BANCA D'ITALIA
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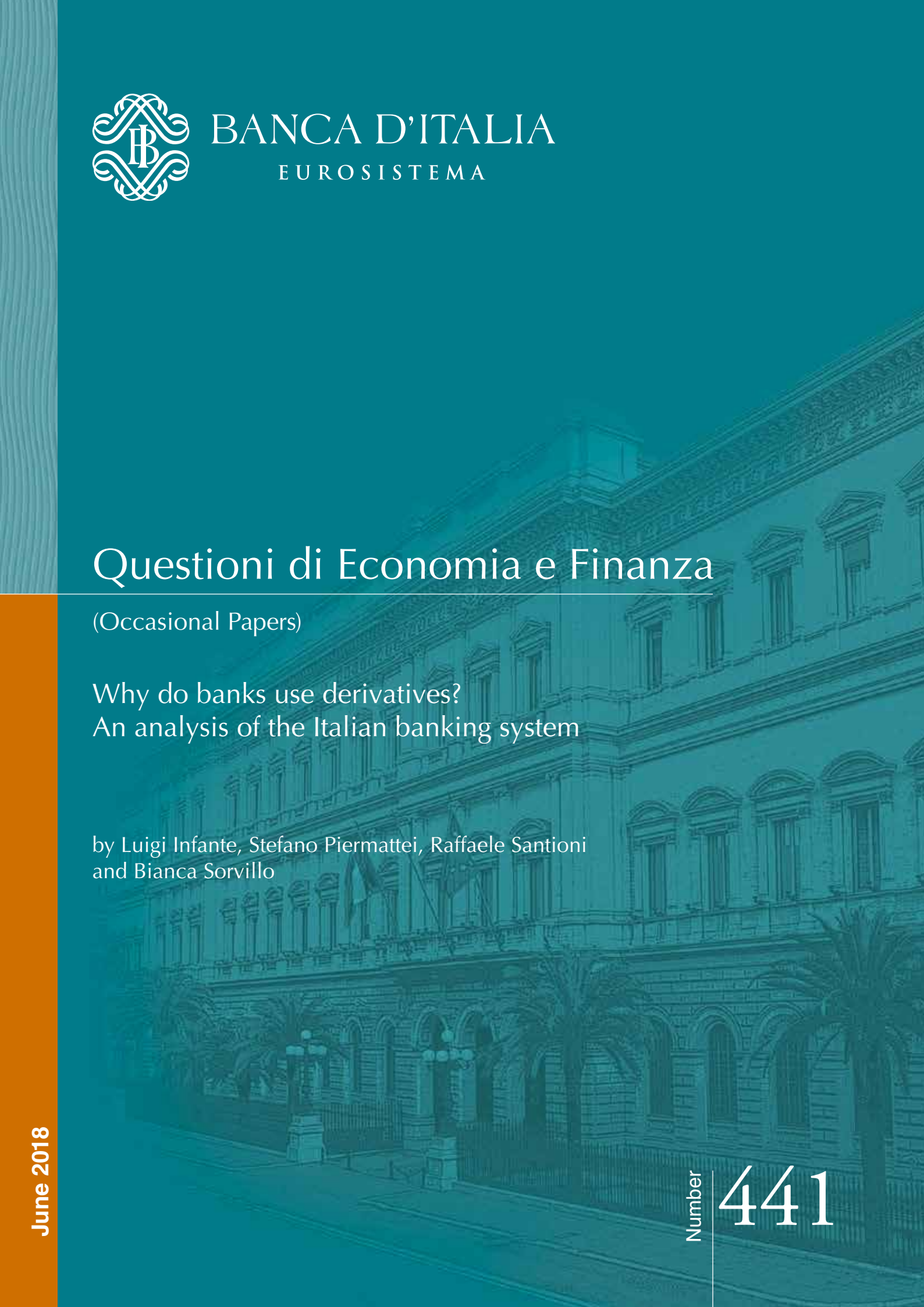

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WHY DO BANKS USE DERIVATIVES?
AN ANALYSIS OF THE ITALIAN BANKING SYSTEM

by Luigi Infante*, Stefano Piermattei*, Raffaele Santioni* and Bianca Sorvillo*

Abstract

The derivatives market has experienced quick growth all over the world in the last two decades. Banks decide to participate in the derivatives market either to hedge against unexpected movements in economic variables or for trading and broker-dealer activities. This paper analyses, by means of multivariate descriptive statistical tools, the determinants of Italian banks' use of derivatives over a long time horizon (2003-2017) by using quarterly Bank of Italy supervisory data. We find that size and being part of a banking group positively affect banks' use of derivatives. Moreover, banks mainly employ derivatives for hedging purposes, especially to hedge against interest rate and credit risks. Finally, derivatives represent a hedging alternative to capital and liquidity. Our results are robust to different specifications that take into account the classification of derivatives by purpose (hedging versus trading) and the distinction between dealer versus end-user banks.

JEL Classification: G21, G32.
Keywords: banking, derivatives, financial risks, hedging.

Contents

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1. Introduction[1]

Derivatives are financial instruments whose value derives from the performance of other underlying variables (e.g. assets, indices, interest rates or exchange rates). The different types of contracts entail private agreements between two parties to exchange future cash flows according to a predetermined formula (swaps), to buy or to sell an asset at a certain future time at a fixed price (forward and futures), or the right to buy or to sell an asset at any time up to a given expiration date (options). Contracts can also envisage payments if contingent events occur (i.e. credit derivatives in case of third-party default). Given their capacity to increase flexibility in portfolio management and to transfer financial risks, the development of these contracts has led to the creation of specialized markets where standardized contracts are traded. Nonetheless, the vast majority of derivatives is traded in unregulated over-the-counter (OTC) markets, where traded contracts are not standardized but tailored to the specific needs of single clients.

Thanks to these instruments' usefulness to transfer risks, the derivatives market has experienced quick growth all over the world in the last two decades. According to statistics collected by the Bank for International Settlements[2] (BIS), in the second quarter of 2017 the global derivatives market reached $576 trillion in terms of total notional outstanding amounts, seven times the value it had at the end of 1998, which is equivalent to a compound annual growth rate of 11 per cent.

Against this backdrop, the use of derivatives as a tool for effective risk management has often raised doubts. Given the contingent nature of cash-flow payments, pricing these assets is not easy. Moreover, derivatives are highly leveraged instruments and this can have negative implications when leverage magnifies the effect of price moves (Sundaram, 2013). This in turn can quickly spread the effects to the entire portfolios and, from there, to other corporations. Therefore, it is of paramount importance to better investigate the

[1] The authors would like to thank Giorgio Albareto, Luigi Cannari, Riccardo De Bonis, Luigi Federico Signorini, Philip E. Strahan and Roberto Tedeschi for valuable comments on a previous version of this paper. The opinions expressed and conclusions drawn are those of the authors and do not necessarily reflect the views of the Bank of Italy.

[2] The BIS compiles and publishes one set of statistics on exchange-traded derivatives and two sets on the over-the-counter derivatives market for a group of 13 countries (Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States).

characteristics of participants in the derivatives market and the main reasons for using derivatives.

Banks are among the most important players in the derivatives market, both because they use derivatives for trading and broker-dealer purposes and because their activity exposes them to different financial risks that they want to hedge. Derivatives represent a unique and multifaceted tool for hedging, in principle, all kinds of risks. Nonetheless, the high flexibility of derivatives is often considered a "double-edged sword", owing to the high degree of complexity of some products and the frequent use of the OTC market. OTC transactions dwarf exchange-traded transactions,[3] raising concerns among policy makers, who in the aftermath of the great financial crisis proposed stricter regulation of this market segment (FSB, 2015). The main measures[4] are bound to promote central clearing of standardized transactions and higher capital requirements for non-centrally cleared contracts. By requiring more capital and the intervention of a third party, policy makers aim at reducing both the misuse of derivatives and liquidity issues that – as experienced during the financial crisis – may easily spread through financial intermediaries.

In this paper we study the determinants of Italian banks' usage of derivatives over a long time horizon (2003–2017) by using supervisory data collected by the Bank of Italy from Italian credit institutions.[5] Despite the use of multivariate statistical tools, the aim of the work is not to identify causal links between the variables taken into account but, rather, to illustrate the main features of the use of derivatives by Italian banks. Supervisory data contain information on (a) the types of derivatives used by banks, (b) notional amounts and the relative fair values, and (c) classification in the banking or trading book, which we use as a proxy for the purpose for using derivatives, hedging and trading activities, respectively.[6]

[3] As at June 2017, according to BIS data, almost 94 per cent of notional outstanding amounts were traded in the OTC market.

[4] Regulation (EU) No 648/2012 on OTC derivatives, central counterparties and trade repositories (known as the European Market Infrastructure Regulation – EMIR), which entered into force on 16 August 2012, requires standard derivatives contracts to be cleared through Central Counterparties (CCPs), introduces margins for uncleared trades and establishes stringent business conduct and prudential requirements for these CCPs.

[5] For a general description of the Italian derivatives market, see Signorini (2015).

[6] The banking book comprises all assets marked as being held to maturity, while the trading book includes assets and liabilities for which a trading intention exists, approximately corresponding with those classified as held for trading from an accounting perspective. It should also be noted that the classification of derivatives into one of the two books follows the classification of the parent instrument. To put in other words, if

Previous works (Purnanandam, 2007; Esposito et al., 2015; Rampini et al., 2016) limit their analysis to derivatives recorded in the banking book, because they focus on the interest rate risk. In our analysis we take a broader perspective on banks' use of derivatives and consider the derivatives classified in the banking as well as those classified in the trading book. We also take into account the distinct roles banks can play when operating in the derivatives market: as end-users, which buy derivatives mainly to hedge risks, or dealers, whose activity is more related to matching the positions of end-users. To this aim, dealers engineer and sell risk-management products to obtain fee income from clients. The period we investigate was characterized by an initial boom in the use of derivatives, which was followed by a contraction and then an increase in the volatility of their market value. This evolution may be partly due to the different shocks that hit the economy and may partly reflect the introduction of changes in banking regulation (which also affected the derivatives market), or the adoption of new rules in the near future (e.g. the Basel III framework). The Italian banking sector represents an interesting case study since banks are the most important intermediary in the financial system. In Italy dealer activities are carried out mainly by banks, contrary to what is observed in other countries (e.g. the US), where brokers and dealers typically are investment banks.

Several contributions analyse the reasons pushing banks to use derivatives, although most of them remain confined to the US financial system (Hundman, 1998; Yong et al., 2014; Shyu and Reichert, 2002). Derivatives are mainly used by banks to hedge different financial risks related to their activity. Banks collect short term funds (mainly sight deposits) to grant longer term loans (i.e. mortgages), and this introduces a duration gap in their balance sheets; the wider the gap, the larger the exposure of banks' balance sheets to unexpected changes in interest rates (Flannery and James, 1984; Kwan, 1991); the use of derivatives represents a strategy to hedge the risks arising from this mismatch (Sinkey and Carter, 2000; Esposito et al., 2015). Financial intermediation is also subject to credit risk if the borrowers are unable to pay back the loans granted; the recent development of credit derivatives allows banks to distribute credit risk across the financial system. The management of risk has a positive effect on the use of capital and consequently on business

derivatives are bought to hedge an instrument being classified in the trading book, it turns out that derivatives must be recorded in the trading book as well (Purnanandam, 2007). For more details see Pepe (2013).

expansion (Hirtle, 2008). The literature also highlights banks' ability to create liquidity through the use of swap derivatives: Purnanandam (2007) finds that banks using derivatives are more likely to meet loan demand in case of monetary policy tightening compared with banks that do not use them.

Dealing with derivatives requires a considerable number of skills and a significant amount of financial investments, which in most cases only a small number of large banks can provide (Hunter and Timme, 1986). This has been confirmed by previous research, which has found a positive relation between bank size and use of derivatives, which in turn means that banks that have the sufficient large scale of activity can afford the financial resources required to manage derivatives. This constraint is relaxed for smaller banks that are members of a group (Sinkey and Carter, 2000). Finally, banks with higher leverage may have an incentive to use derivatives to hedge the risk of bankruptcy. A positive link between banks' leverage and their decision to participate in the derivatives market is in line with the Smith and Stulz (1985) model, according to which hedging activity lowers the bankruptcy probability by reducing the variance of cash flows.

Our results suggest that size and being part of a banking group positively affect banks' use of derivatives. We also find that banks mainly use derivatives to hedge against riskier balance sheet structures and financial risks. An increase in the balance sheet maturity gap is positively associated with banks' gross position in derivatives. The result is statistically significant only when hedging – i.e. the banking book – is taken into account; furthermore, the magnitude of the coefficient is stronger for the interest rate swap, which is the type of instrument more commonly used to counterbalance the potential effect of changes in interest rates. Banks also use derivatives to hedge credit risks, since their use is positively associated with the amount of loans granted to the private sector. Finally, capital and liquidity act as substitutes of derivatives: we find that banks holding more capital and liquid assets tend to have smaller exposures in derivatives.

The rest of the paper is organized as follows: Section 2 describes the Italian derivatives market, examines banks' reasons for using derivatives, details the data sources and the variables used in the empirical methodology. Section 3 discusses the empirical model and the results of the estimates. Section 4 concludes.

2. Data description

2.1 The Italian derivatives market

The analysis of the Italian derivatives market is based on Bank of Italy supervisory data, from which we obtained a set of continuous series beginning in the early 2000s. Our sample contains both on-balance and off-balance sheet items and the data are quarterly (with the exception of those referring to the profit and loss account, which are collected half-yearly).

During the last two decades the process of consolidation of the banking system started in the 1990s continued. In order to eliminate the breaks resulting from mergers and acquisitions (M&A) and to ensure the full comparability of the data, we employ the standard approach of simulating that all the M&As occurred at the beginning of the sample period. Our analysis is based on quarterly data at the bank level from the first quarter of 2003 to the third quarter of 2017. We consider the gross notional amounts (sum of long and short positions) for all types of derivatives contracts (futures, forwards, swaps and options), traded in regulated or unregulated over-the-counter (OTC) markets, using a sample consisting of more than 600 banks over the period. As in previous exercises (Sinkey and Carter, 2000; Demsetz and Strahan, 1997), we decide to work with notional outstanding amounts of derivatives in order to measure banks' extensive use of these financial instruments; this choice prevents confusion between changes in valuation due to market developments and the quantity of derivatives that banks want to hold.

Evidence on the size of the Italian market for derivatives and its growth is presented in Table 1. Notional amounts of derivatives held by banks increased substantially between the end of 2003 and the end of 2011; their values rose from €5,500 billion to about €10,000 billion. After 2011 a phase of reduction was recorded, due to the introduction of EU regulatory reforms addressing OTC derivatives, in particular the European Market Infrastructure Regulation (EMIR)[7] in 2012. The EMIR requires that standardized OTC derivatives be cleared through central counterparties and, in case derivatives cannot be

[7] Other measures, the capital requirements regulation (CRD IV) and the capital requirements directive (CRR) increase the bank capital needs for both cleared and non-cleared derivatives.

cleared, margin requirements must be applied. The reform has also driven an increased use of "compression" on interest rate derivatives: pursuant to the EMIR technical standards, "compression" enables two banks to cancel out contracts (before the normal expiration date) among themselves where the risks associated with the contracts offset one another, according to parameters established by parties involved.[8] This practice reduces the outstanding amount of derivatives, with a benefit in terms of regulatory capital.[9]

Interest rate derivatives are the ones most frequently used by banks: at the end of the third quarter of 2017 they accounted for just under 90 per cent of the outstanding amounts (within this family of contracts the interest rate swaps are predominant). Furthermore, the interest rate segment accounts for the vast majority of OTC derivatives activity (approximately 98 per cent). Futures and forwards are the most important instruments among the foreign exchange contracts. At the end of the third quarter 2017, foreign exchange futures and forwards amounted to €199 billion, that is, 40 per cent of all foreign exchange contracts. The euro market is the segment with the highest amount of interest rate derivatives and equity contracts.

Not all banks participate in the derivatives market; smaller banks are prevented from accessing the market by the requirement of an adequate scale of activity along with that of specialized resources to manage the contracts (Yong et al. 2014; Sinkey and Carter, 2000). At the end of the third quarter of 2017, less than 60 per cent of Italian banks used derivatives (65 per cent at the end of 2003); there is a strict correlation between participation and bank size (Figure 1 and Table 2). Table 2 shows that, if we divide the distribution of total assets into percentiles, only 13 per cent of banks in the first quartile of the distribution uses

[8] Compression is not a new practice, but it started in 2003 (ISDA, 2015). Originally this service required the mutual agreement of the parties involved (so called *linking* of trade records). Since 2014, the service of compression can be run unlinked (without the involvement of the original parties), which more likely contributed to boost the use of this technique.

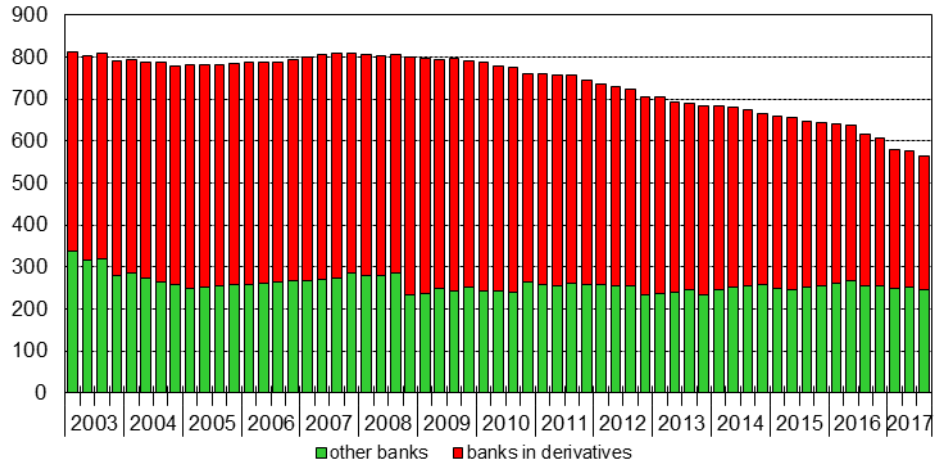
[9] Article 14 of the EMIR regulation states that "Financial counterparties and non-financial counterparties with 500 or more OTC derivatives contracts outstanding with a counterparty which are not centrally cleared shall have in place procedures to regularly, and at least twice a year, analyze the possibility to conduct a portfolio compression exercise in order to reduce their counterparty credit risk and engage in such a portfolio compression exercise. Financial counterparties and non-financial counterparties must ensure that they are able to provide a reasonable and valid explanation to the relevant competent authority for concluding that a portfolio compression exercise is not appropriate".

derivatives; the percentage increases to one out of two in the second quartile; at the 99th percentile of the distribution of assets, all banks use these instruments.

Figure 1

Banks using derivatives

(number of banks)

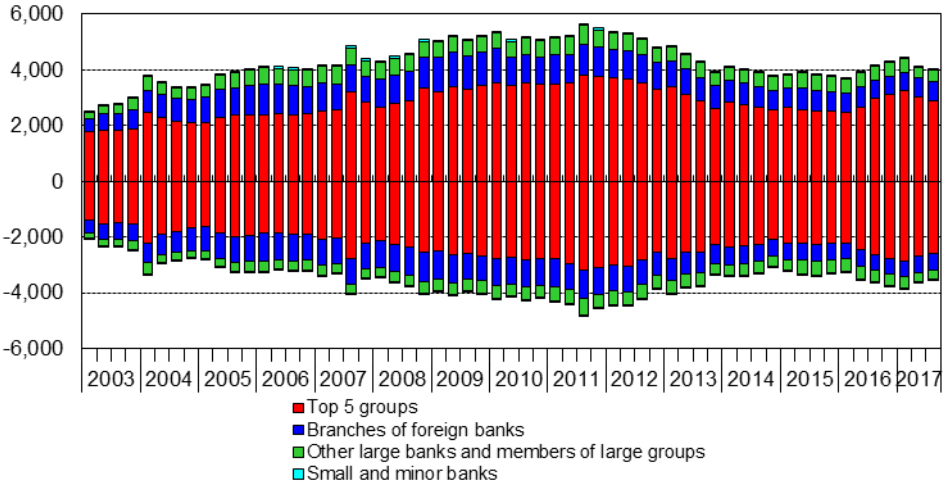


Source: Bank of Italy, Supervisory reports.

Figure 2

The distribution of derivatives by type of bank: long and short positions[1]

(notional amounts; billions of euros)



Source: Bank of Italy, Supervisory reports.

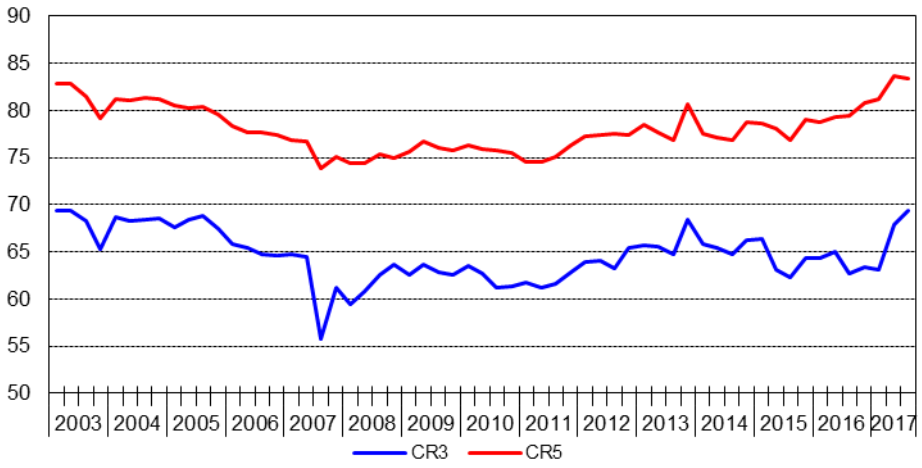
(1) Long positions are reported as positive values, short positions are reported as negative values.

Similar conclusions may be drawn by looking at the extensive use of derivatives. Figure 2 plots the amount of derivatives broken down by type of bank;[10] at the end of the third quarter of 2017 the top five groups accounted for almost 70 per cent of the market, followed by branches of foreign banks with approximately 17 per cent.

The market for derivatives is highly concentrated (a feature common in all countries), as shown in Figure 3, which reports the concentration ratio of the top three and five banks (CR3 and CR5 respectively): between 2003 and the third quarter of 2017 the indicators ranged between 56 and 69 per cent for the top three banks and between 74 and 84 per cent for the top five ones. The observed reduction in concentration up to 2007 was probably related to banks' growing use of derivatives before the onset of financial crisis (Table 1).

Figure 3

Concentration ratio
(per cent)



Source: Bank of Italy, Supervisory reports.

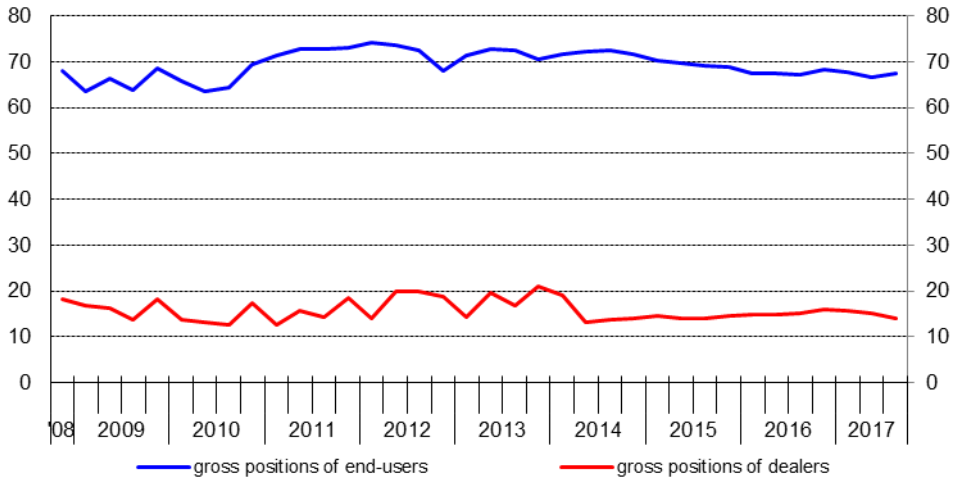
[10] Banks are classified into five size groups: the top five groups, other large banks and members of large groups, small banks, minor banks, and branches of foreign banks. This is the taxonomy used in Bank of Italy publications. Apart from the top five groups and the branches of foreign banks, the categories "large", "small" and "minor" include banks belonging to groups or stand-alone banks with total assets that are respectively greater than €21.5 billion, between €3.6 and €21.5 billion, and less than €3.6 billion.

Dealer banks are selected on the basis of their activity in the market-making services.[11] We consider as dealers the top 15 banks, which account for almost the entire market - over 90 per cent - of the market-making activities. These banks are heavily involved in dealer activities in the OTC market, but at the same time may use derivatives as end-users. Table 3 shows that, on average, dealers tend to be larger banks in terms of total assets compared with end-users (and with banks that do not use derivatives). Dealers are relatively less involved in the traditional banking activity of granting loans. The gross positions of dealers are thirty times the average amounts recorded for end-users. Based on the classification of derivatives into the banking or trading book, Figure 4 shows that, on average, dealer banks make less use of derivatives for hedging purposes and more use of derivatives for trading purposes compared with end-user banks: while end-user banks use 68 per cent of their total amount of derivatives for hedging purposes as at the third quarter of 2017, the share for dealer banks is only 14 per cent.[12]

Figure 4

Dealers and end-users: derivatives for hedging purposes

(notional amounts; percentage average values over total derivatives)



Source: Bank of Italy, Supervisory reports.

[11] Sinkey and Carter (2000) adopted a different criterion based on membership of the International Swaps and Derivatives Association (ISDA). In the econometric exercises discussed in the next section, we also apply the same idea to separate out dealers and end-users without observing any substantial difference in the results.

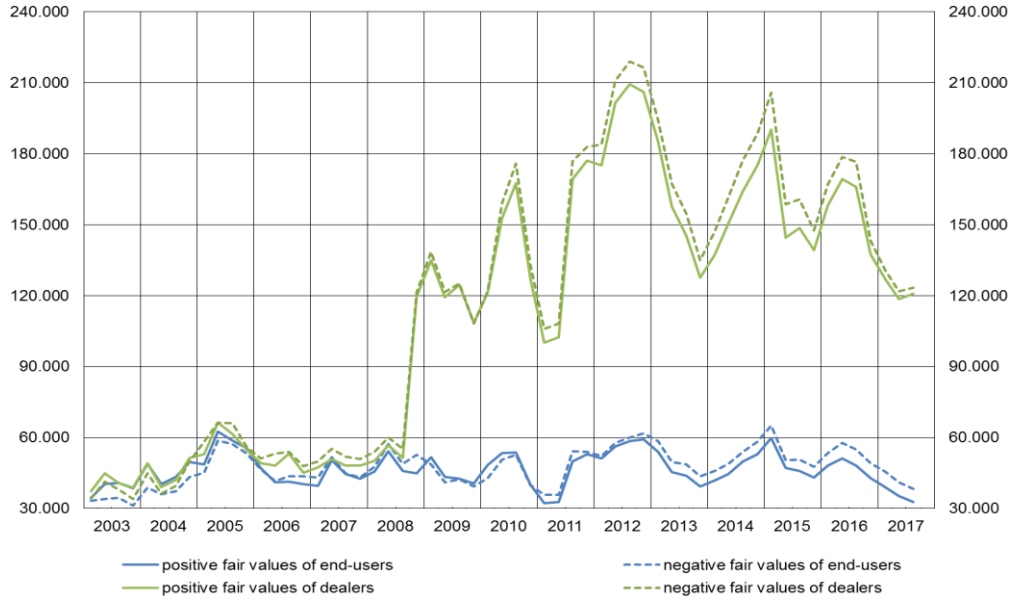
[12] The much higher position in derivatives of dealers and their higher propensity to engage in trading activity determine that, as reported in Bank of Italy (2013), when considering the entire set of Italian banks, derivatives held for trading purposes accounts for the highest shareas at the end of 2011 and shows small differences in comparison with the main euro-area countries (Germany, France, Spain, Netherlands) when measured in terms of fair values. The market value of derivatives held by Italian banks is lower compared with the other European countries.

Finally, the fair values of derivatives contracts, plotted in Figure 5, show that for both dealers and end-user banks positive and negative values are quite balanced over the time period considered.[13] Fair values are more volatile than notional amounts, since they reflect market conditions and change in the prices of underlying assets. The uncertainty that followed the global financial crisis and especially the sovereign debt crisis are mirrored in the fair values of derivatives; in any case, there is a strong correlation between the two groups of banks. The widening gap between the positions of dealers and of end-users is due to the increasing amount of derivatives contracts between Italian dealer banks and non-residents, mainly in relation to the role played by CCPs counterparts after the introduction of the EMIR.

Figure 5

Fair values of derivatives contracts

(millions of euros)



Source: Bank of Italy, Supervisory reports

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[13] Up to the third quarter of 2008 supervisory statistics collected intrinsic values. From the last quarter of 2008 banks are requested to report fair values of derivatives; this introduced a statistical break in the time series (see Infante and Sorvillo, 2017), which seems to affect more the dealers.

2.2 The variables used in the analysis

Banks decide to participate in the derivatives market for different reasons (Sinkey and Carter, 2000). They can use derivatives to hedge against unexpected movements in economic variables, or to trade or provide broker-dealer services. The extent of banks' participation in the derivatives market is also affected by their specific financial characteristics. First of all we can expect that bank size is an important variable in determining the extent of the use of derivatives. Since economies of scale should play a role in these markets, larger banks are more likely to have the resources necessary to manage derivatives. As a measure of size we consider a bank's total amount of financial assets, which is expected to be positively correlated with the notional amount of derivatives. Moreover, being part of banking groups can also affect the extent of participation in the derivatives market by enabling smaller banks to exploit group-level resources. Smaller banks may in fact lack the skills and resources necessary to manage complex financial instruments or to afford the cost of learning how to do so. We identify banks belonging to groups by using individual dummy variables. If belonging to a group allow a bank to overcome size limitation in its use of derivatives, our expectation is that group membership is positively associated with the notional amount of derivatives.

The amount of bank capital can also be relevant. A negative relationship between the ratio of capital to total assets and the notional value of derivatives would suggest that banks use derivatives for hedging purposes because of low capital ratios and to reduce the likelihood of default when debt levels are too high. In other words, banks could face a trade-off between using more capital and using derivatives to hedge risks; this would imply that banks with better capital ratios are less prone to financial distress and less inclined to use financial derivatives for hedging purposes (Esposito et al., 2015).

On the asset side, banks' choice to allocate resources between financial instruments characterized by different yields, maturities or liquidity exposes them to various kinds of risks. Banks, in general, could use derivatives to hedge against risky balance sheet structures. In this sense, holding safer (or more liquid) financial assets in the portfolios should be associated with more limited use of derivatives for hedging purposes. We follow the approach illustrated by Sinkey and Carter (2000) and exploit the liquid assets in the portfolio, computed as the sum of deposits and short-term securities, scaled down by the

total assets. If banks manage their own liquidity buffers to avoid shocks, we would expect a negative relationship with respect to the amount of derivatives, since banks may convert liquid assets into cash to face distress.

During their normal activity, banks transform short-term liabilities, generally deposits, in long-term assets. The different duration between assets and liabilities can be a source of risk in case of movements in interest rates. The duration mismatch can be managed both on-balance, by improving the correlation between the maturities of assets and liabilities, and through derivatives. The literature proposes different ways to capture the depth of the interest rate risk exposure. We employ a measure of maturity gap[14] (sometimes labelled as short-term duration gap), defined as the difference between assets and liabilities maturing within 12 months. The indicator is used to measure the impact of a change in interest rates on banks' net interest income. The higher the difference between short-term assets and liabilities, the more an increase in interest rates positively affects net interest income; on the contrary, a reduction in interest rates implies a fall in bank margins. Interest rate swaps can offer a strategy for attenuating the impact of a change in interest rates. For instance, through long positions, banks pay a floating rate in exchange for a fixed rate, which can benefit them in case of a reduction in interest rates. Conversely, short positions in swaps may be effective when interest rates rise. Therefore, we expect the maturity gap to be positively associated with long positions and negatively associated with short positions.

A source of risk in banks' balance sheets is represented by the amount of loans granted to the private sector, whose quality can be jeopardized by a worsening of the economic conditions or by idiosyncratic shocks affecting borrowers (credit risk). Banks can hedge against these risks by means of derivatives; as a consequence, larger amount of loans are likely to be correlated to larger notional amount of derivatives.

Banks may also use derivatives to manage their intermediation profitability, that is, the difference between interest revenues and interest expenses. On the one hand, derivatives

[14] The same measure has been used by Flannery and James (1984), Landier et al. (2013), Sinkey and Carter (2000). An alternative indicator to measure the exposure to interest rate risk is the duration gap, which takes into account differences in maturity across the whole spectrum of instruments in the balance sheet**.** However this measure requires very detailed data which are not easily available for the whole time span of our sample; furthermore, as suggested by Rampini et al. (2016), in practice the maturity gap indicator is more popular with risk managers.

could be simply used to *protect* interest profitability (Sinkey and Carter, 2000). On the other hand, they could be used to *increase* interest margins by taking long or short positions in derivatives. In order to disentangle these two effects we use two different variables. Use for hedging purposes is controlled by the interest margin, that is the difference between revenues generated by loans and the amount of interests paid on funding. Use for trading and broker-dealer purposes is controlled by the net profits arising from derivatives activities. In both cases we expect a positive relationship between these variables and the extent to which derivatives are used.

Table 4 describes the variables used in our econometric analysis, broken down by type of bank (dealer or end-user). Taken in logarithm, the long positions of dealers are 3.4 per cent higher than the short positions (Panel A), while for end-users (Panel B) the difference is wider (40 per cent). The average size (proxied by total assets) is just over €48 billion in the case of dealers and €5 billion for end-users. For dealers the maturity gap appears almost balanced (-8.5 per cent), while for the end-user group it is three time larger (-25.97 per cent). The average values of the main variables are also broken down by group membership in Table 5. Banks belonging to a group represent 19 per cent of the sample; the derivatives gross position of groups (in logarithm) is slightly more than three times the position of stand-alone banks; similarly, the total assets of banking groups are larger[15] than those of other banks. Among the other variables, capital, net interest income, liquid assets and loans to private sector are smaller for banks belonging to groups. Table 6 reports the correlations between gross notional amounts of derivatives and the regressors in 2003, 2008 and 2017, while the correlations between all the variables used in our exercises are given in Table 7.

[15] For banking groups the amount of gross positions in derivatives is as large as total assets, while for the other banks it is around 13 per cent of total assets.

3. The econometric analysis

3.1 Baseline regression

In order to investigate the relationship between the extent to which derivatives are used by banks and the financial characteristics discussed earlier, we use fixed effects panel data estimators in the following baseline equation:

$$DER_{i,t} = \alpha_i + d_t + \beta_1 TASS_{i,t} + \beta_2 CAP_{i,t} + \beta_3 NIM_{i,t} + \beta_4 NDI_{i,t} + \beta_5 LASS_{i,t} + \beta_6 STDG_{i,t} + \beta_7 LOA_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $DER_{i,t}$ is the logarithm[16] of the notional value of the outstanding amount of derivatives contracts of bank *i* at quarter *t*; $TASS_{i,t}$ is the total amount of bank assets; $CAP_{i,t}$ represents banks' capital; $NIM_{i,t}$ is the net interest margin (i.e. the difference between total interest income and total interest expenses, net of margins on derivatives contracts); $NDI_{i,t}$ is the net profit stemming from derivatives; $LASS_{i,t}$ is the outstanding amount of liquid assets; $STDG_{i,t}$ is the short-term duration gap, that is, the difference between the amount of short-term assets and short-term liabilities; $LOA_{i,t}$ is the amount of loans granted to the private sector. The variables *CAP, NIM, NDI, LASS, STDG, and LOA* are scaled by total assets. $\varepsilon_{i,t}$ is an error term supposed to be independent and identically distributed across units. Finally, α_i is the unobserved heterogeneity that we assume might be correlated with the regressors and which we treat through fixed effect estimator; d_t is a set of temporal dummies. Table 8 reports the estimates for the baseline model over the period ranging from the first quarter of 2003 to the third quarter of 2017. We estimate five different equations: in the first column the dependent variable is the notional value of derivatives contracts in which banks took long positions; in the second column the dependent variable is the outstanding notional amount of contracts in which banks took short positions. The distinction between long and short positions may convey information on banks' expectations about market or interest rate developments; on the other hand it must be pointed out that most of the time banks can take both positions, so focusing on only one of them can hinder a full

[16] Given the highly skewed distribution of derivatives due to their high concentration, we employ the logarithm of the notional values to normalize the distribution of the dependent variable.

understanding of the scale of risks managed by banks. Therefore, in the third column we use the gross notional outstanding amount (the sum of long and short positions). As a robustness check we restrict the sample to end-user banks (column 4). Finally, since interest rate risk turns out to be the most significant risk that banks aim to manage, we also ran a regression in which the notional outstanding amount of interest rate swaps is used as dependent variable (column 5). Our estimates include yearly and bank fixed effects and a correction for the presence of heteroskedasticity.

The positive and significant coefficients of total assets in all the estimations confirm that larger banks are more active in the derivatives market. This can be due to the presence of economies of scale in banks' derivatives activity, since larger banks are more likely to have the resources and to make the investments necessary to manage derivatives. Moving from the first to the third quartile of the total assets distribution, the results in column 3 point to a 2.7 per cent increase in gross positions in derivatives (2.6 per cent in the case of end-users). The coefficient of banks' capital is negative and significant in all the estimations, suggesting that banks do use derivatives to hedge risks in case of low capital levels, for instance to reduce the likelihood of default when debt levels are high (Sinkey and Carter, 2000).[17] The results in column 3 suggest that a shift in the capital ratio from the first to the third quartile of the distribution implies a reduction of around 5 per cent in gross positions in derivatives. Moreover, the result concerning liquidity suggests that a positive shock to liquidity reduces the need to hedge risks through derivatives.

The fact that banks participate in the derivatives market for hedging purposes, among other reasons, is also confirmed by the significance of the maturity gap variable as a measure of banks' exposure to interest rate risk. In particular, this measure of risk is positively associated with long positions and negatively associated with short positions. A higher maturity gap (short-term assets minus short-term liabilities) implies that banks are exposed

[17] In a recent study, Rampini et al. (2016) have found an opposite result regarding the relationship between capital and hedging on interest rate risk, which implies that better capitalized banks hedge more. They consider the result consistent with the presence of financial constraints, which would impose a trade-off on banks to either use their scarce resources to hedge and manage risks or to provide loans. However, in regressions closer to ours, size and market capitalization (which in level can be considered as a measure of bank size), alternatively used in the estimates, have positive signs. The net worth index employed by Rampini et al. is a measure recovered through principal component analysis which in our opinion is not easily comparable to our capital variable.

to declining interest rates. Through long positions in a swap, whereby they received a fixed rate payment in exchange for a floating rate payment, banks may hedge against a decline in interest rates. On the other hand, a lower maturity gap implies an exposure to rising interest rates, a risk that can be hedged by using short swap positions. The positive effect of the maturity gap on the long positions and the negative effect on the short positions cancel one another out partially in columns 3 and 4, where we employ the gross position as a dependent variable whose sign is mostly positive. The magnitude of the coefficient of the maturity gap is stronger when we consider the interest rate swaps separately (column 5), which are the instruments more widely used to counterbalance the risks associated with changes in interest rates.

Credit risks, measured by the amount of loans granted, have a significant and positive coefficient in all the estimations; this result suggests that these risks are managed by means of derivatives. Finally, in all the estimations we find positive coefficients associated with the income variables, but these are statistically significant only for the net derivatives income.

3.2 Hedging and trading

Changes in interest rates represent a significant source of risk in banking; as a consequence, numerous studies focus on the analysis of interest rate swaps (Esposito et al., 2015; Purnanandam, 2007; Rampini et al., 2016) as a hedging instrument, or in some cases as a risk-enhancing tool. Up to now we have considered the full amount of derivatives regardless of their use for hedging or trading purposes.

In this section we refine our analysis by exploiting the classification of supervisory data on derivatives in two books: the banking book, which comprises all assets meant to be held to maturity, and the trading book, which comprises assets and liabilities held for trading purposes. Similarly, in a work assessing major euro-area banks' exposure to interest rate risk, Hoffman et al. (2017) broaden their analysis to consider, in a robustness exercise, risks arising from the trading book. We run different regressions using as dependent variables derivatives used for hedging purposes (i.e. classified in the banking book) and derivatives used for trading purposes (i.e. classified in the trading book) respectively.

As mentioned above, owing to accounting rules the classification of derivatives is affected by that of the underlying asset, in the sense that if a derivative is bought for hedging purposes but it is referred to a trading asset, that derivative is classified in the trading book as well; as a consequence, the derivatives in the trading book may be overestimated.[18]

Estimates provided in Table 9 show results that are consistent with our expectations, especially in columns 1 and 2, where we consider derivatives for hedging purposes respectively for the whole set of banks and for end-user banks only. Coherently with the a priori hypothesis, the coefficient of the net profits on derivatives is significant only in the specification using derivatives for trading purposes (column 4). Finally, in column 4 we find a negative coefficient for the loans to the private sector: while derivatives held in the banking book are indeed used to hedge against credit risk, derivatives in the trading book can be considered as an alternative source of profitability for banks with respect to lending.

The decision to record some assets in a book or another can be interdependent. Therefore, we have also estimated the hedging and trading models as a system of two equations (seemingly unrelated regressions), which assumes simultaneous correlation between the equations through the error components.[19] The results remain unaffected.

3.3 Other robustness checks

a) Banking groups

If economies of scale exist in derivatives activity, then banks could also benefit from being part of a banking group. Being part of a group could indeed enable smaller banks to benefit from group-level resources and make their behaviour more similar to that of their larger affiliates than to similar-sized stand-alone banks. In our sample, the fact of being part of a banking group is a dummy variable that does not vary frequently over time[20] and panel data fixed effects estimation would control for it. In order to study this effect, in Table 10

[18] See Purnanandam (2007).

[19] At this stage we are not assuming simultaneity, or endogeneity, of the observed variables.

[20] During the time span considered in our study, banks tend to persist in their affiliation/non-affiliation to a group. This justifies the scarce variation of the dummy.

(columns 1 and 2) we report the estimate of equation (1) augmented by the interaction of each regressor with the group-association dummy. Since parent banks are very large intermediaries which could drive the group effect, we decide to exclude them from the estimation. The first column of Table 10 refers to individual banks, while the second column displays the overall effect for banks belonging to a group (sum of the basis and the interaction term). Coefficients are consistent with previous results. Interestingly, for the size variable (total assets) the overall effect for banks affiliated to a group is lower than in the case of stand-alone banks. This result suggests that, all things being equal, banks that are part of a banking group can have a smaller size than stand-alone banks: by exploiting group-level resources, they can increase their participation in the derivatives market. The lower coefficient of capital also signals that capital has a more effective role in risk management within a banking group than in the case of stand-alone banks.

Our analysis confirms that holding more liquid assets in the balance sheet is an *alternative* to hedging risks through derivatives, and it is associated with a more limited use of derivatives. The statistical significance is stronger for banks belonging to a group and weaker for the other banks (p-value equal to 0.20). The coefficient associated with the short-term duration gap is significant for stand-alone banks but not for those that are part of a group, likely because within banking groups the single members specialize in specific lines of business while interest risk exposure is managed at the group level (in fact, when we include the parent banks in the regression, the coefficient becomes positive and significant).

b) Banks without derivatives

The results presented so far are based on an estimator which does not properly address the presence of censored observations in our data set, namely banks with zero derivatives, which is the outcome of a bank choice (a corner solution problem). Previous analyses (mainly based on cross-sectional exercises) have dealt with the issue using a Tobit model. This class of estimators, on the other hand, presents some computational issues in dealing with fixed effects in a panel data analysis. We follow Wooldridge (2002) and apply a

Chamberlain-like model, which allows the unobserved effects to be correlated to the regressors as in the following assumption[21]:

$$\alpha_i | X_i \sim \text{Normal}(\zeta + X^m{}_i\theta, \sigma^2{}_\alpha) \quad (2)$$

where X is the set of regressors used in the equation (1), X^m is the average value of the X regressors, and $\sigma^2{}_\alpha$ is the variance of α.

Using this assumption our Tobit model can be written in a standard way as:

$$Y_{it} = \max(0, \zeta + X_{it}\beta + X^m{}_i\theta + \alpha_i + \varepsilon_{it}) \quad (3)$$

with Y representing the gross derivatives positions. Equation (3) may be estimated using a random effects Tobit model, where the departure from the usual model is the inclusion of the X^m as an additional set of time-constant explanatory variables for each time period, to control for the correlation between the unobserved effects and the regressors according to assumption (2).

The estimates reported in the third column of Table 10 are qualitatively similar to the baseline regressions discussed in the previous paragraph. This is indicative of the minor role of banks that do not participate in the derivatives market. We therefore prefer to use the linear model, which allows us to better tackle the unobserved effects without relying on the assumptions necessary to make them treatable.

c) Cross-sectional dependence

Up to now, our results are based on the identification of some risk factors (interest rate risk, liquidity risk and credit risk) that can be hedged by banks by using derivatives. The risk factors have been considered as independent across banks, and we have assumed cross-sectional independence among units in the sample. However, banks – mainly the largest ones – may follow similar strategies or hold similar positions, which exposes them to the same risks and may introduce correlation in their portfolios (Schuermann and Stiroh, 2006). For instance, syndicated loans (Cai et al., 2018) or interbank liquidity exchange may increase

[21] Different assumptions may be used to eliminate α_i from the main equation, in a similar vein as it is done in the linear model (see for example Honoré, 1992), who exploited the assumption of conditional pairwise exchangeability between the transitory error terms).

overlaps among portfolios. Moreover, interdependence across banks can arise indirectly through fire-sales mechanism (Greenwood et al., 2015), where the selling of an asset by some banks can affect other banks that hold the same assets, increasing market risk exposure.

The presence of correlation across banks could weaken the estimate of parameters in equation (1), leading to potentially inconsistent estimates and inference problems.[22] To deal with this issue, the literature assumes that the error structure contains unobserved effects (or factors) that influence each bank but with different intensities (Sarafidis and Wansbeek, 2012). To get consistent estimates in this framework, Ahn et al. (2001) consider a quasi-differencing method which is based on a GMM estimator, while Pesaran (2006) suggests a common correlated effect estimator, where the equation is augmented by the cross-sectional averages of dependent variables and regressors. Finally, Bai (2009) proposes to eliminate these unobserved effects by combining a least square estimator with a principal component method (iterative principal component estimator). Since the GMM estimator can be biased as the time dimension of the panel becomes large and the common correlated effect estimator can be computationally intensive in case of a large number of cross-sections, in our analysis we follow the approach suggested by Bai (2009). The equation we estimate, augmented by the presence of the interactive effects, is the following:

$$Y_{it} = X'_{it}\beta + \alpha_i + d_t + \lambda'_i F_t + \varepsilon_{it} \qquad (4)$$

where the left-hand side variable stands for our measure of derivatives and X contains the same regressors as specified in equation (1); the error term $\lambda'_i F_t$ catches the cross-section correlations, being F being a time-varying effect with a heterogeneous impact across banks that depends on the value of λ. The estimates of equation (4) for the Italian banking system, reported in Table 10 (column 4), show no substantial differences with respect to previous results, indicating that cross-sectional dependence was not actually influencing results in the previous exercises.

[22] Petersen (2009) discusses the implications of this issue in financial models.

4. Conclusions

In this paper we present empirical evidence on the relationship between some bank balance-sheet characteristics and the use of derivatives by Italian banks. Despite the use of multivariate statistical tools, the aim of the work is to illustrate the main features of the use of derivatives by Italian banks, and not to identify causal links between the variables taken into account. We observe a very high concentration in the Italian derivatives market, with the top five groups accounting for almost 80 per cent of the market; this evidence suggests that participation in the market requires an adequate scale of activity along with specialized resources to manage the contracts. Our results confirm the hypothesis that economies of scale exist in derivatives market: the notional amount of contracts is indeed positively associated with bank size. Being part of banking groups enables smaller banks to have access to group-level resources and make their behaviour more similar to that of their larger affiliates rather than to that of similar-sized stand-alone banks.

We find that banks mainly use derivatives to hedge against risks, such as interest rate and credit risks: greater use of derivatives is indeed associated with a higher maturity gap (asset-liability mismatch) and greater amounts of loans granted to the private sector. The magnitude of the coefficient of the maturity gap is higher for interest rate swaps, which are used to counterbalance the risks associated to changes in interest rates. We also find that derivatives represent alternative means of hedging with respect to capital and liquidity, since banks with higher levels of capital ratios and liquid assets tend to have smaller derivatives exposures.

Our results are robust to different specifications. We take into account the role of dealers versus that of end-users and we distinguish between derivatives held for hedging versus those held for trading purposes. End-user banks appear to be more inclined to use derivatives for hedging purposes compared with dealer banks; for the latter, the relationship between risks and the extent to which derivatives are used is less significant. We obtain consistent results when we control for the presence of censored observations in the sample (i.e. banks without derivatives) and for the cross-sectional dependence between banks' activity in derivatives.

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Tables

Table 1

Derivatives held by Italian banks by type of instrument[1]

(gross positions, notional amounts; billions of euros)

	2003	2005	2007	2009	2011	2013	2015	2017[1]
Foreign-exchange contracts	**273.3**	**232.0**	**213.4**	**307.7**	**335.4**	**419.0**	**360.9**	**495.4**
Futures and forwards	0.0	0.0	1.2	191.1	207.5	287.5	196.8	199.2
Swaps	25.5	49.5	80.7	76.2	83.1	86.6	106.2	113.2
Options	247.7	182.5	131.5	40.4	44.8	44.9	57.8	183.0
Interest-rate contracts	**4,867.2**	**6,599.8**	**7,076.3**	**8,468.8**	**8,980.7**	**6,292.7**	**6,415.1**	**6,791.3**
Futures and forwards	782.7	815.6	536.0	1,145.0	1,115.7	612.9	604.5	674.3
Swaps	3,609.6	4,432.7	4,947.8	5,635.4	6,288.3	4,915.8	5,300.7	5,695.8
Options	474.9	1,351.6	1,592.5	1,688.5	1,576.7	764.0	509.9	421.3
Equity contracts	**252.5**	**359.6**	**422.3**	**273.8**	**304.3**	**277.9**	**154.8**	**135.1**
Futures, forwards and swaps	3.0	12.6	32.2	3.1	9.2	4.1	5.9	4.1
Options	249.4	347.0	390.1	270.7	295.1	273.8	148.9	131.1
Commodities	**4.6**	**2.6**	**2.7**	**2.4**	**18.6**	**26.9**	**24.7**	**17.9**
CDS	**86.8**	**122.7**	**206.1**	**228.7**	**397.4**	**286.9**	**144.0**	**150.6**
Total derivatives contracts	**5,484.3**	**7,316.7**	**7,920.9**	**9,281.5**	**10,036.3**	**7,303.5**	**7,099.6**	**7,590.4**

Source: Bank of Italy, Supervisory reports.

(1) The data refer to the third quarter of 2017.

Table 2

Distribution of derivatives by bank size

(September 2017)

Banks using derivatives

Total assets (billions of euros)	**Foreign-exchange contracts**	**Interest-rates contracts**	**Equity contracts**	**Commodities**	**CDS**	**Total derivatives contracts**	**Percent with derivatives**
			(units)				
25th percentile (≤233)	8	12	1	0	0	**18**	13.0
50th percentile (233-718)	18	61	2	0	1	**73**	51.4
75th percentile (718-2,082)	50	93	9	0	3	**100**	73.0
95th percentile (2,082-23,187)	75	76	24	9	5	**92**	82.1
99th percentile (≥158,054)	6	6	6	4	3	**6**	100.0
Total	176	269	54	21	16	**310**	55.7
			(gross positions, notional amounts; billions of euros)				
25th percentile (≤233)	0.2	0.1	0.0	-	0	**0.3**	
50th percentile (233-718)	0.2	0.6	0.0	-	0.1	**0.9**	
75th percentile (718-2,082)	4.9	7.3	1.1	-	1.2	**14.5**	
95th percentile (2,082-23,187)	20.0	251.4	16.8	0.2	1.8	**290.2**	
99th percentile (≥158,054)	267.6	4,481.4	63.3	17.0	112.4	**4,941.8**	
Total	495.4	6,791.3	135.1	17.9	150.6	**7,590.4**	

Source: Bank of Italy, Supervisory reports.

Table 3

Dealer and non-dealer banks

(average values; first quarter 2003 – third quarter 2017)

	Total assets (billions of euros)	Loans granted (% of total assets)	Securities holdings (% of total assets)	Gross positions (notional amounts; % of total assets)	Number of banks
Dealer banks	48,560	17,67	21,42	737.67	15
End-user banks	7,480	57.19	20.11	23.02	334
Banks without derivatives	1,191	46.04	19.52	-	198

Source: Bank of Italy, Supervisory reports.

Table 4

Summary statistics[1]

	Mean	Std. Dev.	Percentiles				
			5th	25th	50th	75th	95th
Panel A: dealer banks							
Long position (log)	10.06	3.20	2.56	9.39	10.64	11.81	13.94
Short position (log)	9.73	3.52	-	8.72	10.46	11.68	13.76
Gross position (log)	10.62	3.34	2.56	9.78	11.29	12.45	14.55
Total assets (millions of euros)	48,559	56,689	291	7,162	37,418	60,238	185,239
Capital (% assets)	7.87	9.46	0.42	2.02	6.22	10.48	18.29
Net interest income (% assets)	0.36	1.66	-0.83	-	0.30	0.76	2.02
Net profits on deriv.(% assets)	0.04	1.50	-0.95	-0.01	-	0.03	0.77
Liquid assets (% assets)	0.12	0.19	-	-	-	0.26	0.51
Maturity gap (% assets)	-8.50	16.80	-49.75	-14.23	-3.33	2.29	8.67
Loans to pr. sector (% assets)	17.67	22.49	-	1.03	4.80	31.33	61.06
Panel B: end-users							
Long position (log)	2.27	2.70	-	-	1.07	4.17	7.47
Short position (log)	1.62	2.48	-	-	0.06	2.48	7.38
Gross position (log)	2.60	2.85	-	-	1.96	4.51	8.14
Total assets (millions of euros)	5,138	34,812	45	173	484	1,587	11,912
Capital (% assets)	11.69	13.21	0.54	8.06	10.84	14.15	22.03
Net interest income (% assets)	1.27	3.32	-	0.50	1.02	1.82	3.15
Net profits on deriv.(% assets)	0.01	1.10	-0.03	-	-	-	0.04
Liquid assets (% assets)	0.48	0.90	-	0.20	0.43	0.65	1.10
Maturity gap (% assets)	-25.97	24.08	-61.28	-40.72	-27.16	-14.37	14.32
Loans to pr. sector (% assets)	53.05	21.42	1.77	44.09	56.64	67.53	81.31

Source: Bank of Italy, Supervisory reports.

(1) The statistics reported are computed over the whole period (first quarter 2003 – third quarter 2017).

Table 5

Participation in a banking group[1]

(average values)

	Banking group membership	
	No	Yes
Number of banks	442	105
Gross position (log)	1.85	6.84
Total assets (millions of euros)	1,685	25,623
Capital (% assets)	12.07	9.56
Net interest income (% assets)	1.33	0.91
Net profits on derivatives (% assets)	-0.00	0.06
Liquid assets (% assets)	0.49	0.38
Maturity gap (% assets)	-26.06	-23.14
Loans to private sector (% assets)	52.87	48.93

Source: Bank of Italy, Supervisory reports.

(1) The statistics reported are computed over the whole period (first quarter 2003 – third quarter 2017).

Table 6

Correlations of derivatives with the main variables[1]

	Gross positions (in log)		
	2003	2008	2017[2]
Total assets	0.41	0.37	0.46
Capital[(3)]	-0.17	-0.08	-0.04
Net interest income[(3)]	-0.03	-0.08	-0.12
Net profits on derivatives[(3)]	0.14	-0.20	0.04
Liquid assets[(3)]	-0.21	-0.16	-0.17
Maturity gap[(3)]	0.30	0.20	0.13
Loans to private sector[(3)]	0.06	0.01	-0.04

Source: Bank of Italy, Supervisory reports.

(1) Notional outstanding amounts of derivatives.

(2) The data refer to the third quarter of 2017.

(3) Variable scaled down by total assets.

Table 7

Correlation matrix

(quarterly data[1]; first quarter 2003 – third quarter 2017)

	Gross positions[(1)]	Total assets	Capital[(2)]	Net interest income[(2)]	Net profits on derivatives[(2)]	Liquid assets[(2)]	Maturity gap[(2)]	Loans to private sector[(2)]
Gross positions[(1)]	1							
Total assets	0.41	1						
Capital[(2)]	-0.12	-0.03	1					
Net interest income[(2)]	-0.04	-0.03	0.03	1				
Net profits on derivatives[(2)]	0.02	0.00	0.00	-0.33	1			
Liquid assets[(2)]	-0.13	-0.07	0.08	0.09	-0.01	1		
Maturity gap[(2)]	0.20	0.06	-0.07	-0.01	-0.01	-0.39	1	
Loans to private sector[(2)]	0.01	-0.11	-0.04	0.07	-0.01	0.23	0.17	1

(1) Notional outstanding amount. Log-transformed variable.
(2) The variable is scaled down by total assets.

Table 8

Banks' use of derivatives - baseline regression[1]

(quarterly data; first quarter 2003 – third quarter 2017)

	Long positions [1]	Short positions [2]	Gross positions [3]	Gross positions (end-users) [4]	Interest rate swap[2] (end-users) [5]
Total assets (x10^3)	0.015***	0.015***	0.017***	0.018***	0.017***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capital(2)	-0.007***	-0.005***	-0.008***	-0.008***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Net interest income(3)	0.000	0.001	0.001	0.001	0.001
	(0.800)	(0.323)	(0.363)	(0.386)	(0.002)
Net profits on derivatives(3)	0.038***	0.044***	0.043***	0.047***	0.041***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)
Liquid assets(3)	-0.078*	0.003	-0.114***	-0.130***	-0.061
	(0.058)	(0.935)	(0.008)	(0.002)	(0.041)
Maturity gap(3)	0.006***	-0.003***	0.002***	0.002***	0.008***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Loans to private sector(3)	0.002***	0.005***	0.006***	0.007***	0.003***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)
Year FEs	Yes	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes	Yes
R^2	0.213	0.170	0.197	0.181	0.188
Observations	32,253	32,253	32,253	31,406	31,406

Std. errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

(1) The dependent variable is the logarithm of the notional value of outstanding derivatives contracts.

(2) Gross positions.

(3) The variable is scaled down by total assets.

Table 9

Hedging and trading[1]

(quarterly data; last quarter 2008 – third quarter 2017)

	Hedging [1]	Hedging (end-users) [2]	Hedging (dealers) [3]	Trading [4]
Total assets (x 10^3)	0.0232***	0.0251***	-0.0849	0.0021**
	(0.000)	(0.000)	(0.223)	(0.040)
Capital(2)	-0.0061***	-0.0060***	-0.0456**	-0.0019***
	(0.000)	(0.000)	(0.039)	(0.000)
Net interest income(2)	0.0018	0.0016	0.4360	0.0007
	(0.569)	(0.612)	(0.137)	(0.772)
Net profits on derivatives(2)	0.0029	0.0003	0.4860	0.0233***
	(0.636)	(0.960)	(0.113)	(0.000)
Liquid assets(2)	-0.1370***	-0.1310***	-3.264**	-0.1710***
	(0.007)	(0.008)	(0.029)	(0.000)
Maturity gap(2)	0.0055***	0.0052***	0.0146	0.0002
	(0.000)	(0.000)	(0.110)	(0.671)
Loans to private sector(2)	0.0060***	0.0062***	-0.0790***	-0.0012*
	(0.000)	(0.000)	(0.000)	(0.058)
Year FEs	Yes	Yes	Yes	Yes
Bank FEs	Yes	Yes	Yes	Yes
R^2	0.218	0.183	0.093	0.102
Observations	20,152	19,615	537	20,152

Std. errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01
(1) The dependent variable is the logarithm of the notional value of outstanding derivatives contracts.
(2) The variable is scaled down by total assets.

Table 10

Banks' use of derivatives[1] – some robustness tests

(quarterly data; first quarter 2003 – third quarter 2017)

	Gross positions (excluding parent banks)		Gross positions[2] (Tobit estimation)	Cross-sectional dependence
	[1]	[2]	[3]	[4]
	No group	Group[3]		
Total assets (x 10^3)	0.0640***	0.0150***	0.0188***	0.0020***
	(0.000)	(0.000)	(0.000)	(0.000)
Capital[(4)]	-0.0056***	-0.0260***	-0.0358***	-0.0030***
	(0.000)	(0.000)	(0.000)	(0.000)
Net interest income[(4)]	0.0015	0.0078	0.0046	0.0010
	(0.002)	(0.603)	(0.489)	(0.001)
Net profits on derivatives[(4)]	0.0520***	-0.0211	0.0457***	0.0360***
	(0.008)	(0.029)	(0.000)	(0.005)
Liquid assets[(4)]	-0.0500	-0.4620***	-0.1720**	-0.2380***
	(0.042)	(0.114)	(0.018)	(0.037)
Maturity gap[(4)]	0.0070***	-0.4610	0.0054***	0.0030***
	(0.001)	(0.114)	(0.000)	(0.001)
Loans to private sector[(4)]	0.0073***	-0.0168***	0.0085***	-0.0020***
	(0.001)	(0.000)	(0.000)	(0.001)
Year FEs	Yes		Yes	Yes
Bank FEs	Yes		-	Yes
Interactive effects	-		-	Yes
R^2	0.171		-	-
Observations	28,790		32,253	31,404

Std. errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

(1) The dependent variable is the logarithm of the notional value of outstanding derivatives contracts.

(2) Model (2) includes the average time-constant values of explanatory variables as regressors.

(3) The Group column reports the sum of the basis and the interaction effects.

(4) The variable is scaled down by total assets.