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Procyclical leverage in Europe and its role in asset pricing

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Non-technical summary

Research Question

Typically, a bank's leverage follows a procyclical pattern. In times of tight funding conditions – as during the financial crisis – the broker-dealers' exposure is comparably low, implying a high marginal utility of wealth. In such a situation anticyclical assets having comparably high returns are beneficial because they reduce the influence of a general negative development of the stock markets on the balance sheet. Procyclical assets, in contrast, are risky and are expected to have higher returns in order to be attractive for investors. The direction and strength of the correlation between broker-dealers' leverage and excess returns should therefore determine the risk premium of asset portfolios. Moreover, recent theoretical studies show the predictability of the risk premium of the leverage ratio. The current paper examines the relevance of these issues for the German and European financial market.

Contribution

Thus far, the described phenomena have mainly been documented for the US market. We look at the interrelationship between asset returns and broker-dealers' leverage ratio for the German and European market. In a second step, we test for systematic variation in the price of funding risk. For our analysis we use German data from 1971 to 2016. European data are available since 2000.

Results

Our analysis delivers two main results. First, we find that broker-dealers' leverage on the German stock market portfolios has explanatory power similar to "classical" factors from the asset pricing literature. For European broker-dealers, however, the results are somewhat weaker, most likely due to a significantly shorter sample. Thus, our results stress the potential of financial intermediaries' balance sheet management to accelerate booms and busts in asset markets. Additionally, we find that German broker-dealers' leverage contributes to the forecasts of one-quarter-ahead returns.

Nichttechnische Zusammenfassung

Fragestellung

Der Verschuldungsgrad von Banken folgt typischerweise einem prozyklischen Muster. In Zeiten angespannter Refinanzierungsmöglichkeiten, wie etwa während der Finanzkrise, sind die offenen Risikopositionen von Wertpapierhandelsbanken vergleichsweise niedrig, was einen hohen Grenznutzen des Vermögens impliziert. Antizyklische Vermögenswerte, die in diesen Zeiten hohe Erträge liefern, sind besonders vorteilhaft, weil sie den Einfluss einer allgemein negativen Entwicklung der Aktienmärkte auf die Bilanz dämpfen. Dagegen sind prozyklische Vermögenswerte risikoreich und sollten im Durchschnitt höhere Erträge erwirtschaften, damit sie von Investoren gehalten werden. Die Richtung und Stärke der Korrelation zwischen dem Verschuldungsgrad von Wertpapierhandelsbanken und den Überschussrenditen sollte daher die erforderliche Risikoprämie von Aktienportfolios bestimmen. Darüber hinaus zeigen neuere theoretische Beiträge, dass die Risikoprämie des Verschuldungsgrads vorhersagbar sein sollte. Das vorliegende Papier untersucht, inwieweit diese Zusammenhänge für den deutschen und europäischen Finanzmarkt von Bedeutung sind.

Beitrag

Bislang wurden die beschriebenen Phänomene hauptsächlich für den US-Markt dokumentiert. Wir untersuchen den Zusammenhang von Wertpapierrenditen und dem Verschuldungsgrad von Wertpapierhandelsbanken für den deutschen und europäischen Markt, wobei wir insbesondere auf systematische Veränderungen beim Preis des Refinanzierungsrisikos testen. Für unsere Analyse nutzen wir deutsche Daten in dem Zeitraum von 1971 bis 2016. Europäische Daten stehen seit dem Jahr 2000 zur Verfügung.

Ergebnisse

Die vorliegende Analyse liefert zwei Hauptergebnisse. Zum einen zeigt sich, dass der Verschuldungsgrad der Wertpapierhandelsbanken für die Kursentwicklung deutscher Wertpapiere eine Erklärungskraft aufweist, die mit anderen „klassischen“ Erklärungsfaktoren aus der Literatur zur Preisbildung von Vermögenswerten vergleichbar ist. Für europäische Wertpapierhandelsbanken sind die Ergebnisse schwächer, was vermutlich vor allem auf den deutlich kürzeren Beobachtungszeitraum zurückzuführen ist. Generell stützen unsere Ergebnisse die Hypothese eines Einflusses des Bilanzmanagements von Wertpapierhandelsbanken auf die Kapitalmarktentwicklung. Darüber hinaus zeigen wir, dass der Verschuldungsgrad deutscher Wertpapierhandelsbanken einen Beitrag zur Prognose der Kursentwicklung im nächsten Quartal liefert.

Deutsche Bundesbank Discussion Paper No 10/2019

Procyclical Leverage in Europe and its Role in Asset Pricing *

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Abstract

Broker–dealer leverage has recently proven to be strongly procyclical, exhibiting impressive explanatory power for a large cross-section of asset returns in the US. In this paper we add empirical evidence to this finding, showing that European and German broker-dealers actively manage their balance sheets. Moreover, by applying standard Fama–MacBeth regressions as well as dynamic asset pricing models (Adrian, Crump, and Moench, 2015), we confirm the importance of broker-dealer balance-sheet indicators for asset pricing. In particular, leverage shows a procyclical behavior with a positive price of risk. Moreover, high leverage coincides with high asset prices, thereby forecasting lower future returns.

Keywords: Broker–dealer leverage; intermediary asset pricing; dynamic asset pricing

JEL classification: E31, G21.

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Motivation

Banks' leverage is procyclical. This is emphasized in the paper by Adrian and Shin (2010), which demonstrates that financial intermediaries manage their balance sheets so as to adjust to changes in asset prices and value-at-risk calculations. Using some simple arithmetics, the authors show that during a market downturn banks face the devaluation of their assets as well as a decline in their equity. Assuming relatively constant liabilities, the resulting leverage increase forces banks to sell assets. Since leverage constraints are binding for all banks, sales across all risky assets are to be expected, which are bound to provoke further deleveraging: this mechanism has been dubbed the "loss spiral" by Brunnermeier and Pedersen (2009). However, the procyclicality of leverage also contributes to accelerating market upturns. With increasing asset prices, a decline in leverage leaves room for additional asset purchases financed by short-run debt. This expansion of the balance sheet recovers leverage, but also tends to increase asset prices, again revealing the mutually reinforcing nature of the relationship between market liquidity and leverage. In fact, as has been observed during the financial crisis, these accelerating dynamics have severe consequences outside the financial sector, too.

Thus far, the procyclicality of financial intermediaries' balance sheet management has been empirically documented mainly on the US market. Adrian and Shin (2010) and Adrian, Etula, and Muir (2014) show that asset growth and leverage growth exhibit a strong positive comovement for US broker–dealer banks, in contrast to non-financial firms and households. The latter group, in particular, seems to abstain from active balance sheet management, leading to a negative correlation between asset growth and leverage. While the reinforcing balance sheet behavior of financial intermediaries has been identified in Adrian and Shin (2010), Adrian, Etula, and Muir (2014) investigate the role of broker–dealer leverage in asset pricing. Thanks to their findings, which corroborate the exceptionally high explanatory power of the leverage factor for pricing a large cross-section of US portfolios, the authors are able to close the outlined feedback loop of banks' balance sheets and asset market liquidity.

This paper adds empirical evidence from non-US financial markets to this important relationship between asset prices and financial intermediary leverage. Using German and European data, we follow the approach taken by Adrian, Etula, and Muir (2014) and test whether shocks to leverage are a useful pricing kernel in a different geographical setting. As a starting point, Figure 1 presents the growth rates of total assets and leverage, defined as $(TotalAssets)/(TotalAssets - TotalLiabilities)$, of different groups of German and European financial firms.[1]

Figure 1 unambiguously confirms that increases in asset values are associated with increases in leverage, supporting the view that financial firms actively manage their balance sheets during market upturns and downturns.[2] In the rest of the paper, we will show

[1]For details on the grouping of banks see the data section of this paper.

[2]For example, the Pearson correlation coefficient is 0.73 for German broker–dealer banks.

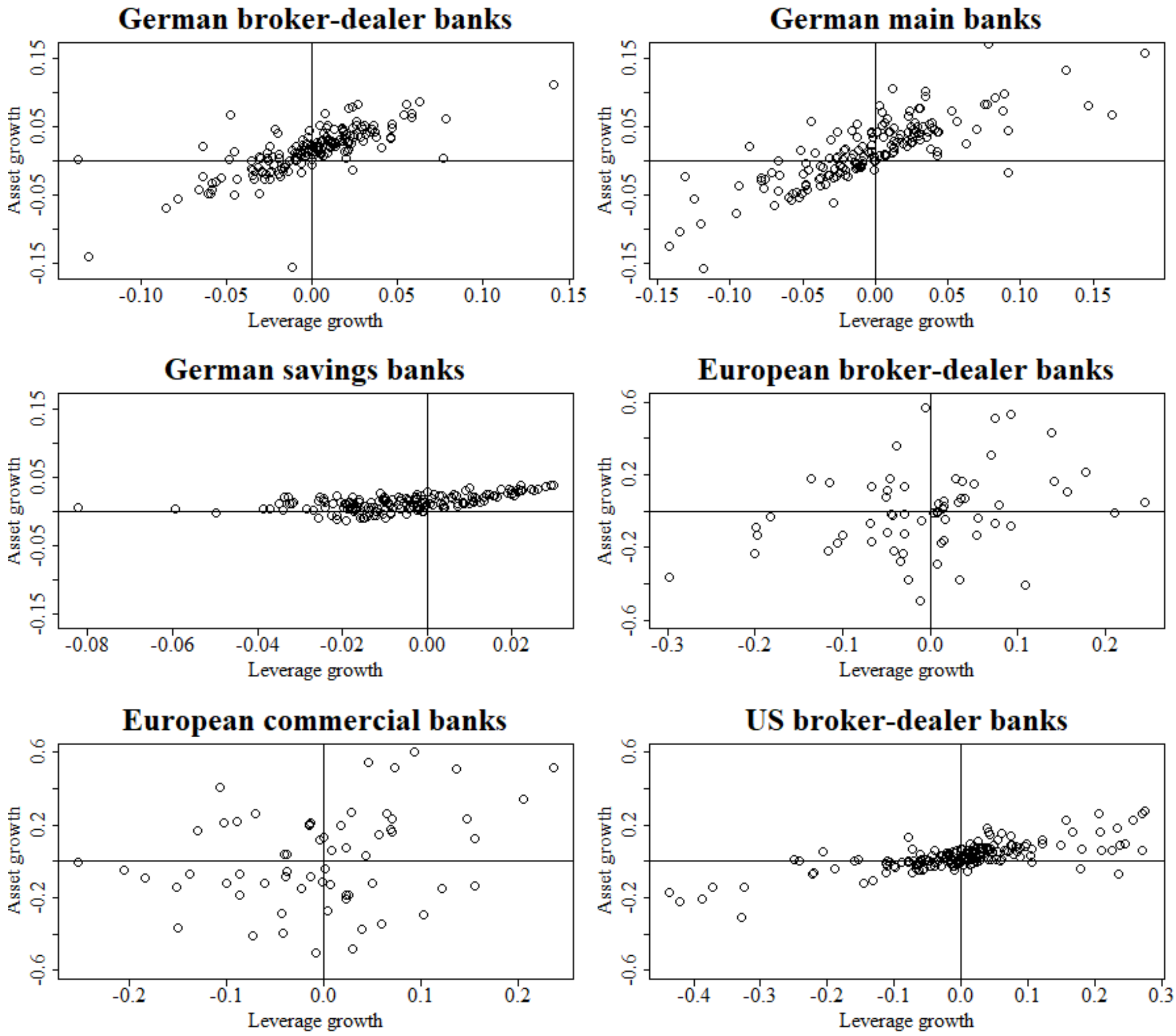

Figure 1: Leverage growth vs. asset growth.

The graph plots leverage growth (x-axis) against asset growth (y-axis). The first three panels report the relationship of the leverage and asset growth for German broker-dealer, main, and savings banks. The fourth and fifth plots report the relationship for European broker-dealer and commercial banks. The last plot shows the relationship for US broker–dealers.

that the procyclicality of German broker-dealer leverage explains the excess returns of a large cross-section of test assets. Applying standard two-pass regressions to data ranging from 1971 to 2016, we find that broker–dealer leverage on the German cross-section of stock market portfolios has an explanatory power similar to competitor models such as the Fama–French three–factor framework. This is remarkable in the sense that the time series of shocks to leverage might be quite noisy while the latter factors are derived from the underlying test asset returns. The results are confirmed using data from European broker–dealers with somewhat lower R^2s due to the shorter sample ranging from 1999 to 2016. Thus, our results lend support to the feedback loop described by Brunnermeier and Pedersen (2009) and stress the potential of financial intermediaries' balance sheet management to accelerate booms and busts in asset markets.

In addition, recent theoretical contributions such as Danielsson, Shin, and Zigrand (2009) and Adrian and Boyarchenko (2015) suggest that the leverage price of risk is time-varying in a predictable fashion. In times of tight funding constraints such as those experienced during the financial crisis, the balance sheet exposure of intermediaries is low, implying a high marginal value of wealth. Given that low asset prices allow higher expected future returns, broker–dealer leverage should forecast future asset returns. Applying the dynamic asset pricing (DAPM) model of Adrian, Crump, and Moench (2015), we test for this systematic time-variation in the price of risk. In line with Adrian, Moench, and Shin (2016), we find that German broker–dealer leverage negatively forecasts one–quarter–ahead returns, thereby lending support to the proposition that this balance sheet factor is also a driver of the market price of risk.

The remainder of this paper is structured as follows: The next section describes the related literature; this is followed by an overview of the cross-sectional empirical approach and the data used for Germany and Europe; we then develop a DAPM framework for the different regional areas; the last section concludes.

Related Literature

In his presidential address of the American Finance Association, Cochrane (2011) delivers a plea for reconsidering the concept of the average investor and discusses intermediated markets. Investors finance intermediaries with different types of claims such as debt and equity. When losses appear, the managers of intermediaries will try to avoid bankruptcy by selling risky assets, thus possibly provoking so-called "fire sales" and "illiquidity spirals": hence the importance of balance sheet data from leveraged intermediaries.

Adrian, Etula, and Muir (2014) take these considerations into account and shift their attention from measuring the stochastic discount factor (SDF) of the average household to measuring the SDF of financial intermediaries. Financial intermediaries fit the assumptions of modern finance theory nicely, being sophisticated investors capable of using the whole spectrum of investment strategies. The authors link information from broker–dealers' balance sheets data – namely the leverage ratio defined as the ratio of assets to equity – to explain the cross-sectional variation of asset returns. Indeed, they are able to show that intermediary leverage has strong pricing potential in the cross-section of US asset returns.

There are several theoretical models, which assume that financial intermediaries influence asset prices. In Brunnermeier and Pedersen (2009), the authors show how funding liquidity enters the pricing kernel when investors are risk-neutral and face funding constraints. Their model is concerned with market and funding liquidity. Investors may experience initial losses which alow funding problems to arise, requiring them to reduce their positions. Under some circumstances, the result can be liquidity spirals, i.e. the drying up of liquidity when several investors have to reduce leverage. Adrian, Etula, and Muir (2014) argue that the leverage of financial intermediaries can be used as a proxy for funding conditions. Another approach by Danielsson, Shin, and Zigrand (2009) also considers risk-neutral intermediaries subjected to a value-at-risk (VaR) constraint. In their model, investors' risk appetite may be time-varying because of the VaR-constraints even if preferences are constant. Asset prices depend on the level of effective risk aversion and hence on the leverage of the intermediaries – in times of low intermediary leverage, effective risk aversion is high. As a result, financial intermediary leverage directly enters the equilibrium SDF.

Adrian and Boyarchenko (2015) develop an equilibrium model of the macroeconomy where intermediaries are subjected to risk-based funding constraints that give rise to an equilibrium representation, with intermediary leverage as a key state variable. The equilibrium pricing kernel can be expressed as a function of shocks to financial intermediary leverage, which represents funding conditions, and shocks to output. When intermediaries experience an adverse shock to their funding, their effective risk aversion endogenously increases as their leverage declines. Therefore, Adrian and Boyarchenko (2015) predict that the price of risk of intermediary leverage is positive, which is consistent with our empirical results.

An alternative approach to modeling an intermediary pricing kernel is proposed by He and Krishnamurthy (2013). In their setup, intermediary wealth, rather than intermediary leverage, is the key state variable. They argue that financial intermediaries are the marginal investor, and, as a result, the SDF is proportional to the wealth growth of the intermediary sector, giving an intermediary CAPM. Brunnermeier and Oehmke (2014) develop a closely related equilibrium asset pricing model with financial intermediaries where intermediation arises as an outcome of principal-agent problems. Their model also predicts that shocks to intermediary wealth are the relevant measure of systematic risk. In addition, both He and Krishnamurthy (2013) and Brunnermeier and Oehmke (2014) feature countercyclical intermediary leverage, thus predicting a negative price of risk of intermediary leverage.

The finding that financial institutions' balance sheets contain information about the real economy and expected asset returns has only recently received more attention in empirical studies. Adrian and Shin (2010) examine the relationship between asset growth and leverage growth for different investor groups. They document that, unlike private households, for example, security broker–dealers adjust their financial leverage aggressively as economic conditions change. Broker–dealers' active balance sheet management practices result in highly procyclical leverage, whereas households exhibit a more passive balance sheet management. Recently, Adrian, Etula, and Shin (2015), Adrian, Moench, and Shin (2010), Adrian, Moench, and Shin (2016), and Etula (2013) have shown that broker-dealer leverage has a strong predictive power for asset prices. Furthermore, around financial crises the equity forecasts and risk premia of intermediaries are especially high (Muir, 2013). The predictive power of intermediaries' balance sheets for stock and bond returns indicates that they contain valuable information about the evolution of risk premia over time. Adrian, Etula, and Muir (2014) connect the cross–section of returns to the exposures to broker-dealer leverage shocks, showing that broker-dealer leverage can price assets. An adverse shock to the leverage of intermediaries increases their effective risk aversion endogenously, so that the equilibrium pricing kernel can be expressed as a function of shocks to the intermediaries leverage.

Lastly, but importantly, Haddad and Muir (2018) show that the relationship between intermediaries' balance sheet factors and asset returns is not merely a comovement. The authors document a larger elasticity of the risk premia of intermediated assets such as credit default swaps and FX to changes in intermediary risk appetite implying that intermediary funding constraints have a strong impact on assets that households hardly have access to.

Data

To conduct our analysis, we need two sets of information: the data to calculate the balance sheet factor, and the portfolio returns on which to test the leverage factor.

We follow Adrian, Etula, and Muir (2014) and use shocks to the leverage of intermediaries as a proxy for shocks to the pricing kernel. Broker-dealer (BD) leverage is defined as:

$$Leverage_t^{BD} = \frac{TotalAssets_t^{BD}}{TotalAssets_t^{BD} - TotalLiabilities_t^{BD}} = \frac{TotalAssets_t^{BD}}{TotalEquity_t^{BD}} \tag{1}$$

and the leverage factor is then computed as the residual of the AR(1) process of the leverage series.

We collect leverage and portfolio data for both the European and German market. In the following, we will give some details on the data used in our analysis.

Leverage

Starting with German financial institutions, a relatively long time series, comparable to the database of US studies is available. Aggregate quarterly balance sheet data from June 1971 to June 2016 of German financial intermediaries are obtained from the Deutsche Bundesbank's banking statistics, which groups banks according to their role in the German financial system. The group of banks closest to the US broker–dealers are classified as depository institutions larger than savings banks but smaller than the big or money center banks. These financial institutions provide services such as securities brokerage, investment banking, insurance sales, and mutual fund and pension fund management, which is why in the following we refer to them as 'broker–dealer banks'. This group of banks comprises relevant financial intermediaries which play a decisive role in the German broker-dealer business. As a robustness test, we also investigate the role of savings banks' leverage for German asset pricing. Since this group of financial institutions is focused on the regional supply of mortgages and loans to small-size firms, the time series of leverage shocks should not provide any explanatory power in Fama–MacBeth regressions.[3] The Deutsche Bundesbank database also reports the leverage of the big money center banks – called 'main banks' – which are substantially engaged in providing loans to the public and private sector: for this reason, and due to the German universal banking system, their business is more balanced. Their aggregate balance sheet indicators are also used for comparison purposes.

To apply our analysis to a European context, we also build a sample of European broker–dealers. We use bank-level data of the constituents of the Europe Stoxx600 Banks, which is a sector index of the Europe Stoxx600 comprising European companies in the banking sector whose activity is expected to have a significant impact on financial markets. We cover the period ranging from the beginning of this index in January 2000, up to June 2016. The construction of this dataset requires the aggregation of two sources: Datastream for market data, and Bloomberg for the financial statements of the financial companies. The sample consists of 80 listed banks operating in continental Europe – including Switzerland – plus the United Kingdom, Denmark, and the Scandinavian countries.

Since the prevailing European business model is universal banking, where investment banking and commercial banking co-exist, albeit in different proportions, we have to investigate whether and how different proportions of investment versus commercial banking affect leverage procyclicality. In our sample, there are banks where the traditional commercial banking activity is prevalent and other financial institutions which are more focused on investment banking. To identify the latter, we follow the strategy oftan Baglioni, Beccalli, Boitani, and Monticini (2013) to distinguish the commercial banks from the investment banks. Investment banks are defined as intermediaries whose ratio between interest income and net revenues is below the median ratio of the whole sample of banks; consequently, commercial banks have a ratio above the median. We check this ratio quarterly and allocate the respective financial institution to one of the two groups.

The banks in the sample are the largest in Europe, and after our classification into investment and commercial banks, many significant differences emerge. Over the whole sample period, commercial financial institutions have a median total asset size of Euro 129 billion, whereas the second group, classified as investment banks, covers a median total asset size of Euro 204 billion. The median ratio between interest income and

[3] As a first indication we observe a Pearson correlation coefficient of 0.07 between the changes in leverage ratios of German broker–dealers and savings banks, which reflects a difference in leverage management.

net revenues significantly exceeds 50%, thus confirming the prevalence of the universal banking business model. The median level of leverage, measured as total assets over equity for each quarter, is 20.5 for commercial and 24.7 for investment banks.

Figure 2 displays long-term leverage movements for US, German, and European financial institutions. For comparability, we standardize each series, setting mean and unit variance to zero. To capture long-term developments, we use five-year averages. Note that due to the limited data availability the long-term series for European financial institutions do not start before 2004 which excludes these series from a long-term comparison. For the much longer series for US and German financial institutions we interestingly find comparable financial cycles. We observe dips both around the 1987 stock market crash and during the recent financial crisis. Moreover, there also seems to be a widespread long-term consensus developing in support of the idea of common (global) financial cycles followed by the internationally–orientated financial institutions (Rey, 2015). Correlation between the long-term leverage of US and German broker–dealers exceeds 70% whereas German main banks and US broker–dealers show a slightly negative correlation. Even German main banks and broker–dealers have a comparable low correlation, not exceeding 28%.

To identify the potential procyclical behavior of banks' balance sheets, as briefly outlined in the motivation of this paper, Figure 1 plots leverage growth against asset growth. As confirmed by Table 1 containing the respective correlation coefficients we find for all regions and across all banks' business models positive correlation with coefficients ranging between 0.31 and 0.85. This strongly supports the view that financial institutions in general actively manage their balance sheets during market upturns and downturns. Of course, this does not imply that all banks might be perceived as marginal investors on asset markets. The above reviewed literature suggests that rather than regional savings banks, for instance, it is the broker–dealers that offer the most promising data for analyzing asset portfolio returns, due to their strong trading activity and constant presence on asset markets.

The difference in business models can be illustrated by the impact of the financial crisis on the associated balance sheet changes. German savings banks report for 2008 the amount of Euro 247 billion of stocks (Euro 68 billion) and bonds (Euro 179 billion), while loans to non-banks accumulate to Euro 726 billion. Total assets sum up to Euro 1071 billion in 2008. After major stock markets plummeted and the financial crisis had fully unfolded in the balance sheets of banks, tradable assets (stocks and bonds) even increased to Euro 270 billion. As result, total assets also slightly increased and savings banks' balance sheets seem to be largely unaffected.

When looking at the respective group of German broker–dealers, in contrast, the following interesting observations can be made. These banks report a total of 145 billion Euro of stocks and bonds and total assets amounting to 791 billion Euro in 2008. A strong decrease of 47.1% in stocks induced a significant decline of total assets in this banking group by 9.5% to 723 billion Euro in 2009.

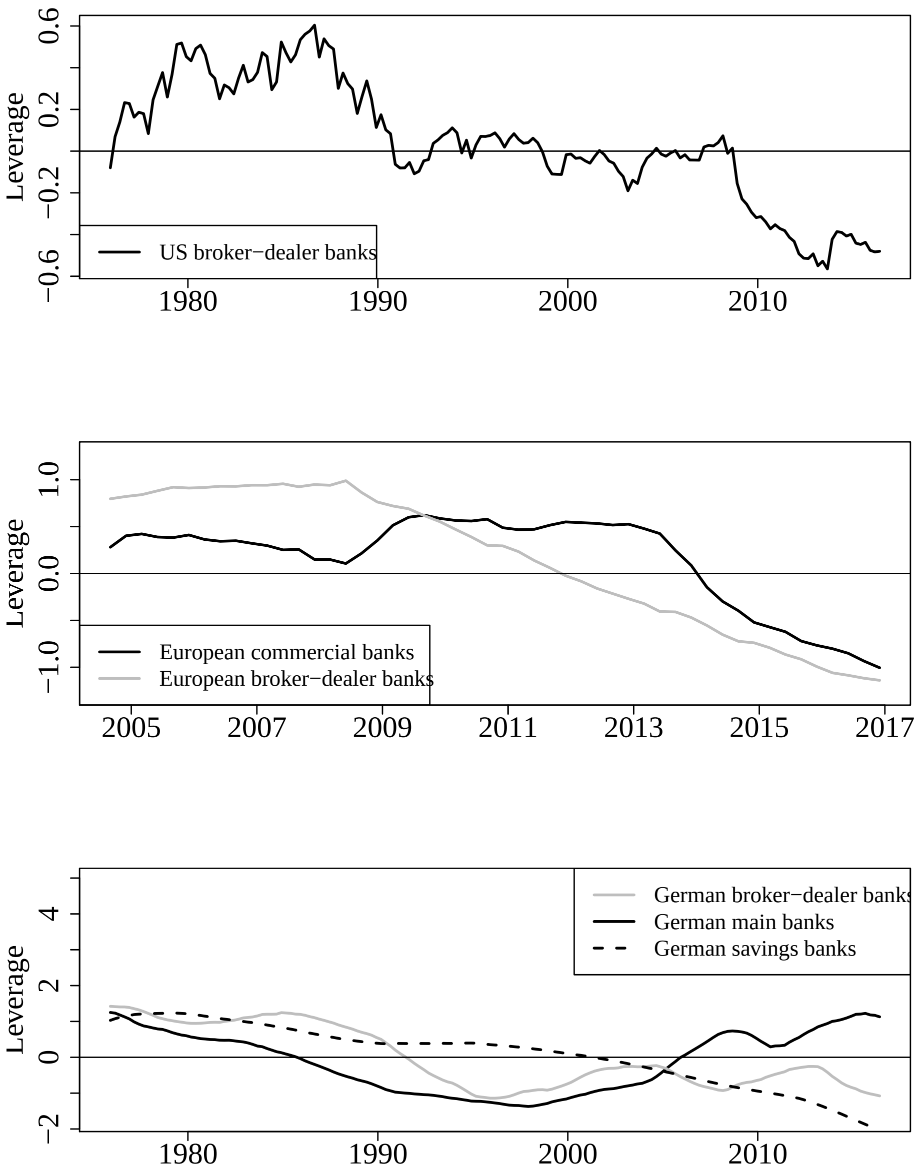

Figure 2: Long-term leverage movements

Long-term leverage movements for US, German and European financial institutions. The first plot reports the leverage movements of US broker-dealer banks, the second plot for European broker–dealer and commercial banks, the last plot for German broker–dealer, savings and main banks. Each series is standardized to have a mean of zero and a unit variance.

A similar picture emerges when looking at balance sheet positions of main banks. Total assets also significantly declined by 11.7% which was mainly driven by the strong balance sheet's dependence on financial assets. However, main banks are much bigger than the above mentioned group of German broker–dealers. The four main banks comprise a sum of total assets of Euro 1,292 billion at the end of 2009. These figures already show that these banks have a much broader business model and are much more universal than the financial institution involved in the broker–dealer business. Therefore, we also provide empirical results for this group of banks as a further robustness test.

With respect to Figure 1, the difference between banks' business models emerges from the size of the growth rates of leverage and banks' assets. While we find growth rates for broker–dealers quite often exceeding 5% percent, growth rates for savings banks are typically confined to lower numbers. This is mirrored in the respective average absolute growth rates. In contrast to average absolute growth rates of 2.2% (leverage) and 2.4% (assets) for broker–dealers, the average absolute growth rates for savings banks are 1.3% and 1.6%, respectively. Again, the reason for this difference in growth rates is the structure of the bank group balance sheets.

Overall, savings banks, which focus on regional supply of mortgages and loans to small firms typically lack a substantial balance sheet position for market-traded assets such as stocks and bonds. The contrary is true for broker–dealers, where a relatively large fraction of traded financial assets can be found. These substantial differences in the impact of the financial crisis on banking groups' balance sheets suggest that if any, it should be broker–dealer leverage that explains asset prices. By contrast, there is very little room for German savings banks to act as marginal investors. We use the latter proposition as an opportunity for robustness tests.

Table 1: Correlation of leverage and asset growth

This table presents the correlation of intermediaries' leverage growth with asset growth. For German broker–dealers, main and savings banks the correlation is calculated for the period from Q3 1971 to Q2 2016. For the European commercial and broker-dealer banks, the correlation is calculated from Q1 2000 to Q4 2016. For comparison purposes, the correlation between US broker–dealer leverage growth and asset growth is reported for the period from Q3 1971 to Q2 2016. For German data, we exclude extreme values/outliers linked to the unification (1990Q2 and Q3) and to the introduction of the Euro (1999Q1).

	Germany			Europe		USA
	Broker–dealer	Main banks	Savings banks	Investment	Commercial	Broker–dealer
Rho	0.73	0.85	0.61	0.31	0.35	0.75
(p-value)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)

Portfolios and Factors

In order to test whether the leverage of intermediaries is able to explain the cross-section of asset returns, we use for the European market the stock return data of 25 size and book-to-market portfolios from Kenneth French's data library.[4] For the German market,

[4]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

we obtain portfolio stock return data from Richard Stehle's website of the Humboldt University of Berlin.[5] Here, the asset portfolios are the intersections of German stocks double-sorted by 4 groups of size and 4 groups of book-to-market value. Summing up all possible combinations we get returns of a total of 16 portfolios. In addition, 10 portfolios sorted on momentum (the past 12 months return) are constructed as in Fama and French (2012). For the European and the German sample we choose to include additional German government bond portfolios with a maturity of 2, 3, 4, 5, 6, 7, and 10 years, as a representative investment in a risk–free European asset. While the European data set ranges from 2000 to 2016, the German sample already starts in 1971.

In a first step, we explain these return data with well-known asset pricing models: the CAPM, the three-factor model of Fama and French (1993), and the four-factor model of Carhart (1997). For the CAPM we construct the market factor as the difference between the market return and a risk free asset. In the Fama-French three–factor model, we additionally add a small-minus-big factor (SMB), which is based on firm size and measures return differences between portfolios with small and big capitalized companies. The third factor, high–minus–low (HML), is based on the book-to-market ratio and measures return differences between portfolios with high book-to-market ratios minus portfolios with low book-to-market ratios. Finally, for the Carhart four–factor model we add a momentum factor (MOM) based on the return difference between the winner and the loser portfolios of the past 12 months. All these factors are available for the European data from the Kenneth French's website and for the German data from Richard Stehle's website.

Empirical Results from a Linear Factor Model

We investigate the role of broker-dealer leverage in pricing the cross-section of asset returns using a standard linear factor model.[6] As a starting point, the asset pricing literature assumes that there exists a stochastic discount factor M_{t+1} so that

$$E_t[M_{t+1}R_{i,t+1}] = 0, \tag{2}$$

where $R_{i,t+1}$ denotes the return of asset i in excess of the risk–free rate.[7] The associated beta representation can be derived using the covariance definition, so that

$$E_t[R_{i,t+1}] = -\frac{Cov[M_{t+1}R_{i,t+1}]}{E_t[M_{t+1}]}. \tag{3}$$

[5] https://www.wiwi.hu-berlin.de/de/professuren/bwl/bb/data/fama-french-factors-germany A description of the dataset is given by Brückner, Lehmann, Schmidt, and Stehle (2015).

[6] The derivation of the estimators follows Adrian, Crump, and Moench (2015).

[7] See, for instance, Cochrane (2005).

If the percentage shocks to the pricing kernel are linear in the shocks to the vector of k risk factors (f_{t+1}), i.e.

$$\frac{M_{t+1} - E_t[M_{t+1}]}{E_t[M_{t+1}]} = \lambda_t \Sigma_f^{-1/2} f_{t+1} \tag{4}$$

and assuming a constant $\lambda_t = \Sigma_f^{-1/2} \lambda_f$,[8] we find

$$E_t[R_{i,t+1}] = \beta'_{i,f} \lambda_f. \tag{5}$$

Regarding the set of risk factors, this paper focuses on an empirical model combining financial intermediaries' balance sheet indicators and the market return to explain the excess returns of test assets. This is motivated by the theoretical contributions reviewed above, namely that the market return and the intermediaries' balance sheet measure as a long-run risk factor and as an important medium-term risk factor, respectively, are both a proxy for shocks to consumption growth. Aside from their theoretical contributions showing how balance sheet factors enter the pricing kernel, Adrian, Etula, and Muir (2014) stress the importance of information and transaction costs. The latter prevents the average household from participating regularly in asset markets, which is why a stochastic discount factor based on the marginal value of household wealth alone will not accurately reflect differences in assets' excess returns. This argumentation leaves room to introduce broker–dealers into the analysis, since they may be perceived as highly-informed agents trading heavily in financial markets. The potential importance of information and transaction costs also allows for a robustness test with which we estimate the asset pricing model using balance sheet factors of German and European credit banks not focussing on the broker–dealer business.[9] Given that these financial institutions have a strong focus on monitoring their borrowers, their balance sheet factors should be less informative in pricing the cross-section of stocks. All balance sheet factors are compared using the Fama-French three-factor (FF) and Carhart four-factor (FF&MOM) models as a benchmark (Fama and French, 1993; Carhart, 1997).[10] Reflecting the ongoing discussion in the literature about the exact specification of the intermediaries' balance sheet factor, we will also provide results for both book equity and leverage.[11]

The risk exposures β_i and the prices of risk λ_f of the above model are estimated using the Fama and MacBeth (1973) two-pass procedure. As a first step, risk exposures are derived from the time series regression of excess returns $R_{i,t}$ on the k risk factors f_t for

[8] In the next section, the time-variation of prices of risk is explicitly taken into account.

[9] Unfortunately, data on German household wealth are unavailable.

[10] It has to be borne in mind that, in contrast to the intermediary leverage model, the competitor models apply factors derived from the returns of the set of test assets.

[11] Since a large subset of German intermediaries are not listed, however, we are unable to use market capitalization as a balance sheet factor. See the discussion on book equity versus market capitalization in Adrian, Moench, and Shin (2016).

each asset i = 1,...,N:

$$R_{i,t} = c_i + \beta'_{i,f} f_t + \epsilon_{i,t}, \quad i = 1, ..., N. \tag{6}$$

To estimate the cross-sectional price of risk associated with the factors f, the second step is a cross-sectional regression of time series mean excess returns on risk factor exposures,

$$E[R_{i,t}] = \beta'_{i,f} \lambda_f + \zeta_i, \quad i = 1, ..., N \tag{7}$$

yielding estimates of cross-sectional prices of risk λ.

In line with most of the related literature, we measure the size of pricing errors by means of the cross-sectional adjusted R^2 ($adjR^2 = 1 - \frac{\sigma^2_\zeta}{\sigma^2_R}(\frac{N-1}{N-k})$) and the mean absolute pricing error ($MAPE = \frac{1}{N}\Sigma\,|\zeta|$) . In order to correct the standard errors for the pre-estimation of betas, we report the t-statistics of Shanken (1992). Indeed, shocks to intermediary leverage stem from a large set of different sources, such as a capital regulation, making the leverage factor a noisy regressor. Although Adrian, Etula, and Muir (2014) argue that this feature affects the quality of the first-stage time series regression but not the cross-sectional regression, Kleibergen and Zhan (2015) indeed stress a potential upward bias of second-stage R^2s. To deal with the problem, we perform the suggested likelihood ratio (LR) test, with which we test the null-hypothesis of whether the leverage factor betas are all equal to zero against the alternate hypothesis that the leverage factor betas are unequal to zero.

In the following subsections, we will outline the results of the geographical and temporal extensions we have made to the work of Adrian, Etula, and Muir (2014). First, we apply and calculate the leverage factor model to data from Germany and, second, we test the application of the leverage factor model to the broader but shorter sample of European data.

Broker-dealer leverage

Table 2 presents the cross-sectional prices of risk for the factor models for Germany. The table is split into two panels. Panel A presents the pricing performance of the different factor models with respect to our set of 33 test portfolios, including equity and bond portfolios, while Panel B reports the results obtained using only the equity portfolios sorted on size and book-to-market as well as momentum. This allows for the identification of a potential specialization of German broker–dealers on stock markets.

Starting the discussion with Panel B, we find that the Fama-MacBeth two-step regression with broker–dealer leverage as single factor performs fairly well in explaining the cross-sectional excess returns with an adjusted R^2 of 53%. The positive and significant estimate λ confirms the findings of Adrian, Etula, and Muir (2014) and reveals the reinforcing balance sheet behavior of the broker-dealers in Germany. By contrast, the market factor exhibits low explanatory power. The leverage factor model also outperforms the FF model, which yields an adjusted R^2 of 18.2%. Only the FF&MOM model does better, obtaining an adjusted R^2 of 78.5%. Regarding the alpha coefficient, we find a statistically significant and relatively large estimate of 10.2%, which is somewhat bigger than in the CAPM model, but smaller than in the FF model.[12] Overall, our findings suggest that the FF&MOM model does better in explaining the excess returns of the cross–section of test assets than the leverage factor model. However, as pointed out in Lewellen, Nagel, and Shanken (2010) the high adjusted R^2 may be misleading, because a relatively large number of factors may easily capture the variation of returns of highly correlated test assets.[13]

When incorporating the seven bond portfolios, as in Panel A of Table 2, the leverage single–factor model is inferior, while the CAPM substantially gains in explanatory power. With respect to the information and transaction costs argument of Adrian, Etula, and Muir (2014), it can be concluded that German broker–dealers seem to concentrate on stock markets. Incorporating the market factor into the leverage factor model, the Fama-MacBeth two-step regression with leverage factor again outperforms the FF factor model with an adjusted R^2 of 66.2%. In addition, we also observe a substantial decline in the estimated constant as well as in the $MAPE$ statistic. The associated LR test statistic of 746.28 has a zero p-value, implying a strong rejection of the null hypothesis that all betas are jointly zero.

Table 3 presents the results of the time series regressions for the German asset pricing model using market and leverage factor. We report the average return of each portfolio, beta and t-statistic of the leverage factor, and the R^2 of the time series regression. Confirming the LR test statistic, the results reveal a reasonable fit of the first-stage regressions, using a noisy variable such as intermediaries' leverage.

In conclusion, broker–dealers in Germany seem to be informed market participants strongly involved in asset market trading. Thus, a stochastic discount factor based on their leverage can reasonably be expected to help explain the variation of excess returns in the respective test portfolios. The positive and significant leverage price of risk supports the view that the balance sheet behavior of the broker–dealers in Germany is reinforcing booms and busts in asset markets. For the broader set of test assets, we find the factor model with both leverage and market factor to be the superior approach over the model with leverage as the single factor. Its relatively small constant in Table 2 further supports this conclusion. The greater ability to explain the cross-sectional variation in expected returns of stocks and bonds thus confirms the choice of our preferred model stressing a role for a long-run factor combined with a medium-term factor as motivated by the theoretical contributions reviewed in the literature section.

[12] Only the FF&MOM yields a statistically insignificant coefficient.

[13] Estimating asset pricing models with each of the factors individually shows that the closest competitor to the leverage factor is the momentum factor, which yields an adjusted R^2 of below 30%.

Table 2: Fama-MacBeth regressions for German broker-dealer leverage

This table presents the results of the Fama-MacBeth regression for Germany. Panel A reports the results for 16 size and book-to-market portfolios, 10 momentum portfolios and 7 German bond portfolios sorted by maturity. The factors used are market, small-minus-big (SMB), high-minus-low (HML), momentum (MOM) and leverage (LevFac). Panel B presents only the results of the Fama-MacBeth regression for 16 size and book-to-market portfolios and 10 momentum portfolios, excluding the 7 German bond portfolios. The 33 portfolios in Panel A and the 26 portfolios in Panel B are used to test the performance of the following five factor-models; CAPM, Fama-French three-factor model, Fama-French three-factor model with momentum factor, leverage factor model, and leverage factor model with market factor. Portfolios, Fama-French and momentum factors are provided by the Humboldt University of Berlin. The leverage is calculated from the monthly German broker-dealer balance sheet data obtained from the Bundesbank and then aggregated to quarterly data. The LevFac is the residual of the AR(1). The results are for annualized quarterly data from Q3 1971 to Q2 2016. The Shanken t-statistics are reported under the Fama-MacBeth prices of risk. The likelihood ratio (LR) test statistics and p-values are reported in the last row (the one-percent critical value for the LR test is 134.64 (bonds included) and 109.96 (bonds excluded), respectively.).

Panel A: Bond portfolios included

	CAPM	FF	FF&MOM	Lev	Lev&Mrkt
Constant	1.719***	1.678***	0.415***	8.102***	2.144***
	(3.833)	(6.464)	(2.418)	(4.138)	(4.146)
Market	9.459***	9.162***	11.189***		11.058***
	(3.133)	(3.052)	(3.723)		(3.639)
SMB		−3.253*	−2.862		
		(−1.805)	(−1.565)		
HML		2.980	5.537***		
		(1.608)	(2.937)		
MOM			9.410***		
			(3.398)		
LevFac				9.827***	9.541**
				(3.088)	(2.336)
Adj. R^2	0.526	0.514	0.906	0.128	0.662
$MAPE$	15.653	13.862	12.806	26.057	15.602
LR	711.68	1642.74	1956.46	32.88	746.28
p-Value	0	0	0	1	0

Panel B: Bond portfolios excluded

	CAPM	FF	FF&MOM	Lev	Lev&Mrkt
Constant	7.826**	16.541***	−6.009	10.165***	10.973**
	(2.443)	(3.696)	(−1.311)	(4.041)	(2.666)
Market	2.242	−6.463	18.093***		1.158
	(0.508)	(−1.146)	(3.135)		(0.224)
SMB		−3.626**	−2.623		
		(−2.010)	(−1.437)		
HML		4.013**	5.653***		
		(2.182)	(3.000)		
MOM			9.910***		
			(3.523)		
LevFac				11.594***	11.775***
				(3.679)	(2.801)
Adj. R^2	-0.026	0.182	0.785	0.532	0.515
$MAPE$	19.255	16.918	15.857	30.974	19.195
LR	702.60	1596.01	1904.03	25.99	731.25
p-Value	0	0	0	1	0

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 3: Time series betas for Germany

Results of the time-series regression for the model $R^e_{i,t} = c_i + \beta'_{i,Levfac} LevFac_t + \beta'_{i,Market} Market_t + \epsilon_{i,t}$. This table reports betas and t-statistics of the leverage factor. The R^2 of the leverage and market factor time series regressions are reported as a percentage. The time-series regression is estimated for each of the 33 portfolios.

	Low	Book-to-Market		High
	Average return			
Small	3.882	6.476	7.834	11.288
Size	7.601	8.715	10.593	11.520
	6.895	9.566	9.404	14.672
Big	7.891	11.108	10.872	13.587
	Betas, $\beta'_{i,Levfac}$			
Small	-0.415	-0.447	-0.288	-0.247
Size	-0.085	-0.192	-0.292	-0.264
	-0.240	-0.205	-0.450	-0.125
Big	-0.192	0.048	-0.024	0.051
	t-stat			
Small	-1.993	-2.398	-1.560	-1.159
Size	-0.532	-1.268	-1.818	-1.451
	-1.676	-1.409	-3.046	-0.707
Big	-1.298	0.382	-0.229	0.445
	R^2 in %			
Small	29.159	32.347	49.967	42.622
Size	47.267	53.175	51.144	52.384
	53.793	58.222	60.860	60.716
Big	75.546	82.231	84.917	82.113

Momentum portfolios				Bond portfolios			
Average return	Betas	t-stat	R^2	Average return	Betas	t-stat	R^2
6.746	-0.552	-2.102	56.803	0.199	-0.004	-0.752	2.239
3.584	-0.525	-2.319	60.599	0.398	-0.005	-0.804	2.199
9.231	-0.415	-2.527	72.459	0.583	-0.006	-0.816	2.213
6.260	-0.106	-0.721	71.997	0.691	-0.007	-0.936	2.355
8.599	-0.308	-2.059	71.531	0.827	-0.008	-0.987	2.426
8.726	-0.175	-1.293	73.659	0.947	-0.009	-1.016	2.450
11.822	0.157	1.128	68.292	1.133	-0.010	-1.054	2.516
11.813	-0.051	-0.352	65.452				
12.493	0.016	0.109	66.368				
19.284	0.300	1.305	48.728				

We now extend our analysis to the European asset market. Table 4 reports the results of the Fama-MacBeth regressions for Europe. The returns of the twenty-five stock and seven bond portfolios are denominated in euro in order to eliminate a potential exchange rate effect. The leverage factor arises from European broker–dealers as defined in the data section. In the first column of Panel A which includes the seven German bond portfolios sorted on maturity, the market return is the sole pricing factor; in the second column the Fama-French three-factors are used as pricing factors and achieve an adjusted R^2 of 75.3%. As it was the case for Germany, the Fama-French three-factor model plus momentum factor obtains the highest adjusted R^2 value of 84.8%. In the fourth column, the only pricing factor is the European leverage factor based on broker–dealer banks, while the fifth column represents the preferred model where the market factor is also considered. The empirical results concur with those of Germany as presented above. The adjusted R^2 of the model using the leverage factor alone is low, while in the fifth column, we see the adjusted R^2 increase to 46.1%. This again suggests that, in order to account for cross-sectional variation in the returns of bond portfolios, it is important to include the market return as a long-run risk factor. For the Fama-MacBeth results reported in Panel B, which does not include the bond portfolios, the adjusted R^2 of the leverage factor model is 24.1%, and adding the market factor substantially lowers the $MAPE$. Overall, the second-stage regressions deliver relatively high adjusted R^2s for our preferred model including the market factor together with the leverage factor, making the latter a useful SDF for European asset pricing.

Table 5 reports the results of the time series regressions for the European asset pricing model using market and leverage. Similarly to the time series results of Adrian, Etula, and Muir (2014), we see an increase in the betas of the leverage factor and an increase in its t-statistic when the average return of the portfolios increases. The pattern of significant betas in the time series regression indicates that our results are unlikely to be due to a spurious regression.

Overall, our sample, circumscribed to European data, largely confirms the above findings for Germany and those for the US presented in Adrian, Etula, and Muir (2014).

Other Banking Groups' Leverage and Equity Factor

The balance sheet data available for Germany and Europe give us the opportunity, firstly, to further investigate to what extent information and transaction costs influence the suitability of financial intermediary leverage as an asset pricing factor and, secondly, to collect empirical evidence in order to answer the question as to whether leverage or equity is the appropriate factor for cross-sectional asset pricing.

For the first purpose, we report in Table 6 the Fama-MacBeth regression results obtained using the leverage factor of main banks' and savings banks' balance sheets for Germany and commercial banks' balance sheet for Europe. Assuming that this group of financial intermediaries is mainly dealing with loans to the public and private sectors, the results

Table 4: Fama-MacBeth regressions for European broker-dealer leverage

This table presents the results of the Fama-MacBeth regression for the European market. Panel A reports the Fama-MacBeth regression results for 25 European equity portfolios sorted on size and book-to-market plus 7 German bond portfolios sorted on maturity. Panel B presents only the results of the Fama-MacBeth regression for 25 test portfolios sorted on size and book-to-market for Europe. The 25 portfolios sorted on size and book-to-market, the Fama-French factors and the momentum factor come from the data library curated by Kenneth French. The factors used are market, small-minus-big (SMB), high-minus-low (HML), momentum (MOM) and leverage (LevFac). The leverage factor is the residual of the AR(1) process of the natural logarithm of the leverage of the investment banks in the Stoxx600 Europe Banks Index. The results are reported in quarterly frequency from Q1 2000 to Q4 2016. Risk premia and returns are reported as yearly variables. The Shanken t-statistics are reported under the Fama-MacBeth prices of risk. The likelihood ratio (LR) test statistics and p-values are reported in the last row (The one-percent critical value for the LR test is 131.14 (bonds included) and 106.39 (bonds excluded), respectively.)

Panel A: Bond portfolios included

	CAPM	FF	FF&MOM	Lev	Lev&Mrkt
Constant	1.165***	0.853***	0.508***	6.003	1.067***
	(6.469)	(4.803)	(4.140)	(1.536)	(5.012)
Market	6.020	5.211	6.671		4.084
	(1.317)	(1.159)	(1.487)		(0.906)
SMB		13.792*	14.215		
		(1.839)	(1.572)		
HML		19.576**	18.611*		
		(2.567)	(2.013)		
MOM			18.416*		
			(1.907)		
LevFac				−0.488	22.512**
				(−0.024)	(2.131)
Adj. R^2	0.337	0.753	0.84	-0.033	0.461
MAPE	10.687	8.639	8.540	26.044	10.282
LR	436.803	818.046	891.334	1.219	516.592
p-val	0	0	0	1	0

Panel B: Bond portfolios excluded

	CAPM	FF	FF&MOM	Lev	Lev&Mrkt
Constant	24.564***	14.687**	1.219	9.975	22.584***
	(3.696)	(2.040)	(0.134)	(1.417)	(2.865)
Market	−16.413**	−8.115	5.948		−16.309*
	(−2.039)	(−0.964)	(0.591)		(−1.810)
SMB		13.005*	14.169		
		(1.713)	(1.585)		
HML		18.267**	18.585*		
		(2.356)	(2.037)		
MOM			17.949*		
			(1.876)		
LevFac				24.586**	23.447**
				(1.992)	(2.226)
Adj. R^2	0.142	0.657	0.7	0.241	0.313
MAPE	12.829	10.210	9.951	31.433	12.296
LR	405.93	770.47	828.611	0.980	469.916
p-val	0	0	0	1	0

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 5: Time series betas for Europe

Results of the time-series regression for the model $R^e_{i,t} = c_i + \beta'_{i,Levfac} LevFac_t + \beta'_{i,Market} Market_t + \epsilon_{i,t}$ for Europe. This table reports betas and t-statistics of the leverage factor. The R^2 of the leverage and market factor time series regressions is reported as a percentage. The time-series regressions are estimated for each of the 33 portfolios.

	Low		Book-to-Market		High
			Average Return		
Small	−2.537	3.423	6.375	8.688	11.570
	3.135	7.511	9.536	11.557	13.090
Size	3.608	8.155	9.829	11.172	12.260
	6.463	8.395	10.159	10.914	9.790
Big	1.960	5.727	4.849	7.560	6.407
			Betas, $\beta'_{i,Levfac}$		
Small	0.106	0.149	0.132	0.202	0.212
	0.066	0.136	0.127	0.161	0.186
Size	0.107	0.101	0.113	0.159	0.148
	0.024	0.083	0.041	0.110	0.095
Big	-0.046	0.019	-0.076	-0.059	-0.017
			t-stat		
Small	1.531	2.444	2.801	4.086	3.871
	0.877	2.618	2.621	2.928	2.917
Size	1.534	2.240	2.685	3.554	2.363
	0.444	2.429	1.001	2.292	1.355
Big	-0.867	0.578	-2.309	-1.254	-0.262
			R^2 in %		
Small	82.059	84.225	89.436	86.879	82.575
	80.502	88.970	87.945	84.621	79.761
Size	82.678	89.689	90.155	88.983	81.460
	87.418	92.870	89.982	87.657	80.063
Big	82.258	91.356	93.759	88.279	85.375

Bond Portfolios			
Average return	Betas	t-stat	R^2
0.049	-0.002	-0.994	16.327
0.181	-0.004	-1.288	20.160
0.359	-0.004	-1.175	18.907
0.503	-0.004	-1.137	19.190
0.672	-0.004	-1.062	19.312
0.800	-0.004	-1.014	18.778
1.109	-0.004	-0.960	21.129

of the asset pricing models should be less convincing than in the case of broker-dealer leverage. Since in the previous sections we find that the leverage factor plus market factor outperforms other specifications in explaining the cross-sectional variation in stock and bond portfolio returns, for this analysis we decided to add the market factor to the leverage factor of main and commercial banks.

Table 6: Fama-MacBeth regressions for non broker–dealer leverage

This table presents the results of the Fama-MacBeth regression for the leverage factor based on the balance sheet leverage of German main and savings banks and European commercial banks. Test portfolios and market factor are provided by the Humboldt University of Berlin for Germany and by the Kenneth French data library for Europe. The results for Europe are reported in quarterly frequency from Q1 2000 to Q4 2016 for Europe, and from Q3 1971 to Q2 2016 for Germany. Risk premia and returns are reported as yearly variables. The Shanken t-statistics are reported under the Fama-MacBeth prices of risk.

	Germany				Europe	
	Main banks		Savings banks		Commercial banks	
	LevFac&Market	LevFac	LevFac&Market	LevFac	LevFac&Market	LevFac
Constant	1.713***	2.269**	1.529***	7.611**	0.954***	0.673
	(4.132)	(2.222)	(5.743)	(2.713)	(3.601)	(0.584)
Market	9.475***		9.265***		5.301	
	(3.141)		(3.038)		(1.149)	
LevFac	0.185	−8.481	-0.985	-0.486	−43.593**	−36.530
	(0.049)	(−1.116)	(-0.490)	(-0.104)	(−2.373)	(−1.256)
Adj. R^2	0.51	0.013	0.508	-0.032	0.504	0.514

Notes:
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

In contrast to the results for broker-dealers discussed in the previous section, the results for Germany presented in Table 6 show no significant price of risk for the leverage factor based on main banks, which remains insignificant with both specifications with and without market factor. The leverage based on the savings banks also exhibits no significant price of risk for the leverage factor.[14] For the European market, the leverage model based on the commercial bank leverage produces a negative price of risk, which is in contrast to the theoretical work presented before. Overall, these findings support the suggestion that particularly broker–dealers in close proximity to asset markets might be viewed as marginal investors, and their leverage works as a significant pricing factor.

To pursue our second aim of collecting further empirical evidence to answer the question of whether leverage or equity is the appropriate factor to use for cross-sectional asset pricing we test a risk factor based on innovations to book equity of broker–dealers. Our approach is similar to the exercise for US data as provided by Adrian, Moench, and Shin (2016), who conclude that the leverage factor is preferable when pricing a cross-section

[14] In Germany, Sparkassen and Volksbanken are both savings banks. The results reported are for the Sparkassen group; however, the results are qualitatively the same for both groups.

of assets.[15] On the basis of Adrian, Moench, and Shin (2016), in Table 7 we report the risk premia for the equity factor model both with the market factor and without it. For Germany, the results in Table 7 show that the equity factor for German broker-dealers fails to explain cross-sectional variation in the bond and equity market better than the broker-dealer leverage factor. Furthermore, the risk premium of the equity factor is negative and contradicts the positive risk premia reported by Adrian, Moench, and Shin (2016) for the US market: this is an indication that the equity model fails to price the market in a correct way. For Germany a low adjusted R^2 and insignificant equity factor coefficients show that the equity factor can do little to explain the cross-sectional variation of the test asset returns. For Europe, the adjusted R^2 of the factor model reaches 49.3% without the market factor and 47.0% with it; however, the risk premia of the equity factor remain negative for Europe as well. These results confirm the view that in Europe and Germany broker-dealer leverage is a more useful risk factor than book equity.[16]

Table 7: Fama-MacBeth regression results for German and European equity factor

This table presents the results of the Fama-MacBeth regression with the equity factor (EQFac) for Germany and Europe. The test portfolios are those used for the Fama-MacBeth regression in the previous section without the 7 German bond portfolios. The factors used are market and equity (EQFac). The results are reported in a quarterly frequency from Q1 2000 to Q4 2016 for Europe and from Q3 1971 to Q2 2016 for Germany. Risk premia and returns are reported as yearly variables. The Shanken t-statistics are reported under the Fama-MacBeth prices of risk.

	Germany		Europe	
	EQFac	EQFac & Market	EQFac	EQFac & Market
Constant	9.280	7.646**	13.629	13.056
	(1.489)	(2.271)	(1.650)	(1.108)
Market		2.510		−6.143
		(0.552)		(−0.472)
EQFac	−0.090	−0.087	−0.636*	−0.643
	(−0.638)	(−1.357)	(−1.806)	(−1.536)
Adj. R^2	-0.011	-0.041	0.493	0.47

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.

Cross-Country Leverage

In Table 8 we test whether and to what extent a leverage factor based on broker-dealers of different countries affects German and European portfolios. Germany being part of the European Union, it may be plausible to employ the German broker–dealer leverage

[15]Note that He and Krishnamurthy (2013) stress that market capitalization is the appropriate variable to use. However, this is unavailable for German and European broker–dealers. As a consequence, the results presented here have to be interpreted with caution.

[16]Note that data on market equity is unavailable for German broker–dealers.

to price the European portfolios and vice versa. Furthermore, broker–dealer banks in the United States may be influential on the German and European markets as well. To test the explanatory power of US broker-dealer leverage, we use data from Table L.130 of the Federal Reserve Flow of Funds Z.1 release, which corresponds to the broker-dealer leverage for the US.[17] All the Fama-MacBeth results are reported for both equity and bond portfolios and include the market return as a second risk factor.

The first three columns of Table 8 show the results obtained from testing the European and US leverage factor on the German market. The European leverage factor offers very little explanation for the cross-sectional variation of returns resulting in an adjusted R^2 of only 1.9%, indicating that the European broker-dealers' behavior has no explanatory power for the German equity and bond markets. The US leverage factor, by contrast, performs substantially better as a relevant risk factor for German equity and bond portfolios' returns. If we use the US leverage as the only factor in the model we find an adjusted R^2 of 56.8% with a λ-coefficient significant at a 10% level. However, including both the German and the US leverage in the model shows that the US leverage factor seems not to carry any pricing information that the German leverage factor fails to capture. For the European equity and bond portfolios, the model with German broker-dealer leverage factor and market factor results in a negative price of risk, and the US broker-dealer leverage factor is statistically insignificant. Overall, there is very little evidence of cross-market influence of broker–dealer leverage. If the general notion of US investors' dominance on European asset market is true then it does not appear to work through broker–dealer leverage.

Empirical Evidence from a Dynamic Asset Pricing Model

The empirical results in the preceding section suggest that, in times of tight funding constraints, financial intermediaries have to deleverage, thereby raising their marginal value of wealth. Under these circumstances, assets that covary positively with leverage must provide a risk premium in terms of higher cross-sectional expected returns. Thus, showing a significantly positive price of risk and relatively low pricing errors, broker–dealer leverage seems to perform well as an intermediary stochastic discount factor. As argued by Adrian, Etula, and Muir (2014), however, a constant price of risk such as it emerges from the Fama–MacBeth regressions might be too restrictive. In fact, theoretical contributions point to a time-varying λ. For instance, Danielsson, Shin, and Zigrand (2009) derive a negative relationship between leverage and effective risk aversion when intermediaries are facing a value-at-risk constraint. In Adrian and Boyarchenko (2015), the deleveraging of broker–dealers further spurs volatility, thereby constituting

[17] Since the study conducted by Adrian, Etula, and Muir (2014) the broker–dealer data has been moved from table L.129 to L.130 and the total liability calculation has also substantially changed.

Table 8: Fama–MacBeth regressions for cross-country leverage

Results of the cross-country Fama-MacBeth regression for Germany and Europe. The factors used are the balance sheet leverage for Germany, the US, and Europe. The results are reported in quarterly frequency from Q3 1990 to Q4 2016 for Europe and from Q3 1971 to Q2 2016 for Germany. When the European leverage factor is included, the time period is only from Q1 2000 to Q4 2016 due to data availability. The leverage factors are the broker–dealer leverages for each country. All the specifications test the factor model on the equity and bond portfolios for Germany and Europe. The risk premia reported in column one are for the European leverage and German market factors; in column two those for US broker-dealer leverage and German market; and in column three for US leverage, German leverage and German market factor.For the European portfolios column four reports the risk premia for German leverage and European market, and column five reports the risk premia for US leverage and European market factor. Column six reports the risk premia of the US leverage, European leverage, and European market factors. Risk premia and returns are based on annualized quarterly data. The Shanken t-statistics are reported under the Fama-MacBeth prices of risk.

	Germany			Europe		
	EU LevFac	US LevFac	US & DE LevFac	DE LevFac	US LevFac	US & EU LevFac
Constant	6.657***	1.772***	2.159***	0.128	0.718***	0.664***
	(13.711)	(3.446)	(3.996)	(0.846)	(3.206)	(3.206)
Market	7.422	10.447***	11.018***	−2.303	6.167	5.080
	(1.436)	(3.460)	(3.630)	(−0.413)	(1.310)	(1.129)
US LevFac		1.662	-1.761		24.693*	18.930
		(1.662)*	(-0.162)		(1.720)	(1.488)
EU LevFac	0.023					14.353
	(0.829)					(1.164)
DE LevFac			2.489**	−7.984**		
			(2.539)	(−2.452)		
Adj. R^2	0.019	0.568	0.651	0.207	0.698	0.77

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

a vicious cycle in financial markets with the testable implication that the price of risk is a time-varying function of intermediary leverage.

To capture a time-varying price of risk, we follow Adrian, Moench, and Shin (2016) and apply the dynamic asset pricing model (DAPM) of Adrian, Crump, and Moench (2015). The systematic part of an economys' risk is proxied by the time series of shocks arising from the vector autoregression (VAR) of risk factors and price of risk factors. Risk factors are defined as state variables that are contemporaneously correlated with returns, while price of risk factors show forecasting power for future excess returns in the time series, which is why they are also called forecasting factors. The DAPM framework is flexible in the sense that any given variable might be a risk factor, a price of risk factor, or both. Based on the results of the US market documented in Adrian, Moench, and Shin (2016) and the results in the preceding section we concentrate on a specification that employs the market return (R^M) as a risk factor and the single balance sheet measure (BSF) both as risk and as price of risk factor. Thus, the VAR is given by

$$\begin{pmatrix} R^M_{t+1} \\ BSF_{t+1} \end{pmatrix} = \begin{pmatrix} \mu_{R^M} \\ \mu_{BSF} \end{pmatrix} + \begin{pmatrix} \phi_{R^M,R^M} & \phi_{R^M,BSF} \\ \phi_{BSF,R^M} & \phi_{BSF,BSF} \end{pmatrix} \times \begin{pmatrix} R^M_t \\ BSF_t \end{pmatrix} + \begin{pmatrix} u^{R^M}_{t+1} \\ u^{BSF}_{t+1} \end{pmatrix}. \quad (8)$$

Assuming linearity of the pricing kernel and the prices of risk being affine in BSF_t the beta representation of our DAPM model can be written as

$$R^i_{t+1} = \beta^{R^M}_i(\lambda^{R^M}_0 + \Lambda^{R^M,BSF}_1 BSF_t + u^{R^M}_{t+1}) + \beta^{BSF}_i(\lambda^{BSF}_0 + \Lambda^{BSF,BSF}_1 BSF_t + u^{BSF}_{t+1}) + e^i_{t+1}. \quad (9)$$

Equation (9) reveals that, in contrast to a standard beta representation, the price of risk is now time-varying. Thus, the expected excess return depends on the βs and the set of $\lambda_t = \lambda^i_0 + \Lambda^{i,j}_1 BSF_t$.[18] For the parameter estimations, we implemented the two-stage procedure of Adrian, Crump, and Moench (2015). Aside from showing consistency and asymptotical normality of estimated coefficients, the authors also provide heteroskedasticity-robust standard errors, which are used to calculate t-statistics of coefficients.

The following Table 9 and Table 10 contain the estimation results of the DAPM model for German and European data. In Panel A of each table we report the results of simple regressions of the stock market return (R^M), the 10-year German government bond return ($BUND10$), the difference between $BUND10$ and the 3-month Euribor rate ($SPREAD$), and the return from a corporate bond portfolio (CBP) on lagged shocks to balance sheet factors. The intent behind this preliminary exercise is to reveal the potential suitability of the balance sheet measures to serve as forecasting factors. Panel

[18]The framework nests the Fama–MacBeth estimator as a constraint specification ($\Lambda^{i,j}_1 = 0$ and $\phi_{i,j} = 0$).

B shows estimates of $\Lambda_1^{R^M,BSF}$ and $\Lambda_1^{BSF,BSF}$ together with the $MAPE$ for comparison purposes.[19] We also calculate the average prices of risk for the market return and the balance sheet factor, denoted by $\bar{\Lambda}^{R^M}$ and $\bar{\Lambda}^{BSF}$, respectively.

Table 9: Time-varying price–of–risk for German intermediary leverage

This table contains the time-varying price of risk estimates for alternative German leverage factors: broker-dealer leverage ($LevBD$), main banks leverage ($LevMain$), and savings banks leverage ($LevSav$). $\bar{\Lambda}^{R^M}$ and $\bar{\Lambda}^{BSF}$ denote the unconditional price of risk for R^M and BSF, respectively. $\Lambda_1^{R^M,BSF}$ and $\Lambda_1^{BSF,BSF}$ are the estimated coefficients of the price of market risk on lagged balance sheet factors and the price of balance sheet risk on lagged balance sheet factors, respectively. $MAPE$ denotes the mean absolute pricing error. $Wald$ reports the test statistic (together with its p-value) of joint beta significance in the time series regressions as recommended by Adrian, Moench, and Shin (2016) (The 1 percent critical value for this F-test is 4.73). The sample ranges between 1971Q1 and 2016Q4. $***$, $**$, and $*$ denote significance at the 1 percent, 5 percent, and 10 percent level.

	$LevBD$	$LevMain$	$LevSav$
		Panel A	
R^M	-0.49**	0.08	-0.06
	(1.97)	(0.45)	(0.11)
$BUND10$	0.01	-0.12**	0.36***
	(0.13)	(2.38)	(2.75)
$SPREAD$	-0.04	-0.01	-0.09
	(1.14)	(0.30)	(1.17)
CBP	0.01	-0.02**	0.10***
	(1.01)	(2.23)	(4.22)
		Panel B	
$\Lambda^{R_M,BSF}$	-0.47*	0.22	0.03
	(1.80)	(1.11)	(0.06)
$\Lambda^{BSF,BSF}$	0.04	0.03	-0.82***
	(0.17)	(0.15)	(2.62)
$\bar{\Lambda}^{R^M}$	13.58***	11.60***	11.89***
	(4.29)	(3.76)	(3.94)
$\bar{\Lambda}^{BSF}$	9.06**	1.33	0.71
	(2.46)	(0.34)	(0.43)
$MAPE$	15.27	15.28	15.23
$Wald$	55.95	81.60	122.69
p-Value	0.00	0.00	0.00
Notes:	***Significant at the 1 percent level.		
	**Significant at the 5 percent level.		
	*Significant at the 10 percent level.		

Panel A of Table 9 shows that the leverage of German broker–dealers exhibits potential to forecast future excess stock market returns, suggesting that this particular balance sheet factor is a successful driver of a time-varying price of risk. The negative coefficient is consistent with the expected role of the broker–dealer leverage. If broker–dealers are buying stocks, both their leverage goes up and stock market prices increase. The price impact implies that future stock returns will be compressed. This funding constraint effect can also be observed with main banks, but in this case the forecasting power is related to the return of the German Bund. Here, improved funding conditions primarily trigger bond purchases. These funding constraint mechanics are in contrast to Haddad and Sraer (2016), who show that, if banks' balance sheet management is dominated by interest rate risk considerations, a larger than average net exposure of banks to long-term

[19]The cross-section of absolute pricing errors is available from the authors upon request.

assets should be a predictor of larger bond risk premia. Interestingly, this is true for savings banks largely focusing on local credit supply. As a result, the estimation result reveals positive and significant coefficients in the case of German government bonds and corporate bonds, but not for the stock market return.

Panel B of Table 9 largely confirms these findings. The estimated coefficient measuring the influence of leverage on the market price of risk is statistically significant (at the 10% level) and negatively signed only with broker–dealers. Moreover, the unconditional prices of risk are all positive and the time-variation of λ obtains a slightly lower mean absolute pricing error compared to the Fama-MacBeth regressions.[20] The time series of $\lambda_t^{R^M,BSF}$ is presented in Figure 3 for illustration purposes. Due to the fact that market price of risk is supposed to be driven by the shocks to broker–dealer leverage, it clearly shows substantial volatility around its long-run mean. Marked episodes, however, may be in accordance with the above argumentation. For instance, in the run-up to the financial crisis, increasing asset prices led to a loosening of funding constraints giving rise to a downward trending market price of risk to below-average levels. This trend is immediately corrected thereafter in the fourth quarter of 2008 when funding started to dry up.

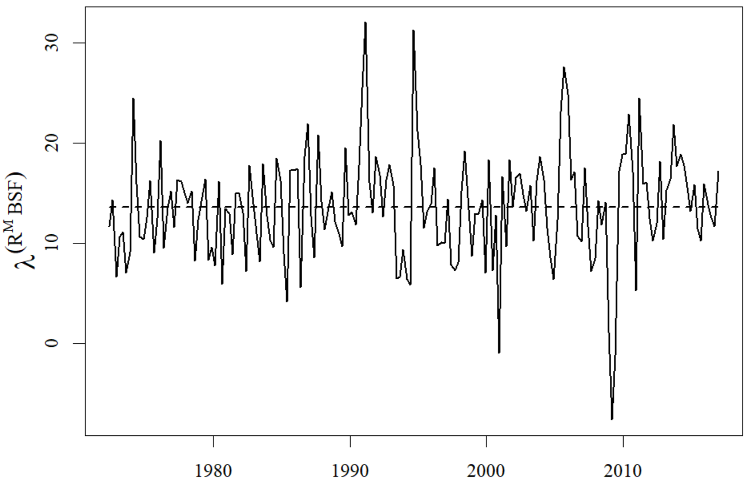

Figure 3: Time varying lambda.

The solid black line is the time series of $\lambda_t^{R^M,BSF}$ and the dashed line is its long-run mean reported as a percentage.

[20]Table 9 also reports the $Wald$-statistic (together with its p-value) of joint beta significance of the time series regressions as recommended by Adrian, Moench, and Shin (2016). The strong rejection of the null hypothesis of $\beta_i = 0$ suggests that weak instrument problems are not an issue here.

In the case of savings bank leverage, Table 9 reports a significantly negative influence of leverage on the leverage price of risk, which is in line with Adrian and Boyarchenko (2015). The estimated unconditional prices of risk for leverage are statistically insignificant for main banks and savings banks, confirming the results of the Fama-MacBeth regressions above. Taken together, the empirical evidence from the DAPM model points to a time variation of the prices of risk along the lines of the theoretical contribution of Adrian and Boyarchenko (2015). This confirms earlier results for the US market as documented in Adrian, Moench, and Shin (2016).

Table 10: Time-varying price–of–risk for European intermediary leverage

This table contains the time-varying price–of–risk estimates for two European balance sheet factors: broker–dealer leverage ($LevBD$) and commercial banks leverage ($LevCom$). $\bar{\Lambda}^{R^M}$ and $\bar{\Lambda}^{BSF}$ denote the unconditional price of risk for R^M and BSF, respectively. $\Lambda_1^{R^M,BSF}$ and $\Lambda_1^{BSF,BSF}$ are the estimated coefficients of the price of market risk on lagged balance sheet factors and the price of balance sheet risk on lagged balance sheet factors, respectively. $MAPE$ denotes the mean absolute pricing error. $Wald$ reports the test statistic (together with its p-value) of joint beta significance in the time series regressions as recommended by Adrian, Moench, and Shin (2016) (The 1 percent critical value for this F-test is 4.99). The sample ranges between 1999Q4 and 2016Q4. $***$, $**$, and $*$ denote significance at the 1 percent, 5 percent, and 10 percent level.

	$LevBD$	$LevCom$
	Panel A	
R^M	0.16	-0.13
	(0.90)	(1.15)
$BUND10Y$	0.05**	0.04**
	(2.30)	(2.00)
$TERM$	0.001	0.01
	(0.06)	(0.72)
CBP	0.03	0.07***
	(1.18)	(3.37)
	Panel B	
$\Lambda_1^{R^M,BSF}$	0.20	-0.09
	(1.63)	(0.78)
$\Lambda 1^{BSF,BSF}$	-0.17	-0.26
	(0.58)	(0.69)
$\bar{\Lambda}^{R^M}$	5.34	7.16
	(1.23)	(1.48)
$\bar{\Lambda}^{BSF}$	23.37**	-39.98**
	(2.52)	(2.46)
$MAPE$	10.11	9.97
$Wald$	1,109.53	199.24
p-Value	0.00	0.00
Notes:	***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.	

The empirical results of European financial intermediaries are comparable to those of German main banks and savings banks. The positive relationship between banks' leverage and future returns of the German Bund shown in Panel A of Table 10 may be explained by resorting not only to interest rate risk management, as in Haddad and Sraer (2016) but also to a 'flight–to–quality' effect as suggested by Brunnermeier and Pedersen (2009) and Acharya and Pedersen (2005). The latter suggests that, in a market downturn, financial intermediaries face increasing liquidity risks of stock holdings, which lead them to substitute them with safe assets such as German government bonds and –

in the case of main banks – also corporate bonds. Buying bonds in a situation of a negative leverage shock raises bond prices, thereby lowering future returns as signified by the positive sign.[21] A statistically significant influence of leverage on future stock returns, however, cannot be identified. This is also reflected in Panel B of Table 10. Although the $MAPE$s are slightly lower than in case of the Fama-MacBeth regressions, there is little evidence in favor of a significant time-variation of λ for European broker–dealers.

Conclusion

This paper provides empirical evidence on the reinforcing nature of financial intermediaries' balance sheet management during boom and bust cycles on European markets. We start by showing that the findings of Adrian, Etula, and Muir (2014) for US broker–dealers also hold for other important financial markets. Particularly, the Fama-MacBeth two-step regression reveals that including broker–dealer leverage as a risk factor explains German asset returns with an adjusted R^2 of up to 66%. To provide some additional evidence on the question of whether or not broker–dealers can be perceived as marginal investors, we also investigate the role of savings banks' leverage. Focussing on mortgage loans and loans to private-sector firms, this group of financial institutions is not strongly engaged in asset market trading. In line with this conjecture, the time series of leverage shocks does not provide any explanatory power in Fama-MacBeth regressions: This is supported by the empirical results from European data since 1999. In addition, a cross-country perspective does not reveal any indication of foreign broker–dealer influence.

Moreover, we consider the suggestions by Adrian, Moench, and Shin (2016), who stress that a constant price of risk as derived from Fama-MacBeth regression might be too restrictive. To capture a time-varying price of risk, the authors' dynamic asset pricing model is applied to German and European data sets. Here, the systematic part of an economic risk is proxied by the time series of shocks arising from the vector autoregression of risk factors and price of risk factors. Risk factors are defined as state variables that are contemporaneously correlated with returns, while price of risk factors show forecasting power for future excess returns in the time series. We find that the leverage of German broker–dealers exhibits potential for forecasting future excess stock market returns, suggesting this particular balance sheet factor as a successful driver of a time-varying price of risk.

From a policy perspective, it can be concluded that broker–dealer leverage shows procyclicality and significantly explains excess asset returns, thus supporting the view that financial intermediaries play a central role in propagating shocks in the financial sector, stressing the importance of macro- and microprudential policies.

[21] Given the low fraction of stocks in savings banks' balance sheets, a flight–to–quality effect is less likely.

References

Acharya, V. V. and L. H. Pedersen (2005). Asset pricing with liquidity risk. *Journal of Financial Economics 77*, 375–410.

Adrian, T. and N. Boyarchenko (2015). Intermediary leverage cycles and financial stability. Federal Reserve Bank of New York Staff Report 567.

Adrian, T., R. K. Crump, and E. Moench (2015). Regression-based estimation of dynamic asset pricing models. *Journal of Financial Economics 118*, 211–244.

Adrian, T., E. Etula, and T. Muir (2014). Financial intermediaries and the cross-section of asset returns. *Journal of Finance 69*(6), 2557–2596.

Adrian, T., E. Etula, and H. S. Shin (2015). Risk appetite and exchange rates. Federal Reserve Bank of New York Staff Report 750 FRB of New York Staff Report No. 361.

Adrian, T., E. Moench, and H. S. Shin (2010). Financial intermediation, asset prices and macroeconomic dynamics. FRB of New York Staff Report No. 422.

Adrian, T., E. Moench, and H. S. Shin (2016). Dynamic leverage asset pricing. Centre of Economic Policy Research CEPR Discussion Paper No. DP11466.

Adrian, T. and H. S. Shin (2010). Financial Intermediaries and Monetary Economics. *Handbook of monetary economics 19*, 419–437.

Baglioni, A., E. Beccalli, A. Boitani, and A. Monticini (2013). Is the leverage of European banks procyclical? *Empirical Economics 45*, 1251–1266.

Brückner, R., P. Lehmann, M. H. Schmidt, and R. Stehle (2015). Another german fama/french factor data set. Working Paper.

Brunnermeier, M. K. and M. Oehmke (2014, October). Predatory short selling. *Review of Finance 18*(6), 2153–2195.

Brunnermeier, M. K. and L. H. Pedersen (2009). Market liquidity and funding liquidity. *Review of Financial Studies 22*(6), 2201–2238.

Carhart, M. M. (1997). On persistence in mutual fund performance. *Journal of Finance 52*(1), 57–82.

Cochrane, J. H. (2005). Financial markets and the real economy. *Foundations and Trends in Finance 1*(1), 1–101.

Cochrane, J. H. (2011). Presidential address: Discount rates. *Journal of Finance 66*(4), 1047–1108.

Danielsson, J., H. S. Shin, and J.-P. Zigrand (2009). Risk appetite and endogenous risk. Working Paper, London School of Economics.

Etula, E. (2013). Broker-Dealer Risk Appetite and Commodity Returns. *Journal of Financial Econometrics 11*(3), 486–521.

Fama, E. F. and K. R. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics 33*, 3–56.

Fama, E. F. and K. R. French (2012). Size, value, and momentum in international stock returns. *Journal of Financial Economics 105*(3), 457–472.

Fama, E. F. and J. D. MacBeth (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy 81*(3), 607–636.

Haddad, V. and T. Muir (2018). Do intermediaries matter for aggregate asset prices? Working Paper, University of California Los Angeles.

Haddad, V. and D. Sraer (2016). The banking view of bond risk premia. Princeton University Working Paper.

He, Z. and A. Krishnamurthy (2013). Intermediary asset pricing. *American Economic Review 103*(2), 732–770.

Kleibergen, F. and Z. Zhan (2015). Unexplained factors and their effects on second pass r-squared's. *Journal of Econometrics 189*, 101–116.

Lewellen, J., S. Nagel, and J. Shanken (2010). A skeptical appraisal of asset pricing tests. *Journal of Financial Economics 96*, 175–194.

Muir, T. (2013). Financial crises, risk premia, and the term structure of risky assets. Working Paper, Yale University.

Rey, H. (2015). Dilemma not trilemma: The global financial cycle and monetary policy independence. NBER working Paper 21162.

Shanken, J. (1992). On the estimation of beta-pricing models. *Review of Financial Studies 5*(1), 1–33.