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Interfaces with Other Disciplines

Controlling for the use of extreme weights in bank efficiency assessments during the financial crisis

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ABSTRACT

We propose a method for bank efficiency assessment, based on weight restricted DEA, that limits banks' abilities to use extreme weights, corresponding to extreme judgements of the risk adjusted prices on funding sources and assets. Based on a data set comprising the largest European banks during the financial crisis, we illustrate the impact of the proposed weight restrictions in two different efficiency models; one related to banks' funding mix and one related to their asset mix. The results show that using a more balanced set of weights tend to reduce the estimated efficiency scores more for those banks which were bailed out during the crisis, which confirms the potential bias within standard DEA that does not control for extreme weights applied by highly risky banks. We discuss the use of the proposed method as a regulatory tool to constrain discretion when complying with regulatory capital benchmarks such as the Basel regulatory capital ratios.

1. Introduction and motivation

The recent financial crisis made it painfully clear that bank risk can arise from heavy reliance on certain types of funding and/or assets, for example the relative exposure to real estate loans or reliance on wholesale funding. Risk consideration in this respect has not previously been explicitly recognised in the literature assessing bank efficiency. Therefore it is important to understand the implications on bank performance measures, of using extreme rather than well-balanced funding or asset portfolios, as was evidently the case for some banks during the recent crisis.

On an abstract level, the definition of true risk is not immediately clear in the financial literature. Holton (2004) makes this point clear: Risk depends on the notions of exposure and uncertainty, neither of which can be defined operationally. Probabilities quantify *perceived* uncertainty. The litmus test for exposure is "would we care if we were…"–it is a hypothetical and unobserved test. Therefore, at best, we can *operationally* define our *perception* of risk.

In the banking literature, several studies have made significant contributions to the understanding of the nature of banking and perceived risks. For instance, Diamond and Dybvig (1983) explain why bank contracts are less stable than other types of financial contracts: demand deposit contracts allow lenders to withdraw money when needed thus provide liquidity; this service provided by banks of transforming illiquid assets into liquid liabilities leave banks vulnerable to runs which occur because there are multiple equilibria with differing confidence levels. Diamond and Rajan (2001) further demonstrate that this fragile nature associated with bank runs and bank capital structure commits banks to creating liquidity, enabling depositors to withdraw when needed while buffering borrowers from depositors' liquidity needs. Other than liquidity risk, banks also face other types of risks such as default risk arising from default of borrowers and market risk arising from the change of market conditions (such as interest rates, exchange rates etc.) resulting in potential losses in banks' trading portfolio. With the rising of structured finance prior to the crisis, a recent study by Coval, Jurek, and Stafford (2009) demonstrates how during the process of pooling and tranching of structured financial products, the default risk of senior tranches can be concentrated in systematically adverse economic states. They show that this systemic risk exposure is not appropriately priced by investors (which include banks) who invest in structured financial products. This shows banks are often exposed to systemic risks too.

The method proposed in the paper is motivated by identifying bank managers' perceptions of risks (which could be related to all types of risk mentioned above) reflected in their funding structures and asset portfolios, while assessing bank efficiency.

Data Envelopment Analysis (DEA) is often used to assess the efficiency of banks. In the ratio (multiplier) formulation of DEA,

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efficiency is estimated as the ratio of a weighted sum of outputs over a weighted sum of inputs. The weights (multipliers) for the inputs and outputs are free variables in the optimisation maximising the efficiency measure for each bank, subject only to the constraint that the efficiency scores for all banks must be between 0 and 1 when applying those weights. If no further restrictions are imposed on the weights, in order to maximize the efficiency for a bank, high weights are placed on variables it performs relatively well on, for examples outputs it produces a lot of, and low weights are placed on variables it performs relatively poorly on, for example inputs it uses a lot of. Therefore, banks with extreme funding or asset portfolios will also prefer, or be assigned, extreme choices of weights in the efficiency assessment. Furthermore, for a bank with the highest ratio of any one output to any one input in the constant returns to scale (CRS) models employed here, weights can be used that result in the largest possible efficiency score of one and thus such banks become "efficient by default", simply because the extreme funding or asset portfolios means that it cannot really be compared to any other bank(s) in the efficiency assessment.[1] A potentially unfortunate consequence of this characteristic of DEA is that the method implicitly rewards extreme behaviour in terms of the composition of the input- and output portfolios. In some cases, like that of bank performance assessment, extreme input- and output (funding or asset) portfolios are associated with high risks, which should be properly accounted for, rather than necessarily rewarded, in the assessment. Since the weights can be interpreted as relative prices for the inputs and outputs, we argue that a proper choice of weights should also reflect the underlying risks of the variable such that the weights reflect risk adjusted prices. This is particularly pertinent for bank efficiency measurement, since studies have shown that banks differ wildly in their assessments of the risks associated with certain assets.

In this paper we suggest that weight restrictions should be used in cases like this, to counter the inclination towards choosing extreme weights that do not account for the risk reflected in extreme input- and output portfolios. We specifically consider two different weight restricted DEA models to measure bank performance, where we restrict the weights attached to different types of funding and other inputs, in a model concerning the transformation of funding and other inputs into assets, and also restrict the weights on the different types of loans and other assets in a second model concerning the transformation of assets into income. The (relative) weights are restricted to having to belong to ranges determined from the average (relative) weights used across the efficient facets of the frontier. This way, efficiency scores are obtained by comparing all banks, regardless of their mixes of inputs and outputs in the two models and corresponding differences in preferred weights, to a balanced set of weights. As robustness checks, we also apply weight restrictions based on the average observed unit and furthermore weight restrictions based on the median rather than mean values. As detailed in the following, the contribution of our proposed method comprises two aspects: One related to performance measurement and the other concerning regulation.

In terms of the first contribution of this paper related to bank efficiency measurement, it is important to note that the standard DEA models (cf. Charnes, Cooper, and Rhodes, 1978) commonly used in the literature to measure bank performance (cf. e.g. Berger and Humphrey, 1997; Berger, 2007) are not well suited to dealing with bank risks reflected in their asset or funding portfolios, cf. the discussion above. Despite the fact that standard DEA is the approach most widely used in the literature to measure bank performance, this feature of the DEA models makes it unsatisfactory for the assessment of the performance of banks where the use of extreme input and output portfolios might mean risky behaviour – a problem which has never been more apparent and relevant than during the recent financial crisis.

It is worth noting that restricting weights can make previously efficient funding and asset portfolios inefficient. But we are not proposing that banks should restrict (the mixes within) their input–output portfolios to belonging to specific ranges or that there exists a unique good risk portfolio. Our weight restrictions are indirectly defined from the weights of the efficient banks (via the corresponding fully dimensional efficient facets, cf. Section 3). So the set of restricted weights depends on the average risk judgement of all included banks; it is not a pre-determined or unique set. Using the actual crisis as our context, we are proposing that when evaluating efficiency in the banking sector, balanced risk judgements are preferred to extreme risk judgements at the practice level. Different sets of weight restrictions can be used in different contexts to achieve the purpose of measuring bank efficiency without being biased by banks' extreme risk judgements. As rightly pointed out by Thanassoulis and Allen (1998), also in the context of weight restricted DEA models, "…it is not so much what ranges of input and output weights are permissible but rather how prior judgements on the relative values of input and output variables can be clarified and incorporated in DEA assessments" (p. 586). Another motivation for using average weights is the possible trade-off between risk and efficiency. On the one hand, an extremely conservative risk attitude is likely to result in inefficiency in the first place; on the other hand, apparently efficient banks may be extremely risky. Therefore we believe that the use of balanced weights across all banks is preferable to extreme weights for individual banks, which can be achieved through weight restrictions based on the average weights.

In terms of the second contribution of the paper, we posit that our method can be used as a regulatory tool to create reference points to complement supervisory benchmarks for risk currently used by regulators, as will be discussed further in Section 5.3.

The rest of this paper is structured as follows: In Section 2 we provide a brief review of selected literature that links DEA measurement of bank efficiency to bank risk. In Section 3 the theoretical DEA models, both without and with weight restrictions, used to assess the efficiencies of the banks are defined. Section 4 provides a description of the data, models and variables used for the analysis and Section 5 comprises the results. Finally Section 6 concludes the paper.

2. Selected literature review: bank efficiency measurement and risk

The recent financial crisis highlighted bank's risks associated with its funding structure, as e.g. over-reliance on wholesale funding exposes a bank to excessive risk if there is a sudden withdrawal of funding in the wholesale funding market, as was the case during the crisis. This is supported by emerging empirical evidence in the wake of the financial crisis. For instance, Bologna (2011) finds evidence from U.S. banks (2007–2009) that banks relying heavily on non-retail deposit or less stable deposit funding are more likely to fail. Vazquez and Federico (2012), considering both European and U.S. banks during 2001–2009, also suggest that the strength of a bank's funding liquidity (measured by the proportion of long-term illiquid assets that are funded with liabilities that are either long-term or deemed to be stable (such as core deposits)) prior to the crisis is negatively related to the bank's probability to fail. Consistent with the above European and U.S. findings, Demirguc-Kunt and Huizinga (2009), based on world-wide data, show that a sizeable proportion of banks attract most of their short-term funding from non-retail deposits at a cost of increased

[1] Under the alternative variable returns to scale assumption this problem is actually exacerbated, since any bank with the highest value of any one output or the lowest value on any input will also be efficient by default.