Cost Structures in American Commercial Banks Under $10 Billion:

Trend Analysis with Policy Considerations

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Abstract

Cost structures in the banking have historically been a point of study for economists, but many existing economies of scale studies use highly restricted samples. I compiled quarterly data from 2002-2020 from the Federal Financial Institutions Examination Council's Uniform Bank Performance Report to estimate the relationship between bank size (measured by total assets) and bank overhead (noninterest) expense for US banks under $10 billion in total assets. I included a continuous time trend as well as binary time variables for the 2008 recession period and the post-Dodd-Frank era in a multiple linear regression model. My estimation found statistically significant evidence for economies of scale in banking under asset levels of $1.45 billion, and that overhead costs trended downwards over time with exceptions during the recession and the Dodd-Frank era. Synthesizing these results with contemporary literature reveals how an understanding of bank cost structures can aid regulators in assessing the potential costs and benefits of new banking regulations.

Keywords: Economies of scale, banking, Dodd-Frank Act, Great Recession, cost structures

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The commercial banking sector in the United States has been characterized by increased competition and consolidation in recent decades, as regulatory scrutiny has increased and technological developments have challenged traditional banking practices (Saunders et al., 2021, pp. 366-369, 433-434, 600-601). American commercial banks provide payment and lending services and are the primary transmission mechanism for US monetary policy, granting them substantial influence over global economic conditions (Saunders et al., 2021, pp. 15-16). Furthermore, the emergence of systemically important depository institutions has gained the attention of federal and state regulatory bodies, so it is increasingly important to the well-being of the global economy that contemporary banking strategies are documented, disseminated, and understood. Continual evaluation of the US banking sector not only offers bank holding companies insights into how to optimize their business strategies, but also grants legislators insight into how effectively various policy proposals may mitigate systemic risks posed by banks to the global economy.

Despite their systemic importance resulting from their unique roles in the financial system, commercial banks in the United States are organized as corporations rather than publicly owned agencies. Mainstream economic reasoning holds that, under typical market conditions and subject to typical incentives, the primary objective of firms' managers is to maximize shareholder profits (Frank, 2015, pp. 318-320). As privately owned enterprises, American commercial banks can thus be modeled as profit-maximizing firms. It follows that a bank's business strategy arises from its managers' desire to maximize output and profits given the bank's current and projected endowment of capital and other resources. If this profit maximizing condition holds, typical commercial bank cost structures offer to explain many of the actions taken by American banks in recent years.

According to Saunders et al. (2021) and others, the banking industry is characterized by economies of scale (p. 15). This means that, as banks expand their deposit bases and lending activities, they become increasingly efficient. This premise is widely accepted but is worthy of closer examination. Feng & Zhang (2014) observe economies of scale in the banking industry, but also find constant and decreasing returns to scale in specific institutions (p. 22). Earlier studies such as Feng & Zhang analyze subsets of the US commercial banking sector, but do not provide a holistic, data-driven evaluation of cost structures across the industry. Consequently, I undertake an expanded evaluation of banking cost structures, constructed from a sample of all US banks under $10 billion in total assets.

The Uniform Bank Performance Report (UBPR) is published by the Federal Financial Institutions Examination Council each quarter and is available online back to Q1 of 2002 (FFIEC). Using this data, I estimate a cost function for the US banking sector for each year from 2002-2020. This cost function examines whether industry data suggests economies of scale and/or economies of scope in the banking industry. Additionally, this analysis explores whether the typical bank's cost structure changed in response to the Dodd–Frank Wall Street Reform and Consumer Protection Act and the recession that predated it.

The US banking sector is uniquely positioned in the world economy, especially with regards to its functions and significance. As privately held firms, banks can be assumed to be profit-maximizing entities whose strategies and incentives arise from their unique cost structures. Aggregating and analyzing nationally available data regarding bank cost structures from 2002 onward promises to provide an empirical basis upon which the incentives faced by commercial banks can be better understood.

Production Modeling Considerations

A cost function models the relationship between a firm's inputs – that is, the quantity of capital and labor employed in production – and the quantity of goods or services that the firm produces (Frank, 2015, p. 250). This definition implies a clear distinction between inputs and outputs in a firm's production process. In banking, however, there is ambiguity regarding the classification of inputs and outputs. The unique role of banks as financial intermediaries and service providers therefore necessitates special considerations when specifying a production function (Humphrey, 1990, p. 3).

According to the American Bankers Association (2020), products and services offered by banks may include deposit accounts, loans, payment facilitation, trust services, financial planning guidance, cash management, foreign exchange service, and more (pp. iv-x). While some of these services, such as financial planning guidance and cash management, can be clearly defined as outputs, the distinction is less clear with regards to deposit accounts and loans. Cecchetti & Schoenholtz (2021) emphasize that deposit accounts are an input for banks because they provide essential capital for lending services. Simultaneously, they provide depositors with benefits such as improved access to the payment system, a safe place to store funds, and they facilitate accounting (pp. 270-271). Nonetheless, a survey of banking literature reveals that bank cost structure analysis lacks a standardized definition of a bank's output.

Early studies such as Benston (1972) and Humphrey (1990) include deposit accounts in their definitions of bank outputs. According to Benston, "the number of deposit and loan accounts are best related to the operations of financial institutions and thus to their operating costs" (p. 322). Humphrey concurs, but also includes the number of loan accounts in his definition of output. He claims that the conclusions of a scale economy study are unlikely to be significantly altered if the dollar value of these accounts is used instead (p. 3).

Many studies, especially more recent ones, reject Benston and Humphrey's inclusion of deposit accounts as bank outputs, instead using loan accounts. Studies whose definitions of output include primarily loans include Kim (1986), Hunter & Timme (1995), Allen & Liu (2007), and Huang et al. (2011). Of these, Kim and Hunter & Timme are the only studies that define bank outputs as solely loans. The others include variables to account for other revenue generating services and investments, but these do not appear to dominate their analyses. These definitions are consequential when comparing banking cost structure studies, as the way an author defines bank output may materially influence their conclusions.

Another consideration when comparing economies of scale studies in banking is the nature of the underlying sample data. Wooldridge (2020) identifies two relevant forms this data can take: datasets may be cross-sectional, or longitudinal. Cross sectional datasets are collected at a discrete point in time, while longitudinal datasets are collected over time (pp. 7-9). The inclusion of time in longitudinal datasets facilitates trend analysis in dynamic systems, whereas a cross sectional dataset may be sufficient to extrapolate relationships between variables in a static system.

Financial data is published quarterly for depository institutions in the United States, making it possible to assemble both cross sectional and longitudinal datasets (see FFIEC – UBPR). A cross sectional dataset contains data for multiple banks *ipso facto*, whereas a longitudinal dataset could be constructed for either a single bank or for multiple banks. Benston (1972) notes that a time series analysis of a single firm could be constrained by a variety of factors including changes in business practices and "partial and inconsistent adjustment of cost to changes in the rate of output…" (pp. 315-316). Benston also identifies weaknesses in cross sectional studies, noting that they

> …suffer from inconsistent definition of output among firms, differences among firms in accounting costs that reflect the time of purchase of equipment and plant, errors in the establishment of firms or plants of suboptimal size, etc. (p. 316).

Benston does not explicitly treat the possibility of longitudinal datasets containing data for multiple firms, as it is likely that procuring a sample of this nature was impractical at his time of writing.

Later authors, such as Hunter & Timme (1995) and Allen & Liu (2007) are more likely to embrace time series analysis. Hunter & Timme argue that, since some prices and inputs are fixed in the short run, a cross-sectional dataset may not capture banks whose production functions are in long-run equilibrium. Both authors' time series analyses examine multiple banks, rather than the single-bank time series analysis favored by Benston. Expanding a sample to include multiple banks over multiple years increases the total number of observations sampled thus increasing the estimation's degrees of freedom. This suggests that the model now captures more variance in the underlying population than comparable single bank or cross-sectional studies (Wooldridge, 2020, p. 94).

Another consideration in bank cost structure analysis is how to define banks' costs and profits. Economists distinguish between two classifications of profit: accounting profit and economic profit. Accounting profit is a function of explicit costs and total revenues, while economic profit expands this definition by including implicit costs, such as opportunity costs (Frank, 2015, p. 318). For welfare analysis purposes, economic profit may be expanded to include externalities as well, providing insights into the social costs associated with a specific firm or industry. Benston advocates this holistic approach to estimating financial institutions' cost functions, though he admits that it is difficult to collect these data (p. 318). Indeed, a survey of banking cost function literature reveals that authors seldom account for implicit costs of production, much less market externalities. This is likely a consequence of the data available – financial reports and statements are prepared by accountants rather than economists, so they reflect accounting costs and omit implicit and external costs (see FFIEC – Uniform Bank Performance Report).

Economic systems are complex, so modeling them concisely requires reductive assumptions. While many of these assumptions go unstated, a survey of literature reveals two significant assumptions about the nature of banking: the profit/cost optimization objective and the nature of outputs. Huang et. al (2011) assume cost minimization, as opposed to profit maximization, as a primary motivator of banks' behavior (p. 842). Though profit maximization is a common assumption in the discipline, cost minimization may be a more appropriate assumption in the realm of cost modeling, as profits are not explicitly captured by cost functions.

Whether banks' outputs (however they may be defined) are assumed to be homogenous is another factor worthy of consideration. Banks offer a variety of financial services, and these vary between firms. Smaller banks offer traditional depository and lending services, while larger banks are likely to offer additional services such as access to foreign exchange markets, personal financial planning, and cash management services (American Bankers Association, 2020, pp. v-vii; Saunders et. al, 2021, p. 286). Assuming homogeneity of outputs in a model facilitates comparisons both between banks and between other banking models but reduces the degree to which a model captures any underlying heterogeneity of outputs existing in the sample.

Model & Assumptions

To model the relationship between bank size and production costs I employ an ordinary least squares multiple regression estimation, of the form

$$\ln C_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 T + \beta_4 T_r + \beta_5 T_{df} + u$$

where C_{it} is an average of banks' non-interest overhead expense during year t on an interval i. Overhead expenses are expressed as a percentage of a bank's average assets during each year t. The term i is defined as the average bank size (measured by total assets), where i increases in $10 million increments. The constant term is represented by β_0, with β_1, β_2, β_3, β_4, and β_5 representing coefficients for their respective variables. X represents the average bank size on each interval i at each year t, and X_{it}^2 is the square of this term. T is a continuous time trend, while T_r is a binary variable for the period 2008-2010 and T_{df} is a binary variable for 2011-2020. The error in the model is represented by u. (See Wooldridge (2020) Chapter 3 for details concerning OLS multiple regression analysis).

This model consolidates some common practices from bank cost structure literature, subject to the following considerations. First, my model does not explicitly address heterogeneity of bank outputs. Instead, it approximates both bank size and bank outputs by using average assets as a proxy variable. Since most bank assets produce income, I infer a positive correlation between banks' asset bases and their output (Saunders et al., pp. 385-387). Using assets as a proxy for output is advantageous because it facilitates comparing banks without directly measuring their unique output mixes (Wooldridge, 2020, p. 299).

An individual bank's inputs and outputs are bound to vary over time due to various institution-specific factors. These decisions originate with managers as they conduct business, and thus are not explicitly captured in financial reports. This model assumes that these institution-specific influences on banks' cost functions are not systematically related across the sample, and that this will mitigate their impact on the aggregate cost estimation if a sufficiently high number of institutions are included when the model is estimated. If doing so mitigates the influence of institution-specific factors, the estimation will emphasize primarily systemic factors in aggregate.

Data & Methodology

I obtained panel data concerning all US-based banks from the Federal Financial Institutions Examination Council's Uniform Bank Performance Report (UBPR). The UBPR contains all mandatory reporting data from every bank in the United States, regardless of whether it holds a national charter or a state charter (https://cdr.ffiec.gov/public/pws/downloadbulkdata.aspx). This data is updated quarterly, and is available for download in bulk, from the Q1 2002 to the present year (See FFIEC, 2021; Saunders et al., 2021, p. 400).

I compiled reports from Q4 2002 to Q4 2020 in Microsoft Excel, extracting yearly measurements of every bank's average assets during the year as well as their yearly overhead expenses (excluding interest expenses). Overhead expenses were expressed as a percentage of average yearly assets in the UBPR, a convention that I maintained throughout my analysis to facilitate comparison between banks of different sizes. After compiling the data, I restricted the sample to banks that had $10 billion or less in assets during each year. I enforced the maximum bank size threshold on a yearly basis, so banks that expanded beyond $10 billion in assets were dropped in the year that they did so. Banks that failed or were acquired during this time period were not dropped from the sample.

After compiling the data, I created bins with a width of $10 million ranging from $0-10 billion and calculated two averages for the banks in each bin: the average bank size, and the average overhead expense. Some bins were empty in some years, resulting in null values for these calculations. These were retained in the dataset but were ignored when estimating the model. Though the practice of averaging the sample before estimating it is nonstandard in literature, I found it made estimating the model more manageable, as visualizing the raw data in Tableau revealed extreme variance and heteroskedasticity in the population.

Descriptive statistics for this dataset are presented below in Table I:

Descriptive Statistics – Table I					
Variable	Obs	Mean	Std. Dev.	Min	Max
Year	19,000*	2011	5.47737	2002	2020
T	19,000*	10	5.47737	1	19
X_{it}	12,062	38.33994	26.94013	0.0596423	99.98568
X_{it}^2	12,062	2195.662	2570.994	0.0035572	9997.136
$\ln C_{it}$	12,060	1.038109	0.4651556	-4.60517	5.041741
T_{prr}	19,000	0.3157895	0.4648418	0	1
T_r	19,000	0.2105263	0.4076932	0	1
T_{df}	19,000	0.4736842	0.4993201	0	1
*Includes null values					*Generated in STATA® 17 BE*

Results

Multiple linear regression analysis on the UBPR data suggests a U-shaped relationship between the independent variable, $\ln C_{it}$, and bank size as measured by total assets, since the coefficient on X_{it}^2 is positive. This is because graphing an equation with a positive coefficient on X^2 will yield an upward-facing parabola. Differentiating the estimation with respect to X reveals a turning point at an asset size of $1.45 billion. A negative coefficient on T suggests that bank costs relative to assets trended downwards over time, while positive coefficients on the binary variables T_r and T_{df} indicate that bank overhead costs increased during the recession and after the Dodd-Frank Act passed into law, relative to the base period of 2002-2007.

All variables in the estimation are significant at 5% since the absolute value of their respective t-stats exceeds the critical value of 1.960. All variables remain statistically significant when tested at 1%, as the absolute values of their respective t-stats exceed the critical value of 2.576 as well (Wooldridge, 2020, p. 786). Though the independent variables in the estimation are highly statistically significant, the estimation yields an R-squared value of 0.0758. The results of this estimation are presented below in Table II:

Regression Results – Table II						
Source	SS	df	MS		Number of obs =	12,060
Model	198.787422	5	39.7574		F(4, 12055) =	198.82
Residual	2410.41475	12,054	0.19996		Prob > F =	0
Total	2609.20217	12,059	0.216369		R-squared =	0.0762
					Adj R-squared =	0.0758
					Root MSE =	0.44718
$\ln C_{it}$	Coefficient	Std. Err.	t-stat	P>|t|	[95% conf.	interval]
X_{it}	-0.0066769	0.0005451	-12.25	0.000	-0.0077455	-0.0056084
X_{it}^2	0.000023	5.71E-06	4.03	0.000	0.0000118	0.0000342
T	-0.0133008	0.0019497	-6.82	0.000	-0.0171224	-0.0094791
T_r	0.0741246	0.0150355	4.93	0.000	0.0446526	0.1035966
T_{df}	0.1487809	0.0241108	6.17	0.000	0.1015198	0.1960421
β_0	1.292128	0.0138841	93.07	0.000	1.264913	1.319343
All variables significant at 95%						*Generated in STATA® 17 BE*

Discussion

According to Wooldridge (2020), the change in the dependent variable of a log-level regression analysis for a one unit increase in a dependent variable can be approximated as a percentage by multiplying the coefficient on the independent variable by 100 (p. 186). Applying this to the estimation above, I approximate that for each $10 million increase in asset size, a bank's overhead decreases initially by about 0.67%. However, this decrease is eventually offset due to the positive coefficient on the X^2 term. When applied to the time trend T, this method shows that banks' overhead functions decreased by about 1.33% each year, but temporarily increased by about 7.4% during the recession and by about 14.88% under the Dodd Frank Act.

However, it is possible that the method by which overhead is measured confounds this conclusion. Since the UBPR measures overhead as a percentage of average assets, this number can be affected by changes in assets and by changes in overhead. This means that a bank's overhead expense in dollar terms could remain constant, while its overhead as a percent of assets would increase if the value of the bank's assets decreased. Indeed, many banks took substantial losses on nonperforming assets during the recession and early Dodd-Frank period (Saunders et al., 2021, p. 100). Since I do not explicitly control for variances in asset levels in my model, it is possible that the coefficients on T_r and T_{df} overstate the degree to which banks' costs increased in dollar terms.

The presence of a turning point at $1.45 billion suggests that banks experience economies of scale as their total assets increase up to this point, and that they experience diseconomies of scale with further expansion. This implies that the optimal size for a bank, in terms of cost efficiency, is $1.45 billion in total assets. However, many banks operate profitably with assets well beyond this level. A notable example is JP Morgan Chase, which is the largest bank in the US with assets exceeding $3 trillion in 2020 (FFIEC, 2021). This is more than 1500 times the size of the optimal bank as suggested by my estimation. However, the notion of an "optimal" bank size is more nuanced than this comparison suggests.

Saunders et al. (2021) note that larger banks tend to offer more financial products and services than other banks; indeed, the way a bank conducts business is largely dependent on its size (pp. 369-370). In contrast, my model assumes that banks employ homogenous business practices. I attempted to mitigate the heterogeneity condition Saunders et al. observe across the population by restricting my sample to banks under $10 billion. Although some heterogeneity of remains within the restricted sample, the difference in business practices between a $1 billion bank and a $10 billion bank is likely much smaller than the difference between a $1 billion bank and a $1 trillion bank. Examining the UBPR data for 2020, I find that approximately 88% of all US banks had assets less than $1.45 billion, and 97% of banks had assets under $10 billion. Thus, my estimation finds economies of scale in the relevant range of the sample I selected, and indeed for nearly 90% of US banks. Though my conclusions may not be applicable to the largest banks, only 3% of the population was large enough to exclude from my sample in 2020. Therefore, my results are applicable to most US commercial banks over the period of my study.

Policy Considerations

My estimation, along with much of the contemporary literature, identifies economies of scale in the US banking industry. Examining UBPR data from 2002 and 2020 reveals that the total number of banks in the United States decreased from about 8500 to about 5100 over this period. Since expansion and consolidation yield dramatic overhead savings, it is likely that American banks will continue consolidating. Regulatory bodies should be aware of the cost efficiency forces acting on the banking industry that promote consolidation, so that future banking policy can account for this behavior.

In the wake of the 2008 recession, much of the rhetoric concerning bank regulation has focused on mitigating the systemic risks posed by financial institutions that have grown “too big to fail” (Cecchetti & Schoenholtz, 2021, pp. 369-370). Though economies of scale promote bank consolidation, assessing the systemic risks posed by such institutions is beyond the scope of an empirical study of bank size. My model explains some of the internal relationships between inputs and outputs that influence bank size but does not explicitly account for how banks interact with central banks or regulators. However, it does explain ways in which banks have interacted with each other over the past twenty years.

Fraser et al. (2011) recognize the limits of assessing mergers in banking, and focus on the welfare effects of mergers over their systemic implications. They identify three aspects by which mergers impact bank customers: relationship banking, market power, and economies of scale and scope (p. 642). They assert that customers may benefit from a merger if it enables banks to lower the costs of financial services, but that these benefits may be cancelled out by increased monopoly power in the industry to the extent that it allows banks to command higher interest rates or require higher levels of collateral (p. 643). They proceeded to analyze how news of large bank mergers affected the stock prices of the merging banks' corporate customers and found that these stock prices decreased in response to news of bank mergers (Fraser et al., 2011, p. 656).

Fraser et al. did not explicitly examine economies of scale. Rather, they examined the welfare effects of consolidation on bank customers. Their focus on stock prices of banks' corporate customers, rather than on the cost structures of the banks themselves, speaks to the weaknesses of extending an empirical analysis such as mine beyond its practical limits. McIntosh (2002), however, recognized the importance of understanding economies of scale in banking when undertaking a welfare analysis of a proposed merger. In an analysis of Canadian bank merger proposals in the late 1990's, he found that empirically unfounded hostile attitudes toward industry consolidation led the Canadian Competition Bureau to reject mergers that were likely to benefit the Canadian public (p. 471). While welfare analysis is methodologically distinct from economies of scale analysis, the work of McIntosh and Fraser et al. underscores the importance of considering economies of scale and efficiency when regulating the banking industry.

My estimation suggests that the Dodd-Frank Act had a negative impact on banks, by increasing their overhead relative to assets. Though fluctuations in asset levels around this time may have skewed the coefficients in my estimation upward, it is nonetheless likely that the Dodd-Frank Act is responsible for increasing banks' overhead through higher regulatory compliance costs. This is because the Dodd-Frank Act restricts banks' business activities and requires that they hold higher levels of capital in reserve, thus reducing their revenue generation capacities (Cecchetti & Schoenholtz, 2021, p. 387). Though my estimation may overstate the accounting costs of compliance due to the way overhead is measured, my model completely omits the opportunity cost of complying with more burdensome regulations. Thus, it is possible that my estimation understates the true costs of complying with the Dodd-Frank Act.

Conclusion

The United States banking system is complex, and analysis of UBPR data reveals that it has consolidated in recent years. While there is an abundance of economics literature that examines economies of scale in banking, many studies are conducted with highly restricted samples. By examining a wide sample of commercial banks under $10 billion from 2002-2020, I find economies of scale in the relevant size range, a downward trend in overhead costs over the time period and increases in overhead during the recession and after the Dodd-Frank Act passed. Studies such as McIntosh and Fraser et al. emphasize the importance of considering economies of scale in banking regulation, while acknowledging its limits. Though my estimation suggests that passing regulations as broad in scope as the Dodd-Frank Act will negatively impact cost efficiency in banking markets, assessing economies of scale is a starting point for effectively assessing the potential impacts of a regulatory policy.

Appendix

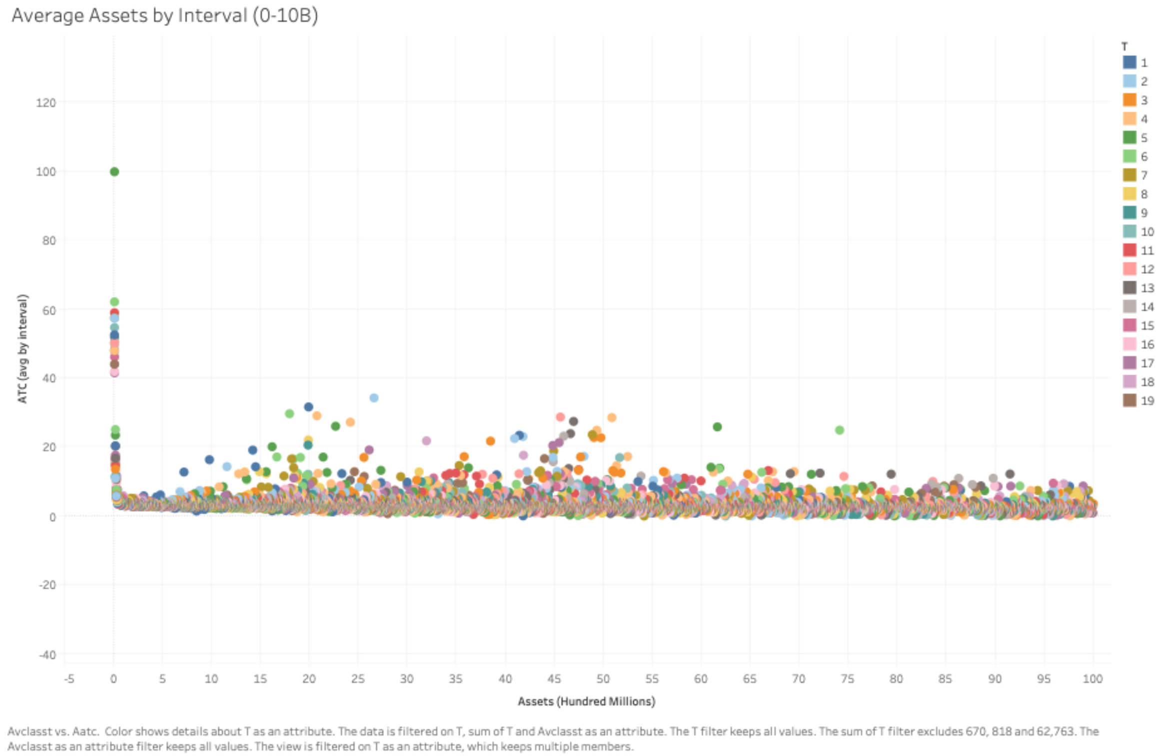

Figure I: A visualization of sample data, produced in Tableau ® Desktop 2021.3

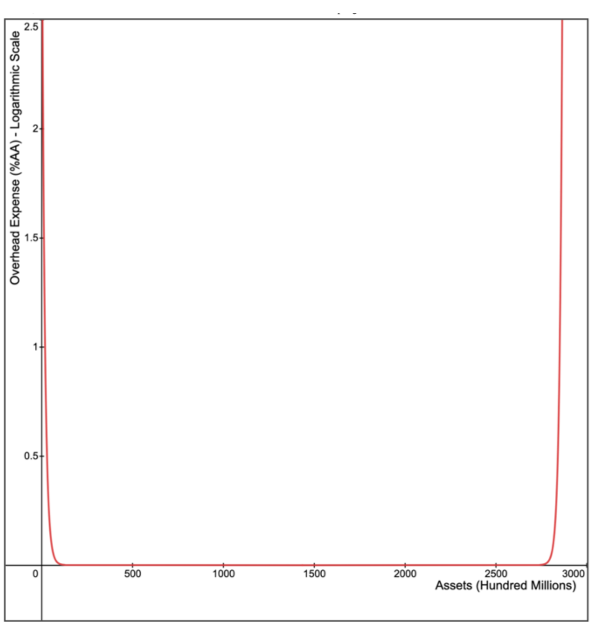

Figure II: A graph of the estimation (Table II), produced in Desmos

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