

This PDF is a selection from a published volume from the National Bureau of Economic Research

Volume Title: Risk Topography: Systemic Risk and Macro Modeling

Volume Author/Editor: Markus Brunnermeier and Arvind Krishnamurthy, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-07773-X (cloth); 978-0-226-07773-4 (cloth); 978-0-226-09264-5 (eISBN)

Volume URL: <http://www.nber.org/books/brun11-1>

Conference Date: April 28, 2011

Publication Date: August 2014

Chapter Title: Remapping the Flow of Funds

Chapter Author(s): Juliane Begenau, Monika Piazzesi, Martin Schneider

Chapter URL: <http://www.nber.org/chapters/c12556>

Chapter pages in book: (p. 57 - 64)

Remapping the Flow of Funds

Juliane Begenau, Monika Piazzesi,
and Martin Schneider

The Flow of Funds Accounts are a crucial data source on credit market positions in the US economy. In particular, they combine regulatory data from various sources to produce a consistent set of flow and stock tables in major credit market instruments by sector. There is also a detailed breakdown of the financial sector by type of institution. This is exactly the kind of data needed to understand how financial innovation changes the amount of borrowing and lending in the economy and reshapes the financial industry. The events of the last five years have underscored the importance of positions data to guide economic analysis.

As do most available data sets on credit market positions, the Flow of Funds Accounts report accounting measures such as book value or fair value. In contrast, most economic analysis views asset positions as random payment streams that are valued by state prices. The latter view is particularly useful to assess the sensitivity of a position to changes in market conditions. For example, one may ask what happens to the value of a position when monetary policy lowers the short end of the yield curve. The answer follows from discounting the payment stream with (hypothetical) state prices that reflect the steeper yield curve. More generally, once positions are viewed as payment streams, the risk in a position can often be parsimoniously rep-

Juliane Begenau is a PhD candidate in economics at Stanford University. Monika Piazzesi is the Joan Kenney Professor of Economics at Stanford University and a research associate and director of the Asset Pricing Program at the National Bureau of Economic Research. Martin Schneider is professor of economics at Stanford University and a research associate of the National Bureau of Economic Research.

We thank Markus Brunnermeier, Darrell Duffie, John Geanakoplos, Arvind Krishnamurthy, and conference participants at the NBER systemic risk conference. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see <http://www.nber.org/chapters/c12556.ack>.

resented by exposures to a small number of risk factors. Exposures are then comparable across positions and can readily be aggregated to create measures of risk for the entire portfolio held by an economic agent, such as a financial institution or a household.

Viewing positions as payment streams typically requires more information than book value or fair value. In particular, to construct the payment stream associated with a given instrument such as a coupon bond or installment loan, one would like to know:

- the maturity or next repricing date of the instrument;
- the promised interest rate, that is, the coupon rate for a bond or the loan rate;
- call or prepayment provisions, if applicable; and
- the credit rating of the issuer.

Importantly, much of this information is already contained in the data sets from which the Flow of Funds Accounts are constructed. This suggests that substantial improvements may be possible at low cost.

This article argues that quantitative analysis of credit market positions would benefit tremendously if the additional information about the structure of payment streams were more readily available. Section 4.1 states why credit market positions are important for policy analysis and economic research in general. Section 4.1.1 describes the currently available data sets. Section 4.1.2 explains how economists think about credit market positions in terms of payment streams. Section 4.1.3 states why information beyond basic accounting numbers is therefore useful. Section 4.1.4 describes how payment streams are represented using factor models, and section 4.1.5 shows how this leads naturally to measures of risk exposure. Finally, section 4.2 derives some concrete suggestions for data collection.

4.1 Why Economists Need Credit Market Position Data

Recent boom bust episodes brought about large credit market positions of individual economic agents, as well as entire sectors of the economy such as households. In the last few years, economics has already been paying more attention to credit market positions, and one would now expect this trend to accelerate.

Data on credit market positions are useful to economists because they help assess the balance sheet effects of shocks that alter the net worth of borrowers and lenders. For example, if inflation picks up or monetary policy raises the short-term interest rate, how much does this help home owners with fixed rate mortgages? How much does it hurt bank shareholders or mortgage bond holders? Can inflation stimulate the economy by redistributing toward financially constrained borrowers who have a larger propensity to spend?

Beyond the study of particular shocks, data on credit market positions can help derive a comprehensive description of risk exposure. Economic agents' credit market positions are portfolios of risky assets that are affected by a variety of shocks, including inflation and interest rate changes. As a result, macroprudential regulation should be based on the entire conditional distribution of economic agents' net worth.

The above-mentioned examples point to two issues that come up when working with data on credit market positions. The first is the need to ensure *comparability* across positions. To develop measures of risk, it must be possible to aggregate different positions into a single portfolio. There must, therefore, be sufficient information so that the—potentially offsetting—risk exposures of individual positions can be taken into account. Indeed, the risk of an institution is different if it uses derivatives to hedge balance sheet exposure than when it does not. Increasing transaction costs in a market has a different effect when that market is typically used to hedge exposure than when it is used to speculate. We argue later that thinking in terms of payment streams and state prices naturally addresses this issue.

The second issue is how to choose the right amount of *detail*. For many questions, it is helpful to go beyond simple aggregate measures of credit and net worth, and consider how positions differ by, for example, maturity or default risk. Indeed, the effect of monetary policy on a sector's net worth will be quite different if this sector borrows mostly long term than when it borrows mostly overnight. We argue that the factor structure of risks provides guidance on the detail required.

4.1.1 Data Sources on Credit Market Positions

There are at least three types of data sets that contain credit market positions. First, there are collections of accounting statements or regulatory filings by individual corporations—for example, annual company reports, SEC filings, or bank “call reports.” The Flow of Funds Accounts of the United States compiles accounting data but aggregates positions to the national level. Second, there are household surveys that ask questions about wealth, such as the Survey of Consumer Finances and the Panel Study of Income Dynamics. A third, and more recent, source of data consists of databases that record particular credit market transactions undertaken by households or firms. On the household side, an example is county deeds records on house purchases, which in many counties also contain information on mortgages. On the firm side, there are commercial data sets on corporate bond and syndicated loan issuance. Transaction data are special because the unit of observation is a transaction, rather than an economic agent.

Most available data sets present credit market positions in terms of *book value* or *fair value* only. Traditional accounting rules call for recording the book value of an instrument. For example, in case of a mortgage, the book value is the face value of the loan, while for a coupon bond it is the principal,

paid at the maturity date. More recently, some credit market positions—especially those in marketable fixed-income securities—have been marked to market on firm balance sheets. In this case, there is also information about the fair value of a position, an estimate of its resale value.

What exactly is reported depends on the particular data set. Company and regulatory institutions typically provide a mix of fair and book value, as do household surveys; the Flow of Funds Accounts report book values. As a rule, data sets in which the unit of observation is an economic agent provide little information on the nature of contracts beyond book value or fair value. In contrast, transaction data tend to come with more detailed information about contracts related to individual transactions.

4.1.2 Economic Analysis of Asset Positions: Payment Streams and State Prices

Economic analysis treats all assets, including credit market instruments, as *payment streams*. A payment stream is a sequence of random variables that says, for every date and every state of the world, what the asset pays off. If there was no uncertainty, then the payment stream would simply be the stream of promises made by the issuer of the instrument. More generally, the random payment stream reflects modifications to initial promises, such as lower payments in default.

The value of an asset in an economic model is typically determined by applying a set of *state prices* to its payment stream. Almost all economic models imply a set of state prices that can be used to compute values. Importantly, this includes models where heterogeneous economic agents face frictions such as transaction costs and borrowing constraints. Such models are likely to be particularly useful to study the real effects of borrowing and lending.

Thinking in terms of payment streams and state prices is well suited to answer questions about the balance sheet effects of shocks and the risk exposure of agents. Viewing positions as payment streams on a common set of states of the world makes them directly comparable. To assess the effect of a shock, such as a policy intervention, one typically first works out the direct effect of the shock on each payment stream (a larger probability of default or a change in duration due to earlier prepayment of debt, for example). One then works out the effect of the shock on state prices, which jointly affect the value of all payment streams.

4.1.3 Information beyond Accounting Numbers

Thinking about credit market positions as payment streams requires information beyond book value or fair value. One important ingredient is information about how contracts specify the structure of the payment stream. As a simple example, consider a Treasury bond. Its book value represents only one of the payments promised by the bond. The fair value says

what the bond trades for, but it does not say why—that is, how the price depends on the structure of the payment stream and state prices. Actually constructing the payment stream requires knowing the coupon rate and the maturity date.

Information about contracts is typically not enough to construct payment streams. An exception is a world where payment streams are certain—if promises have a fixed schedule and are always kept, then the payment stream follows immediately from the promises written into the contract. More generally, promises may not have a fixed schedule (for example, when a bond is callable or a mortgage is prepaid) and promises may not be kept.

With uncertain payment streams, constructing a payment stream will involve some economic modeling. For example, a modeler must make assumptions on when mortgages are prepaid (depending on movements in interest rates and house prices), and when borrowers default. Dealing with these contingencies benefits from information about contracts that speaks to the randomness in payments (such as prepayment rules.) It can also benefit from additional information outside the contract, such as credit ratings that may provide guidance on modeling default probabilities.

4.1.4 Representing Payment Streams with Factor Models

Describing random payment streams—specifying payoffs for all dates and state of the world—may appear excessively complicated. In particular, what is the relevant set of “states of the world”? Fortunately, simple representations are available using a factor model approach. Factors are random variables that represent the major sources of market risk affecting payment streams. One then defines the relevant states of the world for a position next period as the innovations to the factors, as well as possibly idiosyncratic shocks to the position (such as borrower default). The modeling task is to describe the joint conditional distribution of the factors and idiosyncratic events. Factors are assumed to follow Markov dynamics: their distribution depends on the past only through their last realizations.

The criterion for selecting factors is how well the entire cross section of market prices (by maturity and credit quality, for example) can be approximated by the factor model. For credit market instruments, a small number of factors (often less than five, depending on the frequency of the data) has been found sufficient to describe the evolution of market prices. One factor is typically a short-term interest rate (such as the three-month T-bill rate) that captures movements in the level of the yield curve. Other common factors are the slope of the yield curve (e.g., the difference between the ten-year Treasury yield and the three-month T-bill rate), a “fear gauge” (such as the Merrill Lynch Option Volatility Estimate [MOVE] Index, a measure of bond-market volatility that serves as a bond-market analogue of the Volatility Index [VIX]), or a liquidity factor (such as the difference between on-the-run and off-the-run Treasury yields).

Capturing credit risk requires specification of the default event as well as the payments in default, and it may require additional factors to describe the probability of default. The default event can be a missed interest payment, or a missed interest and principal payment. Its arrival is assumed to depend on firm-specific as well as macroeconomic conditions (see Duffie [2011] for details.) In particular, to capture the fact that default is more likely in bad times and risk premia on corporate bonds are countercyclical, the probability of default may depend on factors like GDP growth or credit spreads such as the difference between swap and Treasury rates. The expected loss in default is often assumed to be proportional to the market value of the bond.

4.1.5 Factor Models and Risk Exposure

The factor model approach offers a convenient way to measure risk exposures. In particular, we can represent a payment stream as a portfolio containing only a small number of “spanning securities.” The security payoffs reflect the risk in the factors. For a simple example, suppose that there is only one factor, the short-interest rate. Two securities are then sufficient to represent any position: cash and a long bond, the price of which responds to the short rate. More generally, if N is the number of factors, any payment stream can be represented by a portfolio consisting of cash and N long bonds.

The replicating portfolio has to be recalculated every period. Ideally, the portfolio should be updated every instant—replication with Markovian factor dynamics is exact only in continuous time. However, replication works approximately in discrete time (see e.g., Piazzesi and Schneider 2010). Replication is particularly attractive when the number of assets, and thus the number of payment streams under consideration, is much larger than the number of factors. In this case, the spanning portfolio is a far simpler representation of risk exposures than the original collection of payment streams.

Once the positions of individual economic agents or sectors of the economy are represented as portfolios of spanning securities, the portfolio weights become natural measures of risk exposure. With two factors, we might find that the retirement savings of the household sector can be represented as a portfolio that is about one-third in a two-year bond and two-thirds in a ten-year bond, with some small residual weight on cash. The example weights here reflect a duration somewhere between two and ten years. Since the factor model tells us how bond prices respond to shocks, we can calculate how the households’ retirement wealth moves with changes in the level or the slope of the yield curve.

Portfolios of spanning securities are also easy to compare. For example, consider a bank that has a balance sheet subject to maturity mismatch, but also trades interest risk in the swap market. Both the bank’s swap position and its nonderivative fixed-income position can be viewed as portfolios of spanning securities. It is then easy to check whether the swap portfolio

hedges exposures in the other portfolio or not (see Begenau, Piazzesi, and Schneider [2012] for details on the replication of swap portfolios).

4.2 Concrete Suggestions for Data Collection

The previous considerations lead to a few simple suggestions for how common data sets could be made more user friendly for economic analysis. Here we have data collection efforts in mind, with the unit of observation being an economic agent or sector. In such data sets, credit market positions are usually aggregated into a reasonably small number of instrument classes (“long-term bonds,” “loans,” etc.) for which book value or fair value (or both) is recorded. Our basic suggestion is to add, for each instrument class and each date, a few numbers that describe (a) the structure of promised payments specified by the average contract in the class, and (b) the average credit quality of the class.

Stock versus flows. The following suggestions apply differently whether the data collected are stocks or flows, and collection of information about flows is preferable if possible. If stocks are collected, information about maturities, credit ratings, and callability is typically available only about the currently outstanding positions in each instrument class. For example, one may know the average maturity, credit rating, and interest rate for a pool of mortgages held by an institution. In contrast, if flows are collected, then there is information about newly issued instruments. For example, one will know the maturity, credit rating, and interest on a new vintage of mortgage pools.

Information about flows is preferable because different vintages of long-term instruments may have very different payment streams, and therefore different exposure to risk. For example, if the loan rate and credit rating differ across vintages of mortgage pools with similar maturity. Given information on flows, researchers could track different vintages of credit market instruments issues at different dates. Information on flows would ideally also include redemptions and defaults by vintage (period of origination)—for example, the share of mortgage face values that were prepaid, and the share of face values of corporate bonds that went into default, together with recovery rates.

Promised payments. Every credit market position comes with a stream of promised payments. Abstracting from prepayment, the stream of promises can be described by a few numbers. For coupon bonds, what is needed is the maturity and the coupon rate. For installment loans, the installment, and the maturity are enough. Prepayment options can typically be described by the shortest time from which the debt can be repaid. Finally, some debt contracts make random promises since they pay floating rates. Ideally, those would be broken out from other debt, and the maturity and spread over a benchmark rate reported separately.

Default. Payments are made by issuers who may default. To assess the

risk of default, it would be useful to have some sense of the average credit rating of the issuers in a particular class of instruments. This information would then be used by the modeler to specify how default affects the payment stream as previously discussed.

Derivatives. Firms often use derivatives, either to hedge (or double down) on their exposure to certain factors. Derivative contracts such as swaps or options can also be viewed as a payment stream. Since promised payments typically depend on a small number of factors, derivative positions can again be replicated as portfolios of spanning securities.

Data on derivative holdings come from various sources. Regulatory filings typically contain gross notional values and fair values, possibly some information on maturities. However, to determine the risk exposures of a bank's swap position, it is also important to know the direction of the trades (whether the bank pays a fixed or floating rate) as well as the average swap rate that was locked in on the contract.

In the case of options, it is important to know whether these are put or call options, the average strike price, and whether these options are bought or sold. We expect that this information is more difficult to obtain from banks than the other items on our wish list. Still, the information is crucial for the public to have, because the current data situation does not permit an outsider to determine the risk exposure of banks or the financial sector as a whole—not even after a long time lag.

Foreign currency. Our discussion so far has assumed that all credit is denominated in dollars, as it is true for the overwhelming majority of positions in the United States as well as a large share of positions elsewhere. More generally, the view of positions as payment streams and their representation using factor models extends naturally to the case of multiple currencies. One would then typically include exchange rates as additional factors. The currency in which a position is denominated would become an additional piece of information that should be recorded with the position.

References

- Begenau, Juliane, Monika Piazzesi, and Martin Schneider. 2012. "Banks' Risk Exposures." Working Paper, Stanford University.
- Duffie, Darrell. 2011. *Measuring Corporate Default Risk*. Oxford: Oxford University Press.
- Piazzesi, Monika, and Martin Schneider. 2010. "Interest Rate Risk in Credit Markets." *American Economic Review* 100 (2): 579–84.