS, the leadership dedicated $5,000 for a major revision of the model to include the impact of the MMC on deposit flows.[21] Charles Gibson stressed the MMC's importance amid the introduction of the revised model: "The influence of the Money Market Certificate (MMC) cannot be overstated."[22] In the original version of the model, internal transfers from passbooks to certificates were set as a constant factor of savings flows. In the 1980 revision, there were two separate equations for the flow of savings deposits. First, there was the equation for gross passbook flows without transfers to savings certificates. Second, there was the equation for these transfers. The combination of both equations resulted in the net flow among passbook accounts. The two equations featured different explanatory variables.

The equation for gross passbook flows had become more sophisticated compared to the initial model. The spread between the ninety-day T-bill rate and the passbook rate as well as the unemployment rate remained the main variables. Additionally, inflation entered the equation via a variable for gasoline prices. Contrary to the 1970 FMP model, this inflation proxy was *positively* correlated to passbook flows. Similar to the unemployment variable, the creators of the model explained this positive correlation between

[20] The 1980 Savings and Loan Market Study. "The Savings and Loan Marketing Guide," published by *Savings & Loan News* (May 1980): 27–30.
[21] Minutes of the January 18, 1980, meeting, Corporate Planning Committee 1979–1980, in Hagley 2062, RG I/2-B, Box 29.
[22] PSFS Deposit Forecast Model—1980 Version, Attachment to the Report of the Liquidity Task Force of the PSFS as of July 14, 1980, in Hagley 2062, RG XX/3, Box 137.

inflation and savings deposit flows as an *uncertainty response* that manifested itself in a rise in customer liquidity demand.[23]

The new equation that measured transfers from passbook accounts to certificates contained only three regular variables. The main variable was the interest rate differential between the maximum rate on certificates and the passbook rate. The second variable was the expected rate of inflation. The third variable represented the volume of transfers in the preceding quarter. All of them are positively correlated with transfers from passbooks to certificates and therefore reduced net passbook savings. The choice of the inflation expectations variable is interesting, if one considers both equations simultaneously. Increasing price levels increase passbook savings, while rising inflation expectations increase transfers from passbooks to certificates, thereby reducing passbook deposits. Thus, gross deposits (passbooks and certificates) always rise with inflation, while passbook savings rise only amid stagnant or falling inflation expectations. In addition to these three main variables, several dummy variables accounted for specific events during the 1970s. The most important dummy variable captured the introduction of the MMC.

The model proved its forecast abilities in the 1981 to 1983 PSFS business plan—the first plan that used the revised model. It predicted the ratio of money market certificates to all deposits to rise from 46% in 1980 to between 66% and 72% in 1983. These estimates were almost perfectly accurate, since the actual ratio was 70% in 1983. Thus, the revised model did a good job in predicting the pace of transfers from passbooks to MMCs. The economists at PSFS were even more optimistic about their model's utility in the future of money market and deregulated deposits:

> Liquidity policy has, for some years, viewed as its primary objective provision for disintermediation. This focus must now change in light of the market rate certificates which we already offer and in view of the removal of all ceilings within six years. … It is evident that, in the coming world of no rate ceilings, a liquidity policy based on disintermediation would be in error. Econometric forecasting will be able to assess the potential consequences of any particular rate structure before it is implemented by management. This ability suggests that a doomsday approach to liquidity will no longer be necessary.[24]

However, it was precisely the ability to assess the consequences of potential rate decisions where the model fell short. This became clear in 1983 after the introduction of the first truly deregulated savings account.

Deregulation and the Failure of the PSFS Deposit Forecast Model in the Early 1980s

In 1984, Charles Gibson and other executives at PSFS were asked to analyze the reasons for the sustained negative deposit flows that started in 1979. The numbers are staggering. From 1979 to 1983, PSFS lost $1.8 billion in retail deposits from a deposit base of $5.2

[23] PSFS Deposit Forecast Model—1980 Version, Attachment to the Report of the Liquidity Task Force of the PSFS as of July 14, 1980, in Hagley 2062, RG XX/3, Box 137.
[24] Report of the Liquidity Task Force of the PSFS as of July 14, 1980, pp.17ff, in Hagley 2062, RG XX/3, Box 137.

https://doi.org/10.1017/S1053837225101041 Published online by Cambridge University Press

billion in 1979, if interest payments and mergers are subtracted.[25] Neither the long-term forecasts in the business plans nor the yearly budget forecasts had predicted these large outflows. This failure did not come as a complete surprise, though. Already in October 1982, Charles Gibson had warned the PSFS management that something fundamental had changed in the market for savings deposits that made deposit forecasts almost impossible:

> Added to the uncertainty as to the course of the economy is the growing suspicion that a fundamental change has occurred in the linkage between the economy and the thrifts. … The implications of the break of this link are profound. We can no longer count on automatic reintermediation when rates fall. When, and if, we become competitive once again we will become just another player in the financial services market. … The deposit outlook, then, contemplates more of the same—outflows, wide swings between products and nearly complete unpredictability.[26]

From Gibson's perspective, this unpredictability originated from the introduction of price competition in the US deposit market amid the deregulation of the financial service industry in the early 1980s. From its beginning, the PSFS deposit forecast model had struggled to cope with forecasting deposits in an unregulated market. On the rare occasions of free competition during the 1970s, only the extensive use of dummy variables prevented the model from failing. During the 1980 revision of the model, Gibson's team ran into a more fundamental problem. One aim of the revision had been to find a way to calculate premature redemptions of PSFS's savings certificates. This task required an understanding of consumer behavior that went beyond measuring correlations between deposit flows and macroeconomic indicators. In the end, Gibson's team failed to find a satisfying solution and consequently the variable had to be set externally. The same problem existed with the measurement of rollover and reinvestment ratios of certificates.[27] Thus, in order to forecast sales of certificates, PSFS executives partly had to fall back to rule-of-thumb estimates—in the most important part of the contemporary savings deposit market!

The problems of the model to replicate the effect of competition became paramount when a new competitor entered the retail deposit market. Money market mutual funds (MMMFs) grew at a phenomenal pace from a $10 billion investment volume at the beginning of 1978 to more than $200 billion in 1982.[28] During the same time, deposits at savings institutions largely stagnated, implying that most of the growth in savings assets had gone to MMMFs. At PSFS, the MMMFs were found mainly responsible for the mismatch between forecasted and realized deposits and the stagnation of deposit flows in the early 1980s.[29] Partly in response to this new competition, federal regulatory authorities introduced the money market deposit account (MMDA) in November

[25] Deposit Flow Analysis, April 1984, p. 7, Policy Committee: Minutes 1980–May 1984, in Hagley 2062, RG I/2-B, Box 29.
[26] Deposit Trends, Third Quarter 1982, October 26, 1982, pp. 2–4, Policy Committee: Minutes 1980–May 1984, in Hagley 2062, RG I/2-B, Box 29.
[27] PSFS Deposit Forecast Model—1980 Version, Attachment to the Report of the Liquidity Task Force of the PSFS as of July 14, 1980, in Hagley 2062, RG XX/3, Box 137.
[28] *Mutual Fund Fact Book* 1983, ed. by the Investment Company Institute (ICI), Washington 1983, p. 17.
[29] 1981 Deposit Forecast 7/1 Review, July 21, 1981, Policy Committee: Minutes 1980–May 1984, Hagley 2062, RG I/2-B, Box 29.

https://doi.org/10.1017/S1053837225101041 Published online by Cambridge University Press

1982. The MMDA was expected by virtually the entire banking industry to be a real game changer.[30] It was the first fully deregulated savings account in the US. For the first time, banks were able to set the interest rate at their discretion.

Gibson and his team were assigned the task to determine the expected financial implications of introducing the MMDA.[31] In December 1982, Gibson advised the PSFS board against an aggressive pricing strategy. He came to this conclusion after evaluating the results from simulations carried out with the help of the deposit forecast model. The model predicted that 80% of new MMDAs deposits would come from existing PSFS passbooks or certificates. These transfers would generate additional costs that were estimated as being so high that they would overcompensate any profit from investing additional funds. According to the deposit forecast model, the bank would lose money on the MMDA during the first three years after its introduction in any scenario.[32] By arguing against an aggressive pricing strategy, Gibson expected to minimize the unavoidable losses.

Gibson's advice turned out to be wrong. In contrast to PSFS, commercial banks in Pennsylvania committed to an aggressive pricing strategy regarding the MMDA that significantly outbid the PSFS as well as most MMMFs.[33] By this means, they could evade the pessimistic scenario of increasing the costs of existing deposits. Instead, they were able to win back significant amounts of deposits from MMMFs. In an internal report in early 1984, PSFS officials documented that several of their competitors saw their savings deposits increase by up to 200% between June 1982 and March 1983. Afterwards, the inflows into the MMDA among the entire US banking industry came to a halt, as banks could not sustain their aggressive pricing strategy.[34] However, the newly acquired funds did not flow back to the MMMFs, which means that the gains in MMDA deposits during the first months after its introduction were permanent. Since PSFS did not offer competitive rates on the MMDA during this period, it missed out on the opportunity to win back money from the money funds. PSFS's disappointing performance regarding MMDAs was an important factor in the bank's failure to attract new deposits. The lack of inflows of new money was in turn mainly responsible for the large deposit losses in the early 1980s.[35]

In hindsight, Gibson's main mistake was the assumption that the bulk of funds of the MMDA would come from internal transfers. In part, the source for this mistake can be traced back to the 1980 revision of the deposit forecast model. The revision had eliminated the only variable that measured the impact of interbank price competition.

[30] "Banks Prepare for New Market Rate Deposit Account," *American Banking Journal* (November 1982): 35–39; "The Money Market Fight: Associations Put on New Gloves," *Savings & Loan News* (December 1982): 38–43.

[31] Minutes of the Products & Projects Committee, November 24, 1982, in Hagley 2062, RG V/1-C/i, Box 69.

[32] Financial Review of Money Market Investment Accounts (MMIA), Memorandum to the Chairman of Products & Projects Committee by J. P. Nugent, December 21, 1982, Exhibit I-III, in Hagley 2062, RG V/1-C/i, Box 69.

[33] 1983 PSFS Communications and Marketing Plan, February 1983–4, in Hagley 2062, RG V/1-B/ii, Box 68.

[34] Deposit Flow Analysis, April 1984, p. 7, Policy Committee: Minutes 1980–May 1984, in Hagley 2062, RG I/2-B, Box 29.

[35] 1984 Small Savers Rollover Plan, November 14, 1983, in Policy Committee: Minutes 1980–May 1984, in Hagley 2062, RG I/2-B, Box 29.

https://doi.org/10.1017/S1053837225101041 Published online by Cambridge University Press

Thus, it simply did not measure the impact of very high rates of competing banks. Would there have been a different outcome if the interbank competition variable had not been eliminated? This scenario is unlikely, because it would have required Gibson to make assumptions that he saw as highly unrealistic. Even from hindsight, Gibson claimed that the MMDA "was introduced at very high and unrealistic rates" by PSFS competitors.[36] Thus, it was the inability to anticipate the behavior of PSFS's competitors that was at the heart of the failure in the MMDA market. Here, the deposit forecast model was of little use.

After 1983, the influence of econometric modeling on strategic planning inside PSFS faded. While there are hints that deposit forecasting continued in the annual budgeting process, the PSFS long-term business plans from 1985 onward did not include bank-specific deposit forecasts anymore.[37] Instead, the PSFS relied directly on DRI's nation-wide deposit forecasts and set their deposit goals accordingly.[38] There are several possible reasons for this change. There was a major change in management of the bank that coincided precisely with the mentioned change in the long-term planning strategy.[39] Technological improvements—especially the introduction of the personal computer—led to major changes in the forecasting industry.[40] The availability of cheaper and less sophisticated forecasting technologies caused an existential crisis of DRI in the mid-1980s. While PSFS still used DRI data in their strategic planning after 1985, it remains unclear if they still used time-sharing.

However, the declining influence of the PSFS deposit model might also have been due to its declining utility to the bank. The specific utility of the model derived from its ability to forecast with great precision the deposit flows among one single bank as opposed to predicting deposit flows for a state or even the entire US. The PSFS model had excelled in predicting the behavior of PSFS customers when this behavior mainly depended on macroeconomic factors like unemployment figures or the general interest level. The increasing problems in predicting PSFS deposit flows under competition might have reached a breaking point with the MMDA introduction, after which the specific advantage of the PSFS model over the main alternative—the acquisition of macro-level deposit forecasts—had vanished.

The further fate of the PSFS econometric model remains unclear. The financial planning department was restructured several times. Charles Gibson survived all these changes without ever being promoted. He remained at PSFS until its bankruptcy in 1992.[41]

IV. THE 1985 VERSION OF THE FMP MODEL

The fundamental change in the market for savings deposits also led to significant changes in the FMP model used by the Federal Reserve Board. The first published version of the model after its original introduction is from 1985. The decline of the

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[36] Deposit Flow Analysis, April 1984, p. 7, Policy Committee: Minutes 1980–May 1984, in Hagley 2062, RG I/2-B, Box 29.
[37] 1987–1991 PSFS Business Plan, July 1986, in Hagley 2062, RG V/2-B/i, Box 68.
[38] 1986–1990 PSFS Business Plan, April 1985, 29c, p. 38, in Hagley 2062, RG V/2-B/i, Box 68.
[39] "On the Record," *Online-Extra* 4, 1 (April 1985), in Hagley 2062, RG V/1-C, Box 65.
[40] *American Banking Journal* (July 1984): 92–104.
[41] PSFS/Meritor Employee/Office Directories, in Hagley 2062, RG VI/1, Box 70.

https://doi.org/10.1017/S1053837225101041 Published online by Cambridge University Press

passbook is reflected in the 1985 revised version. It is not easy to find savings deposits in the model. They are part of a variable that encompassed all non-transaction parts of the official money aggregate M2 (e.g., M2 minus M1). Apart from savings deposits, it includes small-time deposits, money market deposit accounts, and money market mutual funds.

The equation for the aggregate shows striking similarities to the PSFS model. First, the ninety-day T-bill rate features prominently in both models. In the FMP model, this rate is used in two rate differentials, one against the passbook rate and one against the maximum rate of either MMMFs or small time deposits. The first differential resembles classical disintermediation. The second difference acknowledges the fact that there were now deposits that yielded rates that were competitive in the money market. Both differentials have a negative impact on the volume of the aggregate. Since the differential between the money market rates and the passbook rate was much higher, the latter differential had a stronger impact than the former (Brayton and Mauskopf 1985, p. 209).

Savings deposits in the traditional sense (passbooks and statement savings accounts) are measured as a ratio of the above-mentioned aggregate (M2 minus M1). The main explanatory variable for savings deposits is the differential between the maximum rate of either small time deposits or MMMFs, on the one hand, and the commercial bank passbook rate, on the other hand. It is negatively correlated. The second important variable is unemployment, which is positively correlated to the ratio of savings deposits to the aggregate, which is similar to the PSFS model. Strikingly, the competition among banking groups has no influence on the overall demand for savings deposits. Thus, the deposit rates that featured so prominently in the original model have lost their influence on determining market share. The passbook rate is a function of the T-bill rate, constrained by the (still-existing) ceiling on passbook rates.

The equations for small time deposits encompass the entire market for savings certificates. They feature a complex set of subequations that determine the highest ceiling rate on time deposits. These equations are important because they encompass the impact of the MMC on the model. The equations are split into two separate equations by a time dummy that changes value in 1978 —the year of the introduction of the MMC. Before that date, the ceiling was measured by a weighted average of the ceilings of the various savings certificates. Afterwards, it depended on the T-bill rate.

In sum, the 1985 version of the FMP model shares many of the features of the 1980 PSFS model. This is true for unemployment as a major explanatory variable but even more for the prominence of money market rates. Like the PSFS model, the FMP model incorporated both a mechanism for classic disintermediation and transfers from savings to time deposits. The newly found dependence of savings deposits on the money market is probably the most striking development in the monetary sector of the FMP model until the 1990s. Simulation runs of the model demonstrated that the M2 minus M1 aggregate showed a significantly higher elasticity to changes in money market rates than M1 (Brayton and Mauskopf 1985, pp. 209ff). At least according to the model, there was no doubt that bank customers had become much more interest rate–sensitive. According to the authors of the model, this revision reflected the disruptive experience of the banking business in the United States in the late 1970s and early 1980s as described above (Brayton et al. 1997). The still-existing long lags in the adjustment equations for deposit rates were not due to demand-side issues but to institutional constraints such as the still-existing ceilings on passbooks. Once these constraints were lifted, the market for deposits would become almost frictionless, according to the model. Conversely, the

https://doi.org/10.1017/S1053837225101041 Published online by Cambridge University Press

FMP model, very much like the 1980 version of the PSFS model, downgraded the importance of interbank competition. The ratio of savings deposits held by either group was meaningless for the model of the deposit market. Differentials between the deposit rates of the respective groups did not matter either. The differentiation of different groups of depository institutions existed only because of reasons outside the deposit market, mainly to determine the market for mortgages.

In sum, the PSFS model was among the most advanced deposit forecast models of its time, incorporating all innovations that are visible in the most sophisticated contemporary macroeconomic models. Whether these innovations stemmed—at least partly—from the bank's own research efforts or if they derived from PSFS's cooperation with DRI is unclear. Both paths of innovation seem plausible. Anyway, the efforts to remain close to the innovative frontier resulted in a deposit model that was very similar to the large macroeconomic models. This may have been the reason why the model developed a blind eye to local competition.

V. CONCLUSION

The turmoil in the market for bank deposits that pervaded the stagflation period in the US is reflected by fundamental changes in the econometric models that simulated this market. I can identify four major changes.

First, savings deposits were redefined as part of the money market. In the original 1970 FMP model, one of the most striking results was the relative independence of savings deposit flows from changes in the rates of competing assets. Instead, deposits seemed to increase steadily with wealth. In the 1985 version of the FMP model, the logic of the deposit market had changed fundamentally. It had become elastic to changes in the money market. The analysis of the PSFS deposit forecast model points to the historical developments that were responsible for this change. The original PSFS model was created as a response to disintermediation—the withdrawal and reinvestment of deposits into the money market. Consequently, the benchmark money market rate played an important role in the model. However, the actual integration of savings deposits into the money market started only with the introduction of the money market certificate in 1978, which caused a fundamental revision of the PSFS model. The emergence of money market mutual funds and the eventual introduction of the money market deposit account in 1983 merely completed the integration of savings deposits and money markets.

Second, during the stagflation period, both the PSFS and the FMP models integrated several variables that hint at the rising importance of precautionary saving. The finding of a positive connection between the unemployment rate and savings flows seems to have surprised the practitioners at the banks. There is not enough evidence to confirm Charles Gibson's claim that he personally discovered this close link. In any case, the unemployment rate entered the PSFS model in 1978 and was part of the 1985 version of the FMP model. Gibson explained this link as an increase in uncertainty that clouded expectations and led to a higher liquidity preference among customers. A similar mechanism was at the heart of the positive connection between gross savings deposits and inflation. The finding of a positive link between the two major economic forces of the stagflation period and savings deposits via household liquidity demand reaffirmed the redefinition of savings deposits as part of the money market.

Third, in the process of adapting to these new macroeconomic conditions, both models eliminated variables that accounted for interbank competition. For the FMP model, this had few consequences, largely because the Federal Reserve Board simultaneously expanded the definition of M2 to incorporate MMMFs. By contrast, the PSFS deposit model struggled with the strong increase of interbank competition for funds in the early 1980s. Due to a lack of sources, it remains unclear if later versions of the model reintegrated this variable. However, it is doubtful that it would have solved the underlying problems. Gibson and his team may have run into similar problems, which they faced while trying to forecast of premature redemptions in the certificate market.

Fourth, coming back to the question raised in the introduction to this article, both the FMP and the PSFS models took Modigliani's path towards the implementation of institutional changes over time. The extensive use of time dummy variables among the PSFS model and the 1980s revision of the FMP model points to the conclusion that both models simply did not work adequately without implementing *history*. In the absence of a coherent theoretical foundation to explain these institutional changes, both models used Modigliani's *speculative* method to assign structural changes to specific historical events. Lacking a consistent theoretical foundation, the PSFS model even mainly depended on historical experience to find the relevant variables. For the FMP model, this approach seems to have worked generally well. Most of the changes featuring in the 1985 version can still be found in later revisions of this model (see Brayton et al. 1997). At PSFS, the *messiness* ensured its good performance in predicting the transition from passbooks to money market certificates.

A fundamental problem with this approach surfaced with the deregulation of the banking industry. Here, economists inside the banking industry could not use historical data to recalibrate their models, since the deregulated deposit market had no *history*. The established macro models like DRI or FMP did not provide any guidance either, because none of the 1980s versions of these models featured equations that simulated interbank competition. It is debatable if a solid theoretical foundation like a version of the portfolio selection theory would have helped economists in the banking industry to overcome the fundamental uncertainty that accompanied the deregulation process. It is possible that some US banks used deposit models that were built on this theory.

In the absence of theoretical, historical, or institutional guidance, the performance of a bank's model ultimately depended on the individual judgments inside the bank. These judgments included the level of reliance on the forecast performance of the respective models. At PSFS, the strong past performance of the deposit model made it harder for bank management to ignore its predictions or their promotion by Charles Gibson. In the end, the overreliance on a model that was ill equipped for predicting deposit flows in a deregulated market caused the bank's failure to attract deposits. Whether better performing banks had better models or whether they were better at ignoring their forecasts is a question that remains for future research to answer.

COMPETING INTERESTS

The author declares no competing interests exist.

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