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This paper examines the implicit subsidy of UK banks by the government and the associated distortions in the financial system. It explains why the subsidy arises, why it is a public policy concern and explores how it can be quantified.

Quantifying the implicit subsidy to banks has generated considerable interest over recent years. The numbers are striking, both in their sheer scale, but also in their variation. Estimates of the implicit subsidy to major UK banks vary from around £6 billion (Oxera (2011)) to over £100 billion (Bank of England (2010)). This paper explains the divergence between these estimates, examines their dependence on differing underlying assumptions, and proposes a new alternative means of quantification.

1 Introduction

A credible threat of failure and insolvency is an integral part of the market functioning of any industry, including banking. However, the crisis has revealed that this process does not always work for banks: the consequences of allowing certain banks to go insolvent through standard procedures would have imposed unacceptably high economic costs. As a result, unprecedented amounts of public money have been used to avert bank failure. These financial institutions had become 'too important to fail'.

Bank equity holdings were severely diluted through state intervention but debt holders of some failed UK banks did not incur losses. Unlike with other firms, holders of certain banks' debt therefore did not face the risk of loss: insolvency was pre-empted by government intervention. To the extent that banks and creditors did not pay for this guarantee, it can be considered an implicit subsidy. Recent reforms aim to reduce or eliminate the likelihood of government intervention.

Quantifying the implicit subsidy to banks over recent years has generated considerable interest. The numbers are striking, both in their sheer scale, but also in their variation. Estimates of the implicit subsidy to major UK banks vary from around £6 billion (Oxera (2011)) to over £100 billion (Bank of England (2010)).[1] This paper explains the divergence between these estimates, and examines their dependence on differing underlying assumptions.

This paper proceeds as follows. The next section explains why the implicit subsidy arises and why it remains a public policy concern. Section 3 sets out the different approaches to its estimation contained within the existing literature and proposes a new alternative means of quantification. Measuring the implicit subsidy is no easy task, given that — unlike other types of explicit financial obligation — it has no transparent terms or observable price. A comparison of these estimates and their relative merits is discussed in Section 4. A final section concludes.

2 Why is the implicit subsidy a public policy concern?

This *implicit* guarantee differs from an *explicit* guarantee such as the insurance of retail deposits below a certain level.[2] To the extent that governments are able to meet their commitments, the size of an explicit guarantee is certain: the loss incurred by explicitly guaranteed creditors in the event of default is either zero, or at least clearly defined. And it is possible for governments to recoup the cost of an explicit guarantee by levying a charge for it.

The implicit subsidy of banks represents a transfer of resources from one set of agents — the government (and ultimately taxpayers) — to the financial sector. The distribution of the benefits depends on the underlying competitive structure of the banking industry, scarcity of its resources and the precise nature of the change in incentives that the subsidy induces (Varian (1992)). But it seems likely that bank creditors, customers, staff and shareholders all benefit to some degree, at the expense of taxpayers.

The implicit subsidy causes three types of distortion:

First, banks that benefit from the implicit subsidy have a competitive advantage over those that do not. The perception by banks' creditors that the government will intervene to protect them from the risk of bank failure reduces the compensation they demand for bearing banks' risk, lowering those banks' cost of funding. This may enable guaranteed banks to expand at the expense of non-guaranteed banks (Freixas and Rochet (2008)).

Second, the implicit subsidy can also increase banks' incentive to take risk. The implicit guarantee reduces market discipline, which distorts banks' risk-taking incentives as investors no longer fully price the risks they are aware the banks are taking, allowing banks to take more risk (Alessandri and Haldane (2009)). A pernicious spiral can therefore develop, where the existence of an implicit guarantee encourages banks to take more risk, raising the likelihood and cost of bank failure, thus increasing the subsidy. The resulting cost to society of financial crises, not least the reduction in GDP, could far exceed the original implicit subsidy (Laeven and Valencia (2008), Hoggarth, Reis and Saporta (2002), Haugh, Ollivaud and Turner (2009), Cecchetti, Kohler and Upper (2009), Cerra and Saxena (2008) and Angelini *et al* (2011)).

Third, the implicit guarantee of banks results in an increase in the size of the financial sector in aggregate. This diverts resources from other sectors of the economy, as more financial services are produced and consumed than would be the case in its absence.

Measuring the size of the subsidy is therefore important as it offers a valuable insight into the potential magnitude of these distortions. And estimates of the implicit subsidy help put into context the costs the financial sector incurs in meeting more stringent financial regulation.

3 Measuring the implicit subsidy

Unlike other financial obligations, an *implicit* subsidy has neither transparent terms nor an observable price. This

(1) Major UK banks are Barclays, HSBC, Lloyds Banking Group, Royal Bank of Scotland and Standard Chartered.
(2) The current deposit compensation limit in the United Kingdom is £85,000.

complicates its measurement. Existing approaches to the quantification of the implicit subsidy contained within the existing literature can be split into two types. First, 'funding advantage' models value the subsidy as the aggregate reduction in the cost of bank funding due to an implicit government guarantee. Second, 'contingent claims' models value the subsidy as the expected payment from the government to the banking system necessary to prevent default. The key contribution of this paper is to set out these two approaches, their merits, and propose a new method of estimation.

'Funding advantage' models

Funding advantage models estimate the implicit subsidy as the reduction a bank enjoys in its annual cost of funding due to the presence of the implicit government guarantee. They compare the cost a bank faces in issuing its debt with a higher *counterfactual* cost that it would face in the absence of implicit government support. The subsidy across the entire banking system is obtained by adding up the individual banks' subsidies, which are calculated for each bank individually.

Funding advantage models differ in how they estimate this counterfactual. A fuller literature review is contained in Box 1 but two approaches have been employed in the literature to date:

- **Size-based approach**. This assumes that only large banks would be supported by governments in the event of their failure, and consequently enjoy a reduced cost of funding compared with their smaller counterparts. It is assumed that, in the counterfactual case where government support is withdrawn, large banks would face the same cost of funding as their smaller peers.

- **Ratings-based approach**. Credit rating agencies often issue two credit ratings for a bank: a 'stand-alone rating' and a (higher) 'support' rating (Fitch Ratings (2011), Moody's Investors Service (2007, 2009) and Standard and Poor's (2011)). Both reflect an external assessment of the probability of a bank defaulting on its debt, but only the latter includes the possibility of a bank receiving government support.(1) This approach compares the difference between a bank's actual cost of funding (reflecting its 'support' rating) with an estimate of the higher cost of funding a bank would face in the absence of the implicit guarantee (consistent with its 'stand-alone' rating). The market prices of bank or high-yield debt are used to estimate these costs of funding.(2)(3)

Under either approach, the difference between the actual and counterfactual cost of funding is assumed to reflect the implicit government guarantee. Multiplying this by the size of each bank's risk-sensitive liabilities gives an estimate of the implicit subsidy.(4)

Funding advantage models of both types implicitly assume that banks' liability structures are independent of the existence of the implicit government guarantee: that is, in the counterfactual case where that support were withdrawn, they assume that the volume of bank debt of each rating would remain unchanged. In reality, it seems likely that were government support to be withdrawn, banks might seek to reduce their more expensive liabilities.

The ratings-based approach has a number of advantages over the size-based approach. First, it goes some way in controlling for the relative risk of different banks' business models as this is incorporated into rating agencies' judgement. Second, its consideration of the difference between banks' 'support' and 'stand-alone' ratings takes account of their likelihood of receiving government support. By contrast, the size-based approach includes no such control for banks' relative risk, and instead makes the crude assumption that only large banks will receive government support. Ratings-based methods have received criticism for their reliance on subjective rating agency judgement, but this criticism could, in reality, be levelled at both methods. To the extent that rating agency opinion affects investor demand for bank debt, this is likely to be incorporated into any method considering banks' relative cost of funding, including the size-based approach.(5)

The bars in **Chart 1** show the estimate of the implicit subsidy to major UK banks calculated using the ratings-based method. This varies over time due to:

(a) Changes in the likelihood of banks receiving government support. This is captured by the difference between banks' 'stand-alone' and 'support' credit ratings (their 'rating uplift'). The average 'rating uplift' (defined as the number of ratings' categories by which the 'support' rating exceeds that of the 'stand-alone') across the sample of banks is shown by the magenta dots in **Chart 1**. This has increased due to changes in the underlying strength of banks in the absence of government support, but could also change in response to initiatives that alter the authorities' willingness and ability to support the banking system.

(1) The support ratings of banks' subsidiaries also factor in the possibility of their failures being averted by their parent holding companies. UK banks considered in this analysis are all bank holding companies, however, so it seems reasonable to assume that any support is extended by the government.
(2) Few banks actually fund themselves at a cost commensurate with lower 'stand-alone' ratings. Therefore the cost of funding associated with lower 'stand-alone' ratings is approximated by non-financial corporates' funding cost.
(3) The estimates of the implicit subsidy in Bank of England (2010) use Moody's ratings as Moody's criteria for 'stand-alone' and 'support' for the period under consideration as the 'stand-alone' ratings include the least amount of government support.
(4) Measuring the scale of banks' risk-sensitive liabilities is subject to a degree of judgement. The estimate used here takes this to be the sum of their deposits from other banks and financial institutions, some financial liabilities designated at fair value (debt securities, deposits), and certain debt securities in issue (commercial paper, covered bonds, other debt securities and subordinated debt).
(5) Sironi (2003) also shows that credit ratings are a better predictor of bank funding costs than accounting variables such as leverage, return on assets, ratio of net loans to total assets and non-performing loans.

Box 1
Related literature on the implicit subsidy of banks

Measuring the implicit subsidy has recently received considerable interest and a number of papers have attempted its quantification for different regions and points in time. This box reviews the literature on 'funding advantage' models. Oxera's 'contingent claims' analysis is covered in more detail in Box 3.

One of the first papers to measure the implicit subsidy of US banks was Baker and McArthur (2009). The authors assume that all banks with assets in excess of $100 billion will receive government support in the event of their failure. They use the difference in funding costs between banks above and below this threshold as an estimate of the subsidy. To control for other factors affecting the cost of bank funding, the authors examine the variation in funding costs pre-crisis and argue that any change is due to the divergence in bailout expectations. This approach is simple but has a number of weaknesses: if expectations of government support were already incorporated in banks' funding costs pre-crisis this would mean that the approach estimates a change in the implicit subsidy but is silent on its level. It also assumes that all banks, irrespective of size, are of comparable risk.

Ueda and di Mauro (2012) estimate the implicit subsidy across a variety of countries using a ratings approach based on Fitch ratings. Fitch produces 'stand-alone' and 'support' ratings on incomparable scales. To compare the two, the authors conduct an ordered probit regression to determine the long-term support rating of a bank, given the individual bank rating and the support score that Fitch assigns. The authors also control for the ability of the authorities to support the bank, taking into account its macroeconomic and fiscal situation. This approach reduces somewhat the precision of the estimates in the paper given that Fitch already takes the ability of the authorities to intervene into account when determining the support score. To calculate the value of support Ueda and di Mauro (2012) take the average debt spreads for different rating categories from 1920–1999.

Li, Qu and Zhang (2011) estimate the implicit subsidy banks in the United States and Europe might be receiving using two different methods. The first is a variant of the approach by Baker and McArthur (2009) but with a correction for banks' differing risk. This approach, however, is still only suited to identifying the change of the subsidy over time, rather than its absolute level. Their other approach uses the difference in credit default swap premia and fair-value spreads (FVS) derived from equity prices. This has the advantage of forward-looking timely information on risk, but at the cost of accepting the distortion in pricing caused by risk aversion. The accuracy of these numbers depends on the accuracy of the model used to calculate FVS which is difficult to assess (given that it is proprietary), but they find results broadly in line with those presented here.

Araten and Turner (2011) estimate the implicit subsidy for different types of US bank liability using a bond pricing model and a 'SIFI dummy' to identify the effect of systemic importance, but with some rather non-standard variables. They find that post-crisis (2009 Q2 onwards) institutions that are 'too important to fail' (TITF) enjoy a bond spread that is 25% lower due to an implicit government guarantee. A number of specification and endogeneity problems such as including profitability, which is itself affected by the bond spread, imply that the model likely produces slightly downward-biased estimates of the subsidy. But more importantly, the model does not capture the time-varying effect of TITF status. If TITF confers a funding advantage then it is likely to be largest at times of financial instability and when investors are most risk averse. But the authors assume banks' funding advantage to be invariant to investor risk aversion.

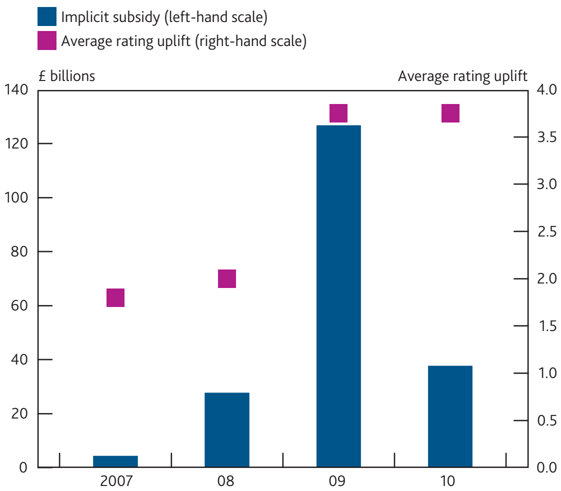
Anginer and Warburton (2011) use a bond pricing model to estimate the effect that bank size has on the relationship between the cost of funding and risk for US banks. Their analysis is likely to underestimate the size of the subsidy for two reasons: they control for the S&P issue rating which already takes the probability of support into account; and the size measure of TITF includes banks which are not likely to be systemically important, biasing their results downwards.

The latter two papers employ regression analysis using data on individual bonds rather than financial indices. While this type of analysis is feasible using data on US banks — given that in the United States there is a large number of banks with liquid debt in issue — it is less feasible using UK or European data on bank bonds.

(b) Differences in the cost of funding of banks of different ('stand-alone' and 'support') ratings. **Chart 2** shows how funding costs for banks of all ratings change between 2007 and 2010. This variation occurs due to changes both in the risk of banks and also in investor demand for their debt.

(c) Changes in the composition of bank funding. If banks substitute towards funding that is explicitly guaranteed (such as insured retail deposits) or secured by collateral, then this reduces the subsidy.

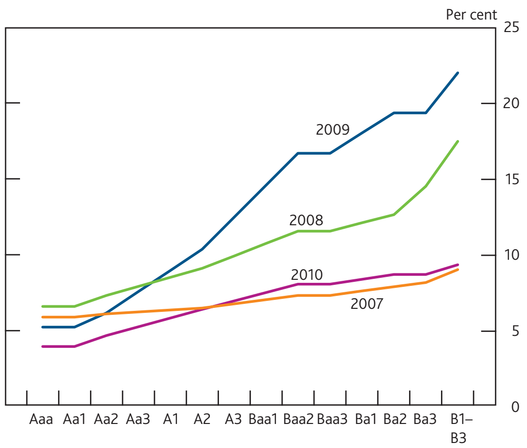
Chart 1 Average ratings uplift[(a)] and the implicit subsidy of major UK banks calculated under the (ratings-based) funding advantage model[(b)]



Sources: Bank of America Merrill Lynch, Capital IQ, Moody's and Bank calculations.

(a) Ratings uplift is defined as the number of Moody's rating categories by which the support rating exceeds that of the stand-alone.
(b) Aggregate implicit subsidy of Barclays, HSBC, Lloyds Banking Group and Royal Bank of Scotland.

Chart 2 The funding cost associated with representative banks of different ratings[(a)(b)]



Sources: Bank of America Merrill Lynch and Bank calculations.

(a) Average yields of Bank of America Merrill Lynch Sterling Corporates Financials Index at each rating.
(b) Where a yield is unavailable for a particularly rating it is linearly interpolated.

The implicit subsidy — as measured by the (ratings-based) funding advantage model — increases substantially between 2008 and 2009. This is mainly due to the first two effects: increases in the perceived likelihood of government intervention ((a), above) and in banks' cost of funding ((b), above).[(1)] The subsidy decreases between 2009 and 2010 but the ratings uplift is unchanged. Instead, the decrease is driven entirely by a reduction in the relative difference of funding costs between lower and higher-rated firms (the steepness of the curves in **Chart 2**).

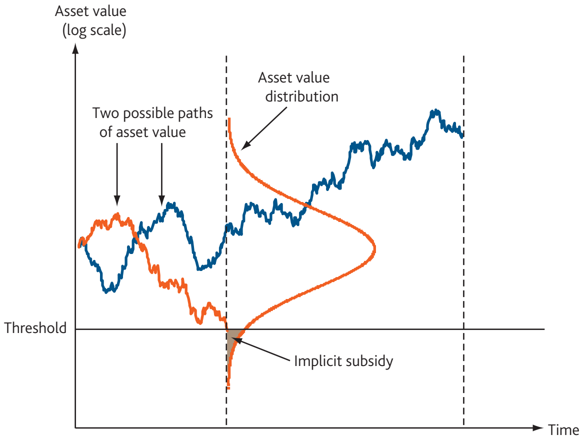
Contingent claims models

Contingent claims models calculate the implicit subsidy across all banks in aggregate. They estimate it as the expected annual payment from the government to subsidised banks necessary to prevent their default. This is modelled as the shortfall between the value of banks' assets and some 'threshold', based on their minimum capital requirements at some future time.[(2)] Failure is assumed to arise when the total assets of all banks fall below this minimum requirement. The value of government support is assumed to be the sum necessary to restore the value of assets to this minimum amount, weighted by the probability of their falling below it. It is represented as a 'claim' that banks, in aggregate, have on the government contingent on their failure, the exercising of which restores their assets to a value necessary to prevent their default.[(3)]

The contingent claims approach to estimating the implicit subsidy requires the modelling of the dynamics of banks' future asset values and their statistical distribution. This is necessary in order to gauge both the probability of banks' assets decreasing below this threshold value; the amount by which they are likely to do so; and the commensurate value of government support. **Chart 3** illustrates two possible paths for banks' asset values under such a model and the implicit subsidy that arises when, under one such path, the value of banks' assets falls below that commensurate with their minimum capital ratio.[(4)] The value of this subsidy is equal to the amount by which the value of assets falls below the threshold, weighted by the probability of their doing so (this is represented by the shaded area beneath the asset value distribution function in **Chart 3**).[(5)]

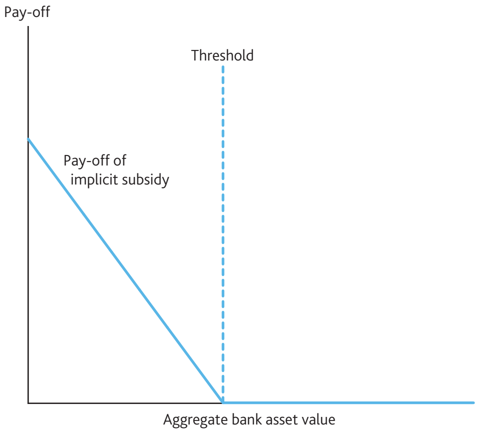
(1) The change in the composition of bank liabilities had an effect but this was small.
(2) A variety of assumptions can be made about the time at which this shortfall is evaluated. Oxera (2011) models the implicit subsidy as the expected shortfall between the value of banks' assets and the threshold at a horizon of one year; see Box 2 for further details.
(3) This technique features widely in the academic literature. For example, Lehar (2005) uses the approach to measure systemic risks, while Haefeli and Juttner (2010) value the state support to Credit Suisse and UBS using similar techniques. Huang, Zhou and Zhu (2010) and Tarashev, Borio and Tsatsaronis (2010) use contingent claims models to value systemic risks in the financial system.
(4) This is a simplifying assumption: in reality a bank can fail with assets that exceed those necessary to meet its minimum capital ratio, due to, for example, liquidity pressures. It also abstracts away from the possibility of the government enforcing the recapitalisation of banks through debt-for-equity swaps.
(5) It is assumed that banks require state support if their assets fall below their Tier 1 regulatory capital ratio. In line with the assumptions of Oxera (2011), banks' actual capital is taken to exceed its regulatory minimum by 3 percentage points of risk-weighted assets (in 2009, the Tier 1 capital ratio of UK banks was around 11%, and their average risk weight around 50%). This implies a fall of 1.5% in the value of total (non risk-weighted) assets would necessitate state intervention.

Chart 3 The implicit subsidy, as a contingent claim, under two illustrative 'paths' for banks' asset values



The contingent claims approach to valuing the implicit subsidy is similar to pricing an option. The banking system is viewed as a residual claimant on the government, receiving a pay-off equal to that of a hypothetical option to sell the banking system's assets at a 'strike price' equal to the trigger point at which banks fail. The value of the implicit subsidy is analogous to that of a 'put option'. If banks' asset values are greater than the threshold minimum asset value when the option expires the option would not be exercised and would expire worthless. But if the value of firms' assets falls below the trigger point, the option is exercised and its pay-off is equal to the difference between the two. This is illustrated in **Chart 4**. The value of the subsidy is the expected value of this pay-off — ie its size multiplied by the probability of it being exercised.

Chart 4 The pay-off of the implicit subsidy, considered as a 'put option' written on the assets of the banking system



Two contingent claims approaches are compared here. Both model the distribution of banks' future asset values based on the distribution of their equity prices. But they differ in how they calibrate the future distribution of banks' assets (and hence the expected shortfall between the value of assets and the failure threshold, and subsequent implicit subsidy):

- **Option-price approach**. This models the future distribution of the value of banks' equities based on the prices of equity options. As options' pay-offs are contingent on banks' future equity prices, their prices yield an estimate of the likelihood of the risk of bank failure as perceived by investors. This is the approach taken by Oxera (2011).

- **Historical approach**. Estimates of the implicit subsidy from the approach based on option prices are likely to be affected by how the prices of equity options reflect risk-averse investors' desire to protect themselves against adverse events. Given this potential distortion, we also propose an alternative approach that estimates the likelihood of bank failure based on the *historical* distribution of observed equity price movements.

Both the approaches use the distribution of bank equity prices over a given time period (see Section 4) to yield an estimate of the distribution of bank equity returns. This is then used to infer the corresponding distribution of banking system assets by scaling the distribution of equity values by an estimate of aggregate bank leverage (for details see Box 2). In line with the approach of Oxera (2011), we assume equity constitutes 6% of total assets.(1)

The use of financial market price data under the contingent claims approach conveys a number of advantages. Market prices reflect the aggregate expectations of actual investors in the market and, at least for larger banks, are available almost continuously. As such they may be a timelier, more reliable and more forward-looking guide to risk than rating agency forecasts.

(1) This approach gives a rough approximation distribution of bank assets based on a distribution of equity prices that, in common with the approach of Oxera (2011), implicitly assumes bank debt to be risk-free. It does, however, produce estimates of asset volatility consistent with those found elsewhere in the literature (for example see Lehar (2005)).

Box 2
Two contingent claims approaches to estimating the value of the implicit subsidy

This box compares two contingent claims approaches to quantifying the implicit subsidy. Both approaches represent the subsidy as a 'claim' that banks, in aggregate, have on the government, the exercising of which results in a payment necessary to restore banks' assets to a value necessary to prevent their failure. Valuing this requires the estimation of the distribution of banks' future asset values, and this is taken as the distribution of bank equity returns scaled by a factor reflecting bank leverage.

But the two approaches differ in how they calibrate the distribution of bank equity returns:

- An approach implemented in a recent report by Oxera (2011) calibrates this distribution using the information contained within the prices of options written on banks' equity.
- A new method is also proposed that bases this distribution on that of historical equity prices.

Equity option-price approach
Information contained in the prices of bank equity options can be used to calibrate the future distribution of banks' asset values. As these options pay out if banks' equity experiences price changes of different magnitudes, they give an insight into investors' expectations of the relative likelihood of changes of different magnitudes in banks' equity prices.

Options prices have the advantage of being forward looking: their prices incorporate information as to investors' views of the future movements in equity price distributions. But the resulting distribution is distorted by other factors, such as investors' degree of risk aversion. And at the height of the crisis, when the level of the implicit subsidy is highest, extreme levels of risk aversion can lead to an increase in demand for — and the subsequent price of — options insuring investors against extreme downward price movements. This may overestimate the value of the expected payout or implicit subsidy.

A simple approach to obtaining the future distribution of equity prices from the prices of equity options is to use the model of Black-Scholes (1973). This is the 'baseline' approach taken in Oxera (2011) and is calibrated to the variance of observed equity prices.

One shortcoming of the Black-Scholes model is that it assumes future prices to be normally distributed. This underestimates the likelihood of sharp jumps in future prices, thereby underestimating the likelihood of bank failure. One improvement — considered as an extension in Oxera (2011) — is to adopt the model of Kou (2002) under which prices follow a Gaussian distribution that is augmented by occasional (upwards and downwards) jumps. This has the advantage of better matching the 'fat tails' of the observed distribution of equity prices.

The approach is applied here by assuming each bank's assets follow the dynamic of Kou (2002), complete with jumps. The frequency and size of these jumps is calibrated to the distribution of options prices using the procedure described in Carr and Madan (1999). The Gaussian components of each bank's equity price are assumed to reflect the correlation of their observed values. These correlations are estimated by first filtering the data of these largest movements in asset values (more than three standard deviations from the mean) to remove the effects of large jumps in price (as these are accounted for separately). The procedure is in line with that described in Oxera (2011).

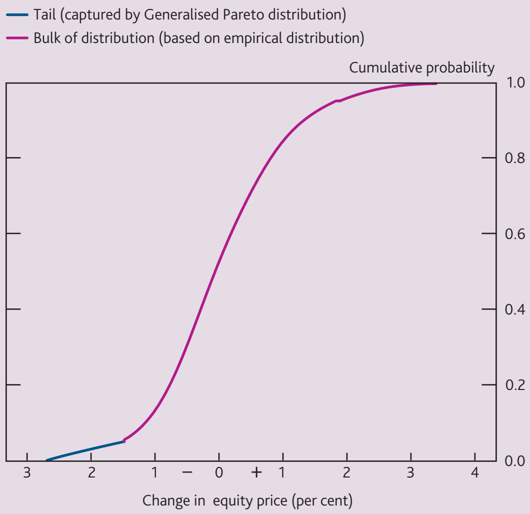
Historical approach
An alternative is to base the estimate of the distribution on historical prices of bank equity. Unlike the equity options-based approach this requires no underlying model of the evolution of banks' assets, thereby lessening the biasing problem related to investor risk preferences. But historical data contain little information on the likelihood and size of large infrequent downward movements in asset prices that are pertinent to the size of the implicit subsidy, as these are, by definition, rare.

One means of avoiding the explicit modelling of banks' assets while incorporating information on rarely observed 'tail events' is to use a result from Extreme Value Theory that allows extreme asset returns — greater or less than a certain threshold — to be predicted using a Generalised Pareto distribution function. This is a flexible approach often used to model the tails of a distribution that exceed a certain value (see Embrechts, Klüppelberg and Mikosch (1997)). The approach applies:

(1) A non-parametric 'empirical density function', fitted to the centre of the distribution (magenta line in **Chart A**). Empirical densities are ideal for modelling the centre of the distribution where there are plenty of observations.

(2) A Generalised Pareto distribution to the lower tail of the distribution of returns, to capture returns that fall below its fifth percentile (blue line in **Chart A**). This is useful for capturing 'tail events', which are — by definition — rare, and so give rise to fewer observations. The parameters of this distribution are fitted using a maximum likelihood procedure.

Chart A The historical approach to modelling the distribution of banks' equity prices



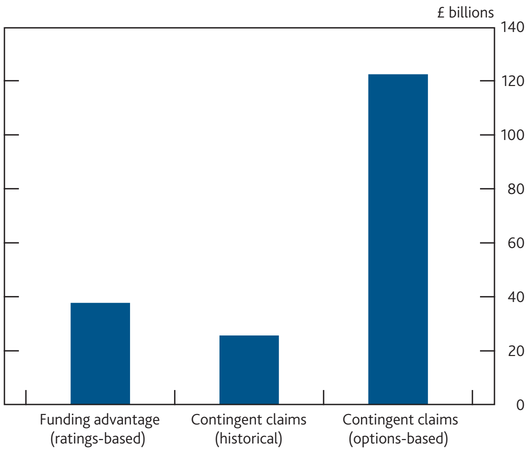
This approach therefore combines the advantage of both empirical and parametric statistical techniques to capture the observed distribution of equity returns without specifying an underlying path for future equity values. This also incorporates information on adverse 'tail events' that is particularly important for the calculation of the implicit subsidy. Together, these allow the veracity of historical price information to be retained, while also allowing for the accurate estimation of the likelihood of changes in market value that are rarely observed in practice.

Further technical details of the approach are contained in Nystrom and Skoglund (2002).

4 A comparison of two approaches and their estimates of the implicit subsidy

The implicit subsidy of major UK banks estimated using both the options-based and historical contingent claims approaches are compared with those of the funding advantage (ratings-based) approach in **Chart 5**. The range of estimates is broad. The funding advantage approach estimates the implicit subsidy in 2010 to be around £40 billion. The historical and options price contingent claims methods produce estimates of around £30 billion and £120 billion respectively; these results value the subsidy as a look-back option discounted at a rate of 1.2% (see Box 3), calibrated to the distribution of bank equity prices during 2010.

Chart 5 The implicit subsidy of major UK banks in 2010 as measured by the funding advantage and contingent claims approaches(a)(b)



(a) Both the historical and options-based contingent claims approaches model the subsidy as a look-back option discounted at a rate of 1.2% (see Box 3).
(b) Aggregate implicit subsidy of Barclays, HSBC, Lloyds Banking Group and Royal Bank of Scotland.

The range of results from the two methods reflects their relative strengths and the information on which they draw. The funding advantage approach relies on subjective rating agency judgement to determine the likelihood of bank failure and the probability of the extension of government support. It therefore has the advantage of parsimony.

In contrast, the contingent claims approach bases this estimate of the likelihood of bank failure and support on information from financial market prices. This, at least in theory, should have the advantage of reflecting aggregate investor assessments of the likelihood of bank failure. But it also comes at the cost of complexity: contingent claims models require the modelling of the future path of banks' assets, and make the simplifying assumption that banks fail when assets fall to a value commensurate with banks' minimum capital ratios, leading to the extension of government support.

The results of the contingent claims approach are also sensitive to underlying modelling assumptions. This accounts for the divergence in results based on the options-based and historical methods. The options-based approach has the advantage of incorporating information on the future prospects for banks, but its estimates of the subsidy may be exaggerated by investor risk aversion that increases the estimated likelihood of an event requiring government support.

The two approaches also differ in the degree to which they recognise how the distress of one bank can adversely affect the health of another. This is significant since banks transact with each other, so that economic shocks specific to one bank might spill over to affect its peers. Conversely, government support of one distressed bank might ameliorate the credit standing of others. Funding advantage models have only limited recognition of the degree to which the distress of one

Box 3
Sensitivities around the value of the implicit subsidy obtained by Oxera (2011)

Oxera (2011) uses the contingent claims approach to estimate the implicit subsidy of UK banks in 2010. But the conclusions of Oxera (2011) are sensitive to a number of its assumptions; in particular:

- **The choice of discount rate**. Oxera (2011) discounts the implicit subsidy at a 'risk-free' rate of 5%. In fact, the average yield on one-year UK government bonds — a common proxy of the risk-free rate — was exceptionally low during 2009/10, and stood at around 1.2% during November 2010. This may be a more appropriate rate at which to discount the implicit government guarantee of banks extended at this point in time, as it reflects the opportunity cost to government of not charging banks for doing so.(1)

- **The timing of state intervention**. Oxera (2011) models the implicit subsidy as the expected shortfall between the value of banks' assets and the threshold at a horizon of one year; ie as a 'European option' valued as the difference between asset values and the threshold at the year-end. But state support could, in fact, be extended at any time were the value of banks assets to fall below the threshold at which support is triggered.

A more realistic alternative is to consider the subsidy as a 'look-back option', whose value is determined by the maximum shortfall between bank assets and this threshold at any time over a year's horizon.(2)

Table 1 illustrates the effect of altering the discount rate and timing of state intervention assumed under both models, on the value of the implicit subsidy calculated in 2010. Oxera (2011) uses two approaches to estimating the implicit subsidy: its 'baseline model', and a more advanced approach based on that of Kou (2002). For more detail on the two approaches see Box 2.

Lowering the discount rate to 1.2% results in a substantial increase in the implicit subsidy. The estimate of the baseline model of Oxera (2011) is increased from £5.9 billion to £41 billion. Applying this adjustment to the approach of Kou (2002) increases the subsidy further to £58.9 billion. A lower discount rate also reduces the average rate at which banks' assets increase in value over the coming year. This lowers the average of the resulting distribution of banks' asset values (shown in **Chart 3**) increasing the likelihood that this value falls below the threshold commensurate with their minimum capital ratio (ie the shaded area in **Chart 3**), and hence the size of the potential future government transfer. In addition, the lower discount rate increases the present value of that implicit subsidy today.

If the subsidy is also valued as a look-back option, in combination with being discounted at this lower rate, its value increases to £90/£123 billion. Together, therefore, these two adjustments to the assumptions used in the approach of Oxera (2011) go some way towards reconciling estimates with those of Bank of England (2010).

Table 1 The implicit subsidy of UK banks in 2010 calculated under the assumption of different discount rates and timings for state support

	Model used in Oxera (2011)			
	Baseline model		Kou (2002) model	
Discount rate	5%	1.2%	5%	1.2%
As a European option:[a]				
Subsidy (per cent of assets)	0.08	0.59	0.12	0.84
Subsidy (£ billions)	5.9	41.0	8.7	58.8
As a look-back option:[a]				
Subsidy (per cent of assets)	0.43	1.28	0.61	1.75
Subsidy (£ billions)	30.1	89.6	42.4	122.5

(a) Estimates based on a 'European' option value the subsidy as the difference between banks' asset values and some threshold (commensurate with their minimum capital ratios) at the year-end; whereas those based on a 'look-back' option value the subsidy as the maximum shortfall between bank asset and this threshold at any time over the forthcoming year.

(1) To see this, consider how, had banks reimbursed the government the value of the implicit subsidy, the government could have reduced the national debt by this amount. The interest rate on one-year gilts reflects the cost of servicing this debt that the government would then have avoided paying.

(2) This, however, ignores the possibility that banks recapitalise themselves in the event of failure or are forced to do so by regulators (essentially shifting the threshold, so that no state support is required).

Table A The relative strengths of the funding advantage and contingent claims methods of estimating the implicit subsidy (and the direction in which they bias the resulting estimated implicit subsidy)

	Funding advantage (ratings-based)	Contingent claims
Scope of liabilities covered by the implicit guarantee.	Risk-sensitive debt liabilities. *Limited bias*	All liabilities, including equity (and assumes the transfer from the government to the bank is one-way). *Overestimation*
Means of determining the severity of the shock to banks' assets that causes their failure and necessitates government support.	Subjective rating agency judgement. *Ambiguous*	Rigidly assumes support extended when assets fall below minimum capital requirements. *Ambiguous*
Means of estimating the risk of banks and probability of their requiring state support.	Subjective rating agency judgement. *Ambiguous*	Equity/equity options prices. *Overestimation*
Capture of how risks spill over between banks.	None (to the extent that rating agency judgement fails to account for this). *Underestimation*	Partially, via the correlation between banks' asset values. *Underestimation*
Does it account for how the existence of the subsidy itself encourages bank risk-taking, and so is self-perpetuating?	Yes, to the extent this is recognised by rating agencies. *Limited bias*	Not as currently implemented (because equity prices may themselves reflect the subsidy). *Underestimation*

bank affects the health of others. Rating agencies judge the likelihood of bank default by considering its individual circumstances in relative isolation and take only limited account of the effect that an adverse shock to one bank might have on the wider banking system. This effect results in an underestimation of the subsidy by the funding advantage approach, since the effect of government support of one bank in avoiding the failure — and subsequent necessary subsidy — of another is not captured.

By contrast, the contingent claims approach has the advantage of going some way toward accounting for these spillovers of risk between banks. Government support is assumed to be extended *if* the *total* assets of all banks — in aggregate — fall below a certain threshold, approximated by their average capital ratio. Modelling the evolution of total bank assets requires some estimation of the degree of correlation between the assets of individual banks, with a higher correlation being consistent with a higher degree of bank interconnectedness (and in both contingent claims approaches, this correlation is estimated from the correlation of changes in their equity prices).(1) But to the extent that one bank may fail and receive government support, whilst the totality of banks' assets do not decrease below the threshold, this approach may underestimate the true value of the subsidy across all banks.

The two approaches also differ in the degree to which they capture one of the potentially most malignant effects of an implicit guarantee: that is, how it encourages banks' owners to take more risk, in the expectation that they will receive government support in the event of failure. To the extent that this increased risk-taking is recognised by rating agencies, this effect is accounted for in the estimates of the implicit subsidy derived from the funding advantage approach.(2) But it may be omitted from the contingent claims approach, as banks' equity prices may be distorted by investors' expectations of support, increasing their value, and reducing estimates of the size of the estimated subsidy.

Neither approach, therefore, provides a perfect measure of the subsidy. The advantages and disadvantages of the two methods are summarised in **Table A**.

In particular, the contingent claims approach is well suited to measuring both the probability with which banks fail and the scale of government intervention this necessitates. Its use of financial market prices allows it to quickly capture sentiment as to the health of the financial sector. But the assumption that support will be extended with certainty when a bank breaches their minimum capital ratio — and that this will entail a transfer to the bank equal to the entire shortfall of its assets below a level commensurate with this minimum ratio — means that the contingent claims approach is uninformative as to the probability with which governments intervene to support banks, and the credibility of their commitment not to do so. The resulting estimate of the implicit subsidy is also likely to be biased upwards by how, in reality, government support of banks need not involve a one-way transfer; for example, government support could be extended in return for bank equity that may appreciate in the future. And since the approach captures the transfer needed to insure the value of all liabilities, it will also capture the value of *explicit* deposit insurance — a second source of upward bias.

In contrast, the funding advantage approach incorporates credit rating agencies' assessment of the probability of the government intervention. But the subjective judgement of

(1) This technique is used widely in the literature; for example, see Segoviano and Goodhart (2009).
(2) It may, however, remain the case that were government support to be withdrawn, banks might adjust their liabilities to reflect their higher cost of funding. If this is the case, the funding advantage approach would partly mis-state the true reduction in funding cost a bank faces, in comparison to the counterfactual case without government support.

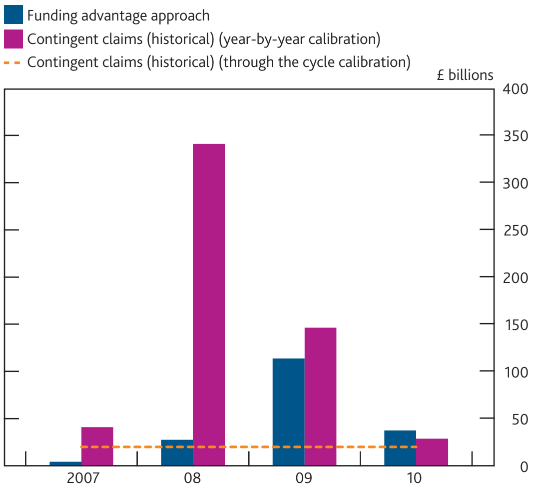
Table B The information content of the two approaches to quantifying the implicit subsidy

	Aspect of implicit subsidy		
	Probability of failure	Probability of government intervention	Size of government intervention
Contingent claims	Captures	Does not capture	Captures (at least in aggregate)
Funding advantage	Captures (but only the view of one rating agency)	Captures	Does not capture

ratings makes them a poorer guide to the likelihood and impact of bank failure as ratings change only infrequently. The relative information content of the two approaches to quantifying the implicit subsidy is summarised in **Table B**.

Chart 6 compares time series of estimates of the implicit subsidy based on the funding advantage and contingent claims (historical) methods. These are broadly comparable in 2009/10, but diverge in 2007/08. In 2007 and for most of 2008, rating agencies assumed there to be almost no difference between the stand-alone and support ratings of most UK banks, which is one reason why the funding advantage estimates are low. In contrast, estimates based on the (historical) contingent claims method vary significantly from year to year, as the observed distribution of banks' equity prices — and associated implied 'tail risk' of bank failure — changes significantly over time. The very high estimate of the implicit subsidy in 2008 is driven by the exceptionally high volatility of equity prices in the later part of that year. Estimates of the implicit subsidy for this period could be seen as an upper bound on its value, since the volatility of equity prices was also driven by, for example, high levels of investor risk aversion.

Chart 6 Variation in the implicit subsidy over time



The historical contingent claims approach facilitates an estimate of the implicit subsidy over a longer time horizon, rather than over a single year. This is based on the calibration to bank equity data taken through the cycle — between 1973 and 2010 — rather than year-by-year, and is illustrated by the orange line in **Chart 6**. Whereas the year-by-year estimates value of the subsidy at the point at which it is realised — ie at the time the guarantee is called upon — this through the cycle estimate represents its value across a longer horizon, incorporating periods of both health and crisis for the banking system.

This alternative framing of the implicit subsidy as annual 'premium' paid by the government across time — rather than its value at the point at which it is realised — highlights an important comparison. Year-on-year estimates of the implicit subsidy vary naturally through the economic cycle, as a government guarantee of banks is likely to be most valuable in the downturn, when banks are most likely to fail. But the longer-term guarantee is also important in the upturn, when banks are more profitable, as it may increase banks' incentives to take risk, given the perception that they will receive government support in the event of their failure at a later point in the cycle.

5 Conclusion

Implicit subsidies arise from a fundamental distortion in the financial system: the costs of bank distress are so large that the authorities have been unable to commit credibly not to intervene to prevent their failure. Creditors perceived this and reduced the compensation they demanded for bearing banks' risk. This causes a deadweight loss as banking crises — and their associated loss of welfare — become more frequent. The extent to which outcomes are distorted is directly related to the size of the subsidy, which is why measurement of its size is useful.

Initiatives such as the structural reforms recommended by the Independent Commission on Banking, extra prudential requirements for globally systemically important banks, resolution planning and ongoing efforts to improve the loss-absorbency of debt instruments will reduce the extent to which authorities intervene in the future to prevent bank failures.

The paper has explored estimates of the implicit subsidy in the existing literature, and shown how the divergence between them depends on their differing modelling assumptions and information content. Finding a definitive measure of the subsidy is frustrated due to its terms, and lack of observable price. But despite their differences, all measures point to significant transfers of resources from the government to the banking system.

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