The Value of Risk: Measuring the Service Output of U.S. Commercial Banks

Susanto Basu, Robert Inklaar and J. Christina Wang

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Abstract:

Rather than charging direct fees, banks often charge implicitly for their services via interest spreads. As a result, much of bank output has to be estimated indirectly. In contrast to current statistical practice, dynamic optimizing models of banks argue that compensation for bearing systematic risk is not part of bank output. We apply these models and find that between 1997 and 2007, in the U.S. National Accounts, on average, bank output is overestimated by 21 percent and GDP is overestimated by 0.3 percent. Moreover, compared with current methods, our new estimates imply more plausible estimates of the share of capital in income and the return on fixed capital.

I. Introduction

Services are an increasingly important part of modern economies, both in terms of size and for their contribution to economic growth. However, the output data for many of these services is notoriously weak, and this is particularly the case for banking.[1] This makes it hard to determine the sources of economic growth and even the size of the economy. A major barrier to progress in this area has been the inadequacy of production models for banks. Wang, Basu, and Fernald (2004, WBF henceforth) propose a general-equilibrium model of interactions between banks, firms, and consumers to remedy this problem.[2] In this paper we estimate the value of output of U.S. banks, following the prescriptions of the WBF model for the period 1997–2007. We find that these new estimates differ considerably from those based on current National Accounts methods: bank output is reduced by 21 percent and GDP is reduced by 0.3 percent. We argue that these new output estimates imply a more plausible capital share in income and internal rate of return on fixed capital than current estimates.

Measuring the value of bank output is challenging, since much of bank service output is not explicitly priced. Instead, the implicit charges for financial services are bundled with interest flows between banks and their customers, chiefly borrowers and depositors. WBF show how implicit service revenue can be unbundled from gross interest flows by applying standard theories of financial intermediation and asset pricing. In particular, the WBF model adopts the established view that the main service provided by banks in making loans is reducing asymmetric information between borrowers and lenders. To that end, banks evaluate the risk characteristics of each loan and monitor the borrower. Instead of receiving an upfront fee for the services, an optimizing bank can charge a higher interest rate than the rate available on a market security with otherwise the same risk attributes.

These models thus make clear the role of risk in inferring banks' income from services. The implicit revenue from screening and monitoring services should equal the spread of the gross loan interest rate over the yield on an equally risky fixed-income security, *not* a risk-free security such as a Treasury bill or bond. This accounting method in essence treats the loan risk premium as part of the borrowing firms' cost of capital and hence as part of households' capital income—their compensation for bearing risk. That is, the risk premium on loans is only a transfer, through banks, of property income from borrowers to savers, and is not part of banks' value added.

A key advantage of this method is that it leads to a uniform treatment of risk premia on all debt instruments, so that nonfinancial firms' output is invariant to their source of debt finance—markets or banks. The risk premium on market debt (for example, corporate bonds) has always been accounted for as part of the producing firms' cost of capital, and hence households' capital income. The risk premium on bank loans should be treated in the same way.

This contrasts with the typical statistical practice in OECD countries. According to current national accounts guidelines, banks' implicit revenue from lending services (per unit of loan balance) equals the spread between the gross loan interest rate and a risk-free rate.[3] This in effect treats loan risk premia as part of banks'—instead of as the borrowing firms'—value added. A producing firm's measured output will thus fall if it switches from market debt to bank loans, or will appear to rise if it starts issuing bonds rather than borrowing from banks.

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[1] See, for example, Griliches (1992, 1994), Triplett and Bosworth (2004), Diewert (2008), and Inklaar, Timmer, and van Ark (2008).
[2] WBF (2004) build on the banking model of Wang (2003) and put it in a general-equilibrium framework.
[3] See SNA (1993, 6.128).

The contrast with the current practice can also be seen from the "user-cost" perspective. This model-implied accounting method is shown to be fully consistent with the "user cost of capital" framework—in fact, it is shown to be an extension of that framework to take explicit account of uncertainty.[4] The yield on the equally risky debt can be regarded as the "user cost of funds," the so-called reference rate. In contrast, typical national accounts currently use a risk-free reference rate.

In this paper, we implement the new model-implied measure of bank output for U.S. commercial banks. To highlight the role of risk, this paper focuses on new estimates of the nominal value of services associated with loans.[5] This is where our risk-based, user-cost approach differs substantially from current practice. We also estimate the nominal output of services to depositors. Not surprisingly, our result coincides with that of the national accounts for the bulk of deposits in the United States, for which deposit insurance makes a risk-free reference rate appropriate.[6]

Our empirical estimates use data for U.S. commercial banks from 1997 to 2007. Implementing the model-implied output measure calls for information on both the actual interest rate on bank loans and the interest rate on market securities with the most comparable risk characteristics. In practice, matching bank loans to market securities is far from perfect. Given the many data limitations, we strive to be conservative with our estimates of the risk premia; this approach should yield a relatively generous estimate of nominal bank output. Despite this conservative approach, we show that imputed bank output is overstated by 45 percent on average in the U.S. national income and product accounts (NIPA). This translates into an overstatement of total bank output of 21 percent, since services associated with originating loans that remain on bank balance sheets comprise only part of bank output.[7] Netting out the lending services to nonfinancial firms, which are counted as intermediate input, this finding implies that U.S. GDP would have been 0.3 percent lower on average over the period of 1997 to 2007 if bank output had been measured correctly. Finally, reducing the imputed value of bank lending services to businesses also implicitly corrects nominal value added in industries where firms borrow from banks—almost every industry—since our measurements imply that borrowing industries are using fewer intermediate inputs.

Models that consider risk explicitly are more plausible than those that do not, especially when the models concern the operations of financial intermediaries, whose chief task is assessing and mitigating the riskiness of their portfolios. This is our main argument for preferring our new measure of bank output over current statistical practice. Moreover, a number of plausibility checks also argue in favor of our output measure. In particular, we compare the share of capital in banks' value added with the share of capital in the total private economy and other industries. Under current practice, banks show up as more (fixed) capital-intensive than petroleum refining, whereas our estimates suggest a capital share closer to the share of capital in the overall private sector. In addition, current practice implies an internal rate of return on fixed assets that is 8 percentage points higher than the

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[4] Diewert (1974) was one of the first to introduce this framework.
[5] Also, we consider only "traditional" loan-making and deposit-taking activities, but none of the novel activities such as securitization and the underwriting of derivatives. See Inklaar and Wang (2007) for an accounting of real bank output from all activities.
[6] In most countries, deposits up to a certain amount ($100,000 in the United States) are insured by the government, so risk is not a factor; see, for example, Gropp and Vesala (2001). However, our reasoning dictates a different approach in the case of uninsured deposits, such as jumbo certificates of deposit.
[7] Nowadays, many loans are securitized and sold to outside investors. In 2007, securitization output was equal to about half of "traditional" loan output.

rate in the private sector as a whole.[8] Our new estimates imply an internal rate that is, on average, slightly lower than the rate in the overall private sector. This is more consistent with the basic principle that the internal rate of return on fixed assets should not vary much across industries as long as capital is mobile.

The rest of this paper proceeds as follows. We begin with a brief review of the theoretical analysis underlying the new output measure, focusing on the role of risk. We then discuss data and present our results. We conclude with a summary, and discuss directions for future research.

II. The Economic Model of Banks

This section reviews briefly the theory of banking output based on dynamic stochastic optimizing models. Interested readers who wish to pursue the theoretical issues in greater detail are referred to Wang (2003), WBF (2004), and Basu and Wang (2007).

II.A Implicit Services in Bank Lending

Before attempting to measure a concept, one must first define it accurately. So, what is the output of banks that corresponds to the asset side of their balance sheet? Wang (2003) and WBF (2004) answer this question with dynamic models of optimal bank operations under uncertainty.[9] By embedding bank operations within the context of competitive financial markets, these papers show that the value added of banks lies solely in resolving information problems and processing transactions. In particular, key to bank lending is screening and monitoring activities that mitigate adverse selection and moral hazard problems, respectively, with regard to borrowers' creditworthiness.[10] All of these services are generated through a production process that uses primary inputs of labor and capital, as well as intermediate inputs (such as office supplies and utilities).

More importantly, Wang (2003) demonstrates the separability between the flow of financial services and the stock of financial instruments. By nature, financial services are intangible; financial instruments such as loans are often the most tangible manifestation of those services. However, Wang (2003) and Basu and Wang (2007) show that there is little theoretical basis for an invariant value mapping between flows of bank services and stocks of their asset holding, let alone a fixed proportionality between the two. This conclusion holds whether the stock is measured by book value or by market value.

The separability of service flows from asset balances is becoming increasingly evident as more financial firms provide financial services without holding the associated securities, and vice versa. For instance, finance companies such as GMAC specialize in loan origination, as well as providing bookkeeping and payment services to both the borrowers and the holders of asset-backed securities, without holding much, if any, of the underlying loans on their balance sheets. On the other hand, a

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[8] Differences in systematic risk between industries can explain differences in the internal rate of return; see Section II. However, our loan risk premium estimates and stock market betas suggest that a 10 percent risk premium is extreme.
[9] WBF (2004) extend Wang's partial equilibrium model to a general equilibrium setting, and demonstrate that all the qualitative results in Wang (2003), summarized in this paper, continue to hold.
[10] Banks' role in resolving information asymmetry is well recognized. For example, Fixler (2004, p. 223) observes that "these [financial] services have to do with overcoming the problems of asymmetric information, a view that is widely accepted in the financial economics literature. … The role of banks as a lender arises out of the private nature of the lending transaction—the bank…reduces the problem of adverse selection…[and] the problem of moral hazard. These are the financial services that Fama (1985) and others identified when they argued that banks were 'special.'"

growing number of small and medium-size banks hire specialized firms to originate and service their residential mortgage loans (Bergquist, 2002).

The fundamental distinction between service flows and asset balances may be less obvious in traditional bank lending, where the intermediary both performs the services and holds the assets. But it is no less intuitive, once we focus on the underlying services. For instance, originating a $1 million residential mortgage almost certainly involves much less than 10 times the services involved in originating a $100,000 mortgage, given the ready availability of individuals' credit scores. Fixed proportionality between services and balances is even harder to defend in the case of transaction services to depositors. The literature on payment services suggests that the amount of work involved in clearing checks is independent of the dollar figure of the check or the account balance.[11] The same is true for many other depositor services (for example, issuing money orders, transferring funds, etc).

II.B Bank Loan Interest Rates and the Role of Risk

One central element of the service-centric notion of bank output in Wang (2003) and WBF (2004) is that the flow of services is distinct from the "pure returns" that accrue to the stock of financial assets. This "pure return" is the "user cost of funds," defined as the (risky) future payoff from investment that compensates suppliers of funds solely for the forgone current consumption and not for any attached services. This can be viewed as an extension of the concept of "user cost of money" à la Barnett (1978) that takes account of the fact that the reward to most investment is uncertain. That is, in a world with risk, the so-called "opportunity cost of money" is comparable across securities only after adjusting for risk. So the return on a risk-free security is not the appropriate opportunity cost for risky securities.

The implication for the measurement of bank output is that, to estimate the nominal value of the services provided but not explicitly charged for, the pure cost of funds must be netted out of a bank's total income, which is a combination of the two income streams. To impute the pure cost of funds on a loan, one should use the rate of return on a debt security subject to the same risk, but without any services attached.

What determines this risk-adjusted rate of "pure return" that investors expect on a financial security? Applying standard theories of asset pricing, Wang (2003) and WBF (2004) show that the pure return depends positively on the correlation between a security's return and systematic factors (such as the representative consumer's marginal utility in the consumption capital asset pricing model (CAPM)).[12] For fixed-income securities such as loans, this means that the expected rate of return demanded by a lender depends on how a debt's prepayment risk, default risk, etc. covary with macroeconomic conditions. The interest rate that the borrower must promise in the contract to pay if he remains solvent *ex post*, however, is higher, and rises with the probability of his default—both the systematic and the idiosyncratic components—in order to offset the positive odds of outcomes where the borrower becomes insolvent *ex post*.

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[11] See, for example, Kimball and Gregor (1995) and Radecki (1999); both present industry data on the average and marginal cost of processing a payment via various means that make no reference to the size of the payment.
[12] A not-so-obvious implication is that, if a security's return does not vary with systematic factors, then its expected rate of return is the risk-free rate, no matter how volatile its return. This is of course predicated on the assumption that the markets are complete once the asymmetric information problems are resolved. Otherwise idiosyncratic risk also matters for a security's expected rate of return.

The distinction between expected rate of return and the promised yield on a debt is important, so we shall elaborate somewhat.[13] The former is the mean rate of return required by a lender given her *ex ante* expectation of the debt's payoff; it should on average equal *ex post* realized returns. The latter is the interest rate a borrower promises *ex ante* in the debt contract (also referred to below as the contractual rate) and is obligated to pay if solvent *ex post*.

Let $R_{t,n}^M$ denote the yield-to-maturity promised at time t on a market debt security with maturity n and no services attached. Then, it can in general be expressed as:[14]

$$R_{t,n}^M = r_{t,n}^F + r_{t,n}^P + d_{t,n}^e, \qquad (1)$$

where $r_{t,n}^F$ is the yield on a debt of the same maturity but not subject to default risk, nor with any embedded options.[15] U.S. Treasurys are the best example. They are typically considered risk-free in that they earn a guaranteed return, $r_{t,n}^F$, if the debt is held until maturity.[16] This return only compensates the lender for sacrificing current for future consumption. In addition to the risk-free return, the yield on debt with positive default risk also contains a premium for risk, $r_{t,n}^P$, and a premium for default, $d_{t,n}^e$, which is the extra return that must be promised to investors because they are paid in full only when there is no default *ex post*. If the probability of default or loss upon default correlates with the risk factors priced in the market, investors will also demand that the average return received *ex post* exceed the default-free yield; that spread is $r_{t,n}^P$ in (1).[17] (See Wang, 2003, for more details.)

So the expected rate of return required on this market debt, denoted as r_t^M, equals:[18]

$$r_t^M = r_t^F + r_t^P = R_t^M - d_t^{M,e}. \qquad (2)$$

Now consider the decision facing an optimizing bank that is considering what interest rate to charge when making a loan with the same (systematic) risk profile as the above market debt. In addition to covering the cost of funds, the bank needs to charge implicitly for the services it performs (for example, screening and monitoring). As shown in Wang (2003), the optimal required rate of return on a loan (r_t^A), including the implicit service charge, is:

$$r_t^A = r_t^M + r_t^S = r_t^F + r_t^P + r_t^S, \text{ and } r_t^S A_t = c_t \mu_t, \qquad (3)$$

where r_t^S represents what we shall call the service spread, that is, the rate increment defining the extra interest that must be charged to compensate the bank for processing the loan. The optimal r_t^S

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[13] See Wang (2003) for a more detailed explanation of the distinction between the two concepts, which is also shown to be equivalent to the distinction between default and risk premia.

[14] To be precise, this equation is exact only for instantaneous returns under continuous compounding. In continuous-time models, the yield-to-maturity should equal the integral of instantaneous yields over the maturity of the debt security; see Duffie and Singleton (2003), a standard reference for pricing defaultable debt securities. Wang (2003) and WBF (2004) apply a simple discrete-time version.

[15] Yields on bonds must be adjusted for the embedded option to be comparable with those on option-free debt instruments. Bonds with prepayment risk, such as mortgage-based securities, are essentially bonds with an embedded call option, as borrowers are granted the option to pay off the debt (that is, call the bond) before maturity.

[16] Note that even for this type of debt there is still interest rate risk, that is, the return is almost surely uncertain if one sells it prior to the maturity date.

[17] Under certain conditions, this is equivalent to the drift adjustments of the default intensity's diffusion state variables in continuous time models, see Jarrow, Lando, and Yu (2005).

satisfies the condition that the extra interest receipt (that is, r_t^S times the loan balance A_t) equals the marginal processing cost of a loan, c_t, times the optimal markup, μ_t (determined by competition in the loan market).

Then, the reference rate for a portfolio comprising N loans of varying maturities and made in various periods, is a weighted average of the reference rates of the individual loans:[19]

$$r_t^M = \sum_{i=1}^N \omega_i \, r_{\tau_i, n_i}^{M_i}, 0 \le \tau_i \le t, n_i \ge t - \tau_i, \tag{4}$$

where ω_i is the portfolio weight of loan i, τ_i is the period when loan i's interest rate was set, and n_i is the maturity of the loan. Empirically, (4) is especially relevant for loan types that typically have long maturities, such as real estate loans.

The optimizing bank then sets the contractual interest rate, R_t^A, accordingly:[20]

$$R_t^A = R_t^M + r_t^S + (d_t^{A,e} - d_t^{M,e}). \tag{5}$$

This highlights the fact that the reference market securities are only required to have the same systematic risk as the loans; the securities can have a different expected probability of default or prepayment than the loans. We will see that the accuracy of our empirical estimates varies positively with the degree to which each category of loans and the reference securities used have the same systematic risk despite the securities' generally lower default probability.

II.C The value of bank output

The derivations in the previous section imply that, on average, a bank's nominal output of implicit lending services to borrowers can be imputed as[21]

$$Y_t^A = r_t^S A_t = \left(r_t^A - r_t^M \right) A_t. \tag{6}$$

According to the nomenclature of the 1993 System of National Accounts (SNA93), r_t^M is the reference rate. Previous discussions make it clear why the reference rate should be risk-adjusted. Consequently, the reference rate varies, depending on risk characteristics of the financial security or portfolio of securities associated with the services considered.

However, the U.S. National Income and Product Accounts (NIPA) currently impute bank services to borrowers using a nearly risk-free rate as the reference rate:

$$\left(r_t^A - r_t^F \right) A_t = \left(r_t^P + r_t^S \right) A_t = Y_t^A + r_t^P A_t. \tag{7}$$

The value of output imputed according to (7) will overstate the actual value of service output. The informal justification for (7) is that $r_t^P A_t$ is regarded as compensation for rendering a so-called "risk-bearing" service. Wang and Basu (2007, section 3.4) discuss at length why risk-bearing is not a productive service according to the conceptual framework of SNA93 and, more importantly, why the NIPA's imputation results in inconsistent accounting of the fund-using firms' output, by making it depend on their source of funding (that is, the public debt market versus banks), even given identical underlying true output.

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[18] For brevity of exposition, from now on we omit the subscript denoting maturity, unless confusion is likely.
[19] See WBF (2004) for discussions of the timing mismatch between screening services and loan interest flow.
[20] This is because $r_t^S = r_t^A - r_t^M = (R_t^A - d_t^{A,e}) - (R_t^M - d_t^{M,e})$.
[21] See WBF (2004) for a detailed discussion of how the actual value in each period deviates from this average.

The value of implicit depositor services can be imputed in a similar manner to the new way we imputed the value of implicit lending services. Let D_t denote the deposit balance, r_t^D the interest rate paid, and r_t^m the corresponding reference rate (that is, the return on a market security with the same risk). Then nominal output of depositor services is

$$Y_t^D = \left(r_t^m - r_t^D \right) D_t . \qquad (8)$$

For insured deposits in the United States (up to $100,000 per individual per bank), the relevant market rate is the risk-free (Treasury) rate, $r_t^m = r_t^F$. For the remaining, uninsured, deposits $r_t^m > r_t^F$, because the holders are exposed to some risk in bank asset portfolios.

Note that equation (6) implies that there are zero implicit services provided to asset issuers (that is, $Y^A = 0$), if a bank passively holds market securities in its investment portfolio, since $r^A = r^M$. Likewise, (8) implies zero implicit services (that is, $Y^D = 0$) provided to holders of bank term liabilities (commercial paper, market bonds, and privately placed bonds), since the interest rate paid equals the reference rate ($r^D = r^m$). Also note that under virtually all circumstances (that is, whenever there are equity holders), r^M in (6) is greater than r_t^m in (8), because bank assets are typically riskier than bank liabilities. In other words, the reference rates for imputing lending and depositor services almost always differ by a positive margin.

Figure 1 illustrates the imputed nominal output value of implicit bank services. Note that only part of a bank's net interest income constitutes nominal output of bank services; the remainder—corresponding to the risk premium, $\left(r^M - r^F \right) A$—is excluded.[22] This is precisely because the reference rate for lending services generally exceeds that for depositor services. The risk premium, along with actual interest expenses on bank liabilities, constitutes a pure transfer of capital income. It is part of the factor income generated by the capital used in the borrowing firms' production or in the consumption of consumers. This factor income is then transferred from the end users of funds to the ultimate suppliers of funds—the bank shareholders. Only when all investors are risk neutral or all risk is idiosyncratic will this risk premium disappear. Figure 1 illuminates how our model-based output measure differs from the NIPA's current measure, which uses a (nearly) risk-free rate as the single reference rate (see Fixler, Reinsdorf, and Smith, 2003). As we have argued, the NIPA's measure overstates bank output by the amount of the risk premium. In the remainder of this paper, we discuss how to estimate the risk premium and its quantitative impact on the measured output of the U.S. commercial banking industry.

III. Data and Empirical Estimates of Bank Service Income

III.A Data Sources

Accounting data for individual commercial banks come from the Consolidated Reports of Condition and Income (the Call Reports).[23] These are quarterly financial statements filed by banks to their regulators and made available by the Federal Reserve Bank of Chicago. Our empirical estimates use

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[22] As is shown, the balance of loans exceeds that of deposits, with bank equity making up the difference. Also note that this figure is a simplified version of Figure 1 in Wang (2003), as it ignores risk premia on deposits due to deposit insurance or uninsured deposits. That is, it sets $r^m = r^F$, and overstates depositor services.
[23] These correspond to the forms FFIEC 031-041; see www.ffiec.gov for details.

data from the second quarter of 1997 to the fourth quarter of 2007, mostly because some of the necessary variables are not available for earlier years.

The Call Reports data are used to estimate the average interest rate earned by banks on each category of loans and deposits. The Call Reports also provide data on the repricing period of various categories of loans. Yields on U.S. Treasury securities of varying maturities are from the Federal Reserve Board,[24] as are yields on commercial paper of the top two tiers of ratings; yields on the remaining tiers are from Bloomberg. Yields on mortgage- and asset-backed securities are based on indices constructed by Citigroup Global Markets and Merrill Lynch. Finally, interest rates charged on commercial and industrial (C&I) loans for clients with various risk profiles come from the Federal Reserve Survey of Terms of Business Lending.[25]

III.B Implementation—Overview

The Call Reports afford no direct observation of either the expected rate of return (r_t^A) or the promised yield on loans (R_t^A). What can be computed is the average interest rate actually received by banks on each individual category of loans and securities, that is, $R_t^A - d_{t+1}^A$, where d_{t+1}^A is the actual rate of loan default in period $t+1$.[26] Rearranging (5), r_t^S can be expressed as

$$r_t^S = (R_t^A - d_{t+1}^A) - (R_t^M - d_t^{M,e}) + (d_{t+1}^A - d_t^{A,e}). \tag{9}$$

Thus, the service spread can be inferred from the realized loan interest rate and the matched market yield, after correcting for the deviation of the actual from the expected rate of loan default. This is our basic formula for imputing the value of implicitly priced services to borrowers.

The reference interest rate for the loan portfolio associated with each type of borrower services is approximated using the expected rate of return ($r_t^M = R_t^M - d_t^{M,e}$) on market debt with the most similar risk. The Call Reports data dictate that we can match loans with securities in only a few broad categories: residential mortgages with mortgage-backed securities (MBS), consumer loans with asset-backed securities (ABS), and C&I loans with commercial paper. Each r_t^M we use is a (noisy) proxy for the true reference rate on the matched category of bank loans, since we observe none of the risk composition and only limited information about the maturity of the loans and thus cannot assess the accuracy of the match. Nevertheless, using market debt returns almost surely underestimate the true risk premium on loans, since market securities on average have much lower realized default rates and are therefore likely to command lower risk premia as well (see details in the next subsection).[27]

Another issue is that in each period we observe only the average interest rate earned by a bank on its portfolio of a given type of loans, regardless of when the loans were priced. In particular, for loans with long periods of fixed rates, like mortgages, this loan portfolio will also include loans that were priced years ago. Comparing this average rate with current market rates to impute the service

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[24] Release H.15; see http://www.federalreserve.gov/releases/h15/. We use the constant-maturity series.
[25] Release E.2; see http://federalreserve.gov/releases/e2/. For more information on banks' internal risk rating, see data reported in Form FR2028a/s, available from 1997 onward (see Appendix A for further details): http://www.federalreserve.gov/boarddocs/reportforms/ReportDetail.cfm?WhichFormId=FR_2028a/s.
[26] This expression is strictly correct only for one-period bonds, otherwise the realized return also includes a term reflecting the change in bond price due to fluctuations in yield. See further discussion below and chapter 10 of Campbell, Lo, and MacKinlay (1997).
[27] It is possible, but unlikely, that the systematic component of risk, which determines the risk premium, is still the same for loans and the matched securities.

spread is obviously not correct. Unfortunately, the data necessary for a proper matching—gross flows of new loans originated and old loans paid off or reset at a new interest rate in each period—are not available. So, rather than trying to make rough assumptions about the composition of the loan portfolios, we compare the average interest rate to the current market reference rates in our baseline estimates.[28] The one exception is C&I loans, because we can use data from the Survey of Terms of Business Lending, which provides data on the interest rate charged on new C&I loans originated by commercial banks in the survey week. In this case, we can match the timing of bank loan interest rates and the market rate. While still not perfect, this matching likely provides a more accurate estimate of actual service spreads than could be obtained by using the difference between average bank loan rates earned and current market reference rates.

Estimating depositor services according to equation (8) is straightforward, especially once we assume $r^m = r^F$. This assumption is necessary, because the Call Reports do not provide adequate data for estimating the risk premium on uninsured deposits, whose share is, fortunately, modest. The following subsections detail the estimation of implicit incomes from bank services.

III.C Estimates of Risk Premia

To facilitate comparison with the NIPAs' current measure of bank output, we estimate separately the two components—the risk-free rate and the risk premium—of each reference rate for loans. Rearranging equation (2), the risk premium on a reference security can be expressed as

$$r_t^P = r_t^M - r_t^F = R_t^M - r_t^F - d_t^{M,e}. \qquad (10)$$

Data indicate that the unconditional estimate of $d_t^{M,e}$, equal to the long-term average of realized d_t's, is extremely low for certain categories of market debt, such as commercial paper.[29] For example, according to Moody's, the historical average default rates of commercial paper with the top two rating grades (P-1 and P-2) are basically nil.[30] So, for certain categories of loans, when such corporate debt is used as the reference securities, a reasonable estimate of r_t^P is simply the yield spread between such debt and the maturity-matched Treasury securities (that is, $R_t^M - r_t^F$); the upward bias from ignoring $d_t^{M,e}$ should be negligible.

We compute the respective risk premium on C&I loans and consumer loans, as follows: First, to gauge the default risk and maturity composition of C&I loans and find the best match of market securities, we rely on the Federal Reserve's Survey of Terms of Business Lending (STBL).[31] Data from this survey indicate that about 70 percent of C&I loans are repriced in less than a month and over 90 percent less than a year. This suggests that commercial paper is a more appropriate type of reference security than corporate bonds. On the other hand, using the yields on commercial paper

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[28] This means that we estimate a market rate that would be the theoretically correct reference rate if all the loans in the portfolio had been (re)priced during the current period.

[29] The conditional estimate of d_t^e is procyclical.

[30] "For a 180-day period, these risks are estimated to be 0.00 percent for P-1, 0.02 percent for P-2, 0.12 percent for P-3, and 0.43 percent for Not Prime (NP)." www.moodyskmv.com/research/whitepaper/60917.pdf.

[31] It is possible that the loans covered in the survey are still not representative of the banking industry as a whole, or at all times. But this is the best micro data source available, and there is no reason to suspect systematic bias.

likely results in conservative estimates of the risk premium on C&I loans, since C&I loans tend to have both longer average maturities and greater default risk than commercial paper.[32]

Among the four risk categories reported in the STBL, two have readily available reference market securities. First, the "minimal risk" classification explicitly requires that the loans be to customers with a bond rating of AA or higher; such firms generally also carry a P-1 short-term rating by Moody's. Second, the "low risk" category requires customers to have a BBB bond rating, which maps into a P-2 rating by Moody's.[33] However, the reference securities for the other two, relatively higher, risk categories, "moderate risk" and "other," are not as clear. So we assume that the higher interest rate relative to the "low risk" category is entirely due to greater risk but not to extra implicit service revenue.[34] With estimates of the risk premium for each of the four categories of C&I loans, we calculate a weighted average premium using the volume of new loans in each category, and we subtract this from the overall C&I loan interest rate obtained from the STBL.

The risk premia of consumer installment and credit card loans are estimated using Merrill Lynch's (ML) asset-backed securities (ABS) indices for fixed-rate auto and credit-card loans, respectively. A weighted average yield is computed based on the share of credit cards versus all other loans in the portfolio. The average rating of the ABS underlying the two indices should be between BBB and AA, since both these indices are components of ML's ABS master index.[35] Following this procedure almost certainly yields a rather conservative estimate of the average risk premium on the consumer loans held on the books of banks because to receive investment-grade ratings, the ABS invariably must obtain credit enhancement to ensure that their holders will be subject to minimal credit risk.[36] Moreover, even at the original loan level, the loans kept on banks' books may be riskier than the ones that are securitized.[37] In terms of maturity, however, no data are available to gauge how well on average the indices' constituent bonds match consumer loans held by banks.[38]

To estimate the risk premium on residential mortgage loans, we use the maturity-weighted redemption yields on MBS issued by government-sponsored enterprises (GSEs, such as Fannie Mae and Freddy Mac) as the reference rate. The maturity data are available in the Call Reports (schedule RC-C) since the second quarter of 1997. Again, this reference rate likely gives a conservative estimate

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[32] It does not improve the match to use asset-backed commercial-paper (ABCP) as the reference for those bank loans that are secured. The yields on ABCP and on regular nonfinancial CP are virtually the same until July, 2007, when the subprime-induced financial turmoil broke out in the United States. See Figure A.3 for a comparison of risk premium estimates using corporate bonds versus commercial paper as the reference securities.

[33] AA and BBB are bond ratings by S&P, equivalent to ratings of Aa2 and Baa2 by Moody's. The mapping between long- and short-term ratings can be found at http://federalreserve.gov/releases/cp/about.htm.

[34] This will likely overstate the risk premium, since common sense suggests that riskier loans require more screening and monitoring, and the cost of servicing these riskier loans must be recouped.

[35] We choose not to use a general index for the ABS market because, between 2003 and the first half of 2007, a rapidly growing share of the market comprised securities backed by subprime and Alt-A mortgage loans—from less than 20 percent in 2003 to over 30 percent in 2006, according to the Securities Industry and Financial Markets Association.

[36] Credit enhancement can be obtained in a variety of ways. It can be purchased from third parties such as insurance companies, or created "internally" by forming a sufficient loss-absorbing cushion of junior claims within the tranche structure "wrapped" around a pool of assets in a manner that enables the issued ABS can obtain senior ratings.

[37] Using securitization to save on capital requirements is a form of regulatory arbitrage. This may not be a major concern; for example, Calomiris and Mason (2004) find little evidence of this motivation in banks that securitize credit card loans.

[38] Since these are indices for fixed-rate ABS, their average maturity may exceed that of the underlying consumer loans, some of which carry floating rates.

of the risk premium on these loans, since agency MBS are not subject to default risk but only to prepayment risk: mortgage holders may repay their loans in part or in full ahead of schedule.[39] More importantly, for this reference rate to be a good proxy for the pure (risky) return in the loan rates, a substantial fraction of the mortgage portfolio must be repriced in the period of consideration. This timing requirement is made clear in equation (9): the reference rate should be for the period when a loan's interest rate was set or *last* reset.[40]

To gauge the extent to which the above baseline estimates are affected by the interest-rate timing mismatch, a problem that we suspect is particularly acute for long-term, fixed-rate loans, such as many residential mortgages, we also compute the risk premium on mortgage loans using a series of moving averages of current and past (up to five years) market rates. For the period 2002–2007, the average service spread on mortgage loans using current market rates is 0.80 percent, while that using the 5-year moving average rates is 0.69 percent. Service spreads estimated using shorter moving averages lie in between. A maximum effect of 0.11 percentage points seems modest compared to the size of the service spreads. It therefore seems that the problem of timing mismatch between bank loan rates and the market reference rates is not a major concern.

For each category of loans, we now have an estimate of the risk premium, namely, the difference between the reference market rate and Treasury yield of the same maturity.[41] The spread between the latter and the 3-month Treasury yield is the usual term premium. We use the 3-month Treasury yield as the reference rate on transaction deposits —short-term and largely default-risk-free claims—and refer to it as the risk-free rate in the subsection below on the empirical results. The reference rate for savings and time deposits, on the other hand, includes the pertinent average term risk premium. So, by and large, the gap, in terms of reference rate, between loans and deposits includes both risk and term premia.

III.D New Estimates of the Value of Borrower and Depositor Services

Given the reference rate for each category of loans, we now estimate borrower and depositor services. Table 1 is a detailed exposition using the estimates for the fourth quarter of 2007, comparing our model-based, service-flow measure of bank output with the measure according to NIPA's current methodology. In total, it lists five types of services—to holders of two types of deposit accounts and borrowers of three types of loans.[42] Other categories of assets and liabilities, such as investment securities and subordinated debt, are excluded because, as explained in Section II, their holders do not receive financial services created by banks.

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[39] All conforming residential mortgages that back the agency MBS carry no prepayment penalties. This, in essence, grants the borrowers an implicit call option that allows a borrower to buy back (that is, to pay off) the loan at face value. The option is most likely to be exercised when a loan's market value exceeds its face value, that is, when the current period mortgage rate falls below the loan's contractual interest rate. See, for example,. Dunn and McConnell (1981) or Kau *et al.* (1992) for the magnitude and determinants of prepayment risk.

[40] There are, of course, timing issues regarding when the screening or monitoring is done versus when the implicit revenue is recognized. See WBF (2004) for an in-depth discussion.

[41] The data in Call Reports refer to the amount of time until maturity or next repricing of the loans, which is the economically relevant information for comparing with market securities.

[42] Among the loan categories covered in the Call Reports, we consider only those for which reasonably similar reference securities can be found in the market. So, lease financing receivables are excluded. Moreover, we include only loans and deposits made in banks' domestic offices, since activities in foreign offices do not contribute to U.S. GDP. In sum, the four categories in Table 1 account for 90 percent of the total balance of loans and leases in 2007.

Table 1 shows that for 2007:Q4, the risk-adjusted reference rates on the three types of loans are at least one percentage point higher than the risk-free rate. Using the risk-adjusted reference rates lowers the imputed value of borrower services by $116.8 billion, to $88.2 billion. To gauge the impact on GDP, we net out the value of borrower services to businesses (that is, services related to commercial real estate loans and C&I loans).[43] Accordingly, GDP in 2007:Q4 would be $52.9 billion, or 0.4 percent points, lower using our risk-adjusted bank output measure. We suspect that this figure is on the low end because, as detailed above, we have adopted conservative estimates of risk premia to adjust the reference rates for risk.

Figure 2 plots the respective average risk-adjusted reference rates for deposits and loans from 1997:Q2 to 2007:Q4. Throughout the sample period, the risk plus term premium stays positive, so the average reference rate for loans consistently exceeds that for deposits. For comparison, Figure 2 also plots the actual average interest rate paid on deposits and received on loans, respectively. The quarterly average rate is calculated as the interest received or paid during a quarter over the average balance of the corresponding instruments for the quarter.[44] It is clear that the interest rates paid on deposits are, on average, more inertial than the risk-free reference rate, a well documented, stylized fact in empirical banking studies (for example, Berger and Hannan, 1989). Likewise, the interest rates received on loans are on average less volatile than the reference market rates.

Figure 2 also shows that the average loan rate consistently exceeds the average loan reference rate, implying a positive service spread on average. By contrast, between late 2001 and early 2004, the average deposit rate, in fact, rose above the deposit reference rate. Flannery (1982) explains such occurrences as reflecting the quasi-fixed nature of deposit relationships. That is, depositors are to some degree "locked" into a bank account because of the transaction cost that they would incur to switch banks; in return, banks implicitly commit to smoothing deposit interest rates. There may also be substitutions between "headline" interest rates and various direct charges and fees on deposit accounts at such times.

In Figure 3 we plot the service spreads for deposits and loans directly. Not surprisingly, the two spreads frequently move in opposite directions, since their formulae carry negative signs (see (6) and (8)), while both actual rates are more inertial than the respective reference rate. Furthermore, the spreads appear to comove with the business cycle: the deposit-service spread narrows, while the loan-service spread widens following monetary easing in economic downturns, and vice versa. Variations in the loan-service spread can mostly be traced to C&I and consumer loans, as the service spread on real estate loans remains fairly stable throughout the period. One explanation for this pattern is that bank C&I loans become riskier relative to commercial paper in periods of economic weakness, possibly because smaller or riskier firms are more likely to draw on their credit lines in bad times. If this is the case, then our empirical results underestimate the risk premium on C&I loans in such periods.

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[43] We infer the former from total services related to real estate loans, based on the simplifying assumption that the share of services to commercial customers is proportional to the share of commercial loan balances in total real estate loans.

[44] Table A.1 in the Appendix lists the specific data items used in calculating the average interest rate on each category of securities, loans, and deposits. Table A.2 summarizes major changes, in terms of reporting requirements and variable definitions, in the Call Reports between 1997 and 2007 and the way they are handled to arrive at harmonized time series.

Figure 4 depicts the imputed bank service income and the compensation for risk.[45] Compensation for term risk and for the risk of default represents the difference between our new model-implied measure of bank output and the NIPA's current measure. Variations across time in income from the two services echo those in the two service spreads depicted in Figure 3. The term-risk compensation is time-varying as well; it rises as the yield curve steepens, and falls as the yield curve becomes less steep. In comparison, the default risk compensation is more stable over time. Especially worth noting are the last two quarters of 2007. Both the default and the term risk compensation increased sharply because of the turmoil in financial markets and the monetary easing that followed in response.

III.E Plausibility Checks

So far, we have made the case for using our measure of bank output on theoretical grounds, that is, we have explained why the reference rate used to impute the value of bank service output should be adjusted for the risk of the associated financial instrument. By removing the risk premium, this new measure of output reduces banks' operating surplus.[46] We now examine whether or not the lower surplus is "implausibly small," as Fixler and Reinsdorf (2006, footnote 6) have asserted in arguing against risk-adjusted reference rates. We focus on two indicators, the capital share in value added and the internal rate of return on fixed capital, since the range of values of each indicator in other industries can be viewed, under certain conditions, as the plausible benchmark for comparison. The capital share, defined as the share of operating surplus in industry value added, gives an indication of the capital intensity of production in that industry. The internal rate of return (IRR) is the return an industry or a firm would need to earn on its fixed capital assets, such as buildings and computers, to exactly cover the rental cost of fixed capital.

We must note the close link between the IRR and the user cost of funds. The latter is, in fact, simply the former net of depreciation (consisting of both obsolescence and physical wear and tear). The concept of a risk-adjusted user cost in the case of fixed capital has long been an integral part of investment theories. The IRR in some industries is consistently higher than in others, even after controlling for depreciation and expected changes in the price of capital goods—precisely because investing in those industries incurs greater systematic risk. Investors thus demand a higher rate of payoff on average, so long as capital is mobile and the no-arbitrage condition holds. The risk-based user cost measure is also routinely used in industry-level growth accounting studies.[47] We calculate the IRR using the standard Jorgensonian framework (for example, Jorgenson, Gollop, and Fraumeni, 1987), and capital includes fixed reproducible assets, such as buildings and machinery, as well as land and inventories.

The first step is to gauge by how much our new measure would revise downward total nominal output of all depository institutions. Total output equals the sum of explicit bank service charges (comprising the bulk of non-interest income) and implicit revenue from services (that is, our

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[45] "Loan services" in the figure corresponds to Y^A in equation (6), and "Deposit services" to Y^D in (8). "Default risk compensation" corresponds to the term $r^A A$ in equation (7). "Term risk compensation" denotes the return due to maturities longer than three months.

[46] Operating surplus is defined as value added net of labor compensation and indirect taxes. As explained above, part of the "excess" bank operating surplus should be reallocated to nonfinancial firms that purchase bank services, while the remainder should be reallocated to interest payments and receipts of households.

[47] See, for example,. Jorgenson, Gollop, and Fraumeni (1987).

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estimate of borrower and depositor service output in Table 1 and Figure 3).[48] While imputed bank output is overstated by 45 percent on average, total banking output is overstated by only 21 percent on average over the sample period 1997:Q2–2007:Q4. Next, we obtain a new output estimate for all depository institutions (that is, the credit intermediation industry as defined in the NIPA Industry Account) by assuming that output of the rest of the industry is overstated by the same percentage as that of commercial banks in each year.[49] Obviously it would be preferable to have direct estimates of the overstatement for both savings banks and credit unions, but that is beyond the scope of this paper.

Table 2 shows the results of our plausibility exercise comparing capital shares and internal rates of return according to the current NIPA measure versus our new measure of output. Under the NIPA output measure, the banking industry's capital share averages 59 percent, which ranks it higher than the capital share of the petroleum refining industry and similar to the share of coal mining. This seems an implausibly high capital share, since the other industries with similar shares are generally regarded as intensive users of large-scale machinery. The implication is that the operating surplus may be implausibly large under the NIPA measure. The new output measure, by excluding the risk premium, decreases the capital share of the industry to 42 percent on average—the same as the share of private industries as a whole.[50] This is also close to the capital share of retail trade but higher than that of business services.

The internal rate of return of the banking industry, based on the NIPA measure of output, also seems implausibly high, at 17.8 percent, on average, over the period. In comparison, the IRR for the private sector as a whole is only 9.3 percent. The premium of 8 percentage points seems unwarranted by the systematic risk of the credit intermediaries, since many of those with publicly traded shares have a beta around one. Once the new measure of bank output is used, the resulting lower operating surplus reduces the IRR of the industry to a level close to that of the overall private sector.

Mismeasured capital assets are a far less plausible reason for the observed gap between the IRR of the overall private sector and the financial intermediation industry. It may be argued that credit intermediaries have built up more intangible assets than the average private industry, for example, through business reorganization that complements the investment in information technology (IT).[51] However, the intermediation industry would need to have an investment share of intangibles nine times higher than that of the average private industry to account for the difference in the IRR. This seems unlikely, since the IT investment share of banks is only 30 percent higher than that of the overall private sector.[52]

The decrease in the capital share and the internal rate of return on fixed capital toward a more reasonable level is an indirect effect of excluding the risk premium in our new measure of bank

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[48] Note that we exclude the trading-income elements of non-interest income, since we argue that it is also not output but transfer of property income; see Inklaar and Wang (2007) for further discussion.

[49] This industry (NAICS 521 and 522) comprises commercial banks, the Federal Reserve, savings banks, and credit unions. Commercial banks account for more than half of the employment. Savings banks, the second largest category, tend to have a larger share of real estate loans than commercial banks. Although the risk premium on real estate loans tends to be somewhat lower than on other loans, a robustness check that applies the same interest rate margin by loan category to savings banks leads to similar estimates of overstatement.

[50] Lower bank operating surplus also means lower operating surplus for the overall private sector. But taking this into account has only a minimal effect on the values reported in Table 2 for the private sector.

[51] The BEA counts only software and a few intangibles as capital. Corrado, Hulten, and Sichel (2006), among others, argue that the scope of capital should be expanded to cover organizational capital, brand capital, etc.

[52] Specifically, 34 percent versus 26 percent of total investment.

output. We therefore view the results reported in Table 2 as empirical support for the new measure, complementing the theoretical argument for risk-adjusted reference rates.

IV. Conclusions

Banks provide important services to both borrowers and depositors. They reduce the information asymmetries that impede borrowers' access to credit, and provide transaction services to depositors. However, banks generally do not charge explicit fees for these services; instead, they bundle the fees with loan and deposit interest flows. As a result, the output value of both borrower and depositor services must be imputed. In the statistical and research community, it is generally agreed that the value of such implicit bank services is most appropriately imputed as the difference between the interest paid on loans (and interest received on deposits) and the opportunity cost of the associated funds as determined by a reference rate. The choice of this reference rate, however, is more contentious. Under the current System of National Accounts (1993) and in the U.S. National Income and Product Accounts (NIPA), this reference rate is stipulated to be a single, risk-free rate.

In contrast, Wang (2003) and WBF (2004) show that, in a world with risk-averse investors, each reference rate should take account of the non-diversifiable risk of the associated financial instrument.[53] Specifically, the opportunity cost of a risky loan is not the return on a risk-free investment, but rather the return on an investment of comparable risk. The model in WBF (2004) is, of course, an abstract representation of reality, assuming, for example, (nearly) complete and efficient financial markets. Relaxing these assumptions would likely affect the exact risk premium concept that should be incorporated into the reference rates, but the core message of the model should continue to hold: bearing risk that is priced in the market is not a productive activity.

In this paper, we show that the output measure implied by the banking model of WBF (2004) can be implemented for U.S. commercial banks from 1997 onward. In particular, diverse financial markets provide adequate data of yields on debt instruments comparable to those held on banks' balance sheets to enable the derivation of risk-adjusted reference rates. We show that removing the risk premium, the return between the risk-adjusted reference rate and the risk-free rate, is quantitatively important. Comparing bank output calculated using our risk-adjusted reference rate with output computed using the risk-free reference rate according to the current NIPA method, we show that the latter overstates, on average, imputed bank output by 45 percent, total bank output by 21 percent, and U.S. GDP by 0.3 percent.

Our risk-adjusted reference rates are far from perfect, since the bank loan categories for which interest rates are reported separately are quite broad. As a result, the matching of risk characteristics between bank loans and comparable publicly traded debt instruments is imprecise. Nonetheless, we would argue that we have captured some of the risk premium by using relatively conservative estimates, and that accounting for some of the risk premium is an improvement over not accounting for it at all. Furthermore, estimates of the share of capital in banks' value added, and the internal rate of return on fixed capital of the banking industry also suggest that our measure of bank output is more plausible than the current NIPA measure.

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[53] The argument is the same for deposits, but less relevant due to the existence of deposit insurance. However, not all deposits are insured, and some countries (for example., Switzerland) do not insure deposits at all. In such cases, the need for risk adjustment applies to deposits as well.

We conclude by drawing two important implications of our paper. First, we find no convincing theoretical or practical reasons for using risk-free reference rates in estimating bank output. Instead, we show that it is feasible to use risk-adjusted reference rates and that doing so is quantitatively significant. The fact that our risk-adjusted measure of bank output is both conceptually preferable and leads to more plausible outcomes argues strongly for changing current statistical practice to remove the compensation for risk-bearing in general from bank output. Second, information about loan risk rating and the attendant interest rates charged by U.S. commercial banks is scarce, despite the central role of risk rating in measuring bank output, as well as in studying other important banking issues such as competition in credit supply. We, therefore, urge the statistical agencies to improve data collection in this important area.

Table 1, The Effect of Risk Adjustment: Imputed Output of U.S. Commercial Banks at Current Prices in 2007:Q4 ($billions)

|	Average Balance	Interest Flow	Annualized interest rate	Reference rate			Imputed output		
				risk-free	term	default & term	risk-free	term	default & term
Deposits in domestic offices	5,504	152	2.8%	3.5%	3.5%	3.5%	39.0	42.5	42.5
Demand deposits	486	0.0	0.0%	3.5%	3.5%	3.5%	16.9	16.9	16.9
Time and savings deposits	5,018	152.2	3.0%	3.5%	3.5%	3.5%	22.1	25.6	25.6
Loans in domestic offices	5,471	395	7.2%	3.5%	4.0%	5.6%	205.0	177.0	88.2
Real estate loans	3,545	235.3	6.6%	3.5%	4.3%	5.8%	112.2	84.3	31.5
Consumer loans	804	80.9	10.1%	3.5%	3.5%	4.4%	53.0	52.9	45.7
Commercial & industrial loans	1,123	78.8	7.0%	3.5%	3.5%	6.0%	39.8	39.8	11.1
Total	10,975	547	6.6%	3.5%	3.8%	4.6%	244.0	219.5	130.7

Notes: "Average Balance" is the average of the balance reported on December 31, 2007 and September 30, 2007. "Interest Flow" is the actual interest received or paid within the quarter. "Annualized interest rate" is the interest flow divided by the average balance and then annualized. The risk-free reference rate is the average 3-month Treasury yield, the term-adjusted reference rate is the Treasury yield corresponding to the average maturity of the loans or deposits, and the default- & term-adjusted rate also includes the default risk premium. See Tables A.1 and A.2 in the Appendix for details of the Call report data items used in constructing these variables.

Table 2. The Impact of Risk Adjustment on Labor Share and Internal Rate of Return, 1997–2006 Average

	Capital share in value added	Internal rate of return on fixed assets
Financial intermedation		
Risk-free	59	17.8
Risk-adjusted	41	6.8
Private economy	42	9.3

Notes: "Financial intermediation" refers to NAICS industries 521 and 522 in the BEA's GDP by Industry Account. "Risk-free" and "Risk-adjusted" denote the two measures of bank output that use the risk-free and the risk-adjusted reference rates (corresponding to the "risk-free" and "default & term" output columns in Table 1), respectively. "Private economy" is as defined in the GDP by Industry Account. The "capital share in value added" includes an estimate of the labor compensation of self-employed, assuming they earn the same average wage as employees. The "internal rate of return on fixed assets" is the shadow rental rate on the gross capital stock at current prices that would generate the actual capital compensation (defined as value added minus labor compensation). All fixed assets as covered by the BLS are included, that is, fixed reproducible assets, land and inventories. The industry-level capital and income data are available annually for the 1997–2006 period.

Figure 1. Decomposition of a bank's interest flows (A simplified version)
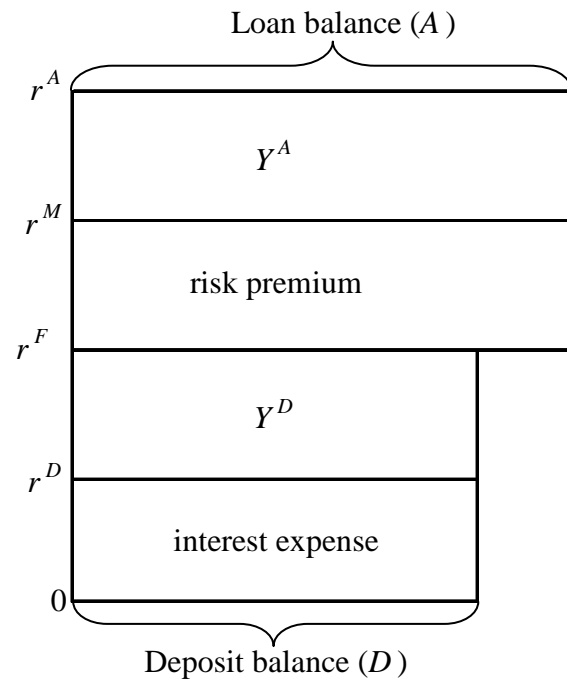
Notes:

r^A: (Average) interest rate received on loans

r^M: Expected rate of return required on market securities with the same (systematic) risk characteristics as the loans

r^F: Risk-free rate

r^D: Interest rate paid on deposits

Y^A: Nominal output of bank services to borrowers

Y^D: Nominal output of bank services to depositors

For a more detailed decomposition, see Wang (2003).

Figure 2. Average interest rates on loans and deposits, and corresponding reference rates, 1997:Q2-2007:Q3
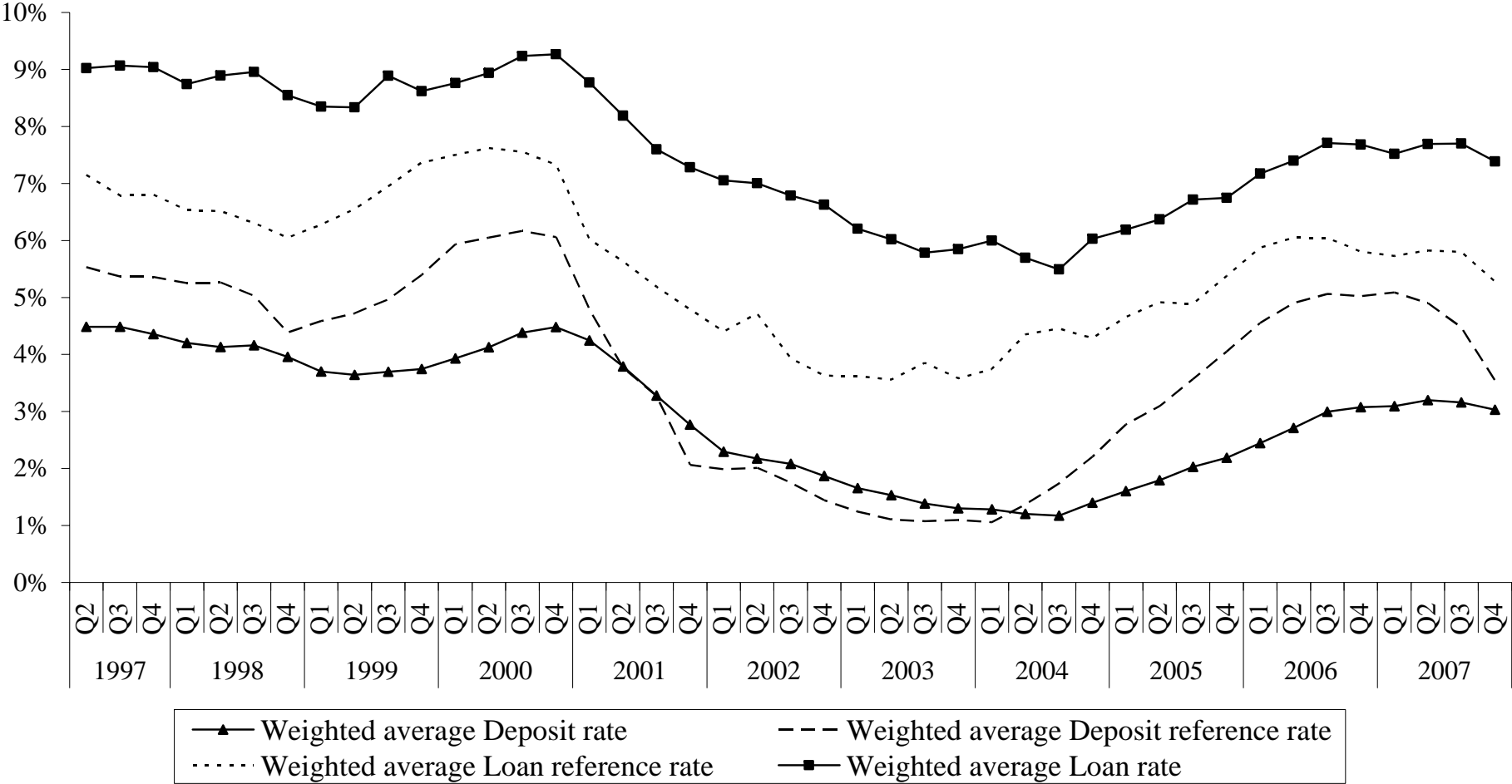

Legend:
- Weighted average Deposit rate
- Weighted average Loan reference rate
- Weighted average Deposit reference rate
- Weighted average Loan rate

Figure 3, Weighted average service spread for loans and deposits, 1997:Q2-2007:Q4

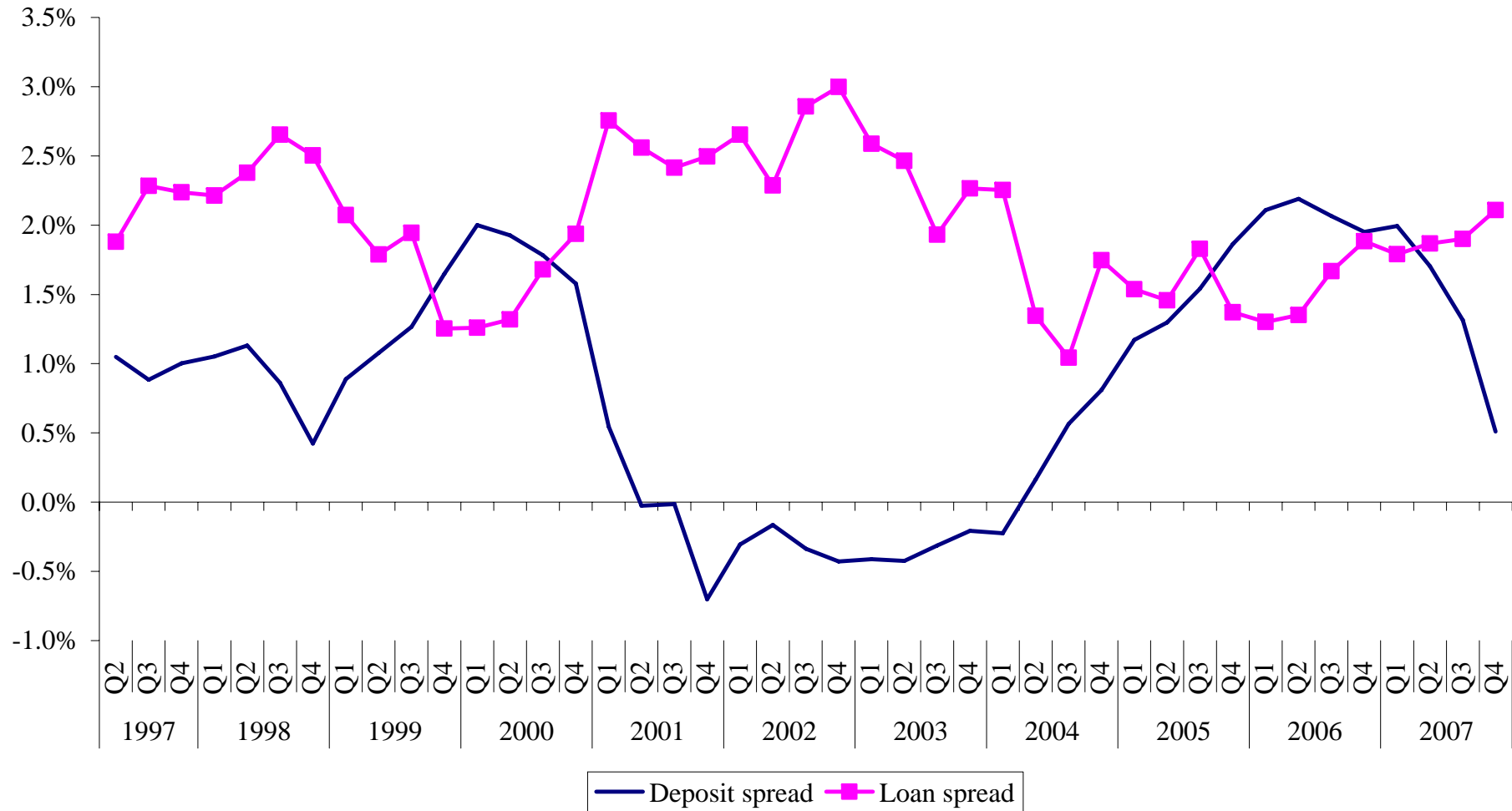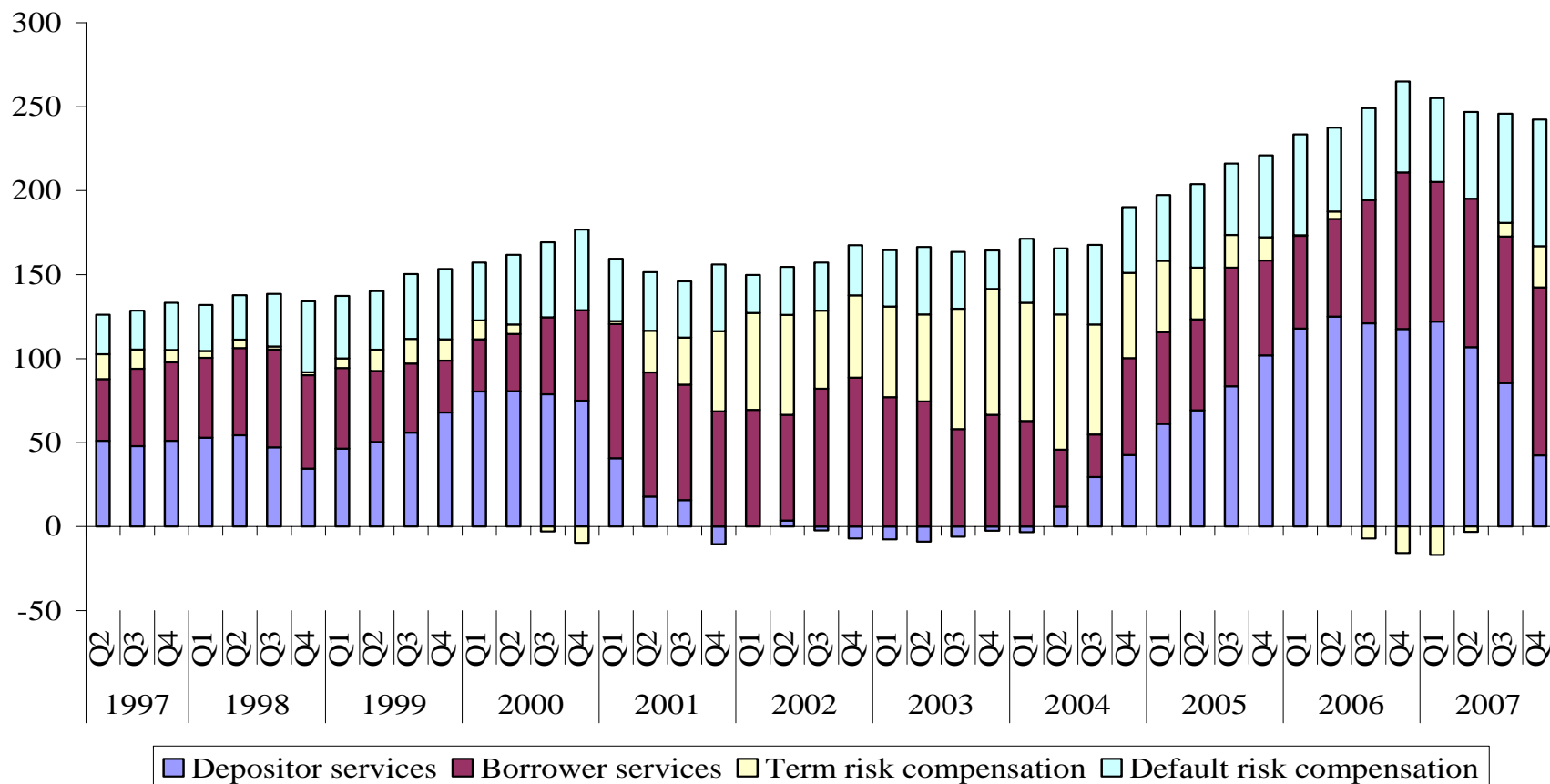
Legend: Deposit spread — Loan spread

Figure 4, Imputed output of U.S. commercial banks and risk compensation at current prices, 1997:Q2-2007:Q4 (billions of dollars)

Notes: "Deposit services" equals the deposit service spread (cf. Figure 3) times the quarterly average deposit balance (see equation (8)). "Loan services" equals the loan service spread (cf. Figure 3) times the quarterly average loan balance at all banks (following equation (6)); "Term risk compensation" denotes the value of the return on loans and deposits due to maturities longer than 3 months. "Default risk compensation" denotes the value of pure default risk-based return on loans.

Appendix. Details of Data and Estimation Procedures

Table A.1. Call report data items used in the analysis

	1997Q2-2000Q4	2001Q1-2007Q4
Interest income and expenses		
Income on real estate loans	RIAD4011+RIAD4246	RIAD4011
Income on consumer loans	RIAD4013+RIAD4247+RIAD4248	RIAD4013
Income on commercial and industrial loans	RIAD4012	
Expenses on time and savings deposits	RIAD0093+RIADA517+RIADA518	
Loan/deposit balance		
Real estate loans	RCON1410	
Credit card loans	RCON2008	RCONB538
Other consumer loans	RCON2011	RCONB539+RCON2011
Commercial and industrial loans	RCON1766	
Time and savings deposits	RCON2385	
Demand deposits	RCON2210	
Maturity data		
Real estate loans (1-4 family)	RCONA564-RCONA569	
Loans except 1-4 family real estate loans	RCFDA570-RCONA575	
Time deposits of less than $100 000	RCONA579-RCONA582	
Time deposits of $100 000 or more	RCONA584-RCONA587	

Notes: Entries reference the mnemonics in the Call report data, listed under the relevant period(s). The shaded rows refer to variable names that remain the same throughout the sample years. Data are downloaded from the Federal Reserve Bank of Chicago (http://www.chicagofed.org/economic_research_and_data/commercial_bank_data.cfm). All data items (balances as of December 31st) are from the fourth-quarter report of each year. Using the Entity Type Code variable (RSSD9331), only data of commercial banks are selected. A bank is included in the loan-interest-rate calculation only when data on both interest income and loan balance are available. This requirement mostly affects banks with less than $25mln in assets, which before 2001 did not have to provide a breakdown of total interest income by loan category. In 2004, this category of banks represented around 0.1 percent of total commercial bank assets.

Table A.2. Notes on changes in variable definitions in the Call Reports, 1997–2007

Code/Item	Note
RIAD4246, RIAD4247, RIAD4248	Up to 2000, small and medium-sized banks used these variables to report their interest income for the different loan categories. RIAD4249 covers interest income on Commercial & Industrial loans, but also on all other loans, so this variable was omitted at the cost of coverage of the industry loan totals. Banks with fewer than $25mln in assets did not have to report any of these variables.
RCON2008, RCON2011	Up to 2000, banks with domestic and foreign offices only had to distinguish between credit card loans and consumer installment loans for the consolidated bank. Total loans to individuals are available for the bank's domestic offices. To increase coverage, the share of credit card loans and of consumer installment loans was calculated based on the consolidated totals (codes RCFD2008 and RCFD2011) and applied to the total for the bank's domestic offices.
RCONB538, RCONB539	From 2001 onwards, credit card loans (RCONB538) do not include other revolving loans (RCONB539) anymore.

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