

Real Output of Bank Services: What Counts Is What Banks Do, Not What They Own

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July 2010

Abstract: The measurement of bank output, long a difficult and contentious issue, has become even more important in the aftermath of the devastating financial crisis of recent years. In this paper, we argue that models of banks as processors of information and transactions imply a quantity measure of bank service output based on transaction *counts* instead of *balances* of loans and deposits. Using data for the U.S. and a range of European countries, we show that the counts-based output measure exhibits significantly different growth patterns than the balances-based output series over the years 1997 to 2009. Since the U.S. statistics rely on counts while European statistics rely on balances, this implies a considerable bias in the estimate of bank output growth in Europe vis-à-vis that in the U.S.

JEL Classifications: E01, E44, O47

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We would like to thank Chris Kask of the Bureau of Labor Statistics (BLS) for providing us with the data and description of the BLS output statistics for commercial banks, and Susanto Basu, Erwin Diewert, John Fernald, Alice Nakamura, Marshall Reinsdorf, Paul Schreyer, Kevin Stiroh, Marcel Timmer, Jack Triplett, and participants at the NBER/CRIW Summer Institute 2006 and seminars at the Federal Reserve Bank of San Francisco and the University of Groningen for useful comments and suggestions on previous versions. The views expressed in this paper are solely those of the authors and do not necessarily reflect official positions of the Federal Reserve Bank of Boston or the Federal Reserve System.

I. Introduction

The measurement of bank output has long been a difficult and sometimes contentious topic that is yet to see a consensus resolution. Reaching the right output measure for bank services has become more important in the aftermath of the recent devastating financial crisis as the role of financial firms have come under intense scrutiny. One of the questions attracting greater attention is how much have banks truly contributed to the real economy in terms of the value of their services, which can be construed as corresponding to the so-called “utility” function of banks. In particular, has their output over the past decade been overestimated because bank income has been inflated by the higher return on more risky asset holding?

What makes measurement of bank output, even its *nominal* value, challenging is the fact that banks often do not charge explicit fees for many of their services. Instead, banks receive implicit compensation in the form of wider interest margins – charging higher interest rates on loans and paying lower rates on deposits than would be implied solely by their respective risk.¹ As a result of this business model, it is difficult if not impossible to apply the standard approach of surveying revenue and prices.

From a methodological standpoint, one must rely on a coherent theory of bank operation to derive the right output measure – there is no measurement without theory. To that end, extensive theoretical research has identified a set of useful services that constitute banks’ *raison d’être*. Chief among these are screening and monitoring borrowers to mitigate asymmetric information problems and facilitating transactions in general.² Once we agree on these theoretical results, the question then becomes what indicators to use in practice to best track the quantity of such bank services.

The goal of this paper is to empirically implement an output measure implied by a banking model that is built on basic theories of financial intermediation and asset pricing. This model’s central message for measurement is that bank output should be measured as indices of quality-adjusted³ counts of different categories of banking transaction. This is

¹ Hence the analogy to the other, better understood, margin industries such as wholesale and retail.

² See e.g. Levine (2005) for an overview.

³ Throughout the paper, ‘quality-adjusted’ refers to adjusting the output index for variation in the composition of individual services constituting the aggregate index.

generally equivalent to deflating revenue when fees for services are explicit, as with novel bank activities that typically generate no financial claims on the balance sheet. When banks charge implicitly via an interest margin on loans and deposits, it becomes necessary to measure output by directly constructing quantity indices, based on quality-adjusted activity counts.

In principle, what constitutes a distinct type of banking services should be determined by demand – that is, buyers’ perception of a distinct product – just as for any other services. It is, however, not obvious how this applies to some of the bank services furnished without explicit charges that do not directly generate utility for customers, such as screening and monitoring borrowers. A reasonable hypothesis is that bank customers classify such services according to the affiliated category of financial instruments, since they generally perceive their needs in terms of features of the financial contracts. For instance, lending to businesses most likely involves different services than lending to households; within the latter category, making residential mortgage loans is likely also regarded by consumers as a different kind of service than making car loans or credit card loans. In practice, types of bank services are largely dictated by data availability – for however many varieties of transactions and categories of financial instruments (e.g., loans and deposits) with implicit services attached.

In this paper, we measure bank services associated with loans and deposits for which activity count data are available. For example, the number of commercial loans measures one type of bank output of lending services to businesses while the number of debit card transactions measures one type of bank payment services. This approach amounts to assuming that processing every loan and deposit transaction within each empirically available category corresponds with a constant quantity of services over time.

We then contrast this model-implied output measure based on transaction counts with a measure based on outstanding balances of loans and deposits deflated using a general price index. This latter approach in effect assumes that every euro or dollar corresponds with a constant quantity of services over time. However, models in previous studies have shown that there is no fixed proportionality between outstanding balances

and service flows under a broad set of conditions.⁴ In contrast, counting activities directly always yields the right output measure in theory, although adequate quality adjustment is difficult in practice because of the lack of relevant detailed data.

The theoretical distinction between these two approaches would be of limited interest if they produced the same empirical estimates. But they do not, according to the comparisons using data from both the U.S. and Europe on categories of bank activities for which transaction data are available. We consistently find that (CPI-)deflated balances provide a very different picture of bank output than loan and transaction counts. In the case of U.S. commercial and industrial loans, the average loan size (in both nominal and real dollars) has decreased steadily over time, so the deflated-balances approach underestimates true output growth. Likewise, the number of deposit transactions has grown much faster than deposit balances, meaning deflated balances understate true output growth. On the other hand, house prices in the U.S. and most European countries have increased faster than the overall price level, leading to an increase in the average size of residential mortgages. As a result, the CPI-deflated balances overestimate true output growth of mortgage lending.

These findings have important implications for cross-country growth comparison. In the U.S., official statistics have so far been based on the activity-counts approach,⁵ while the European statistics almost entirely rely on the deflated-balances approach.⁶ Following our reasoning, European bank output growth is biased relative to the U.S. estimates, although the overall magnitude of the bias is unclear given our finding of biases in both directions and the fact that we lack data to conduct a similar comparison for other types of loan or deposit services. It is an empirical matter for future studies.

Our proposal for an activity-count-based measure of bank output can also have implications for productivity estimates over the past decade or so. In particular, if bank output has been overestimated because of inflated asset valuation and in turn balances, it would call for revisiting estimates of the U.S. productivity revival since the mid 1990s

⁴ These arguments are formalized most extensively in Wang, Basu and Fernald (2009) and Basu and Wang (2006).

⁵ See e.g. Brand and Duke (1982) for the approach taken by the U.S. Bureau of Labor Statistics (BLS) and Fixler and Reinsdorf (2006) for recent research by the U.S. Bureau of Economic Analysis (BEA).

⁶ In the Netherlands, the number of deposit transactions is used for depositor services, but a deflated balances approach is used for lending services.

because the financial services industry accounts for a non-trivial fraction of the productivity speed-up. Furthermore, growing interest has been expressed in discussions of financial regulatory reform to separate banks' "utility" function from their risk-taking function.⁷ Our estimates in this study can be viewed as a first attempt to gauge, given data availability, the growth contribution of banks' utility function that is minimally contaminated by the risky returns earned by banks.

The rest of the paper is organized as follows. In the next section we outline our methodology and compare with the other commonly used methods. Section three outlines the data sources, implements the two approaches to bank output measurement and compares the resulting output series. Section four discusses the implications for bank efficiency research and Section five concludes.

II. Methodology

This section first reviews the banking model underlying our preferred measure of bank output. The emphasis is on the theory's methodological implication for measuring bank output, at both current prices and, more importantly, constant prices – decomposing nominal output into its price and quantity components.⁸ We discuss why our method yields consistent measure of bank services, regardless whether they are associated with financial claims on the balance sheet and whether they generate explicit fees.

2.1 The Theory and Its Implications for the Measurement of Traditional Services

The theory behind our measurement is developed in Wang (2003a) and Wang, Basu and Fernald (WBF, 2009). Wang (2003a) considers the partial-equilibrium case while WBF (2009) extend it to general equilibrium. In these models, the core function of banks is to screen and monitor borrowers to reduce information asymmetry in lending, and to provide payment services to depositors and borrowers. Modeling banks' *raison d'être* as resolving asymmetric information problems follows the tradition of an extensive

⁷ See, e.g., various speeches by the Bank of England governor Mervyn King, one of which can be found at <http://www.bankofengland.co.uk/publications/speeches/2009/speech406.pdf>.

⁸ In what follows, real output is used interchangeably with output quantity and output at constant prices.

literature on financial intermediation.⁹

One key implication of this theory for output definition is that, even though the provision of banking services is often integrated with the transfer of funds between depositors and borrowers, these funds *per se* are not bank's output. Rather, their role can be thought of as analogous to that of the goods transported and marketed by wholesalers and retailers.¹⁰ This implication is particularly relevant for bank services that are remunerated implicitly through extra interest margins because they result in financial claims on the balance sheet, which is characteristic of most traditional banking activities. In fact, the models in both WBF (2009) and Wang (2003a) purposely consider the polar case where a bank charges for *all* services via interest margin.

Consequently, the models stipulate that, to measure bank output, one should try to directly estimate the *flow* of services, just as one does services of consulting and accounting firms. And one should *not* use the accompanying *stock* of loan and deposit balances, since there is no theoretical basis for assuming fixed proportionality between service flow and asset balance. In fact, using an extension of the Baumol-Tobin model, Basu and Wang (2006) demonstrate that there is no constant relationship, let alone fixed proportionality, between the two if the relative technology for producing bank services changes over time. Besides technological progress, many other real-world factors, including inflation, can cause the balance-service relationship to vary over time.

To see the intuition of the distinction between the activity-counts and the deflated-balances methods, consider the analogy to estimating the service output of a car dealership. Is it more sensible to count the number of each make of cars *sold* in a period (and aggregate using sales commissions by make as weights), or count the CPI-deflated dollar value of the *accounts receivable* on the dealer's book at period-end? Counting the number of specific types of cars sold is no doubt imperfect, since it ignores possible

⁹ See for example Campbell and Kracaw (1980), Leland and Pyle (1977), and Diamond (1984, 1991) for theoretical modeling along these lines. See Mester (1992) for an empirical analysis that takes some of these considerations into account.

¹⁰ Although helpful for intuition, this analogy should not be taken literally because funds do not satisfy the technical definition of purchased intermediate inputs in the current national income accounting system, which must have themselves been counted as the output of some other productive units.

changes over time in the quality-adjusted sales services devoted to each vehicle sold.¹¹ But this is no more than the usual empirical difficulty with quality adjustment.

In contrast, the dollar value of accounts receivable at a point in time deflated by some general price index such as the CPI would bear a fixed relationship to the amount of sales services only under restrictive conditions that are unlikely to be realistic.¹² One should at least deflate the dollar value of cars *sold* during the period with a composite price index for autos based on the mix of cars sold. However, for this series to be a valid proxy for the amount of sales services, one still needs the assumption of a constant relationship between the price of cars and the price of sales services.¹³ Furthermore, it too suffers from the same quality adjustment problem that afflicts the output measure based on direct number counts. So it seems that one can do no better than to use counts directly.

Counting the number of loans and depositor transactions is exactly analogous to counting the number of cars sold, while using deflated loan and deposit balances is analogous to using the deflated dollar amount of the auto dealer's accounts receivable. We argue that the former is more sensible. For indices of transaction counts to accurately measure bank output, however, each category of bank services must be defined carefully. Since products in principle should be identified from the perspective of demand, bank services should be classified according to customers' perception of the objective of tasks performed. For instance, if all residential mortgage loans conforming to the underwriting criteria issued by the U.S. government-sponsored enterprises are perceived to be the same product, then the origination of such loans should be defined as a type of bank service. Likewise, the origination of business loans with principal less than \$100,000 to fund working capital may be another type of service. With the output of each type of service measured, aggregate output growth can be derived in the standard way using (implicit as

¹¹ Differences in service quality across sales of different kinds of cars (for example, selling Mercedes entails more up-scale services) in principle cause no problem (for aggregation), so long as the revenue accrued to each type of sales services is correctly measured, providing the right aggregation weights.

¹² The resulting series has little reason in theory to bear any stable relationship to even the number of cars sold, let alone the amount of sales services. And this is true even under the stringent assumption that all dealers sell the same mix of cars at all times.

¹³ The problem lies in the aggregation weights implicit in this proxy: it is based on a vehicle's entire value instead of just the sales commission part, which is the right weight for aggregating across types of sales services. Under perfect competition in both car manufacturing and sales markets, the use of this proxy amounts to assuming the same rate of technological progress in the production and sales of cars.

well as explicit) revenue shares. Furthermore, efforts should be made to adjust for quality differentials in a service across banks and over time, just as in other service industries.

Some may argue that the financial balances are merely used as proxies for the true bank output, which is agreed to be productive services such as loan screening. Then our models can be reinterpreted as establishing that financial balances are a poor proxy for financial service output. To see the logic, consider a simple example. Suppose C&I loan A has a smaller balance but is more risky than C&I loan B, then monitoring A may well require more bank services, manifesting in a bigger (implicit) income. An output measure based on loan balance will, however, give the opposite result. This example illustrates intuitively one basic problem with using financial balance to measure bank output: any single attribute of a financial instrument is almost inevitably a poor proxy for the quantity of services involved in its creation. Financial instruments are fundamentally contracts of contingent claims and thus have multi-dimensional attributes; all of the attributes can affect the amount of bank services produced in creating the contracts.

On the other hand, differences in any of the financial attributes do not necessarily affect the quality or quantity of the associated services. For instance, we control for the composition of risk ratings in our estimate of the output of C&I lending services since riskier loans generally require more screening and, all else equal, should result in higher implicit charges and hence quality-adjusted output. But greater risk does not per se equal greater output. To illustrate, again consider the above example. Even if there were no monitoring, loan A would carry a higher interest rate because of its greater credit risk and so bring in more interest income so long as the borrower is solvent. But this extra interest represents purely a transfer of property income but not value creation from new (bank) services, *if* there exist (combinations of) market securities with the same risk attributes. The intuition is that no productive activities are needed to invest in market securities and earn their risk-adjusted returns. So, only the interest above and beyond the risk-adjusted return should be counted as implicit revenue for bank services, and loan A may not bring more service revenue if the bank applies the same credit-scoring software to every loan.

In light of the recent financial crisis brought on by poor performances of subprime mortgage loans, one aspect of quality adjustments of lending service output needs further elaboration. Intuitively, the average ex post performance of a bank's loan portfolio should

depend foremost on how well it screens and monitors its borrowers, once relevant aggregate factors are controlled for (such as GDP growth and the general level of risk premia). So, to account for the quality differentials both across banks and over time, one would ideally also factor in the bank-specific ex post outcome of loans in each category. Compared with simple loan counts, this adjustment would avoid the problem of crediting banks that churn out large numbers of poorly scrutinized loans with high output.

The framework of Wang (2003a) and WBF (2009) also implies answers to some long-standing debates, in particular the role of deposits and depositor services. Notably, it can distinguish between deposits and depositor services and classify them separately. Deposits are regarded as an intermediate input in lending, whereas depositor services are an output of transaction services, albeit often furnished without explicit charges. In contrast, the three output measures used in bank efficiency studies cannot distinguish between depositor services and deposits, because the flow of services is measured using the stock of deposits, meaning that they have to be classified the same – both as input or both as output.¹⁴

In fact, classifying depositor services as an output is a natural conclusion since the models are motivated in part by the need for coherent measurement of bank services furnished without explicit charges. Unsurprisingly, the models imply a definition and measure of output that is invariant to how a service is compensated for – via explicit revenue or a barter for cost saving on certain inputs.¹⁵ The basic logic holds in general: when a firm expends inputs to create a commodity that is valued by certain parties, this commodity should be recognized as an output – it is conceptually irrelevant via what medium (e.g., fiat money or other commodities) the firm exchanges for the output's value. Applied to banks, this principle means that it makes no difference whether a bank charges depositors for its services and at the same time pays the market rate for the depositors' funds, or pays for the funds in part with the services directly.

¹⁴ Specifically, the intermediation approach treats deposits as an input for making loans, the value-added approach treats depositor services and hence deposits as an output, while the user-cost approach lets the role of deposits be set endogenously by the reference interest rate. More on their underlying theories later.

¹⁵ The debate about depositor services goes at least as far back as Sealey and Lindley (1977) and Benston and Smith (1976). Sealey and Lindley (1977) argue that bank transaction services yield no direct revenue and are merely part of the cost of acquiring deposits while Benston and Smith (1976) argue that banks produce financial services (“commodities”) for both depositors and borrowers and are compensated for the accompanying costs.

III. Data and Estimates of Bank Output

This section first describes the methodological choices we have to make in order to implement our theory-implied output measure using available data. It then outlines the data sources (with greater detail available in the data appendix) and discusses the construction and properties of output series for a range of bank services. The categories of implicitly priced bank services are chosen because both activity and balance data are available for them. We also endeavor to construct price and quantity indices for non-traditional bank activities.

3.1 Methodological Choices for Implementing Our Output Measure

As mentioned above, traditional bank activities often generate interest margins but no explicit fees for services. So, the difficulty with measuring their output at current prices carries over to measuring real output. The usual method – deflating revenue using price indices to estimate indices of real output – is seldom applicable. The alternative we adopt is what we will call the “activity-counts” method: estimate real output indices using direct quantity indicators. The Bureau of Labor Statistics (BLS) is one source of such activity data. The BLS series cover the number of four types of loans – residential real estate, credit card, other consumer and commercial & industrial (C&I) loans – and transactions on two types of deposit accounts – demand, and time and savings deposits.¹⁶

We also derive activity counts of business lending services using data gathered by the Federal Reserve’s Survey of Terms of Business Lending (STBL). The STBL collects data quarterly on terms of C&I loans originated during the survey week at a sample of banks operating in the U.S.; for this study, we only use data on domestic banks in order to scale up to the industry level by mapping to the C&I loan balances in the Call reports. The publically available information covers total volume, average size and maturity of loans originated by credit risk rating and repricing (i.e., interest rate reset) frequency.¹⁷ This enables us to infer the number of C&I loans originated by risk rating, which is probably the attribute most relevant for the amount of screening services performed.

¹⁶ We thank Chris Kask at the BLS for kindly providing these data along with the documentation.

¹⁷ For documentation and more details, see data release E.2 at <http://federalreserve.gov/releases/e2/>.

Accordingly, aggregate growth of overall bank C&I lending services can be calculated as the weighted average growth in different rating classes. That is,

$$\Delta \ln L_t = \sum_i \bar{w}_{it} \Delta \ln L_{it}, \text{ where } \bar{w}_{it} = .5(w_{it} + w_{i,t-1}) \text{ and } w_{it} = V_{it} / \sum_i V_{it}. \quad (1)$$

$\Delta \ln L_t$ is the growth rate of overall C&I loan count index L_t , while $\Delta \ln L_{it}$ is the growth of loans in rating class i . $\bar{w}_{it}$ is the average share of rating- i loans in total implicit revenue from C&I services. Implicit revenue from rating- i loans, V_{it} , can be imputed as follows:

$$V_{it} = [(r_{it} - r_{it}^M) Z_{it}] L_{it}, \quad (2)$$

where r_{it} is the interest rate on rating- i loans, r_{it}^M the yield on reference market securities, and Z_{it} is the average size of rating- i loans. $(r_{it} - r_{it}^M) Z_{it}$ is the extra interest margin on each loan of type i to pay implicitly for the bank's lending services; its role is analogous to the price, albeit implicit, of services.

As detailed in BIW (2009), r_{it}^M for loans in “Minimal” and “Low” risk classes can be identified according to the STBL instructions, whereas r_{it}^M for risk classes “Moderate” and “Other” are unclear. We hence experiment with two polar assumptions about their r_{it}^M : 1) use the same r_{it}^M for Moderate- and Other- as for Low-risk loans so that all the extra interest margin is regarded as greater implicit revenue for services; 2) raise r_{it}^M for Moderate- and Other-risk loans until their service margins (i.e., $r_{it} - r_{it}^M$) equal that for Low-risk. See **Figure A.1** in the appendix for the respective estimate of $r_{it} - r_{it}^M$. These two alternatives yield the upper- and lower-bound estimate, respectively, of $(r_{it} - r_{it}^M) Z_{it}$, the true implicit service revenue associated with Moderate- and Other- risk C&I loans.

Together, (1) and (2) make clear that only when either $\bar{w}_{it}$ or $\Delta \ln L_{it}$ were constant would $\Delta \ln L_t$ from (1) equal $\Delta \ln L_t$ calculated as $\Delta \ln \sum_i L_{it}$. If $\bar{w}_{it}$ and $\Delta \ln L_{it}$ are correlated, then the latter estimate of the aggregate growth rate will introduce not only random noise but bias. For instance, if the number of loans with falling relative service margin tends to grow sufficiently faster that their revenue share in fact rises in overall C&I services, then estimating aggregate growth based on unweighted total loan counts would underestimate

the true growth of C&I services.¹⁸ Likewise, the frequency of interest rate resets can also affect the implicit price and in turn the aggregation weights for each type of loan because it determines the frequency of updates as well as the maturity of reference rate r_{it}^M .

An index of weighted number of loans originated is our theory-consistent measure of banks' output of screening services. Extra interest margins earned by banks as implicit revenue for screening loans serves as the weights. By the same token, an index of weighted number of outstanding loans is our output measure for monitoring services, assuming that banks monitor every loan in the portfolio. Implicit revenue earned on monitoring serves as the weights. So one needs respective revenue data for screening and monitoring to account for their output separately. With only the estimate of all C&I-based implicit revenue, we choose to account for bank C&I services using the number of loans outstanding in each period. This sum includes new loans originated in the current quarter plus loans that were originated in previous quarters but remain on bank balance sheets. So we in effect assume that screening and monitoring each C&I loan of a given set of attributes (that is, rating and repricing frequency in this case) involves equal amount of services and that newly originated loans need no monitoring in the same period.¹⁹

To estimate the number and dollar volume of outstanding loans implied by the STBL data on originations, we apply the perpetual inventory method (PIM) to the origination count as well as volume. That is,

$$L_{it}^S = \sum_{\tau=t}^{t-K} (1 - \delta_{i\tau})^{t-\tau} L_{i\tau}^N, \text{ and } A_{it}^S = \sum_{\tau=t}^{t-K} (1 - \delta_{i\tau})^{t-\tau} A_{i\tau}^N. \quad (3)$$

L again denotes the number of type- i C&I loans, while A denotes the corresponding dollar volume. The superscript “ S ” stands for stock, while “ N ” stands for new origination. $\delta_{i\tau}$ is the constant rate of amortization for loans originated in quarter τ , determined by their maturity. Specifically, we estimate a geometric amortization rate $\delta_{i\tau}$ as follows:

$$\delta_{i\tau} = \alpha / T_{i\tau}. \quad (4)$$

¹⁸ Such a pattern of correlation is not uncommon in markets of many other products: those with falling relative prices tend to witness increasing shares.

¹⁹ We could instead use the sum of loans outstanding plus a half of origination, which amounts to assuming that loans are on average originated in the middle of a period and then immediately monitored in the same period. Since the number of loans outstanding exceeds that of origination by many times, this alternative estimate exhibits similar time series properties.

α is analogous to the so-called declining balance rate for capital accounting, and we adopt the value of 2, which is typically used for fixed capital. $T_{i\tau}$ is the average life of type- i loans originated in period τ , which we assume equal to the average maturity.²⁰

To arrive at C&I output estimate for all U.S. domestically chartered banks, we then scale up the STBL-based figures using C&I balances in the Call reports. That is, we estimate the number of type- i loans outstanding in all domestic banks using the ratio between STBL- and Call-reports-based loan balances:

$$L_{it}^{S,Call} = (A_t^{S,Call} / \sum_i A_{it}^S) L_{it}^S. \quad (5)$$

The implicit assumption here is that the composition of C&I loans in the STBL sample is the same as that of the aggregate C&I portfolio in the Call reports. This assumption notwithstanding, more detailed data on loans by rating class and repricing frequency in the STBL should in principle produce more accurate estimates of aggregate growth in overall bank C&I lending services according to equation (1), with $L_{it}^{S,Call}$ substituting for L_{it} . Once we construct the quantity indices, together with imputed service revenue, they imply the price indices.

Among the existing data, these activity counts accord best conceptually with our model-based output measure, because they correspond more directly to the natural units of bank services. They are of course not perfect, since using them in effect assumes that a given loan or a given depositor transaction represents the same quantity of a specific type of services over time. But this is fundamentally an empirical limitation, no different from the general difficulty with quality adjustment that troubles the measurement of all services. Moreover, we argue that this assumption is (much) more sensible than assuming that a given amount of purchasing power on a bank's book represents a constant quantity of services over time, which is the implicit assumption underlying commonly used output measures that are based on loan or deposit balances deflated by the CPI or the like.

Nevertheless, since asset balances are often more readily observed, it is useful to examine the conditions under which bank activity counts can be adequately approximated using properly deflated loan balances. We hypothesize that such balance-based proxies

²⁰ Lacking sufficient information on prepayment, we ignore its potential impact on amortization.

are most promising for categories of loans that are used to finance purchases of assets for which accurate price indices exist. In addition, loan-to-value ratios are available to link loan balances and asset values. A prime example is residential mortgage loans, and we use it to illustrate the mapping between activity counts and loan balances. In growth rate, the relationship between the number and the balance of mortgages can be expressed as:

$$n_t + p_t = b_t - v_t . \quad (6)$$

n_t is an index of the number of mortgage loans processed. Importantly, the number of loans should equal the number of houses purchased, a condition mostly satisfied in the U.S. where almost all borrow to buy houses. p_t is the price index of those houses whose purchases are financed with loans. b_t is the loan balance, and v_t the average loan-to-value ratio. Both sides of (6) equal total value (in growth rate) of homes financed with loans. This way, the growth rate of a real bank output (n_t) can be inferred from the more readily available loan balance (b_t) so long as p_t and v_t are also available.

Note that, for (6) to hold, n_t and p_t can be chosen as either unweighted or house-value-weighted indices. The two alternatives correspond to different assumptions about the relationship between loan counts and bank service output, so the choice should be guided by our assessment of which assumption is more plausible. Using value-weighted loan counts amounts to assuming that the implicit-revenue share of each (type of) mortgage equals its house-value share, while using unweighted loan counts assumes that each loan generates about the same implicit revenue. We choose the unweighted indices because we deem the latter assumption more plausible. Note that the correct asset balance to use should still be a *flow* instead of a stock variable – the cumulative balance of loans processed within a period, not the outstanding balance at period end. In particular, cumulative balances account for refinancing services, whereas period-end balances cannot. The latter may serve as a proxy if it is the only available data.

Assuming the loan-to-value ratio is stable, then the relationship simplifies to

$$n_t = b_t - p_t . \quad (7)$$

That is, an output quantity indicator (n_t) can be derived from a deflated balance. Key to the derivation is the proper deflator – it should be the price index for the assets funded but not just any general price indices. Obviously, the accuracy of such an output estimate

hinges on the quality of the asset price deflator. In the empirical section below, we will estimate the output of residential mortgage origination based on (7).

Ultimately, to improve the accuracy of the output estimates, more effort must be devoted to obtaining direct counts of precisely defined transactions, since any output measures based on asset balances are at best approximations whose accuracy depends on the validity of the underlying assumptions. For lending services, effort should be made to collect data of loan numbers for a larger set of more finely classified loans, since the content of bank services is likely to be more stable for finer categories of loans. In particular, the data should distinguish between new loans made each period (which maps into origination services) and outstanding loans (which maps into monitoring services). Moreover, multi-dimensional data on the features of each type of lending service are also needed to facilitate adjusting for quality changes over time. Similar data collection efforts should be expended for depositor services as well.

3.2 Estimates of Bank Service Output

In this section, we describe and compare empirical estimates of the real output of a variety of bank services according to the different measures. To this end, we focus on those categories of traditional bank services for which count data are available.

3.2.1 Real Output of Bank Lending Services

Figure 1 plots the time series of different estimates of output index for C&I lending services. All the series are scaled to the industry level. First, the line labeled “Deflated Balance” is based on the CPI-deflated balance of C&I loans. In contrast, all the other three output series are based on the Call-reports number of outstanding C&I loans in each rating and repricing frequency class (i.e., $L_{it}^{S,Call}$) as described in Section 3.1.2 above. The indices are all derived according to formula (1), only with different aggregation weights w_{it} ’s. The “Summed Number” index is calculated using the simple sum of all C&I loan counts, equivalent to setting $w_{it} = 1/N$ in (1), for every t and class $i = 1, \dots, N$. Both of the other two series use i ’s implicit-revenue share as the weight, but they differ in the assumption regarding the market reference rate r_{it}^M , leading to different w_{it} ’s. The “Weighted Number - Common Risk” line assumes the same r_{it}^M , while the “Weighted

Number - Common Margin” line assumes the same service margin (i.e., $r_{it} - r_{it}^M$), for C&I loans in all but the Minimal-risk class.

One clear pattern emerging from the chart is that the CPI-deflated balance series exhibits by far the lowest growth rate throughout the sample period, averaging a mere 0.5% per year. The faster growth of count- vs. balance-based indices is to be expected, given that the average size of C&I loans have steadily fallen over 40% during the sample years (see **Figure A.2** in the appendix). Among the loan-count-based indices, “Summed Number” and “Weighted Number - Common Margin” lines have similar time series, with average annual growth rates of 2.0% and 2.2%, respectively. This is not surprising given that the latter series assumes the same aggregation weight (i.e., service margin) for over three-quarters of loans. The fastest growing is the “Weighted Number - Common Risk” index, averaging 3.1% per year. This is the combined result of 1) much higher service margins for the two riskier (i.e., “Moderate” and “Other”) classes of loans (see **Figure A.1**), and 2) faster growth in the number of those riskier classes of loans (see **Figure A.3**). The true output index should lie between the “Common Risk” and the “Common Margin” series, given the underlying polar assumptions about the service margin.

Figure 2 illustrates our effort to derive a proxy for bank service output from the associated asset balance and the most suitable price index. Specifically, we approximate the number of mortgage loans processed (including both existing loans serviced and new loans originated) with a suitably deflated balance. According to the discussion above (Section 3.2.1), we apply the equal-weighted purchase-only house price index published by the Federal Housing Finance Agency (FHFA) to equation (6).²¹ The loan-to-price data also come from the FHFA; loan-to-price ratios for all mortgages prior to October 2002 are spliced with values specific to mortgage loans made by commercial banks afterward. For comparison, **Figure 2** also depicts the index based on the same loan balance deflated using the CPI. Last, it plots the index based on simple counts of mortgage loans, derived from the loan balance and average loan size. The count series and the FHFA-index

²¹ Formerly known as the Office of Federal Housing Enterprise Oversight (OFHEO). Strictly speaking, the price index should be specific for the houses whose purchases are financed with bank loans. So the implicit assumption here is that there are no systematic price differences between houses financed by mortgages on banks’ balance sheets and conforming-mortgage-financed houses underlying the FHFA index. The two alternative house price indices, LoanPerformance and Case-Shiller S&P, are both value-weighted.

deflated balance are highly correlated, and have a similar average growth rate of roughly 5% per year.²² This is to be expected since the average loan-to-price ratio has been stable over the sample period. By comparison, the CPI-deflated balance shows faster growth throughout the sample, especially since around the turn of the millennium. This pattern is no surprise given that house price appreciation far outstripped general inflation since late 1990s. The growth correlation between the loan-count and the CPI-deflated series is also lower.

We extend this modified deflated-balance approach to estimating the output of mortgage lending services to an international sample. **Figure 3** shows estimates for a panel of European countries for which we have found fairly consistent data on house prices and aggregate mortgage balances; Appendix Table A1 details these data. We again compare the house-price-deflated balance with the CPI-deflated balance. The former is not adjusted for variations in the loan-to-price ratio over time because of the lack of data. But this should have minimal impact on the overall time series properties of the output estimates provided that loan-to-price has been as stable in these European countries as in the U.S. The most prominent finding emerging from these comparisons is that, with the exception of Germany, using house price indices to deflate loan balances lowers the estimates of growth in residential mortgage lending services in all the other seven countries.

This is the same pattern seen in the U.S. data, and owing to the same reason – house prices appreciation outpaced general inflation over the sample period in almost all these European countries as well. In fact, six of these countries saw the relative price of houses rise by five to seven percentage points on average per year over the 15 years of our sample, much more rapid than that experienced in the U.S. As we have elaborated above, this means that one would be overstating the growth of bank services in making mortgage loans by a considerable margin for some countries if one uses the CPI-deflated loan balances. These overstatements would in turn bias productivity estimates for the banking industry in these European countries vis-à-vis in the U.S.

The mapping between deflated balance and activity counts, however, is hardly stable for the other loan and deposit categories: the correlation between the average loan

²² This is not to say that either quantity series is free of the usual problem with quality adjustment.

or deposit balance (approximated by the balance-to-count ratio) and the price inflation for the most relevant capital assets varies between -0.6 and +0.3 across loan and deposit categories.²³ This is not surprising, since neither a valid price index for the underlying assets nor a stable loan-to-value ratio is likely to exist for the other loan categories.

3.2.2 Real Output of Bank Services to Depositors

Figure 4 depicts the composite output index of bank depositor services estimated according to three different approaches. As the legend indicates, one of them is based on “Deflated transaction account balances” while the other two are aggregate indices of the number of a variety of transactions associated with deposit accounts. We use annual data collected by the Bank of International Settlements (BIS) of both the number and the value of the following types of transactions: credit transfers, direct debits, debit and credit card payments, checks, and ATM transactions. Table A1 lists the underlying data between 1997 and 2008.

The two transaction-count-based indices differ only in their aggregation methods. “Number of transactions: unweighted sum” is an index derived according to the simple sum of total number of transactions across all types, equivalent to setting the weights equal to shares in total transaction numbers. It averages 3% growth per year. “Number of transactions: transaction-value weighted” weights the growth of each type of transactions by its share in total value of all transactions. It averages 2% growth per year, somewhat slower than the index based on the simple sum of transaction counts. On the other hand, both of these indices show faster growth vis-à-vis the third index, which is based on deflated balances of transaction accounts. In fact, the CPI-deflated account balances fall by an average of 2% per year over the sample period.

We recognize that none of these aggregation weights is ideal, which should be the share of implicit depositor service revenue accrued to each type of transactions. The series reported here can be regarded as sensitivity checks in the absence of detailed data needed to apportion total implicit deposit-related revenue. Interestingly, those types of transactions (e.g., credit transfers, direct debits) that used to account for smaller shares in

²³ For deposits, the balance-to-count ratio equals the average dollar of deposits per transaction. Appendix Table A.5 reports the indices of these ratios for each activity covered by the BLS quantity counts.

either number or value saw faster growth over the sample years. Consequently, among the transaction-count-based output indices, weighting by transaction counts or values yield similar average growth rates for depositor services as a whole, while an aggregate output index based on the simple average growth rate of each type of transactions would exhibit much faster growth over the sample period (averaging 8% per year, not shown).

Figure 5 summarizes an international comparison of the same three indices of depositor services. Specifically, it shows average growth rates of the three similarly constructed output indices in seven European countries for which the BIS has collected comparable data since 2000.²⁴ Limited by data, we use overnight accounts as the European counterpart to transaction accounts in the U.S. (again see Table A.1 for details of the data.) A similar pattern emerges from this panel of European countries: like in the U.S., the output index based on simple sum of number of transactions experiences consistently higher growth rates than the index based on deflated balances of overnight accounts. On the other hand, the relationship between the two transaction-number-based indices (due to different weights) varies from country to country. For instance, between the two series, growth in the value-weighted transaction index is faster in Italy and U.K. but much slower in Germany and Sweden. Nevertheless, if we take the average of the two series to be the transaction-count-based output index, it would show faster growth than the account-balance-based index in all of the sample countries except Germany and Sweden.

V. Conclusions

Activities of banks have attracted greater scrutiny in the aftermath of the recent damaging financial crisis. The difficult question of how to measure bank output has thus taken on greater importance as well. Recent theoretical effort (Wang 2003a, WBF 2009) to model the operation of financial institutions such as banks yields a coherent framework for measuring the output of bank services whether or not they generate explicit fees. These models recognize that, regardless of how a bank service is remunerated, banks perform qualitatively the same services – processing information (especially to resolve

²⁴ In a future version, these data will be extended to the mid-1990s using earlier editions of the BIS Red Book.

asymmetric information problems) and transactions – and so their output should and can be measured in the same way. This generally entails constructing quantity indices based on quality-adjusted count for each type of finely and exactly defined transaction, especially in the case of bank services furnished without explicit charges. In contrast, asset balances deflated by a general deflator are a poor and often biased proxy for true bank output under most conditions. To aggregate across these types of bank services, the true revenue from each type serves as the weight. In cases where implicit charges for services are bundled with asset returns, the true service revenue needs to be imputed from total bank income by removing the risk-dependent returns on the associated assets.

To highlight how activity-count-based quantity indices of bank output differ from deflated-balance-based indices empirically, this study applies the above model-implied output measure to several categories of traditional bank services for which data on both transaction counts and affiliated financial balances are available over the years 1997 to 2009. These include lending to businesses, to households for home purchases and deposit-account-related transactions. For quality adjustment, the count-based quantity index for each sub-category of activity is aggregated using its share in the implicit service revenue as weight when such detailed data are available. Ideally, quality of a bank's lending services should also incorporate information on the ex post performance of its loan portfolio, which on average depends on how well the bank has screened and monitored borrowers.

These activity-count-based output indices almost invariably exhibit notably different growth path compared with output indices based on deflated balances. In particular, for most of the bank activities we consider, the count-based indices show faster growth on average over the sample period than the deflated-balance series. As previous theoretical work (Basu and Wang, 2006) has shown, CPI-deflated balances can be a valid indicator of service quantity only under restrictive conditions, such as static technology for producing financial services. This suggests that bank output in traditional services may have been understated in official statistics. In turn, it suggests that official estimates have not overstated the productivity growth in traditional bank services. In fact, the estimates may need to be adjusted upward. This result, however, is subject to the caveat that loan-counted based measure of bank lending output may be biased up without

the quality adjustment that takes into account of the average loan performance ex post. This financial crisis indicates that banks may have sacrificed the quality of screening and monitoring mortgage loans in order to rev up the number of loans processed.

Statistical properties of an output estimate cannot *per se* establish its validity or superiority. Instead, it should be justified on theoretical grounds – being consistent with basic economic theories that can rationalize, under realistic assumptions, the operation of the firms concerned. This is exactly the logic underlying our preference for the new output measure – it is consistent with widely received theories of financial intermediation, asset pricing and production, and thus able to provide a coherent measurement framework for both traditional and non-traditional bank output.

This conceptually sound measure, however, can only be imprecisely implemented at present because of data limitations. So, we argue that a sensible approach to improving the empirical estimates is to collect additional data that are called for by the theory. Arguably the most important among such data needs is the quantity counts of a broader array of more finely defined transactions. In addition, data on the ex post performance of loans by detailed category should be gathered to enable better quality adjustment of the output of lending services. Meanwhile, when one has to use approximations for practical purpose, one must be clear about the conditions under which the proxies are appropriate. Our example of a proxy for the output of mortgage lending based on house-price-deflated loan balances illustrates that, in practice, deflated balances are reasonable proxies only for a few types of bank activities that satisfy a set of restrictive conditions.

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Table 1, Average annual growth of U.S. commercial bank output of commercial & industrial lending services (%), 1997Q2-2009Q3

CPI-deflated balance	2.0
Summed number of loans	7.8
Weighted number of loans (common margin)	8.6
Weighted number of loans (common risk)	12.4

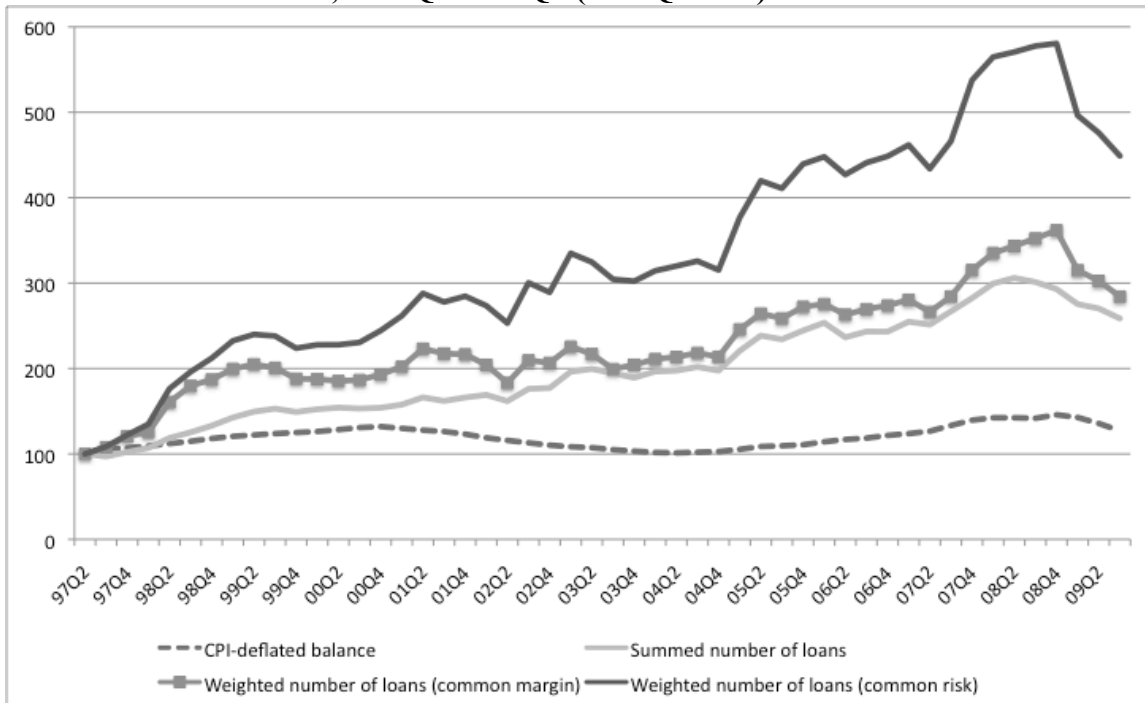
Notes: “Summed number of loans” means a simple unweighted sum of all C&I loans. “common margin” and “common risk” both refer to the assumption used to impute the implicit service revenue that serves as the aggregation weights: “common margin” assumes that loans of different risk ratings involve the same service margin in their interest rates, while “common risk” assumes that the three risky categories have the same risk-based interest rate spread. See Section 3.2.1 for details.

Table 2, Average annual growth of U.S. commercial bank output of residential mortgage lending services, 1991-2009

	1991-2009	1991-1996	1997-2009
CPI-deflated balance	6.5	6.7	5.1
Loan count	5.2	7.0	3.0
House price-deflated balance (FHFA index)	5.4	6.9	3.3

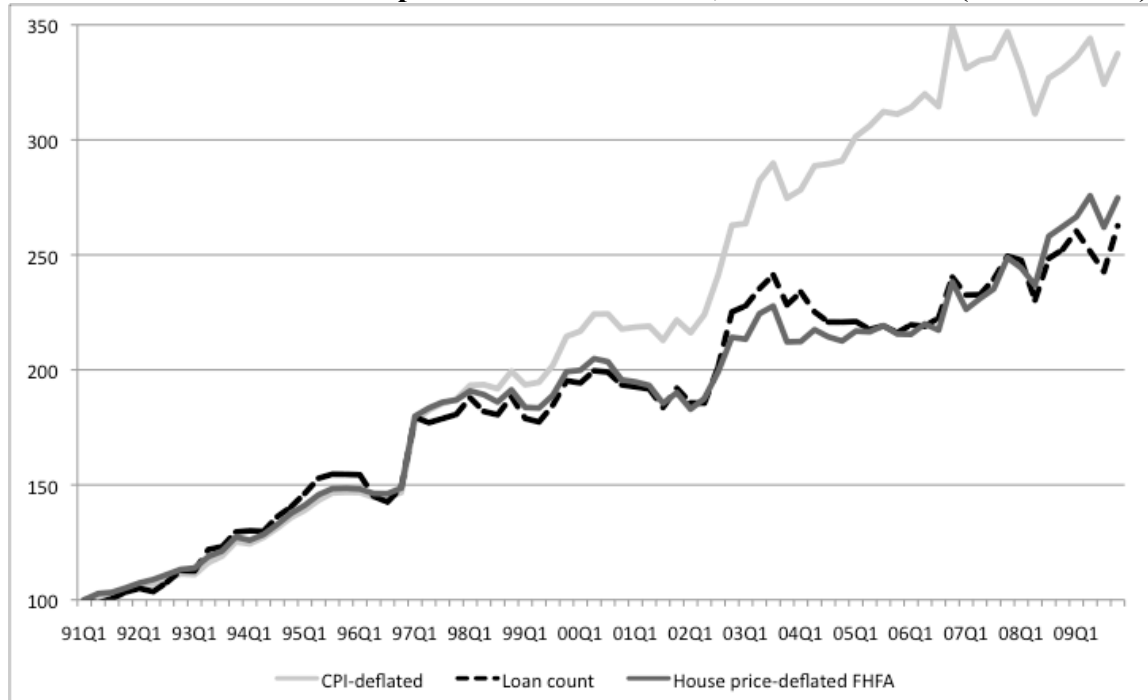
Notes: the house price index used is the equal-weighted index published by the FHFA.

Figure 1, Output indices for U.S. commercial & industrial lending services: deflated balances vs. loan counts, 1997Q2-2009Q3 (1997Q2=100)



Notes: see notes for Table 1 regarding the legend.

Figure 2, Output indices for U.S. residential mortgage services: loan counts, CPI-deflated balances and house price-deflated balances, 1991Q1-2009Q4 (1991Q1=100)



Notes: see notes for Table 2 regarding the legend.

Figure 3, Average annual output growth of residential mortgage services in Europe and the US: CPI-deflated vs. house price-deflated balances, 1995-2009

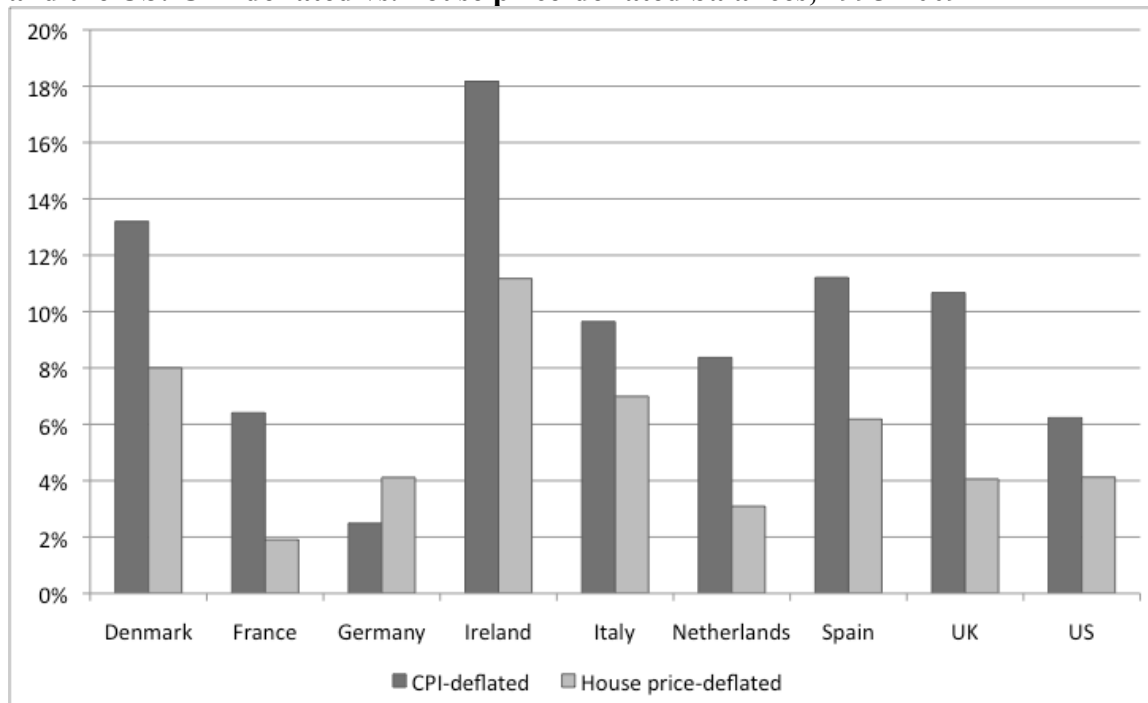


Figure 4, Output indices for U.S. deposit services: deflated balances vs. alternative transaction counts, 1997-2008 (1997=100)

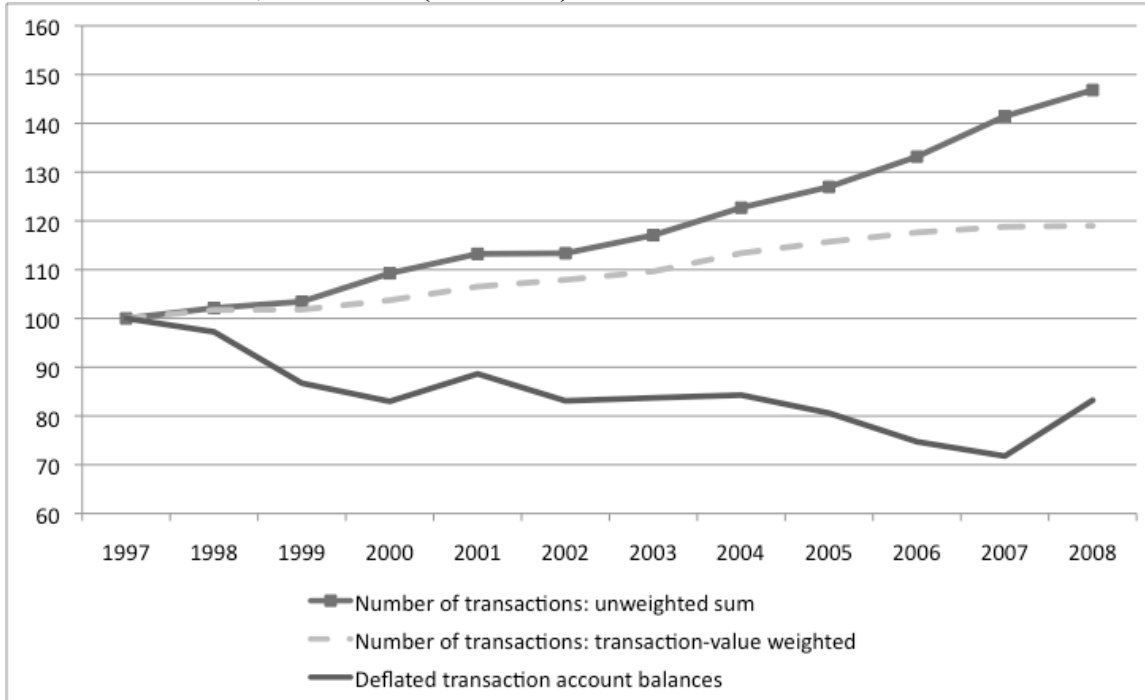
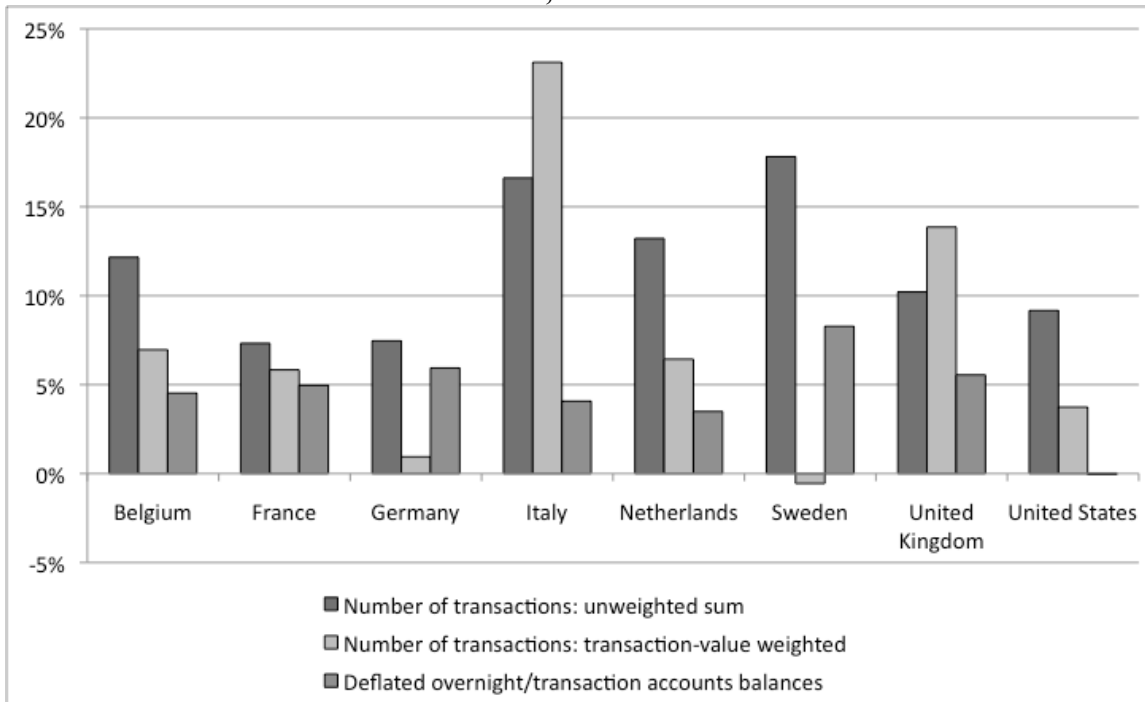
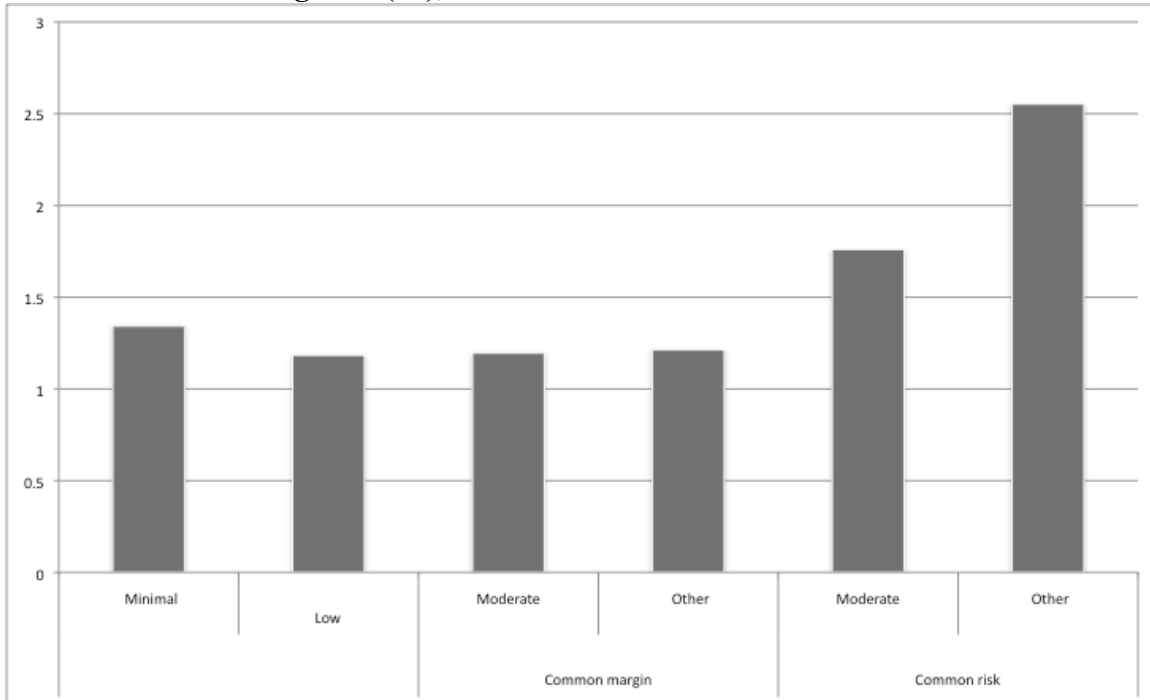


Figure 5, Average annual output growth of transaction services in Europe and the US: CPI-deflated vs. transaction counts, 2000-2008

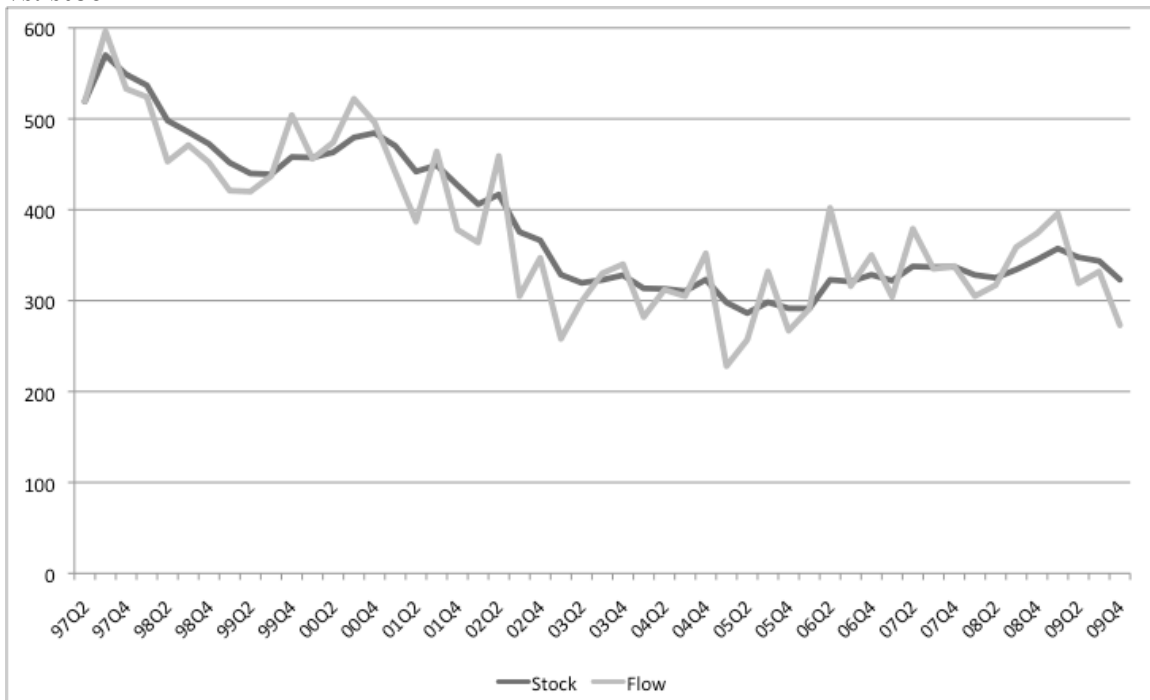


Appendix Figure A1, Average interest margin on U.S. commercial and industrial loans across risk categories (%), 1997Q2-2009Q3

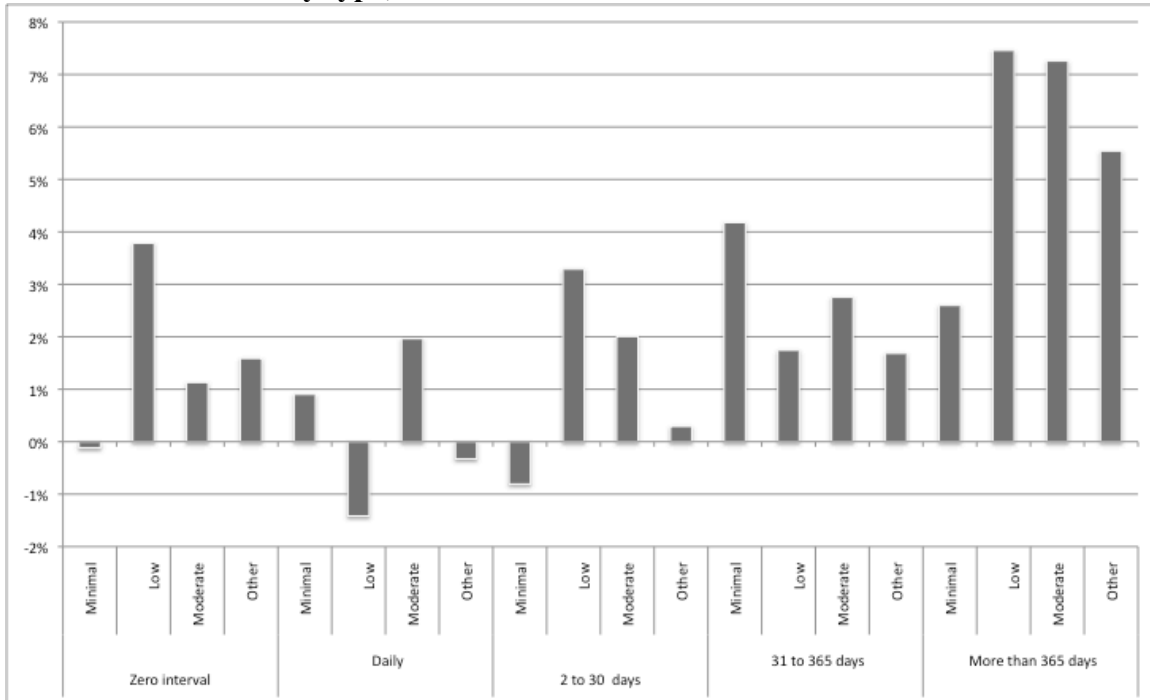


Notes: “Minimal,” “Low,” “Moderate” and “Other” refer to the risk categories. See notes for Table 1 regarding “Common margin” and “Common risk.”

Appendix Figure A2, Average size of all U.S. commercial and industrial loans, flow vs. stock



Appendix Figure A3, Average annual growth rate of the number of U.S. commercial and industrial loans by type, 1997Q2-2009Q3



Notes: “Minimal,” “Low,” “Moderate” and “Other” refer to the risk categories. “Zero interval,” “Daily,” etc. refer to the repricing frequency of the C&I loans.

Appendix Table A1, Data sources by bank activity and country

Source	Data	Period
<i>Commercial & Industrial loans - U.S. only, Figure 1, Table 1</i>		
Federal Reserve - Survey of Terms of Business Lending	Average loan size, interest rate, average time to maturity; by maturity and risk category	1997Q2-2009Q3
Federal Reserve - Commercial Paper	Commercial paper yields	1997Q2-2009Q3
FDIC - Report of Condition and Income (Call reports)	Commercial & Industrial loans in domestic offices	1997Q2-2009Q3
<i>Residential mortgages, Figures 2 and 3, Table 2</i>		
<u>United States</u>		
FDIC - Report of Condition and Income (Call reports)	Closed-end loans secured by first liens on 1-4 family residential properties in domestic offices	1991Q1-2009Q4
FHFA - Monthly Survey of Rates and Terms on Conventional Single-Family Non-farm Mortgage Loans	Historical summary tables on average mortgage size, all homes, all mortgages	1991Q1-2009Q4
FHFA - House Price Index	FHFA USA Indexes, seasonally-adjusted purchase-only index (1991Q1=100)	1991Q1-2009Q4
<u>Denmark</u>		
Danmarks Nationalbank - Balance Sheets and Flows of the MFI Sector	Bank lending to domestic households by purpose and maturity, Households - Housing, extrapolated before July 2000 using total Household loans	1995-2009
Statistics Denmark	Price index for sales of property (2006=100) by time and category of real property; transaction-weighted index of one-family houses, weekend cottages and owner-occupied flats	1995-2009
<u>France</u>		
Banque de France - Monthly Monetary Statistics	Lending by credit institutions to households (stocks) - Housing (MH.M.EC.CREDIT.3.R.1D.HF.T.M.E.B.X)	1995-2009
Insée	Price index of existing houses	1996-2009
BIS	BIS Real House Price data, downloaded at http://www.finfacts.ie/biz10/BISHOUSE_PRICE_DATA.xls ; re-inflated using the CPI	1995-2006
<u>Germany</u>		
European Central Bank - Balance Sheet Items (BSI) database	Lending for house purchase (BSI.M.DE.N.A.A22.A.1.U2.2250.Z01.E)	2003-2009
Bundesbank - Statistical Supplement Banking Statistics	Mortgage loans to domestic enterprises and resident individuals / Total / All categories of banks (PQ3013) (used for extrapolation of 'Lending for house purchase' series, assuming constant individual mortgage share)	1995-2009
OECD - Banking Statistics	Loans (used to bridge time series break in 1998 due to the removal of Trauhandkredite)	1995-2007
Hypoport	House price index, hedonic, composite of apartments, new homes and existing homes	1995-2009
DeStatis	House price index of new homes and of existing homes (unweighted average of price change)	2000-2008
BIS	BIS Real House Price data, downloaded at http://www.finfacts.ie/biz10/BISHOUSE_PRICE_DATA.xls ; re-inflated using the CPI	1995-2006

Appendix Table A1, continued

<u>Italy</u>		
Banca d'Italia - Supplements to the Statistical Bulletin	Bank loans for house purchases, sum of <1Y, 1< <5, >5Y maturity	1998-2009
OECD - Banking Statistics	Loans (used for extrapolation of 'Bank loans for house purchases' series, assuming constant mortgage share in total loans)	1995-2007
Muzzicato, Sabbatini and Zollino	"Prices of residential property in Italy: Constructing a new indicator" Banca d'Italia Occasional papers, no. 17; August 2008	1995-2007
Global Property Guide	Price index from Banca d'Italia and Statistics Italy, data at http://www.globalpropertyguide.com/Europe/Italy/Price-History	2008-2009
<u>Ireland</u>		
European Central Bank - Balance Sheet Items (BSI) database	Lending for house purchase (BSI.M.IE.N.A.A22.A.1.U2.2250.Z01.E)	2003-2009
OECD - Banking Statistics	Loans (used for extrapolation of 'Lending for house purchase' series, assuming constant mortgage share in total loans)	1995-2007
ESRI - Permanent tsb/ESRI House Price Index	National index	1996-2009
BIS	BIS Real House Price data, downloaded at http://www.finfacts.ie/biz10/BISHOUSE_PRICE_DATA.xls ; re-inflated using the CPI	1995-2006
<u>Netherlands</u>		
De Nederlandsche Bank - Domestic MFI Statistics (Monetary)	MFI Lending for house purchases, sum of <1Y, 1< <5, >5Y maturity	1995-2009
CBS/Kadasters (Statistics Netherlands/Property Register)	Sales price index, existing homes	1995-2009
<u>Spain</u>		
European Central Bank - Balance Sheet Items (BSI) database	Lending for house purchase (BSI.M.ES.N.A.A22.A.1.U2.2250.Z01.E)	2003-2009
OECD - Banking Statistics	Loans (used for extrapolation of 'Lending for house purchase' series, assuming constant mortgage share in total loans)	1995-2007
Ministerio de Vivienda	House price per m2	1995-2009
<u>United Kingdom</u>		
Bank of England	Quarterly amounts outstanding of UK resident banks' (inc. Central Bank) sterling net secured lending to individuals and housing associations (in sterling millions) seasonally adjusted (LPQVTXI)	1995-2009
Nationwide	House price, all houses	1995-2009
<i>Deposit transactions, Figures 4 and 5</i>		
<u>All countries</u>		
BIS Red Book, editions 2004 through 2008	Credit transfers, Direct debits, Card payments, E-money, Cheques and Other transactions, number and value of transactions	2000-2008 (1997-2008 for US)
<u>United States</u>		
FDIC - Report of Condition and Income (Call reports)	Transaction accounts	1997-2008
<u>European countries</u>		
European Central Bank - Balance Sheet Items (BSI) database	Overnight deposits (BSI.M.??N.A.L21.A.1.U2.2300.Z01.E, where '??' refers to the 2-letter country code)	2000-2008
Statistics Sweden	Total deposits (used to extrapolate for 2000 and 2001 data for Sweden missing from ECB - BSI)	