The Social Costs and Benefits of Too-Big-To-Fail Banks: A "Bounding" Exercise †

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Abstract

While the Too Big To Fail issue has received wide attention in the academic literature and popular press, there is little agreement regarding economies of scale for financial firms. We take the stand that systemic risk increases when the larger players in the financial sector have a larger share of the output. Our calculations indicate that the cost to the economy as a whole due to increased systemic risk is of an order of magnitude larger than the potential benefits due to any economies of scale when banks are allowed to be large. When distributional and inter generational transfer issues are taken into account, the potential benefits to economies of scale are unlikely to ever exceed the potential costs due to increased risk of financial crisis.

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I. Introduction

Many argue that the market's $ex-ante$ belief in a public policy of too-big-to-fail (TBTF) caused the excessive risk that produced the recent financial crisis. It is further believed that the government's $ex-post$ actualization of that TBTF policy produced a series of massive government bailouts (Boyd and Jagannathan (2009), Johnson (2010), Volcker (cited in Casey (2010)). Some of these same individuals have argued that the TBTF banks are inherently costly to society and should be broken into smaller independent pieces. Boyd, Kwak and Jagannathan (2009) provide empirical evidence that the twenty largest banking firms took extraordinary risks in the 2000s and suffered extraordinary losses beginning around 2007. Importantly, the rest of the banking industry did not experience losses to nearly the same extent, and only after the crisis had severely damaged the real economy, did small and medium sized banks begin to report serious problems. Problems at small and medium-sized banks were an effect of the financial crisis, not a cause. Such empirical evidence cannot "prove" causality running from TBTF to the crisis, but the results are strongly suggestive.

An Estimation Problem. A counter-argument to the above is that very large banks exhibit economies of scale, and if they are broken into pieces, efficiency gains will be lost. It is widely believed, however, that scale economies in banking are extremely difficult to estimate. There is a large literature on this topic, and the only general point of agreement is that very small banks (less than a few hundred million in assets) are generally not efficient. One problem for the empirics is that, for this industry, output is difficult to measure. Theory tells us that commercial banks provide three broad classes of economic functions: payments services, inter-temporal risk management in the sense of Diamond and Dybvig (1983), and delegated monitoring in the sense of Diamond (1984) or Boyd and Prescott (1986). The first function is susceptible to measurement using proxy variables such as cash provided and checking account balances/transactions. However, the second two economic functions change the nature of the macroeconomic equilibrium (see studies cited above) and are almost impossible to measure. Various authors have taken different approaches to this problem, but none of this empirical literature can claim to be derived from the theory in a serious way.

The policy of TBTF complicates the estimation problem further. This policy provides an obvious advantage to very large banks; they have $de-facto$ insurance of all their liabilities. Other banks do not. This advantage looks like a funding cost efficiency and affects Tobin's Q and related measures in the same manner. Unfortunately, the correlation between size and TBTF coverage is believed to be close to one hundred percent. TBTF is not any kind of a scale economy - it is just favorable treatment of a few banks by the government.

Recently, it has been argued that reliable estimates of scale economies for very large banks cannot be obtained in the current environment with a rapidly changing technology and industrial structure. As DeYoung (2010) points out, there are two main problems in using traditional statistical techniques on modern banking data. First, the distribution of bank size is severely skewed.[1] Second, the largest banks differ from smaller banks in kind, not just size. Small and big banks operate differently and make money in different ways.[2]

A Policy Dilemma. If these arguments are correct, then the policy-maker cannot ascertain whether the social cost of these large institutions exceeds the social benefit, or vice-versa. However, the policy-maker must make decisions in real time, and to ignore the issue is a decision in itself. This is especially significant at the present time, since the recent bailout greatly increased concentration in the US banking industry (Wheelock and Wilson, 2011). We believe we have found a new and different way to approach this problem.

In this study, we place "bounds"[3] on the social costs and benefits of TBTF banks. We estimate the social cost of the recent financial crisis assuming (initially) that the crisis was strictly caused by the TBTF banks. We use assumptions that are consistently biased so as to

[1]Econometric tools provide the most accurate estimates for average companies, but they become less precise for firms that are substantially larger or smaller. The three largest banks, holding more than $2 trillion in assets, are almost ten times as large as the thirteenth largest bank.

[2]The literature on economies of super scale is mixed at best. Some studies using panel data across countries have found evidence of diseconomies of scale in very large banks (De Nicolo, 2000). Moreover, there is evidence that although large banks are better diversified than smaller banks, they offset this advantage by increasing risk in other ways, especially through the use of financial leverage (Boyd and Runkle, 1993).

[3]It should be clear from above that we do not mean bounds in the mathematical sense. What we essentially mean is "unreasonably biased in a systematic manner."

produce the lowest conceivable crisis cost estimates. Next, we estimate the economies of scale benefits of TBTF banks and make similarly Herculean assumptions about economies of scale so as to obtain the largest imaginable social benefits estimates. Then, we compare costs and benefits using a methodology due to Boyd, Kwak and Smith (2005, hereafter BKS). Their method converts both costs and benefits into a comparable metric: the present value-added to (or lost from) real per-capita GDP at a base date.

As we will see in the next section, the costs are assumed to cover a relatively short time period, while the benefits are assumed to go to infinity. Therefore, we must employ a social discount factor to compare the two. There is an old and ongoing debate on how this is to be done, and therefore, we employ several methods.[4]

Findings. We find that even under these extreme assumptions, the social costs of TBTF banks substantially exceed the benefits. Mostly, this is because the estimated crisis cost, even though intentionally biased downward, is very large. Our median crisis cost estimate is $7.2 trillion in 2011 dollars. An unbiased estimate of the total crisis cost, again in 2011 dollars is $15.9 trillion. Both estimates include output losses extending a number of years into the future. Such large cost estimates may not be so surprising given some estimates already available in the literature (Rogoff *et al*. (2004)).

Now, it could be that TBTF was only one of several factors leading to the crisis. Therefore, we make probability calculations showing how large the role of TBTF banks would have needed to be such that the costs and benefits were equated. Our results show that if the policy of TBTF increases crisis probabilities by even a modest percentage, then the cost of the policy exceeds the benefit.

[4]http://onlinelibrary.wiley.com/doi/10.1002/pam.20047/pdf and http://www.adb.org/Documents/ERD/Working_Papers/WP094.pdf

II. Estimating the Social Cost of the Financial Crisis

To estimate the costs associated with the TBTF banks, we estimate the real per capita output losses associated with the recent financial crisis. These real cost estimates include output lost during the crisis as well as output lost during the time it takes the economy to recover to its pre-crisis trend level of output. Using the methodology of BKS, we assume that had the financial crisis not occurred, output would have continued to grow at the long-run trend real growth rate of the economy. We use two methods to estimate the long-run trend in output. The first estimate is very simple - a 25-year arithmetic average of historical US growth rates in real per-capita GDP over the period 1983-2007. That rate is 2.27%.

The second trend estimator employs the maximum likelihood estimator proposed by Easterly *et al.* (1993). With this method, the trend estimate depends on the United States' growth rate and the world growth rate. If we define g_t as the estimated growth rate in real per capita GDP for the United States in period t, w_t as the world growth rate in period t, as the historical average growth rate as of year t, and n as the number of years used to compute the historical average, then the Easterly *et al.* (1993) estimate yields a growth rate estimate of 2.16% from the years 1983-2007. This trend rate of real GDP growth is defined as:[5]

$$g_t = \left[n \times \frac{\text{var}(w_t)}{\text{var}(\bar{g}_t) + n \cdot \text{var}(w_t)} \right] \times \bar{g}_t + \left[n \times \frac{\text{var}(\bar{g}_t)}{\text{var}(\bar{g}_t) + n \cdot \text{var}(w_t)} \right] \times w_t. \tag{1}$$

We then use these two trend estimates to obtain the hypothetical real per capita GDP per capita values for 2007 and after - economic performance that might have been obtained had the crisis not occurred.

We also need to know the economy's actual output path. For that purpose, we use reported US real per-capita GDP figures for 2007-2010. After that, we make estimates. Our first set of estimates employs Blue Chip's consensus GDP forecasted growth rates of 1.8%,

[5]The estimate obtained using the method of Easterly *et al.* (1993) provides a trend rate of 2.16%, which is lower than the average rate of 2.27%. This consequently leads to smaller estimated output losses resulting from the financial crisis when the Easterly *et al.* (1993) method is used.

2.1%, and 2.2% for the years 2011-2013.[6] Our second set of estimates uses the Organization for Economic Co-operation and Development's economic growth forecasts of 1.7% and 2.0%, and 2.5% for 2011-2013.[7]

To be conservative in estimating the crisis cost, we assume that the crisis ends in 2013, so for the years 2014 and after, we assume real per-capita GDP has risen to the pre-crisis trend. Thus, the trend GDP line and the actual GDP lines come together in 2014, forcing the loss estimates to be zero from that date onward. The result of this procedure is shown in Figure 1. Our estimate of the social loss is the integral of the area between the two lines in Figure 1.

Assuming that the financial crisis is over rather quickly in 2014 and there are no further economic losses after that date is a conservative assumption that massively reduces our crisis cost estimates. By contrast, BKS find that only four out of twenty-three countries in their sample of historical banking crises re-attain their pre-crisis trend level of output within seventeen years after a crisis onset. Pappell and Prodan (2011) find that in developed countries, the return to the potential GDP path following recessions associated with financial crises takes an average of nine years. As will be seen in a moment, we obtain cost estimates of about 45% of base year (2007) GDP. This may be contrasted with BKS who find an average lower bound cost estimate of 63% of base year GDP and an upper bound of 302%.

Cost Computation. First, we compute the actual and trend rates for each crisis year. Next, we assume that each annual loss continues to grow by the growth rate in each period. Then, all annual losses are discounted back to 2007 and expressed as a percentage of 2007 real per capita GDP. Essentially, we integrate the difference between the actual real per capita GDP and the trend values but allow these costs to grow at the growth rate, g. A similar procedure will be employed later for the benefits stream. Define c_t as the annual crisis cost in year t. The present value of the total crisis cost is:

[6] http://www.erfc.wa.gov/forecast/documents/p0511.pdf

[7] http://www.oecd.org/document/48/0,3746,en_2649_33733_45268528_1_1_1_1,00.html.

$$C = \sum_{t=1}^{6} \frac{c_t(1+g)^{6-t}}{(1+o)^t}, \qquad (2)$$

where o is a social discount rate to be discussed in the following section.

As shown in Table 1, when a simple average historical growth is used for the historical growth trend, this estimate ranges between 48.07% and 53.96% of 2007 real per-capital GDP. When trend growth is estimated with the Easterly *et al.* (1993) method, cost estimates range between 46.01% and 51.62% of 2007 real per capita GDP.

To conclude this section, we note another source of conservatism in our crisis cost estimates. We are assuming that all economic costs are represented by lost real output in the United States and *assign no weight to economic problems elsewhere in the world.*[8]

III. The Social Discount Rate

In conducting a cost-benefit analysis, it is necessary to reduce both costs and benefits to a single date in order to compare them. For risky projects, a higher social discount rate is typically used in order to reflect the riskiness of the project. We believe that both the social costs and benefits of TBTF banks are inherently risky and thus, a risky social discount factor seems appropriate. The future benefits to TBTF banks depend on technology advances and on the industrial organization of the banking industry, both difficult to predict. The future costs of financial crises depend on a myriad of things that are also extremely hard to predict. To be abundantly conservative, however, we use three different estimates of the social discount rate. The definition and estimation of these rates is discussed in Appendix A.

[8]Some readers have noted that there probably would have been a recession in 2007 - 08, even if the crisis had not occurred. Further, this argument goes, we are therefore overstating the crisis costs by some unknown amount. We accept that even without TBTF banks, there could have been a recession anyway. However, this is of a question regarding the order of magnitude of the crisis, and we are already understating crisis costs substantially. If we examine the mean Boyd, Kwak, Smith (2005) crisis cost estimates, we see that they are 116% of base year GDP (Table 8). In our analysis, our midpoint crisis cost as a percentage of 2007 real per capita GDP is only 49.98%, which is less than 45% of the BKS (2005) sample mean.

IV. Estimating The Benefits of Economies of Scale in TBTF Banks.

Hughes, Mester and Moon (2001) have obtained some of the largest banking scale economy estimates in the literature, and we shall first use their benefits estimates in our calculations.[9] Mester (2010) has recently argued that these scale economies currently remain intact and would be lost if the largest banks were broken up. "The literature on scale economies in banking, including my own studies, suggests that imposing a strict size limit would have unintended consequences and work against market forces." (*op. cit.*, page 10). Hughes, Mester, and Moon (*op. cit.*) find that when managers are allowed to make value maximizing decisions and rank projects based on both their profitability and risk, scale economies increase with bank size, suggesting that even mega-mergers are exploiting scale economies.[10] Their measure of scale economies is the inverse cost elasticity of output.

For their full sample, the mean measure of scale economies for the banking industry is 1.145, while the largest banks with assets of more than \$50 billion have scale economies of 1.25. This implies that TBTF banks are on average (1.25-1.145)/1.145 = 9.2% more efficient than the overall industry.[11] We define the returns-to-scale parameter as l. For our first benefits calculations, we assume that the largest banks obtain economies of scale that, *ceteris paribus*, increase their contribution to national output by $l = 9.2\%$. This value-added is being produced under the current banking arrangement and would, by assumption, be lost if the TBTF banks were broken up. Thus, the benefit we estimate is effectively a counter-factual: an estimate of existing economic benefits that could be lost.

[9] Several other studies have found economies of scale in large banks including Hughes, Lang, Mester, and Moon (1996), Berger and Mester (1997), Hughes and Mester (1998), Hughes, Lang, Mester, and Moon (2000), Bossone and Lee (2004), Feng and Serletis (2010), Wheelock and Wilson (2010), Hughes and Mester (2011).

[10] An important innovation of this study is that it identifies and measures scale economies not just in terms of operating costs but also in terms of risk management. The authors argue that to ignore scale economies in risk management results in a serious miss-specification.

[11] Recall that this study was published in 2002 and employs data earlier than that. Thus, at this time banks with assets exceeding \$50 billion were clearly TBTF. Their sample includes 15 banks in this size category which were the largest banks in the United States at that time.

Wheelock and Wilson (2011) obtain economies of super-scale estimates that appear to be even larger than those obtained by Hughes *et. al., (op. cit.)*. We next assume their economy of scale results in our calculations. However, they do not provide a breakdown that allows us to compare TBTF banks (roughly the largest 20) with the rest of the banking industry. What they do provide is an estimate of the economies of scale advantage of the largest four banks $vis - a - vis$, the costs that would obtain if the largest four were broken into eight equal sized banks. This cost advantage estimate is 16%, and that is what we shall employ in what follows (Wheelock and Wilson, *op. cit.* p. 18).[12]

IV.A Numerical Implementation: National Income Accounts Value-added Sector

We next define the percentage of total real per capita GDP provided by TBTF banks, s. From the National Income Value-added Accounts,[13] we obtain the data for the sector called "Federal Reserve Banks, Credit Intermediation, and Related Activities" and employ an average of this sector's percentage value-added to national output over the twenty-year period between 1988 and 2007. We obtain $s = 3.63\%$.

The annual social benefit attributable to economies of scale in TBTF banks is $G_t sl$, where G_t is real per capita GDP in year t. G_t is growing, and we need to take that into account in our estimates. Our empirical proxies for real output growth will be the two trend growth rate estimators presented in the last section. To realize real growth, the TBTF banks, like all firms, must retain earnings so they can invest in real capital. The fraction of their earnings that is retained, r, is not available for consumption in the current year and must be subtracted from current benefits. For empirical purposes, we obtained the average retention ratio of commercial banks, defined as the difference in the average net income after taxes and average dividends declared over the period 1990-2007 divided by average net income

[12]Note that their estimated cost advantage must be considerably larger when the top four banks are compared with the overall industry.

[13]http://www.census.gov/eos/www/naics/

after taxes for all US commercial banks over the period 1990-2007. We obtained $r = .3226$.

In the base year, the annual social benefits of TBTF are $G_t sl$, and it is assumed that these benefits are growing and continue indefinitely into the future. Therefore, we have:

$$V = \frac{s \cdot l \cdot (1-r)}{o-g}, \tag{3}$$

where V is the period zero value of the entire future stream of economies of scale additions to real economic output going out to infinity, expressed as a percent of period 0 real per capita GDP. [14]

Note that when we estimate the benefits stream due to TBTF banks, we are attributing the super-scale economy gain not just to TBTF banks but to *all commercial banks plus the Federal Reserve Banks, plus other miscellaneous financial intermediaries.* This is unavoidable because the Flow-of-Funds Accounts, which are essential to the BKS method, have no finer sector breakdown. However, this is yet another large bias in favor of the social value of TBTF.

From Table 2, we can see that when we employ the 25-year arithmetic average growth rate of 2.27% and the Moon *et. al. (op. cit.)* scale estimates are employed, the discounted value of TBTF benefits ranges between 5.03% and 17.01% of base year per-capita output. When the larger Wheelock and Wilson scale estimates are employed, it ranges between 8.74% and 29.58%. Table 3 shows benefits estimates if we utilize the growth rate estimate of 2.16% proposed by Easterly *et. al.* (1993) and the Moon *et. al. (op. cit.)* scale estimates. The discounted value of TBTF benefits ranges between 4.91% and 15.71% of base year real per capita output. When the larger Wheelock and Wilson scale estimates are employed, it ranges between 8.53% and 27.32%.[15]

[14] We do not allow the super-normal growth of TBTF banks to feed back and affect the growth rate of the economy. To do that would require a two technology general equilibrium growth model. Further, if that growth model did not impose some kind of convergence restriction, the TBTF banks would come over time to be 100 percent of the economy (which would be growing at the super normal rate).

[15] Real growth has two opposing effects in this analysis. First, as trend growth increases, the value of

V. Comparing Costs and Benefits

We can now compare cost and benefits estimates. Table 4a shows the cost and benefits estimates obtained when the 25-year average is used to approximate trend growth in real, per capita GDP. Column 5 shows the cost to benefit ratio when the Blue Chip economic indicators are employed for future output over the period 2011-13, and Column 6 shows the cost-benefit ratio when the OECD economic forecasts are used. The cost benefit ratio ranges from a high of 9.59 to a low of 1.82 depending mostly on the social discount rate o. Table 4b shows the cost and benefits estimates obtained when the method from Easterly *et al.* (1993) is used to approximate trend growth in real per capita GDP. Column 5 shows the cost to benefit ratio when the Blue Chip economic indicators are employed for future output over the period 2011-13, while Column 6 shows the cost-benefit ratio when the OEDC economic forecasts are used. These cost benefit ratio ranges from a high of 9.41 to a low of 1.88. In all of the cases in Tables 4a and 4b, including the most extreme, the estimated cost of TBTF exceeds the estimated benefit.

The Payback Period. Tables 5 and 6 use a different metric for comparing costs and benefits – one that is not so dependant on the choice of the social discount rate o. This is the payback period, a commonly used analytical tool in accounting. In this application, the payback period measures how many good, non-crisis years it would take to make up for the social cost of a single crisis. TBTF benefits are not discounted in these calculations, but the 6 years of crisis costs must be reduced to a single cost number. To do that, we go back to the original cost estimates shown in Figure 1 and define c_t as the annual crisis cost in year t. In computing the payback period, the crisis cost number is defined as:

$$\sum_{t=1}^{6} c_t \cdot (1+g)^{6-t}. \tag{4}$$

TBTF benefits rises along with the real economy. Second, the social cost of a crisis increases as trend growth rises, since the opportunity loss becomes larger.

We express this cost as a percentage of 2007 real GDP per capita. This is symmetric with our treatment of the TBTF benefit stream, which is also assumed to grow at the rate g. To estimate the payback period benefits, we use the expression:

$$\sum_{t=0}^{n} l \cdot s \cdot r \cdot (1+g)^n. \qquad (5)$$

The actual solution procedure is to solve for the integer value of n above that renders expressions 4 and 5 approximately equal.

When the 25-year average growth rate is used to estimate trend real per capita growth (Table 5), these payback period estimates vary between 66 and 86 years. When the Easterly *et al.* *(op. cit)* method is used to estimate trend real per capita growth (Table 6), they vary between 67 years and 89 years. Therefore, the shortest payback period, under the most extreme assumptions, is over 65 years.[16]

Crisis Arrival Rates Under TBTF: Actual Experience. Laeven and Valencia (2008) document 124 systemic banking crises in 161 countries over a 37 year period. The average country is present in their sample for 34.5 years. This means there are 161*34.5 country-year points (total data points) and 124 systemic crises documented. Therefore, the average world crisis-arrival rate in recent years has been 124 / (161 * 34.5) = 0.0223 or a crisis arrival approximately every 45 years. It is important to note that virtually all modern systemic banking crises have involved some form of TBTF policy. Thus, the estimates of Laeven and Valencia (2008) give us a modern estimate of crisis frequencies but only in the presence of TBTF.

We can now compare the payback period to the average actual crisis arrival rate based on recent international experience. The shortest payback period in Tables 5 and 6 is 66 years — or about 1.47 times the average world time between crises. This suggests that when the TBTF policy is present, there is simply not enough time between crises for the TBTF benefits to outweigh the costs.

[16]Note that the payback period is considered the first integer year where benefits exceed costs.

VI. What if TBTF is One among Several Causes of Financial Crises? Some Probability Calculations

Even without TBTF banks, financial systems can exhibit crises as is demonstrated by centuries of monetary history. In this section, we allow for that possibility in a simple model in which crises can occur with or without TBTF.

In what follows, there are two regimes: i. TBTF banks are present and ii. TBTF banks are not present. Banking crises can occur in either regime. In the TBTF regime, TBTF banks are assumed to provide social benefits in all years including crises. We assume that the annual social benefit of TBTF banks' scale economies, as a percent of real per-capita GDP, is at the mid-point of our previous estimates reported in Tables 5 and 6. This is $ls(1-r) =$ .3098

The structure of the two regimes is depicted in Figure 2. In the no-TBTF regime, the social benefits of economies of scale are never obtained. In both regimes, when a crisis occurs, we assume the same social cost of a banking crisis that was estimated earlier. We further assume that when a crisis occurs, it lasts six years (as in the previous analysis the crisis was assumed to last from 2008 - 2013). A crisis realization is assumed to produce a cost at the midpoint of our previous crisis cost estimates in Tables 5 and 6. This represents the cost of the crisis in terms of lost real GDP per capita over six years, C. We treat a crisis as a single event and including all six years of costs appropriately discounted. That's because once the economy enters a crisis state, it remains there for six years. Then, by assumption, the economy always returns to a non-crisis state.

With this structure, there is no randomness in leaving a crisis state; the single random variable is the probability of going from a non-crisis to crisis state. Again, all parameters are fixed in this section at their midpoints from Tables 5 and 6. The only variables that change are the probabilities of a crisis arrival.

A Key Assumption. It is fundamental to our analysis that TBTF (weakly) increases the probability of a crisis. That assumption is crucial in the present section. If this were not assumed, the TBTF regime would always dominate the no-TBTF regime *by construction.* The TBTF regime would exhibit weakly lower expected crisis costs and would also have positive returns in non-crisis states. The No-TBTF regime would never have positive returns in non-crisis states. Thus, there could be no trade-off.

With this structure, one can directly compute expected welfare by calculating the *ex-ante* expected cost/benefit in any year. Given the simple probability structure, this will be the same at all times. In the TBTF regime, the expected social return is $p_i C + (1-p_i)(sl(1-r))$, where p_i is the probability of a crisis arrival in the TBTF regime. In the No-TBTF regime, the expected welfare next year is $p_n C$, where p_n is the probability of crisis in this regime.

The results are shown in Table 7, where it is assumed that the crisis arrival rate in the TBTF regime is once every 25, 35, 45, 55, or 65 years as shown in row 1. We center the computations on one crisis every 45 years, since this was indicated by the results of Laeven and Valencia (2008). The second row shows the total crisis loss at the point where the TBTF and no-TBTF regimes break even, which corresponds to the crisis frequency under TBTF. The third row shows the breakeven probability - that is, the value of p_n which would give the two policies the same expected return. If we assume that a crisis occurs once every 45 years, this breakeven value is 1.63%. Finally, the last row in Table 7 shows the object (p_i - p_n) / p_i. This represents the percentage difference in crisis probabilities associated with the breakeven point. The interpretation is straightforward. For the case of a crisis occurring once every 45 years, we can interpret column 4 as meaning, "If the presence of TBTF increases the probability of a crisis by more the 22.27%, then TBTF is not good policy and is dominated by No-TBTF." A more detailed version of Table 7 is explained in Appedix B.

We have some values of crisis arrival occurring more frequently than the Laeven and Valencia (2008) benchmark case and some values occurring less frequently. What these cases show is that the lower the probability of a crisis under TBTF, the larger the percentage increase at the breakeven point. This should be intuitive; the longer the average elapsed time between crises, the more years TBTF benefits have to accumulate. However, even when crises only arrive once every sixty five years on average (see Table 7 Column 6) the breakeven occurs at $p_n = 1.04\%$. Even in this case, if the presence of TBTF increases the probability of a crisis by more than 32.35%, it is not good policy.

VII. Realistic Crisis Cost Assumptions

In this section, we briefly drop the "bounding" approach and employ realistic crisis cost estimates for eighteen countries studied by BKS. We continue to assume the TBTF scale benefits that we have just presented. The idea is to see how much of a difference it makes to drop one important biasing assumption and substitute realistic estimates.

We assume those parameter values that tend to most inflate TBTF benefits. We use the lowest discount rate, $o = .036$ and the highest economies of scale parameter $l = 0.16$. We do, however, employ the Easterly *et al. (op. cit)* trend growth estimate because it is a maximum likelihood estimate and clearly superior to a simple historical average.[17] In essence, this part amounts to a "half-bounding" exercise – costs estimates are realistic and benefits are intentionally overstated.

Table 8 shows the eighteen countries from BKS, their crisis dates, and the estimated cost of their crises as a present discounted percentage of base year real GDP.[18] In Table 8, the crisis cost estimates vary enormously - from 24.7% in the case of France to 232.5% in the case of Korea.[19] The sample mean (median) crisis cost is large at 116% (106.9%).

Table 9 Column 3 shows the cost/benefit ratios for the eighteen countries with the parameter assumptions discussed above. These are highly variable. One country, France, has positive net benefits due to TBTF. However, the mean (median) cost benefit ratio is 4.25

[17] This choice tends to reduce estimated TBTF benefits (as shown in Table 8) because these benefits are assumed grow at the trend growth rate.

[18] There are four crisis countries that BKS do not report because their estimated crisis costs are zero or negative. However, as is clear from BKS (footnote 5), the bias from this omission will be very small. These cost estimates come from Table 4, column 2 of BKS and do not include the estimated losses for four countries that never converge to the original growth path. Thus, we are not employing the upper bound estimates from BKS.

[19] The crisis in France involved the failure of just one large bank, Credit Lyonaise.

(3.91), suggesting an extremely unfavorable trade-off for TBTF. Column 4 shows the payback period calculations for these eighteen countries estimated with the same parameters. Recalling that the historical average crisis arrival rate from Laeven and Valencia (2008) is 45 years, there are only two countries with shorter estimated payback periods - France and Zimbabwe. The mean (median) payback period in Table 9 is 81.4 (87) years, almost double the estimated arrival rate from Laeven and Valencia (2008). In sum, both the cost-benefit and payback calculations indicate that TBTF appears to be an undesirable policy.

VIII. Conclusion

Our work needs to be further tested and we encourage others to consider the "bounding" methodology as an alternative to econometric techniques. The policy-maker needs to make decisions and cannot wait while economists experiment with new empirical methods or search for new data. Our main point is that the costs of TBTF seem to substantially exceed the benefits. This suggests that the link between TBTF banks and financial crises needs to be broken. One way to achieve that is to break the largest banks into smaller pieces as argued by Boyd and Jagannathan (2009). However, there are other policies that could be effective. If economies of super-scale are actually as large as some believe and go on without limit, an attractive policy would be to turn the TBTF banks into something like regulated public utilities. This would require regulating their rates of return on capital and managerial compensation as is done by state public utility commissions. A third alternative is to require them to hold very high capital ratios - as high as 20 or 30 percent. It has recently been argued by Hellwig *et. al.* (2010) that such capital requirements are only costly because of policy interventions in the form of tax deductibility of interest expense and the policy of TBTF.

Appendices

A Estimating a Social Discount Rate

To estimate a risky social discount rate, we use the methodology of Boardman (2001). We average the real pretax rate of return on Moody's AAA long-term corporate bonds over the period 1947-2007 and get an estimate of 6.77%. Our second estimate of 5.25% is taken from BKS.[20]

Our second estimate uses the optimal growth model proposed by Ramsey (1928) and reviewed in Moore *et. al.* (2004). This is meant for public projects, not risky projects. To obtain this estimate, we estimate the absolute value of the rate at which the marginal value of consumption decreases as per capita consumption increases e, a utility discount rate d, which measures the rate society discounts the utility of future per capita consumption, and the growth rate of per capita consumption g. The social discount rate, o, is then defined as:

$$o = d + g \cdot e. \tag{A.1}$$

We regress the natural logarithm of real per capita aggregate consumption on time over the period 1947-2007 and use the slope coefficient to obtain our estimate of g.[21] Based on the previous literature by Brent (2006) and Arrow *et al.* (1995), we use $e = 1$. Arrow suggests a figure of around 1 percent for d. Thus, with estimates of $g = 3.6\%$, $e = 1$, and $d = 1$ we obtain the estimate of the (gross) social discount factor o by substituting into (A.1):

$$o = d + g \cdot e = 1.0 + 0.36 \times 1.0 = 1.036. \tag{A.2}$$

[20]This is computed as the average real rate of return of equity for the twenty-three countries in their sample. We do not update these estimates because that would include the crisis years and result in an unreasonably low estimated cost of equity.

[21]Data come from http://www.bea.gov/.

B Probabilistic Calculations Explained

In this section, we expand the discussion of the probabilistic calculations from Section VI. The results are shown in Table B.1, where it is assumed that the crisis arrival rate in the TBTF regime is once every 25, 35, 45, 55, or 65 years. Panel A in Table B.1 shows results when crisis occur once every 45 years or $p_i = .0222$ - as reported by Laeven and Valencia (2008). What is allowed to vary in the panel is the crisis probability under the No-TBTF regime. For example, in column 1 it is assumed that $p_n = .005$ and we can see the net benefits under both regimes. Clearly, No-TBTF is better with these probabilities since -0.31% > -1.06%. Columns 3, 4, and 5 makes the same calculation allowing for successively higher values of p_n. As would be expected, the advantage of No-TBTF declines as p_n rises. In the fourth row, last column in Panel A Table B.1, we have the breakeven probability - that is, the value of p_n which would give the two policies the same expected return. This is 1.73%. Finally, the last row and column in each panel of Table B.1 shows the object (p_i - p_n) / p_i. This represents the percentage difference in crisis probabilities associated with the breakeven point. The other panels in Table B.1 are similar to Panel A, except that in each panel we change p_i, the probability of crisis arrival under TBTF.

Panels B, C, D, and E show the various losses and break-even points as crisis occur less frequently. The lower the probability of a crisis under TBTF, the larger the percentage increase at the breakeven point. This means that the longer the average elapsed time between crises, the more years TBTF benefits have to accumulate. Panel B shows the same types of calculations when crisis occur more frequently than the data suggest. If we assume that a crisis occurs every 25 years, opposed to every 45 years as Laeven and Valencia (2008) suggest, then we see that if the presence of TBTF increases the probability of a crisis by more than only 12.13%, then it is not a good policy.

Table B.1
Present Discounted Value Under Different Regimes Elaboration

Panel A: Assume Crisis Occurs Every 45 Years ($p_i = 0.0222$)				
Assumed Probability Under no-TBTF Regime (p_n)	$p_n = 0.005$	$p_n = 0.01$	$p_n = 0.013$	$p_n = 0.0173$
TBTF Regime Crisis Cost	-1.06%	-1.06%	-1.06%	-1.06%
no-TBTF Regime Crisis Cost	-0.31%	-0.61%	-0.80%	-1.06%
Break Even Probability, p_n				**1.73%**
Difference as a Percentage of TBTF Crisis Probability				**22.27%**
Panel B: Assume Crisis Occurs Every 25 Years ($p_i = .04$)				
Assumed Probability Under no-TBTF Regime (p_n)	$p_n = 0.020$	$p_n = 0.025$	$p_n = 0.030$	$p_n = 0.0351$
TBTF Regime Crisis Cost	-2.15%	-2.15%	-2.15%	-2.15%
no-TBTF Regime Crisis Cost	-1.23%	-1.53%	-1.84%	-2.15%
Break Even Probability, p_n				**3.51%**
Difference as a Percentage of TBTF Crisis Probability				**12.13%**
Panel C: Assume Crisis Occurs Every 35 Years ($p_i = 0.02857$)				
Assumed Probability Under no-TBTF Regime (p_n)	$p_n = 0.010$	$p_n = 0.015$	$p_n = 0.020$	$p_n = 0.0237$
TBTF Regime Crisis Cost	-1.45%	-1.45%	-1.45%	-1.45%
no-TBTF Regime Crisis Cost	-0.61%	-0.92%	-1.23%	-1.45%
Break Even Probability, p_n				**2.37%**
Difference as a Percentage of TBTF Crisis Probability				**17.19%**
Panel D: Assume Crisis Occurs Every 55 Years ($p_i = 0.018182$)				
Assumed Probability Under no-TBTF Regime (p_n)	$p_n = 0.005$	$p_n = 0.0075$	$p_n = 0.010$	$p_n = 0.0132$
TBTF Regime Crisis Cost	-0.81%	-0.81%	-0.81%	-0.81%
no-TBTF Regime Crisis Cost	-0.31%	-0.46%	-0.61%	-0.81%
Break Even Probability, p_n				**1.32%**
Difference as a Percentage of TBTF Crisis Probability				**27.30%**
Panel E: Assume Crisis Occurs Every 65 Years ($p_i = 0.015385$)				
Assumed Probability Under no-TBTF Regime (p_n)	$p_n = 0.003$	$p_n = 0.005$	$p_n = 0.007$	$p_n = 0.0095$
TBTF Regime Crisis Cost	-0.64%	-0.64%	-0.64%	-0.64%
no-TBTF Regime Crisis Cost	-0.18%	-0.31%	-0.43%	-0.64%
Break Even Probability, p_n				**1.04%**
Difference as a Percentage of TBTF Crisis Probability				**32.35%**

Table B.1 shows the Present Discounted Value Under Different Regimes. Row 1 shows the Crisis Frequency under the regime where TBTF banks are present, Pi. Row 2 shows the Total Crisis Loss for both regimes when evaluated at the Break even Probability, p_n. Row 3 shows the value of this breakeven probability, p_n, for each frequency, and Row 4 shows (p_i - p_n)/p_i, which is the percentage difference in crisis probabilities associated with the breakeven point. Panel A assumes that Crisis occur every 45 years, as Laeven and Valencia (2008) have documented. Within each panel, crisis probability under no-TBTF regime is allowed to vary, which is shown in columns 2-5. Columns 3-5 make the same calculations for successively higher values of p_n. Column 5 contains all calculations for the breakeven probability. Panels B, C, D, and E perform the same calculations assuming crises occur every 25, 35, 55, and 65 years respectively.

C Notation

C = The present discounted value of social output losses due to the financial crisis, in 2007 dollars.

c_t = Annual crisis cost in year t.

d = The utility discount rate, which measures the rate society discounts the utility of its future per capita consumption.

e = The absolute value of the rate at which the marginal value of that consumption decreases as per capita consumption increases.

g = The growth rate of per capita consumption

g_t = Estimated growth rate in real per capita GDP for the United States in period t

G_t = Real per capita GDP in year t

$\bar{g}_t$ = Historical average growth rate as of year t

k = Number greater than 1 that is multiplied by pf to bring the probability of failure closer to 1

l = Efficiency advantage of TBTF banks relative to the banking industry.

o = The social discount rate.

p = Probability of a crisis arrival.

P_i = Transition probability of going from the no crisis to crisis state in TBTF regime

P_n = Transition probability of going from the no crisis to crisis state in No-TBTF regime.

s = Share of total real per-capita GDP that is produced by TBTF banks. (Estimate from Flow-of-Funds data, $s = 3.63\%$)

V = Discounted 2007 value of the net social benefit of TBTF banks (in terms of their contribution to real per-capita GDP).

w_t = World growth rate in period t.

References

[1] K. Arrow. Economic Welfare and the Allocation of Resources for Invention, 1962.

[2] K.J. Arrow, WR Cline, KG Maler, M. Munasinghe, R. Squitieri, and JE Stiglitz. *Intertemporal Equity, Discounting, and Economic Efficiency*. Cambridge, UK, New York and Melbourne: Cambridge University Press, 1996.

[3] J. Barth, G. Caprio, and R. Levine. Guardians of Finance: Making Them Work for Us, 2006.

[4] J.R. Barth, G. Caprio, and R. Levine. *Rethinking Bank Regulation: Till Angels Govern*. Cambridge Univ Pr, 2008.

[5] A.N. Berger and L.J. Mester. Efficiency and Productivity Change in the US Commercial Banking Industry: A comparison of the 1980s and 1990s. *Working Papers*, 1997.

[6] A.E. Boardman, D.H. Greenberg, A.R. Vining, and D.L. Weimer. Cost-benefit Analysis: Concepts and Practice. 2006.

[7] B. Bossone and J.K. Lee. In finance, Size Matters: The "Systemic Scale Economies" Hypothesis. *IMF Staff Papers*, pages 19–46, 2004.

[8] J.H. Boyd and R. Jagannathan. Avoiding the Next Crisis. *The Economists' Voice*, 6, 2009.

[9] J.H. Boyd, R. Jagannathan, and S. Kwak. What Caused The Current Financial Mess and What Can We Do About It? 2009.

[10] J.H. Boyd, S. Kwak, and B. Smith. The Real Output Losses Associated with Modern Banking Crises. *Journal of Money, Credit and Banking*, pages 977–999, 2005.

[11] J.H. Boyd and E.C. Prescott. Financial Intermediary-Coalitions. *Journal of Economic Theory*, 38(2):211–232, 1986.

[12] J.H. Boyd and D.E. Runkle. Size and Performance of Banking Firms: Testing the Predictions of Theory. *Journal of Monetary Economics*, 31(1):47–67, 1993.

[13] R.J. Brent. *Applied Cost-Benefit Analysis.* Edward Elgar Publishing, 2006.

[14] M. Casey. 'Volcker: Fed Must Retain Bank Supervisor Role'. *Wall Street Journal*, January 2010. January 14.

[15] G. De Nicolo and Board of Governors of the Federal Reserve System (US). *Size, Charter Value and Risk in Banking: An International Perspective*, volume 689. Board of Governors of the Federal Reserve System, 2000.

[16] A. Demirgüç-Kunt and R. Levine. *Financial Structure and Economic Growth: A Cross-Country Comparison of Banks, Markets, and Development.* the MIT press, 2004.

[17] R. DeYoung. Scale Economies Are a Distraction. *The Region, Federal Reserve Bank of Minneapolis*, 2010.

[18] D.W. Diamond. Financial Intermediation and Delegated Monitoring. *The Review of Economic Studies*, 51(3):393, 1984.

[19] D.W. Diamond and P.H. Dybvig. Bank Runs, Deposit Insurance, and Liquidity. *The Journal of Political Economy*, pages 401–419, 1983.

[20] W. Easterly, M. Kremer, L. Pritchett, and L.H. Summers. Good Policy or Good Luck? *Journal of Monetary Economics*, 32(3):459–483, 1993.

[21] R. Feldman. Size and Regulatory Reform in Finance: Important but Difficult Questions. *The Region, Federal Reserve Bank of Minneapolis*, 2010.

[22] R. Gropp, C. Gründl, and A. Güttler. *The Impact of Public Guarantees on Bank Risk Taking: Evidence from a Natural Experiment*. European Central Bank, 2010.

[23] Curtis Hanson. *Too Big To Fail*. HBO, 2011.

[24] M. Hellwig. *Capital Regulation after the Crisis: Business as Usual?* Max Planck Inst. for Research on Collective Goods, 2010.

[25] J.P. Hughes, W. Lang, L.J. Mester, and C.G. Moon. Efficient Banking under Interstate Branching. *Journal of Money, Credit and Banking*, 28(4):1045–1071, 1996.

[26] J.P. Hughes, W. Lang, L.J. Mester, and C.G. Moon. Recovering Risky Technologies Using the Almost Ideal Demand System: an Application to US Banking. *Journal of Financial Services Research*, 18(1):5–27, 2000.

[27] J.P. Hughes and L. Mester. Who Said Large Banks Don't Experience Scale Economies? Evidence from a Risk-Return-Driven Cost Function. 2011.

[28] J.P. Hughes and L.J. Mester. Bank Capitalization and Cost: Evidence of Scale Economies in Risk Management and Signaling. *Review of Economics and Statistics*, 80(2):314–325, 1998.

[29] J.P. Hughes and L.J. Mester. Efficiency in Banking: Theory, Practice, and Evidence. In P. Molyneux A.N. Berger and J. Wilson, editors, *The Oxford Handbook of Banking*. Oxford University Press, 2010.

[30] J.P. Hughes, L.J. Mester, and C.G. Moon. Are Scale Economies in Banking Elusive or Illusive?: Evidence Obtained by Incorporating Capital Structure and Risk-Taking into Models of Bank Production. *Journal of Banking & Finance*, 25(12):2169–2208, 2001.

[31] S. Johnson and J. Kwak. *13 Bankers: The Wall Street Takeover and the Next Financial Meltdown*. Vintage, 2011.

[32] B.T. Kelly, H. Lustig, and S. Van Nieuwerburgh. Too-Systemic-To-Fail: What Option Markets Imply About Sector-wide Government Guarantees. Technical report, National Bureau of Economic Research, 2011.

[33] L. Laeven and F. Valencia. *Systemic Banking Crises: A New Database*. International Monetary Fund, 2008.

[34] R. Levine. Finance and Growth: Theory and Evidence. *Handbook of economic growth*, 1:865–934, 2005.

[35] L. Mester. Scale Economies in Banking and Financial Regulatory Reform. *The Region, Federal Reserve Bank of Minneapolis*, 2010.

[36] M.A. Moore, A.E. Boardman, A.R. Vining, D.L. Weimer, and D.H. Greenberg. Just Give Me a Number! Practical Values for the Social Discount Rate. *Journal of Policy Analysis and Management*, 23(4):789–812, 2004.

[37] G. Morgenson and J. Rosner. *Reckless Endangerment: How Outsized Ambition, Greed, and Corruption Led to Economic Armageddon*. Times Books, 2011.

[38] G.D. Nicoló, P. Bartholomew, J. Zaman, and M. Zephirin. Bank Consolidation, Internationalization, and Conglomeration: Trends and Implications for Financial Risk. *Financial markets, institutions & instruments*, 13(4):173–217, 2004.

[39] D.H. Papell and R. Prodan. The Statistical Behavior of GDP after Financial Crises and Severe Recessions. 2011.

[40] F.P. Ramsey. A Mathematical Theory of Saving. *The Economic Journal*, 38(152):543–559, 1928.

[41] K.S. Rogoff, A.M. Husain, A. Mody, R. Brooks, and N. Oomes. *Evolution And Performance Of Exchange Rate Regimes (Occasional Paper (Intl Monetary Fund))*. Internationall Monetary Fund, 2004.

[42] A. Taskm. ‘Reckless Endangerment’: Morgenson, Rosner Name Names - Point Finger at Fannie Mae’. *Yahoo! Finance - Business Finance, Stock Market, Quotes*, May 2011. May 27.

[43] D. Wheelock and P. Wilson. Do Large Banks have Lower Costs? New Estimates of Returns to Scale for US Banks. 2011.

[44] J. Zhuang, Banque asiatique de développement. Economics, and Research Department. *Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey.* Asian Development Bank, 2007.

Figure 1: Estimate of Social Loss Due to Crisis

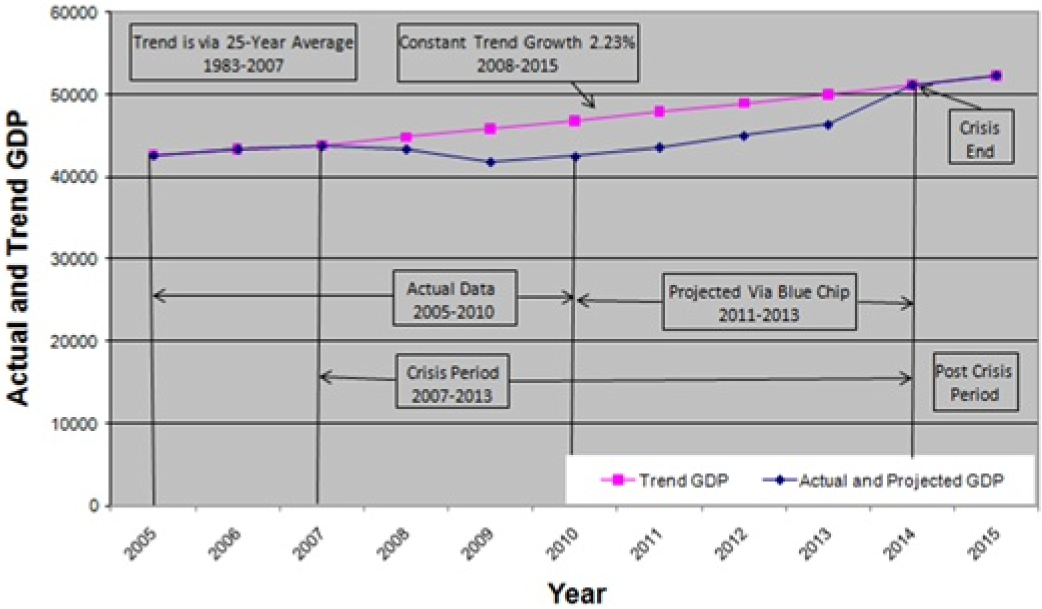

Figure 2
Regimes, Transition Paths, and Probabilities

P = **Transition probability**
P_n = **Transition probability of going from the no crisis to crisis state in No-TBTF regime**
P_i = **Transition probability of going from the no crisis to crisis state in TBTF regime**

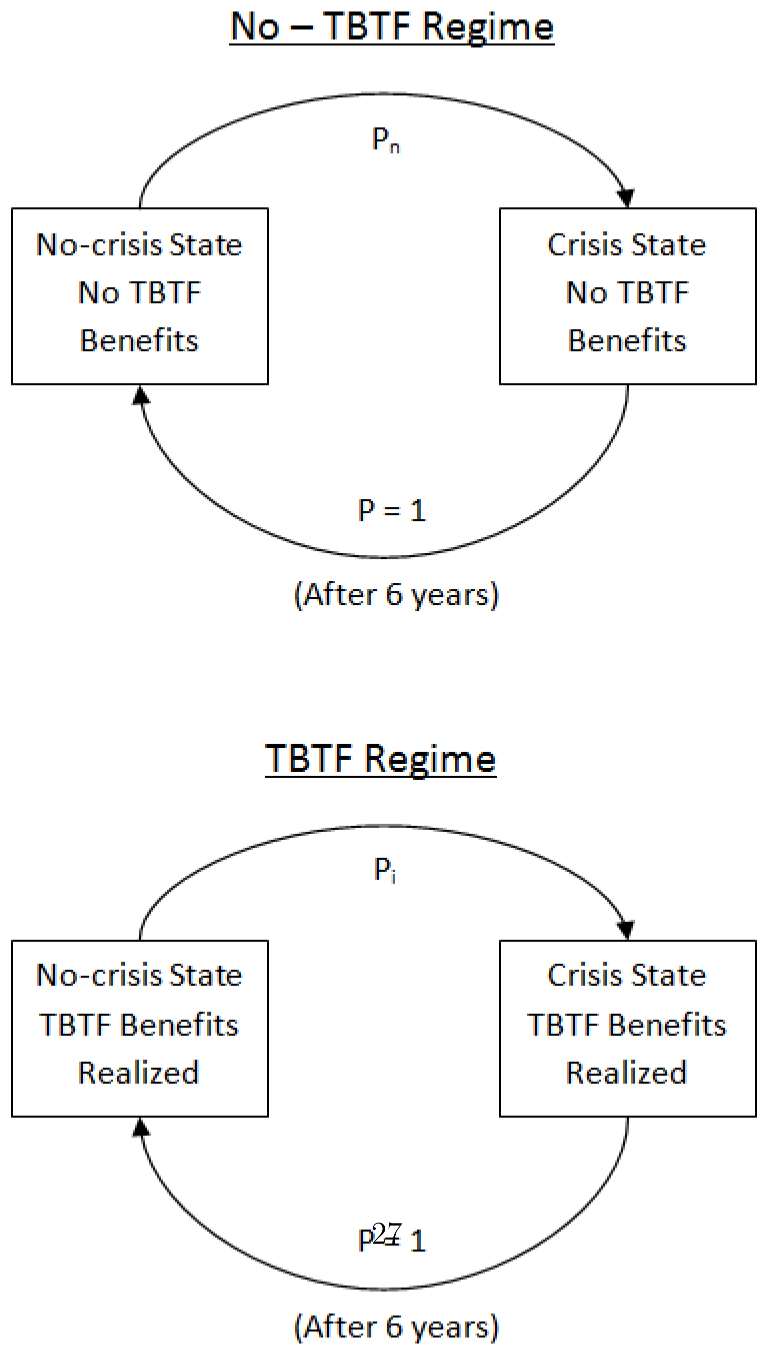

Table 1

Estimated Economic Losses Due to the Banking Crisis

Social Discount Rate (o)	Blue Chip Estimates Loss as a Percentage of 2007 Real GDP per capita (C)	OEDC Estimates Loss as a Percentage of 2007 Real GDP per capita (C)
Panel A: Trend Predicted Using 25-Year Average Rate of 2.27%		
6.77%	48.07%	48.23%
5.25%	50.70%	50.86%
3.60%	53.78%	53.96%
Panel B: Trend Predicted Using Easterly *et.al*. Method Rate of 2.16%		
6.77%	46.01%	46.16%
5.25%	48.50%	48.67%
3.60%	51.44%	51.62%

Table 1 compares the estimated losses employing varying GDP growth rate and trend assumptions. Column 1 shows the social discount rates used. Column 2 shows the loss values as a percentage of 2007 real per capita GDP for each of the corresponding social discount rates in Column 1 when Blue Chip's growth estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 3 shows the loss percentage of real per capita GDP when OEDC estimates were used to predict the actual real per capita GDP values from 2011-2013. Panel A estimates the losses based on trend calculations, which are the average growth rate of real per capita GDP of 2.27% over the period 1983-2007. Panel B estimates losses based on trend calculations of 2.16% based on the method proposed by Easterly *et. al* (1993) over the period from 1983-2007.

Table 2
Estimated Social Value-added of TBTF Banks
Estimated Social Value-added of TBTF Banks Resulting from Economies of Scale
Growth Rate Calculated using 25-year average 2.27%

Social Discount Rate (o)	Benefit as a Percentage of 2007 Real Per Capita GDP (V)
Panel A: Moon et. al. Measure of Scale Economies 9.2%	
6.77%	5.03%
5.25%	7.59%
3.6%	17.01%
Panel B: Wheelock & Wilson Measure of Scale Economies 16%	
6.77%	8.74%
5.25%	13.20%
3.60%	29.58%

Table 2 shows the benefits of Too Big to Fail Banks (TBTF) where the growth rate of real per capita GDP is calculated using the arithmetic average of the previous growth rates, 1983-2007. Column 1 shows the varying social discount rates. Column 2 shows the benefits as a percentage of 2007 real per capita GDP where 2007 is assumed to be the year of crisis onset. Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010)

Table 3
Estimated Social Value-added of TBTF Banks
Estimated Social Value-added of TBTF Banks Resulting from Economies of Scale
Growth Rate Calculated using Easterly *et.al*. Method 2.16%

Social Discount Rate (o)	Benefit as a Percentage of 2007 Real Per Capita GDP (V)
Panel A: Moon et. al. Measure of Scale Economies 9.2%	
6.77%	4.91%
5.25%	7.32%
3.6%	15.71%
Panel B: Wheelock & Wilson Measure of Scale Economies 16%	
6.77%	8.53%
5.25%	12.73%
3.60%	27.32%

Table 3 shows the benefits of Too Big to Fail Banks (TBTF) where the growth rate of real GDP per capita is calculated using the method proposed by Easterly *et. al* (1993) over the period 1983-2007. Column 1 shows the varying social discount rates. Column 2 shows the benefits as a percentage of 2007 real per capita GDP where 2007 is assumed to be the year of crisis onset. Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010)

Table 4a

Summary of Costs and Benefits as a Percentage of 2007 Real Per Capita GDP Calculated Using 25-Year Average Method for Trend Growth 2.27%

Social Discount Rate (o)	Blue Chip Cost Estimates (C)	OEDC Cost Estimates (C)	Benefit Estimate (V)	Blue Chip Cost Benefit Ratio	OEDC Cost Benefit Ratio
Panel A: Moon *et.al.* Measure of Scale Economies 9.2%					
6.77%	48.07%	48.23%	5.03%	9.56	9.59
5.25%	50.70%	50.86%	7.59%	6.68	6.70
3.60%	53.78%	53.96%	17.01%	3.16	3.17
Panel B: Wheelock & Wilson Measure of Scale Economies 16%					
6.77%	48.07%	48.23%	8.74%	5.5	5.52
5.25%	50.70%	50.86%	13.20%	3.84	3.85
3.60%	53.78%	53.96%	29.58%	1.82	1.82

Table 4a shows the Summary of Costs and Benefits as a percentage of 2007 Real Per Capita GDP where the growth rate is calculated using the 25-year arithmetic average, 1983-2007. Column 1 shows the varying social discount rates. Column 2 shows the cost estimates when Blue Chip growth estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 3 shows the OEDC loss estimates as a percentage of 2007 real per capita GDP when OEDC estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 4 shows the benefits estimate as a percentage of 2007 real per capita GDP. Column 5 was calculated by taking the ratio of Column 2 to Column 4, and Column 6 was calculated by taking the ratio of Column 3 to Column 4. Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010).

Table 4b

Summary of Costs and Benefits as a Percentage of 2007 Real Per Capita GDP Calculated Using Easterly *et.al.* Method for Trend Growth 2.16%

Social Discount Rate (o)	Blue Chip Cost Estimates (C)	OEDC Cost Estimates (C)	Benefit Estimate (V)	Blue Chip Cost Benefit Ratio	OEDC Cost Benefit Ratio
Panel A: Moon *et.al.* Measure of Scale Economies 9.2%					
6.77%	46.01%	46.16%	4.91%	9.38	9.41
5.25%	48.50%	48.67%	7.32%	6.63	6.65
3.60%	51.44%	51.62%	15.71%	3.27	3.29
Panel B: Wheelock & Wilson Measure of Scale Economies 16%					
6.77%	46.01%	46.16%	8.53%	5.39	5.41
5.25%	48.50%	48.67%	12.73%	3.81	3.82
3.60%	51.44%	51.62%	27.32%	1.88	1.89

Table 4b shows the Summary of Costs and Benefits as a percentage of 2007 Real Per Capita GDP where the growth rate is calculated using the method proposed by Easterly *et.al.* (1993) over the period 1983-2007. Column 1 shows the varying social discount rates. Column 2 shows the cost estimates when Blue Chip growth estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 3 shows the loss estimates as a percentage of 2007 real per capita GDP when OEDC estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 4 shows the benefits estimate as a percentage of 2007 real per capita GDP. Column 5 was calculated by taking the ratio of Column 2 to Column 4, and Column 6 was calculated by taking the ratio of Column 3 to Column 4. Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010)

Table 5
Payback Period
Calculated Using 25-Year Averages for Trend Growth 2.27%

Growth Rate	Blue Chip Cost Estimates	OEDC Cost Estimates	Blue Chip Payback Period	OEDC Payback Period
Panel A: Moon *et.al.* Measure of Scale Economies 9.2%				
2.27%	61.31%	61.53%	86	86
Panel B: Wheelock & Wilson Measure of Scale Economies 16%				
2.27%	61.31%	61.53%	66	66

Table 5 shows the Payback Period where the growth rate is calculated using the 25-year arithmetic average from the years 1983-2007. Column 1 shows the growth rate of the 25-year arithmetic average. Column 2 shows the cost estimates when Blue Chip growth estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 3 shows the loss estimates as a percentage of 2007 real per capita GDP when OEDC estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 4 shows the estimated payback period for Blue Chip cost estimates in years when costs and benefits are assumed to grow at the constant arithmetic growth rate. Column 5 shows the estimated payback period for OEDC cost estimates in years when costs benefits are assumed to grow at the constant geometric growth rate. Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010). Please note that the payback period is the first integer year where benefits exceed costs. This is a form of rounding which explains why they two estimates above are the same.

Table 6
Payback Period
Calculated Using Easterly *et.al.* Method for Trend Growth 2.16%

Growth Rate	Blue Chip Cost Estimates	OEDC Cost Estimates	Blue Chip Payback Period	OEDC Payback Period
Panel A: Moon *et.al.* Measure of Scale Economies 9.2%				
2.16%	61.05%	61.27%	88	89
Panel B: Wheelock & Wilson Measure of Scale Economies 16%				
2.16%	61.05%	61.27%	67	67

Table 6 shows the Payback Period where the growth rate is calculated using the method proposed by Easterly *et.al.* (1993) over the period 1983-2007. Column 1 shows the Easterly Growth rate. Column 2 shows the cost estimates when Blue Chip growth estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 3 shows the C loss estimates as a percentage of 2007 real per capita GDP when OEDC estimates were used to predict the actual real per capita GDP values from 2011-2013. Column 4 shows the estimated payback period for Blue Chip cost estimates in years when the costs and benefits are assumed to grow at the constant growth rate obtained by the method of Easterly et. al (1993). Column 5 shows the estimated payback period for OEDC cost estimates in years when costs and benefits are assumed to grow at the constant growth rate obtained by the method of Easterly *et.al.* (1993). Panel A estimates Too Big to Fail (TBTF) benefits based on scale economies obtained by Hughes, Mester, Moon (2001), and Panel B estimates TBTF benefits based on scale economies obtained by Wheelock and Wilson (2010). Note that the payback period is the first integer year where benefits exceed costs. This is a form of rounding which explains why they two estimates above are the same.

Table 7

Present Discounted Value Under Different Regimes

Crisis Frequency Under TBTF, P_i	25	35	45	55	65
Total Crisis Loss at Break Even Point	-2.15%	-1.45%	-1.06%	-0.81%	-0.64%
Break Even Probability, P_n	3.51%	2.37%	1.73%	1.32%	1.04%
Difference as a Percentage of TBTF Crisis Probability	12.13%	17.19%	22.27%	27.30%	32.35%

Table 7 shows the Present Discounted Value Under Different Regimes. Row 1 shows the Crisis Frequency under the regime where TBTF banks are present, p_i. Row 2 shows the Total Crisis Loss for both regimes when evaluated at the Break even Probability, p_n. Row 3 shows the value of this breakeven probability, P_n, for each frequency, and Row 4 shows $(p_i - p_n)/p_i$, which is the percentage difference in crisis probabilities associated with the breakeven point.

Table 8

Crisis Costs From Boyd, Kwak, and Smith (2005) Sample

Country Name	Total Crisis Cost Expressed as a Percentage of Year Zero GDP	Crisis Dates
Australia	62.4%	89-92
Columbia	109.0%	8287
Denmark	49.5%	87-92
Spain	143.3%	77-85
Finland	182.9%	91-94
France	24.7%	94-95
Greece	86.7%	91-95
Hong Kong	140.0%	82-86
Italy	96.2%	90-95
Jamaica	104.8%	94-?
Jordan	207.9%	89-90
Japan	140.4%	90-?
Korea	232.5%	97-?
Norway	111.3%	87-93
New Zealand	66.7%	87-90
Peru	194.1%	83-90
Sweden	100.8%	91
Zimbabwe	34.4%	95-98
Mean	116.0%	
Median	106.9%	

Table 8 shows the crisis costs of the sample from Boyd, Kwak, and Smith (2005). Column 1 shows the country name, and Column 2 shows the total crisis cost for that country expressed as a percentage of GDP of the last pre-crisis year. Column 3 shows the crisis dates in years. A question mark indicates that the crisis was not officially over at the time BKS were writing.

Table 9

Payback Period From Boyd, Kwak, and Smith (2005) Sample

Country Name	Total Crisis Cost Expressed as a Percentage of Year Zero GDP	Cost Benefit Ratio	Payback Period
Australia	62.4%	2.28	68
Columbia	109.0%	3.99	89
Denmark	49.5%	1.81	60
Spain	143.3%	5.25	101
Finland	182.9%	6.69	11
France	24.7%	0.90	39
Greece	86.7%	3.17	80
Hong Kong	140.0%	5.12	100
Italy	96.2%	3.52	84
Jamaica	104.8%	3.84	88
Jordan	207.9%	7.61	116
Japan	140.4%	5.14	100
Korea	232.5%	8.51	121
Norway	111.3%	4.07	90
New Zealand	66.7%	2.44	71
Peru	194.1%	7.10	113
Sweden	100.8%	3.69	86
Zimbabwe	34.4%	1.26	48
Mean	116.0%	4.25	81.4
Median	106.9%	3.91	87

Table 9 shows the payback period in years of the sample from Boyd, Kwak, and Smith (2005). Column 1 shows the country name, and Column 2 shows the total crisis cost for that country expressed as a percentage of GDP of the first pre-crisis year. Column 3 shows the cost benefit ratio, which is defined as the crisis cost divided by 27.32, which is assumed to be the benefit. This benefit number represents the U.S. benefits using the Wheelock and Wilson estimates of 16%, low social discount rate of 3.6%, and Easterly *et. al* (1993) growth rate of 2.16%. Column 4 shows the estimated payback period for sample cost estimates in years when costs are assumed to be those from Boyd, Kwak, and Smith, (2005), and benefits are assumed to grow at the constant growth rate of 2.16% obtained by the method of Easterly *et.al.* (1993). The scale measure of 16% found by Wheelock and Wilson (2011) is also used. Please note that the payback period is the first integer year where benefits exceed costs.