Incentive Compensation, Accounting Discretion and Bank Capital

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September 25, 2010

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Abstract

This paper examines the impact of the U.S. banking agencies' recent guidance on incentive compensation on efforts to have banks build countercyclical capital buffers that can absorb losses during periods of economic weakness. The connection arises from the impact of the compensation guidelines on bank senior manager's incentive to engage in earnings management. The results suggest that the parts of the guidance related to accounting earnings based compensation create earnings management incentives that support the building of countercyclical capital buffers. However, the parts that encourage the payment of compensation in the form of equity-linked instruments may create occasional incentives for senior managers to reduce capital buffers during periods of higher earnings.

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The financial crisis that began in 2007 sparked a sweeping review of prudential regulatory and supervisory policies in the developed countries with an express goal of acting expeditiously to reduce the probability of future crises. The breadth of issues under consideration and the determination to move quickly has resulted in many of these issues being addressed independent of each other. Yet some of the various reform measures are likely to have unintended consequences for other reform measures. This paper examines one set of unintended potential consequences; the consequences new supervision of bank incentive compensation will have on the effectiveness of measures to make banks build countercyclical capital buffers.

The idea behind countercyclical capital buffers is that banks should increase their buffers for absorbing losses in good times and use these buffers to absorb losses during economic downturns. Much of the policy discussion has related to varying the numerical capital requirements over the business cycle with higher requirements during boom times than during periods of weakness. Policymakers, however, have recognized that another way of building such a buffer would be by building up the loan loss allowance during good times and allowing it to drop during weakness. What is perhaps less well recognized is that earnings management through discretionary accounting policies can have the effect of building up or reducing buffers. For example, if a bank is using earnings management to smooth reported earnings it will under-report earnings and capital during good periods and over-report earnings (and possibly capital) during periods of economic weakness.

Whether and how senior bank managers engage in earnings management will depend crucially on the impact of reported earnings on their incentive compensation (IC). Bank IC has become a topic of considerable interest to bank supervisors since the crisis, in large part due to

concerns that poorly structured IC systems encouraged banks employees (including senior managers) to take excessive risk. In July 2010, the Board of Governors et al. (2010) set out supervisory expectations with regards to bank IC systems for employees that can take material risk. In most cases the Board of Governors et al. (2010) provides only general recommendations and lets banks decide how to implement the recommendations. However, the Board of Governors et al. (2010) lays out more specific expectations with respect to senior executives at large banking organizations. To the extent the Board of Governors et al. (2010) changes the way senior managers are compensated, it has the potential to impact the way in which these managers exercise their accounting discretion to manage reported earnings.

In order to analyze the impact of the Board of Governors et al. (2010) on the use of accounting discretion, this paper decomposes IC into the part whose value depends upon reported earnings and the part that depends upon the stock market's valuation of the firm. The part of IC that depends solely on reported earnings is analyzed in a two period model that allows for three types of IC: fixed bonuses for achieving a target, variable bonus for exceeding the target and a variable penalty for missing the target. As shown below, the Board of Governors et al. (2010) may also impact the timing of payments which is incorporated into the model via discount rate applied to future payments.

The part of IC that depends on the market's valuation of the firm is important because the guidance encourages banks to pay senior executives IC in the form of equity linked instruments. Both theoretical and empirical evidence suggests that earnings management may impact a firm's stock price implying that to the extent the Board of Governors et al. (2010) results in the greater use of equity linked compensation, it may also impact earnings management.

The results suggest that parts of the Board of Governors et al. (2010) guidance dealing with the amount and timing of incentive compensation paid to senior executives at large, complex banks is likely to work to reinforce the goals of countercyclical capital requirements. However, other provisions in the guidance that encourage the payment in equity linked instruments may work to amplify volatility around the times bank senior executives convert the instruments to cash. The net effect may be to dampen earnings volatility and create countercyclical capital buffers most of the time but to increase volatility and reduce capital buffers around the time senior management plans on selling substantial fractions of its shares.

The next three sections of the paper lay the ground work by discussing countercyclical capital, incentive compensation, and accounting discretion. The fourth section analyzes the impact of the accounting earnings based portions of Board of Governors et al. (2010) on earnings management and capital. The fifth considers the equity compensation portion and its implications for earnings management and capital. The paper concludes with summary remarks.

1. Countercylical capital

The Basel Committee on Banking Supervision (BCBS) (2010, p. 2) gives as the primary aim of countercyclical capital that of protecting the banking sector from "periods of excess aggregate credit growth." An effective countercyclical capital policy would accomplish three benefits according to BCBS (2010). First, it would help insure that banks remain solvent during periods of stress. Second, it would help ensure that the banking system has sufficient credit to maintain the flow of new lending to the economy during periods of stress. Third, it would also help damp the excess growth of credit during good times.

The most direct way to establish regulatory capital requirements that vary through the business cycle with higher requirements during periods of economic strength and lower requirements during periods of weakness. This is the approach taken by BCBS (2010).

Another, not mutually exclusive, way of building capital buffers during good times is to require banks to have higher allowances for losses during the good times and use this build-up to reduce required provisions during economic weakness. The focus of this way of building capital buffers is on the loan loss allowance, albeit the same principle could be applied to other loss allowances. Wall and Koch (2000) note proposals to build up loan loss allowances during good times are consistent with the way bank supervisors think about loan losses, that bad loan portfolios are created during good times and are merely revealed as such during economic downturns. However, Wall and Koch (2000) also note that the accounting authorities view this approach as allowing banks to smooth their reported net income and mask the true variability in the firm's earnings. While the U.S. accounting and bank supervisory authorities have debated the correct approach to loan loss provisioning, the Bank of Spain's dynamic provisioning system effectively required its banks to take higher provisions during good times prior to the recent crisis.[1]

While some accounting requirements may be structured to provide countercyclical buffers to absorb losses, other accounting requirements may also create procyclical movements in capital. For example, reporting financial assets at their fair value (the accounting approximation of market value) is likely to lead to the reporting of more capital in periods of increasing asset values and less capital in periods of falling values than would be the case if values are reported at their amortized cost.

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[1] Saurina (2009) makes the case for the Bank of Spain's provisioning policies as a macroprudential tool and Balla and McKenna (2009) simulate its application using U.S. data. See also Caprio (2010) and Carbó-Valverde and Rodríguez-Fernández (2010) for an analysis of dynamic provisioning policies.

In addition to creating countercyclical or procyclical buffers through required financial accounting procedures such as loan loss accounting, the level of buffers may also be significantly influenced by the use of managerial discretion in financial accounting. The use of managerial discretion to smooth earnings will tend to produce countercyclical capital requirements similar to Spain's dynamic provisioning. Managers that smooth earnings will reduce reported earnings, asset values and capital during good times which will build a buffer to absorb future losses. This buffer is then drawn down during periods of weak performance to increase reported earnings. Thus, for any given level of reported capital during economic good times, the bank will have a larger economic buffer to absorb losses during periods of negative earnings. Conversely the use of discretion to boost short-run earnings during good periods will tend to make the buffers more procyclical. That is, for any given level of reported capital during good economic times, the bank will have a smaller economic buffer with which to absorb losses.

An important difference between the effect of accounting requirements and accounting discretion is that buffers due to earnings smoothing would not necessarily be readily observable to third parties and thus cannot be easily incorporated into regulatory capital requirements. Another important difference is that the amount of such buffers would be under the control of the banks' managers and not the supervisors. Nevertheless, the effect of banks' earnings management on capital buffers is no less real than cyclically varying regulatory requirements or dynamic provisioning.

2. Incentive Compensation

The compensation contract of senior managers at banks virtually always contain clauses that adjust the amount of the compensation up or down based on their personal performance and

that of their firm.[2] Typically these incentive compensation (IC) provisions are justified as ways to encourage the senior managers to increase their bank's value. However, the terms under which the IC is paid to the senior managers may also encourage the senior managers to take actions which will not increase long-run shareholder value. For example, bonuses based on accounting earnings may encourage the senior managers to use accounting discretion to report higher earnings. Similarly, the use of stock options as an incentive compensation tool may incent senior managers to have their bank take more risk than is optimal for shareholders.

This section begins with a general discussion of different types of IC, focusing on those types with implications for reported net earnings. The second subsection considers how these structures may influence risk taking decisions by senior management and reviews the limitations on senior managers IC set out by the Board of Governors et al. (2010).

2.1 Alternative incentive compensation structures

While firms may pay incentives based on a variety of measures, the measures most relevant to reported capital levels are incentives based on measures of accounting profits. Murphy (1998, 2001) examined CEO incentives contracts across a wide range of industries and found that "almost all companies rely on some measure of accounting profits." This is especially so for the financial and insurance firms in his sample where (almost) all of the firms used earnings or EBIT.[3]

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[2] The set of senior managers that may influence financial accounting certainly includes the chief executive officer, CEO, but may also include other senior managers. For example, Jiang, Petroni, and Wang (2010) finds evidence that the chief financial officer, CFO, may exercise more influence over accounting discretion than the CEO. For our purposes, which senior manager or managers in a firm have control over the exercise of accounting discretion is unimportant. The potential methods of compensation and the limitations set by the Board of Governors et al. (2010) do not distinguish among the different senior officers.

[3] The ambiguity in Murphy (1998, Table 2) about the proportion of firms using earnings or EBIT (earnings before interest and taxes) arises in part because one firm relied solely on discretionary measures which may (or may not) include earnings and in part because of the way the data are summarized for the firms using two or more measures. Murphy (2001, Table 1) summarizes the same information but provides a little less detail.

The relationship between earnings and incentive payouts could in principal take a variety of forms. Murphy (1998) finds that CEO compensation typically takes the form of salary plus positive bonuses for achieving various objectives. Firms in his sample often times did not pay a bonus until the CEOs performance exceeded some threshold. After exceeding the threshold, the CEO obtains a threshold performance bonus about one-half of the time. In addition, after exceeding the threshold, the CEO often receives a variable bonus that increases in the firm's performance. Often this variable bonus is capped so that earnings above some level do not cause an increase in the bonus.

In principal, firms could also impose penalties in the form of reduction in salary or a taking back of past bonuses.[4] These appear to have been rare at the time of Murphy (1998, 2001) with no mention of penalties, clawbacks or malus. However, with the adoption of the Sarbanes Oxley Act in 2002, CEOs at publicly traded companies are vulnerable to clawbacks if as a result of misconduct a restatement was necessary because of material noncompliance with financial reporting requirements under federal law.[5]

Another way to incent CEOs to boost shareholder value is to provide them with their company's stock or options. Often times these grants are restricted and are not available for sale until sometime after the grant. The amount of these grants could be related to the firm's performance, albeit the size of the grants in Murphy's study do not appear to be determined by performance. Even if the number of shares or options is not tied to the firm's performance, the value of the grant will depend on the investors' perceptions of the firm's past and future performance.

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[4] The penalties could take the form of requiring reimbursement of bonuses already paid out (called clawbacks) or in the case of deferred bonuses it is possible to vest less than 100 percent of the original grant (called malus).
[5] Public Law 107-204.

2.2 Interagency guidance

The structure of a banks IC system may incent him to take more risk. For example, the market value of stock options granted the senior managers are increasing in the variance of the firm's stock returns. That compensation structure may play an important role in bank risk taking is supported by a survey published by the Institute for International Finance (2009) in which 98 percent of the large international banks participating in a survey agreed that compensation structures were a factor in the financial crisis of 2007 and 2008.[6] In response concerns that IC helped cause the crisis, the G-20 Leaders (2009) in effect called for its members to adopt Financial Stability Forum (2009) and Financial Stability Board (2009) statements related incentive compensation principles and implementation of the principles. The Board of Governors et al. (2010) emphasizes the importance of compensation arrangements that balance risk and financial results for all employees that can take material risk. Importantly, the guidance emphasizes the need to tailor the arrangements to range and time horizon of risks that may be taken by the employee. The guidance also calls for reduced sensitivity to short-term performance as the employee achieves higher levels of performance.

The Board of Governors et al. (2010) is mostly guidance that leaves the decision on how best to achieve balanced incentives for most employees to each bank. However, for the senior executives at large, complex banking organizations, Board of Governors et al. (2010, p. 33) provides firmer direction about what is required to achieve balance. The Board of Governors et al. (2010) notes that senior executives make a variety of decisions that are not easily captured by reliable quantitative measures and the use of ex ante measures to risk adjust their rewards is

[6] One limitation of this finding for our purposes is that the survey does not specifically address the question of whether senior management compensation was a significant factor. Nevertheless, the finding of widespread industry agreement that compensation was a problem gave additional support to efforts to increase supervision of bankers' IC.

unlikely to provide balance. The guidelines instead recommend that the incentive compensation be spread over multiple years or that performance be measured over multiple years. It further states that balance is more likely to be achieved if the payments are made in the form of equity based instruments where a substantial portion would vest over a several year period and where the amount of instruments ultimately received depends on the bank's performance.

The Board of Governors et al. (2010) have several implications for the design of senior management compensation at large banking organizations. The general call for reduced sensitivity to short-term performance at the higher range of performance is certainly consistent with, albeit does not absolutely require, that banks impose a cap on the bonus payments to senior managers. Second, the Board of Governors et al. (2010) calls for deferred payments that vest over several years with the amount actually vested depending upon performance. The call for penalties for poor performance is a significant change from Murphy (1998, 2001) where performance based penalties was so rare as to not merit substantial discussion. Additionally, the call for the penalties to be based on poor performance in subsequent years would give CEOs an incentive to consider the impact of earnings management on the banks' ability to hit future performance targets—possibly even targets in the years after the CEO retires. Third, the recommendation that CEOs be paid in equity linked instruments may increase the proportion of IC paid in equity.

3. Accounting Discretion and earnings management

The variety of methods by which senior manager can use to raise or lower their bank's reported net income fall into three broad categories: accounting discretion, real earnings management and accounting fraud. Each of these comes with its own set of advantages and disadvantages.

Accounting discretion exists because the financial statements of firms under U.S. generally accepted accounting principles (GAAP) require a number of discretionary decisions over the choice of accounting methods and the valuation of each firm's assets. Management is able to exercise this discretion because a firm's financial statements are the representations of the management, with the role of the auditor to attest that the statements were prepared in accordance to GAAP. Thus, wherever GAAP requires judgment; the financial statements reflect managements' decisions subject to the auditors agreeing that the decisions fall within the bounds set by GAAP. The use of accounting discretion to manage earnings has the important advantage that it does not adversely impact the firm's cash flows—except, of course, for any intended impact on the payment of IC.[7] However, reliance on discretion also has the important limitation that the maximum amount of earnings management is constrained by the range of discretion permitted under GAAP by the bank's auditor

Real earnings management arises when a firm makes operating decisions based on their current impact on reported earnings at the cost of reducing the net present value of the firm's cash flows. Classical examples of real earnings management are reducing research and development, and deferring maintenance to boost current earnings. A possible example for a large bank is that of deferring the expenses associated with integrating and updating legacy information technology systems. The advantage of this approach is that provides additional scope for earnings management when the mere exercise of accounting discretion is insufficient. The disadvantage is that it will have adverse impacts on the firm's future cash flows.

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[7] Cash flow may also be impacted by taxes to the extent that discretionary choices for financial reporting must also be used for tax accounting.

Accounting fraud exists when the firm decides to report its results in a manner that is materially inconsistent with GAAP. Notable examples of accounting fraud include Enron and WorldCom. Recent examples in the area of financial institutions include Fannie Mae and Freddie Mac, both of which chose to continue using hedging accounting without following the requirements for hedge accounting adopted by the Financial Accounting Standards Board (1998) as Financial Accounting Statement 133 (FAS 133).[8] The use of accounting fraud requires that the actions either be hidden from the firm's auditors or the auditors must agree to go along with the fraud. The advantage of accounting fraud is that it permits larger adjustments in reported net earnings than would be possible with accounting discretion and real earnings management. The disadvantage of engaging in fraud is that there can be substantial penalties if the fraud is detected.

The following subsections gives some examples of the discretionary accounting decisions made by banks, the theory on the use of earnings management and the empirical analysis of earnings management at financial firms. The focus of this discussion will be on the use of accounting discretion, earnings management which imposes no costs on the firm but for which the range of possible management is limited by GAAP. However, some theoretical and empirical papers that are important for our purposes either do not distinguish the type of earnings management or explicitly consider earnings management methods that are costly in expected value terms.[9]

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[8] See Jickling (2005a, 2005b) for a discussion of Fannie Mae and Freddie Mac's accounting problems.

[9] For example, some studies assume that increased earnings management are associated with higher expected costs which is more consistent with real earnings management and accounting fraud.

3.1 Accounting discretion

The managers of firms are given some discretion in their choice of accounting techniques, in principal so that they can use methods that best fit the business model of the firm. Common choices that are important for non-financial firms include the choice of depreciation method (straight line versus accelerated) and of the method of inventory accounting (FIFO versus LIFO). An important choice that banks must make for securities on an individual basis at the time of acquisition is bank's willingness to sell the security. The accounting standards set out by Financial Accounting Standards Board's *Accounting Standards Codification* (ASC) 320-10-25 list three possibilities for securities: trading account, available for sale (AFS) and held to maturity (HTM).[10] ASC 320-10-35 describes how their value should be measured subsequent to acquisition. [11] Securities classified as a trading account asset must be accounted for at fair value with any gains or losses accounted for through net income. The accounting is more complicated for securities classified as an AFS or HTM. Gains or losses on AFS securities are included in shareholder equity, but they may be reported as an element of net income and/or as an element of other comprehensive income depending upon the circumstances. Securities that are classified as HTM are reported at amortized cost unless the security suffers other than temporary impairment, in which case the losses will be recognized in net income and/or in other comprehensive income depending upon the circumstances.

The ability to select the classification of a security for accounting purpose can be an important discretionary power. In periods of rising securities prices, fair value gains on trading

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[10] The ASC are available on-line (after registration) at http://asc.fasb.org/ (accessed September 16, 2010).

[11] Heretofore, U.S. GAAP was established by a series of pronouncements that dealt with individual topics, such as Financial Accounting Statement Board's (FASB) statement 133 on derivatives. In 2010 the various pronouncements were restructured into a single document called FASB Accounting Standards Codification.

account and AFS securities are recognized in capital, whereas gains on HTM securities would ordinarily not be recognized. Conversely, during the recent crisis banks were forced to recognize losses on securities held in the trading account even if management believed the decline in value was due solely to temporary drop in market liquidity. In contrast, management was not obligated to lower its valuation of securities in the HTM category if it believed the drop was temporary and it expects to hold the security to maturity.[12]

ASC 320-10-25 provides banks with some ability to change the categorization of a security. However, this ability is constrained by various provisions that restrict management's ability to recategorize securities for earnings management purposes. One of the most powerful of these constraints is that the sale of a HTM security (which would require the immediate recognition of a gain or loss) may trigger the need to reclassify all HTM securities as available for sale under ASC 320-10-35-9.

Managers also exercise discretion is through their control of the valuation of illiquid securities and through the estimation of credit losses on loans. An important factor in the valuation of securities is the determination of their fair value, which ASC 820-10-35-2 defines as the "price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date." ASC 820-10-20 defines three "Levels" of information for measuring fair value. The preferred form of measurement is to use Level 1 inputs, the price of an identical liability traded in an active market. However, many liabilities are not traded in an active market in which case Level 2 and/or Level 3 inputs are necessary. Level 2 inputs are inputs "other than quoted prices included within Level 1 that are observable for the asset

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[12] ASC 320-10-35 does provide some criteria that must be followed in determining whether the loss is other than temporary, including the length of time and the extent to which amortized cost is above fair value.

or liability, either directly or indirectly," and Level 3 inputs are "unobservable inputs for the asset or liability." If Level 1 inputs are not available, firms are obligated to use Level 2 inputs rather than Level 3 inputs where possible. Level 2 and Level 3 inputs would be fed into valuation models. Management has some discretion both in its choice of valuation models, and for Level 3 inputs, on the value of the inputs. Critics sometimes deride securities valued using Level 3 inputs during the crisis as being "marked to myth."

The other large asset category in bank's portfolios is loans which are ordinarily carried at amortized cost. However, ASC 450-20-25-2 requires that firms make provisions for possible losses when information available before the financial statements are issued "indicates that it is probable that an asset had been impaired … at the date of the financial statements," and "The amount of loss can be reasonably estimated." Although GAAP sets out procedures for determining whether it is probable that an asset has been impaired and the amount of the impairment, significant discretion must be exercised in both determinations. Over time, some banks have gained a reputation for conservative loan valuations that seek to recognize the maximum allowable losses at the earliest possible date. Other banks have developed a reputation for not being so conservative.

3.2 Earnings management theory

Compensation contracts contain incentives intended to induce senior managers to take hidden actions that will maximize shareholder value. One set of important measures of firm value creation are the earnings of the firm. The only verifiable measures that outsiders receive are the accounting earnings prepared in accordance with GAAP. Yet as discussed above, there are a variety of ways in which GAAP earnings may be managed. Crocker and Slemrod (2007) show

that in this setting, it is not possible to design a contract that both incents managers to maximize shareholder value and incents them to report profits honestly.[13]

Murphy (1999, 2001) finds that IC contracts frequently contain fixed bonus for attaining some threshold. Degeorge, Patel and Zeckhauser (1999) show that fixed bonuses generally induce CEOs to smooth income in a two period model. In the first period, the CEO uses discretion to reduce reported earnings relative to latent earnings if latent earnings exceed the threshold and raises earnings up to the threshold if possible. However, in their model it is possible for first period earnings to fall so far short that attaining the threshold is impossible. In this case, their model predicts the CEO will forgo any effort to reach the threshold, and instead reduce reported earnings relative to latent earnings in what Degeorge, Patel and Zeckhauser's (1999, p. 12) label as "Saving for a better tomorrow." This "saving" gives the CEO additional discretion to meet the earnings target in the second period.

Healy (1985) incorporates both a fixed bonus for attaining a threshold and variable bonus for exceeding the threshold that is capped above some level. The addition of the capped variable bonus creates a high and low threshold. If latent earnings exceed the upper threshold, discretion is used to exactly reach the cap if possible and to reduce earnings to the maximum extent possible if earnings exceed the cap amount by more than the available discretion. If latent earnings fall short of the lower threshold, if the reported earnings can reach the threshold then CEO uses maximum discretion to reach or exceed the threshold if possible. If the threshold cannot be reached the CEO uses maximum discretion to reduce current period earnings to save for tomorrow, which Healey

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[13] Recent papers by Goldman and Slezak (2006) and Sun (2009) analyze the implications of the potential for earnings management on the optimal structure of IC. The focus of these papers is on a tangent from the purpose of this paper which is to analyze the impact of supervisory IC guidance on bank's incentive to engage in activities that smooth and activities that increase the variance of reported net earnings.

(1985) describes as taking "a bath." Healey parenthetically notes that absent a cap, the manager has an incentive to use maximum accounting discretion to boost earnings whenever latent earnings are sufficient to reach the minimum threshold.

Although Murphy (1999, 2001) does not discuss penalties for missing earnings targets in IC contracts, CEOs are nevertheless subject to the large fixed penalty of being fired. Fudenberg and Tirole (1995) consider the case of a divisional manager that is subject to being fired for failing to attain an earnings target. Their results are generally consistent with that of a fixed bonus in that the fixed penalty creates an incentive to smooth earnings. The one difference in Fudenberg and Tirole (1995) is that if the manager cannot reach the minimum threshold for retaining his job, the decision to use accounting discretion is moot.

Ownership of equity is another major motivating factor for CEOs. Murphy (1999, 2001) finds that stock and option grants are common in his sample of major firms. The potential wealth gain due to higher prices when liquidating these stock and options provide a strong incentive to maximize the market's expectation of future earnings, both by improving the firm's performance and by managing the firm's accounting earnings. Equity analysts and sophisticated shareholders are well aware of the likelihood that a firm is managing its reported earnings. Nevertheless, managers may be able to influence stock valuations given that investors are unable observe actual amount of earnings management.

Stein (1989) develops a model in which management takes as given investors conjectures about the extent of earnings management. In this setting, earnings manipulation produces a one-for-one increase in investors' perception of the firm's latent earnings in the steady state. In equilibrium, management has an incentive to engage in value reducing real earnings management

up to the point where the marginal value of the increase in the stock price equals the marginal discounted cost of lower earnings in future periods.

3.3 Earnings management evidence in banking

A number of empirical papers have sought evidence of earnings management on the part of banking organizations. This literature is only loosely related to the theoretical earnings management literature because important details in senior managers' compensation contracts are rarely revealed. As a substitute for compensation contracts, many studies analyze the use of earnings management to help meet supervisory capital adequacy requirements.

Wall and Koch (2000) review the results of six studies of bank earnings management, especially through the management of loan loss provisions. The papers they survey consistently found evidence that estimates of discretionary loan loss provisions and other earnings management tools are related to bank capital levels. Some of the papers also found evidence that discretionary provisions were related to earnings management but others failed to find a statistically significant relationship. A more recent study by Adams, Carow and Perry (2009) found evidence that mutual savings banks engaged in earnings management prior to their initial public offering (IPO) to drive down the price managers paid for their stock purchases when the savings bank converted to stock ownership.

Dechow, Myers and Shakespeare (2009) examine the firm's fair value estimates made in connection with securitized assets. They note that sponsors must estimate the fair value of their retained interest in securitizations. These estimates depend in part on the assumptions about the revenant likelihood of default, prepayment rates, and appropriate discount rates. They find evidence that these assumptions were chosen to smooth earnings, with high gains reported the firm would otherwise have low reported earnings and vice versa. Fietcher and Meyer (2010) analyze

unrealized gains on securities valued using Level 3 information. They find evidence that banks with poor pre-managed earnings during the period from 2008 Q1 to 2009 Q1 were using their discretion in valuing the Level 3 securities to report even larger losses or "take a big bath." Consistent with earnings management, the firms with negative pre-managed earnings subsequently show positive pre-managed earnings in future periods.

4. Compensation based on accounting income

This section analyzes the impact of the Board of Governors et al. (2010) impact accounting capital on earnings management by banks. The four subsections below use a two period model to analyze how the structure of IC changes incentives to engage in earnings management. The first subsection considers the various ways in which a manager's compensation may depend on the firm's reported earnings. The next two subsections analyze special cases in which the manager must attain the time t reported earnings target and when the manager cannot attain the time t reported earnings target, respectively. Subsection 4.4 builds on the first two parts to consider how different parts of the compensation function influence the manager's choice of accounting discretion. The last subsection uses the findings of subsection 4.4 to evaluate the impact of the Board of Governors et al. (2010).

4.1 Model

A risk neutral manager with a positive rate of time preference, r, runs the firm. The firm realizes its latent earnings at two dates, t = 1, and 2. Immediately after the end of the period the manager observes the true value of the firm's underlying or latent earnings, LE_1 and LE_2. The auditor then informs the manager of the range of acceptable accounting discretion.

$$-MAXDA \leq DA \leq MAXDA$$

where

MAXDA = maximum amount of discretionary adjustment that may be made by the manager.

DA = amount of discretionary adjustment actually made by the manager.

Next the manager selects the amount of accounting discretion to include in reported earnings and announces reported earnings. Reported earnings in period *t* are latent earnings adjusted for net accounting discretion (AD). At time 1, the adjustment takes the form of adding discretionary adjustments to latent earnings. At time 2, the discretionary adjustments are assumed to be reversed out of earnings.

$$RE_1 = LE_1 + DA,$$

and

$$RE_2 = LE_2 - DA,$$

where

RE_t = reported earnings at time *t*.

Reversing out discretionary adjustments in the second period is a simplified way of operationalizing the assumption that current discretionary adjustments constrain future discretionary adjustments.[14]

The use of accounting discretion is influenced by the manager's IC contract. The board of directors authorizes the manager to receive a salary, normalized to zero, and a bonus payment at times 1 and 2, BP_t, which is a function of the relationship between the target earnings, TE_t, set by

[14] If discretionary adjustments at time 1 are negative, the subsequent recovery of the adjustment into time 2 income recognizes that negative adjustments in one period provide a sort of hidden capital which will be taken back into income in a subsequent period. If discretionary adjustments at time 1 are positive, subtracting that adjustment from time 2 income recognizes that firms have reduced discretion to boost earnings in future periods.

the board of directors and RE_t. Although target earnings may differ between periods 1 and 2, the other terms of the bonus function are assumed to be the same in both periods:

$$BP(RE_j) = FB + VB(RE_j - TE_j) \qquad \text{if } RE_j \geq TE_j, \text{ and}$$

$$BP(RE_j) = -VP(TE_j - RE_j) \qquad \text{otherwise,} \qquad (1)$$

With

$j = 1,2$

$FB, VB, VP \geq 0.$

where

FB = fixed-bonus payment,

VB = variable-bonus rate, and

VP = variable-penalty rate.[15]

4.2 Firm is constrained to attain the reported earnings target

Assume that latent earnings at time 1 are sufficiently high so that the firm will attain its time 1 earnings target for any value of DA_1 that lies within the bounds set by the auditors. That is,

$LE_1 - MAXDA > TE_1$.

In this case the manager's problem is:

$$\max E(ME) = \max \begin{pmatrix} FB + VB(RE_1 - TE_1)) \\ -\dfrac{1}{1+r}\displaystyle\int_{-\infty}^{TLE} VP(TE_2 - RE_2)\, p(LE_2)\, dLE_2 \\ +\dfrac{1}{1+r}\displaystyle\int_{TLE}^{-\infty} (B + VB(RE_2 - TE_2))\, p(LE_2)\, dLE_2 \end{pmatrix} \qquad (2)$$

[15] The inclusion of a variable penalty for missing the earnings target seems inconsistent with the manager earning a fixed salary. One way of interpreting this penalty would be that the probability that the manager would be fired is an increasing function of the amount by which the firm misses its earnings target.

with

$TLE = TE_2 + DA$

subject to:

$-MAXDA \leq DA \leq MAXDA$

where

ME = discounted value of managerial earnings.

TLE_2 = latent earnings required to obtain the target for reported earnings at time 2.

If an interior solution exists, it must satisfy the following condition:

$$\begin{aligned}\partial E(ME)/\partial DA = VB - \left(VP/\left(1+r\right)\right)&\left[\begin{array}{l}\int_{-\infty}^{TLE} p(LE_2)dLE_2 + \\ (TE_2 - LE_2 - DA)\,p(TLE_2)\end{array}\right] \\ -\left(1/\left(1+r\right)\right)&\left[\begin{array}{l}\int_{TLE}^{\infty} VB(p(LE_2))dLE_2 + \\ \left(FB + VB\left(LE_2 + DA - TE_2\right)\right)p(TLE_2)\end{array}\right] \\ = 0\end{aligned} \tag{3}$$

where the value of DA must also satisfy the constraints on DA's minimum and maximum values. The first term in equation (3) is the increase in the time 1 variable bonus resulting from an increase in DA. The second term is the decrease in expected time 2 compensation resulting from the increase in DA causing a increase in the expected penalty, including both the increased value of the penalty if it occurs and the increase in the probability of paying a penalty. The third term is the reduction in expected value of the time 2 bonus, again resulting from both a reduced expected variable bonus and a reduction in the probability of receiving the fixed and variable bonuses.

A value for *DA* may exist that satisfies this condition within the constraints, but nothing in the structure of the problem guarantees such a result. The derivative could take on a positive or negative value for all permissible values of *DA*.

4.3 Firm is constrained to miss its reported earnings target

A second case is that in which latent earnings at time *t* are sufficiently low so that the firm will not be able to attain its time 1 reported earnings target for any value of *DA* that lies within the bounds set by the auditors and regulators. That is, assume

$LE_1 + MAXDA < TE_1$.

In this case, the manager would maximize

$$\max E(ME) = \max \begin{pmatrix} VP(RE_1 - TE_1) \\ -\dfrac{VP}{1+r}\displaystyle\int_{-\infty}^{TLE} (TE_2 - RE_2)\, p(LE_2)\, dLE_2 \\ +\dfrac{1}{1+r}\displaystyle\int_{TLE}^{\infty} \left(FB + VB\left(RE_2 - TE_2\right)\right) p(LE_2)\, dLE_2 \end{pmatrix} \tag{4}$$

subject to:

$-MAXDA \le DA \le MAXDA$.

If an interior solution exists, it must satisfy the condition that

$$\begin{aligned} \partial E(ME)/\partial DA = VP - \left(VP/\left(1+r\right)\right) & \begin{bmatrix} \displaystyle\int_{-\infty}^{TLE} p(LE_2)\, dLE_2 + \\ (TE_2 - LE_2 - DA)\, p(TLE_2) \end{bmatrix} \\ & -\left(1/\left(1+r\right)\right) \begin{bmatrix} \displaystyle\int_{TLE}^{\infty} VB(p(LE_2))\, dLE_2 + \\ \left(FB + VB\left(LE_2 + DA - TE_2\right)\right) p(TLE_2) \end{bmatrix} \\ = 0 & \end{aligned} \tag{5}$$

where the value of *DA* at this point must also satisfy the constraints on *DA*'s minimum and maximum values. The first term is the decrease in the variable penalty associated with an increase

in *DA*. The second term represents the increase in the expected amount and probability of the variable penalty at time 2. The third term represents an decrease in both the expected amount of the variable bonus, as well as an increase in the probability of receiving the fixed and variable bonuses.

Equation (5) may be zero for some value of *DA*, but such a result is not guaranteed. However, as is the case where the manager is guaranteed a time 1 bonus, the derivative may be either strictly positive or strictly negative for all values of *DA*.

Thus, we do not necessarily obtain the result that the firm will always engage in income smoothing. The problem is that the time 1 variable bonus and penalty may be strictly greater than or less than the expected net present value of the time 2 bonus and penalty. Whether time 1 or time 2 considerations dominate depends on four factors. First, the discounting for the value of time makes payments made at time 1 more valuable than comparable payments at time 2. This tends to make the derivative positive encouraging the firm to make a larger discretionary adjustment at time 1. Second, a decrease in the probability of obtaining the fixed bonus at time 2 tends to make the derivative negative. The reduction in the probability of a 2 bonus encourages the firm to take a smaller discretionary adjustmen at time 1. The third factor is the effect of *DA* on the probability that the firm will attain its time 1 target. Finally, the time consideration depends on the relative magnitudes of the marginal variable bonus, *VB*, and marginal variable penalty, *VP*.

4.4 Analysis of the elements of the compensation function

The previous two sections present special cases that may be combined to analyze the impact of the three compensation parameters (*FB, VB* and *VP*) and the manager's rate of time discount. The impacts of these parameters are addressed in a setting that allows for the possibility

that the manager's choice of *DA* determines whether the firm will attain its time 1 earnings target, that is,

$$MAXDA \geq |LE_1 - TE_1|.$$

The solution procedure in this case involves solving for the value of *DA* that maximizes managerial earnings in equations (2) and (4) subject to appropriate boundary conditions. First, the manager would solve for the value of *DA* that maximizes the value of managerial earnings if the firm attains the time 1 earnings using equation (2) and subject to:

$$LE_1 + DA \geq TE_1$$

$$-MAXDA \leq DA \leq MAXDA\ .$$

The manager would then solve for the value of *DA* that maximizes the value of managerial earnings if the firm does not meet its time 1 earnings target using equation (4) and subject to:

$$LE_1 + DA \leq TE_1$$

$$-MAXDA \leq DA \leq MAXDA\ .$$

This would yield two candidates for the value of *DA* that maximizes the discounted value of managerial earnings. The manager would select whichever value is greater.

4.4.1 One period model with infinite discount rate

The first of the four parameters in the accounting model is the discount rate that senior managers apply to future earnings as a way of incorporating planned retirement where the CEO would receive no future bonuses. The marginal variable bonus and penalty coefficients are allowed to be positive, VB, $VP > 0$.[16]

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[16] It can easily be seen that making *FB* also take a positive value will not change the conclusions of this proposition.

Proposition 1. If the parameters of the manager's compensation function take the values *VB, VP* > 0, *FB* = 0, and *r* = ∞, the manager optimally sets DA = MAXDA.

Proof:

Consider three cases:

A. $LE_1 \geq 0$. Plugging the assumed parameter values into equation (3) yields:

$$\partial E(ME) / \partial DA = VB > 0 \tag{6}$$

The manager may maximize his current period's bonus by setting the highest possible value of *DA*, -*MAXDA*.

B. $LE_1 \leq -MAXDA$. Plugging the assumed parameter values into equation (5) yields:

$$\partial E(ME) / \partial DA = VP > 0 \tag{7}$$

The manager may minimize his current period's penalty by setting the highest possible value of *DA*.

C. $-MAXDA < LE_1 - TE_1 < 0$. The manager may eliminate his penalty by setting $DA = LE_1$. He may then maximize his bonus by using the rest of his discretion to set $DA = MAXDA$. .

Thus, the manager always benefits from $DA = MAXDA$. QED.

4.4.2 Positive variable penalty

A positive variable penalty with no fixed or variable bonus will induce the manager to use accounting discretion to try to minimize the gap to the time 1 earnings target.

Proposition 2. If the parameters of the manager's compensation function take the values *VP* > 0, *VB, FB* = 0, and 0<*r* < ∞ and

$$VP\left(1-\left(1/\left(1+r\right)\right)\int_{-\infty}^{TLE} p(LE_2)dLE_2\right)-VP(TE_2-TLE_2-DA)p(TLE_2)>0,$$

the manager optimally sets *DA* as follows:

A. If $LE_1 + MAXDA \leq TE_1$ then DA = MAXDA

B. If $LE_1 - MAXDA > TE_1$ then $DA = -MAXDA$

C. If $LE_1 > TE_1$ *and* $LE_1 - MAXDA \leq TE_1$ <u>or</u>

if $LE_1 < TE_1$ and $LE_1 + MAXDA \geq TE_1$ then $DA = LE_1 - TE_1$

Proof:

Consider each of the three cases:

A. $LE_1 + MAXDA \leq TE_1$

Plugging the assumed parameter values into equation (5) yields:

$$\begin{aligned}\partial E(ME)/\partial DA_t &= VP-\left(VP/\left(1+r\right)\right)\begin{bmatrix}\int_{-\infty}^{TLE} p(LE_2)dLE_2 + \\ (TE_2-TLE_2-DA)p(TLE_2)\end{bmatrix} \\ &= VP\left(1-\left(1/\left(1+r\right)\right)\int_{-\infty}^{TLE} p(LE_2)dLE_2\right)- \\ &\quad VP(TE_2-TLE_2-DA)p(TLE_2) \\ &> 0\end{aligned} \tag{8}$$

An increase in *DA* has three effects on the expected penalty. First, it directly reduces the expected penalty in the first period. Second, if the manager pays a penalty in the second period then it increases the expected net present value of that penalty. However, conditional on a penalty, the net present value of the expected value of the penalty in the second period is lower than that of the first because it is discounted at a positive discount rate and the second period penalty occurs with a probability of less than one. The third impact of increasing *DA* is that it increases the probability that the firm will bear a penalty. Under the assumptions of Proposition 4A, equation (8) is

negative for all possible values of *DA*. Thus, the manager's value is maximized at *DA* = *MAXDA,* which reduces the absolute difference between reported earnings and target earnings to the maximum extent permitted by the auditor.

B. $LE_1 - MAXDA > TE_1$

Plugging the assumed parameter values into equation (5) yields:

$$\partial E(ME)/\partial DA_t = \left(-VP/\left(1+r\right)\right)\begin{pmatrix} \int_{-\infty}^{TLE} p(LE_2)dLE_2 + \\ (TE_2 - TLE_2 - DA)\,p(TLE_2) \end{pmatrix} > 0 \qquad (9)$$

If latent earnings at time 1 are sufficiently high so that the manager will not incur a penalty for period 1, the only impact of a change in *DA* is on the expected time 2 penalty. A decrease in *DA* reduces both the net present value of penalty if one is incurred and the probability that a penalty will be incurred. Thus, a decrease in *DA* increases the manager's expected wealth for all values of *DA*. Under the condition of proposition 4B, the optimal policy is to set *DA* = -*MAXDA,* which also reduces the absolute difference between reported earnings and target earnings to the maximum extent permitted by the auditor.

C. $LE_1 < TE_1$ *and* $LE_1 + MAXDA \geq TE_1$ <u>or</u> $LE_1 > TE_1$ *and* $LE_1 - MAXDA \leq TE_1$

Consider first the case where time 1 latent earnings are less than target earnings. The results of equation (8) established that if the manager may incur a penalty during time 1, it is always in his interest to set *DA* to minimize that penalty. The point at which the manager will not incur a penalty is to set *DA* so that reported earnings equal or exceed the target earnings at time 1. Yet if reported earnings equal target earnings, equation (9) shows that any further increase in reported earnings will only increase the expected time 2 penalty. Thus, under the conditions of proposition 4C the manager optimally sets

$DA = LE_1 - TE_1$

The same logic holds if time 1 latent earnings exceed target earnings. The manger may reduce expected time 2 penalties by decreasing *DA*. However, he should not decrease *DA* by so much that he incurs a penalty at time 1. Thus, the manager should set *DA* so that reported earnings at time 1 that exactly equal target earnings if such a value for *DA* would fall within the range permitted by the auditor.

QED.

4.4.3 Positive fixed bonus

A positive fixed bonus in this model produces a result similar to that of a fixed bonus in Degeorge, Patel and Zeckhauser (1999).

Proposition 3. If the parameters of the manager's compensation function take the values *FB* > 0, *VB, VP* = 0, and 0<*r* < ∞, the manager optimally sets *DA* as follows:

A. If $LE_1 + MAXDA < TE_1$ then $DA = -MAXDA$

B. If $LE_1 - MAXDA > TE_1$ then $DA = -MAXDA$

C. If $LE_1 > TE_1$ *and* $LE_1 - MAXDA \leq TE_1$ <u>or</u>

if $LE_1 < TE_1$ and $LE_1 + MAXDA \geq TE_1$ then $DA = LE_1 - TE_1$.

Proof:

Consider each of the three cases:

A. $LE_1 + MAXDA < TE_1$

If the manager cannot report earnings sufficient to make his time 1 fixed bonus, changes in *DA* will only change the probability of his receiving a time 2 fixed bonus:

$$\partial E(ME)/\partial DA_t = \left(FB/\left(1+r\right)\right) p(TLE_2) > 0 \qquad (10)$$

An increase in *DA* increases the probability that the manager will earn his time 2 bonus. Thus, under the conditions of Proposition 5A, the manager optimally sets his *DA* equal to -*MAXDA*.

B. $LE_1 - MAXDA > TE_1$

Similar to the first case, if the manager is must report earnings sufficient to make his time 1 fixed bonus, changes in *DA* will only change the probability of his receiving a time 2 fixed bonus:

$$\partial E(ME)/\partial DA_t = \left(FB/\left(1+r\right)\right) p(TLE_2) > 0 \qquad (11)$$

An increase in *DA* increases the probability that the manager will earn his time 1 bonus. Thus, under the conditions of Proposition 5B, the manager optimally sets his *DA* equal to -*MAXDA*.

C. $DA = TE_1 - LE_1$ if $LE_1 > TE_1$ *and* $LE_1 - MAXDA \leq TE_1$

or if $LE_1 < TE_1$ and $LE_1 + MAXDA \geq TE_1$

Suppose the manager could set a value for *DA* that resulted in the firm exactly obtaining its time 1 earnings target. Consider first the case where the firm's time 1 latent earnings are above its target earnings. If the firm sets a value of *DA* to exactly obtain the time 1 fixed bonus, the manager obtains a sum with a present value of *FB* with probability 1. A lower *DA* will cost the manager the time 1 bonus, but in return he will only increase the probability of receiving the fixed bonus and that bonus, if received, will have a present value of $FB/(1+r)$. Thus, the manager always obtains greater wealth by obtaining the time 1 fixed bonus.

The manager could set *DA* so that the firm exceeds its target earnings. However, doing so will not increase the manager's fixed bonus. Moreover, setting a higher bonus would reduce the expected present value of next period's fixed bonus. Thus, if latent earnings are below the target, the manager should set *DA* to exactly obtain his target earnings.

Alternatively, suppose latent earnings exceed target earnings. The same arguments apply. The manager may increase the expected net present value of the time 2 fixed bonus without reducing the time 1 bonus by using *DA* to reduce time 1 reported earnings to the target level. However, any further reductions would result in the manager losing the time 1 fixed bonus in order to increase the probability of receiving a time 2 bonus with a lower present value. Thus, the manager optimally sets *DA* so that

$$DA = LE_1 - TE_1.$$

QED.

4.4.4 Positive variable bonus

A positive variable bonus for exceeding the target earnings in effect gives the manager an option on reported earnings with the payments bounded below at zero and uncapped above.

Proposition 4. If the parameters of the manager's compensation function take the values *VB* > 0, *FB, VP* = 0, and 0<*r* < ∞, and

$$-VB + \left(1/\left(1+r\right)\right)\int_{TLE}^{\infty} VB(p(LE_2))dLE_2 < VB\left(TLE_2 + DA - TE_2\right)p(TLE_2)$$

the manager optimally sets *DA* as follows:

A.	**if $LE_1 + MAXDA < TE_1$**	**then $DA = -MAXDA$**
B.	**if $LE_1 > TE_1$**	**then $DA = MAXDA$**
C.	**if $LE_1 < TE_1 < LE_1 + MAXDA$**	**Then the managers solve for the firm's profitability at *MAXDA, - MAXDA,* and where $LE_1 + MAXDA = TE_1$. They then select the value that maximizes expected earnings.**

Proof:

Consider each of the three cases:

A. $LE_1 + MAXDA < TE_1$

If the manager is not going to exceed target earnings in the first period, changes in *DA* will only influence his time 2 earnings

$$\partial E(ME)/\partial DA = \left(-1/\left(1+r\right)\right)\left[\begin{array}{l}\int_{TLE}^{\infty} VB(p(LE_2))dLE_2 + \\ \left(VB\left(TLE_2 + DA - TE_2\right)\right)p(TLE_2)\end{array}\right] > 0 \qquad (12)$$

If the manager cannot earn a fixed bonus in the first period because latent earnings are too far below target earnings, the manager should set *DA* equal to *MAXDA* to maximize the expected time 2 variable bonus.

B. $LE_1 > TE_1$

If latent earnings exceed the the time 1 target, changes in *DA* will change both the time 1 bonus and the expected discounted time 2 bonus. Under the conditions of proposition 6

$$\partial E(ME)/\partial DA = VB - \left(1/\left(1+r\right)\right)\left[\begin{array}{l}\int_{TLE}^{\infty} VB(p(LE_2))dLE_2 + \\ VB\left(TLE_2 + DA - TE_2\right)p(TLE_2)\end{array}\right] < 0 \qquad (13)$$

Thus, if the manager is going to obtain a time 1 bonus, increasing *DA* reduces the expected present value of time 1 bonus by more than it increases the expected present value of the time 2 bonus. Thus, if time 1 latent earnings exceed that period's target earnings, the manager maximizes firm value by setting *DA* = *MAXDA*.

C. $LE_1 < TE_1 < LE_1 - MAXDA$

If time 1 latent earnings are below target earnings but the manager can exceed target earnings for *DA* values equal to –*MAXDA*, the manager faces a tradeoff. The manager may use *DA*

to boost time 1 earnings so that he earns a bonus for the period. However, in doing so he reduces both the probability of at time 2 bonus and the value of that bonus if it is earned.

Parts A and B of this proof have already established that if the bank is constrained to exceed (miss) TE_1 then it should set DA equal to $MAXDA$ ($-MAXDA$). The one case not considered is where the bank can exactly hit its target. Thus, the manager's earnings must be maximized for one of three values of DA: $MAXDA$, $-MAXDA$, or $DA = LE_1 - TE_1$.

QED.

4.5 Accounting based IC and the Interagency Guidance

Likely the biggest impact of the Board of Governors et al. (2010) on capital buffers is its call for deferred senior managers' bonus payments to be subject to malus, which is reduced vesting if the bank has poor performance. This is potentially a large change in bank senior managers' IC as penalties appear sufficiently rare in Murphy's (1999, 2001) analysis to not merit any discussion. The effect of malus would be similar to that of a variable penalty in the above model which is to induce the senior manager to engage in earnings smoothing in order to minimize the expected present value of the penalty. The direct effect of such income smoothing will be to build a countercyclical buffer to absorb losses. Reported earnings and the reported increase in retained earnings during periods of high earnings will understate the increase in the bank's ability to absorb losses. The buffer will then be used during periods of low or negative earnings to boost reported earnings and increase retained earnings more (decrease retained earnings less) than would otherwise have been the case.

The Board of Governors et al. (2010) also calls for a substantial portion of senior managers' compensation to be deferred. The above analysis showed that senior managers are incented to maximize earnings in a "Live for Today" approach if their decisions in period 1 have

no impact on their utility in period 2. The effect of requiring deferred compensation is that retiring CEOs would not necessarily be able to cash out the full value of their prior bonuses upon retirement but would rather have to wait until their bonuses vest. Given that these bonuses are subject to malus if future earnings fall below the relevant target, a CEO that used accounting discretion in a "Live for Today" manner could find the value of bonuses earned late in his career reduced by malus because the firm failed to meet its targets after his resignation. The significance of this change in practice would depend upon the extent to which bank CEOs use accounting discretion to maximize reported earnings in their final year.[17]

Finally, the Board of Governors et al. (2010) called for reduced sensitivity of IC to higher levels of short-term performance. A reasonable interpretation of this guidance is that firms should not pay uncapped short term bonuses to their senior managers. The problem with uncapped bonuses is that they incent senior managers to use their discretion to maximize reported earnings during periods of unusually good latent earnings. In other words, uncapped variable bonuses by themselves encourage banks to reduce their effective capital buffers at precisely the time they are best able to increase the buffers. The significance of this change depends largely on the extent to which senior management's variable bonuses have been effectively uncapped prior to the adoption of Board of Governors et al. (2010).[18]

5. Stock-based compensation

Bank managers have an incentive to be concerned about their firm's share price because it impacts other key participants in the corporate governance process (their shareholders and board of directors). Senior managers also have an incentive to be concerned about share prices to the extent

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[17] No one has addressed this question to the best of our knowledge.
[18] That is either no cap exists or the cap is set at levels well beyond reasonably possible performance values.

they hold stock and other equity linked instruments. If senior management behavior is to be changed by Board of Governors et al. (2010) call for deferred compensation to be paid in equity linked instruments, the guidance must significantly increase these managers' asset portfolio's exposure to their bank's stock price. Such increases in exposure, however, not only create a general incentive to increase the firm's share prices but also a specific incentive to maximize share prices around the time of the senior manager is selling a substantial fraction of his firm's shares. If the value of the bank's equity can be influenced by earnings management, the senior manager may also be incented to engage in earnings management shortly before liquidating his equity linked compensation.

This section develops a model in which a firm's earnings management may influence its stock price. Our analysis considers two types of stock-based compensation: restricted stock grants which may be liquidated only at time 2 and unrestricted grants that may be liquidated at time 1 or time 2. Whether the grant is for stock or for stock options that are in the money is not important for the analysis. The amount and timing of the grant is assumed to be independent of other performance measures to focus on the direct impact of stock-based compensation.

The model for latent and reported earnings is generally similar to that of the accounting earnings based compensation but with a few important differences to make the model relevant to share price valuation. First, financial reporting must provide information about the value of the firm to have an impact on share prices. In this model the latent earnings are taken to be equivalent to the firm's cash flow. These latent earnings follow a random walk which has the effect of inducing investors to estimate future earnings based on current reported earnings. Second, a terminal third period is added in which the latent earnings are realized and distributed to shareholders. There is no earnings management in this period. Third, shareholders know the

distribution of latent earnings and the distribution of the range of feasible earnings management but cannot observe their realizations (except third period earnings). The result is that shareholders rationally anticipate earnings management but their observation of reported earnings is not sufficient to allow them to precisely determine to the extent of management.

The first subsection develops the earnings model. The next subsection discusses stock valuation in the model. The third subsection develops the implications for earnings management and bank capital cushions.

5.1 Model

A risk neutral manager with a positive rate of time preference, r, runs the firm. The firm realizes its latent earnings at three dates, t = 1, 2, and 3. Immediately after the end of the period the manager observes the true value of the firm's latent earnings. After the manager observes latent earnings at time 1 the auditor informs the manager of the range of range of discretionary adjustments. The manager then selects the amount of discretionary adjustments to include in reported earnings and announces reported earnings.

The realized latent earnings at time 1 are:

$$LE_1 = E_0(LE_1) + \varepsilon_1,$$

where,

LE_1 = latent earnings at time 1

$E_0(LE_1)$ = expectation as of time 0 for latent earnings at time 1, and

ε_t = innovation in latent earnings from time 0 to time 1.

The latent earnings for periods 2 and 3 follow a random walk.

$$LE_2 = LE_1 + \varepsilon_2, = E_0(LE_1) + \varepsilon_1 + \varepsilon_2 \qquad (14)$$

And

$$LE_3 = LE_2 + \varepsilon_3 = E_0(LE_1) + \varepsilon_1 + \varepsilon_2 + \varepsilon_3. \quad (15)$$

The innovation in earnings is distributed as $\varepsilon_t \sim N(0,\sigma_\varepsilon)$ within each period and is uncorrelated across the three periods and. Investors know the distribution of the innovation terms, but only the manager observes the realized value of ε_t.

Reported earnings in period *t* are latent earnings adjusted for net discretionary adjustments (*DA*). At time 1, the adjustment takes the form of adding discretionary adjustments to latent earnings. At time 2, the discretionary adjustments are assumed to be reversed out of earnings as they were in the model with IC based on accounting earnings.

$$RE_1 = LE_1 + DA,$$

and

$$RE_2 = LE_2 - DA.$$

The amount of discretionary adjustments is set subject to limits set by the auditor. As with the accounting IC model, assume that the manager must set discretionary adjustments within the bounds [-*MAXDA*, *MAXDA*]. In this model, however, *MAXDA* is a random variable distributed with $MAXDA \sim N(E(MAXDA), \varepsilon_{DA})$ and is uncorrelated with the innovation in earnings, ε_1, ε_2, and ε_3.[19] Investors are assumed to know the distribution of *MAXDA* but to be unable to observe the realization.

[19] The distribution assumptions contain two simplifications. First, the use of the normal distribution leaves open the possibility that *MAXDA* will take a value less than zero. However, the use of the normal distribution simplifies the analysis and is unlikely to have any qualitative impact for reasonable values of E(*MAXDA*) and ε_{DA}. Also, the use of symmetric boundaries around zero does not allow for the possibility that the auditor may allow greater income reducing discretionary adjustments than income increasing adjustments. This potential problem could be resolved at the cost of additional notation, but would add little to the results below.

5.2 Stock valuation

The firm invests its latent earnings from times 1 and 2 in a zero net present value project until the firm is liquidated at time 3. Upon liquidation, shareholders receive the sum of the latent earnings in the three periods. Thus, the value of the firm (SP_3) at time 3 is

$$SP_3 = LE_1 + LE_2 + LE_3. \tag{16}$$

Investors are risk neutral with a zero rate of time preference. Thus, they value the firm as the sum of its expected latent earnings conditional on their information. Prior to the first report of earnings the firm's value is"

$$SP_0 = \mathrm{E}_0(LE_1) + \mathrm{E}_0(LE_2) + \mathrm{E}_0(LE_3) = 3\ \mathrm{E}_0(LE_1). \tag{17}$$

The stock price at time 0 reflects only latent earnings at time 1 because innovations in the earnings have an expected value of zero. At time 1, investors update their estimation of the firm's value based on the reported earnings.

$$SP_1 = \mathrm{E}_1(LE_1|RE_1) + \mathrm{E}_1(LE_2|RE_1) + \mathrm{E}_1(LE_3|RE_1) = 3\ \mathrm{E}_1(LE_1|RE_1). \tag{18}$$

The expected reported earnings for the last two periods are equal to the first period's reported earnings because the expected value of the innovations is zero.

At time 2, investors again update their expectations based on the firm's reported earnings:

$$\begin{aligned} SP_2 &= \mathrm{E}_2(LE_1|RE_1, RE_2) + \mathrm{E}_2(LE_2|\ RE_1, RE_2) + \mathrm{E}_2(LE_3|\ RE_1, RE_2) \\ &= \mathrm{E}_2(LE_1|RE_1, RE_2) + 2\mathrm{E}_2(LE_2|\ RE_1, RE_2). \end{aligned} \tag{19}$$

Investors update their estimate of LE_1 using RE_2 because RE_2 contains information about the manager's use of his accounting discretion.

5.3 Earnings management

The manager would have an incentive to influence an investor's estimate of the firm's value if he receives stock-based compensation and he is allowed to sell stock after the earnings

report at time 1 or time 2. A potential tool for exercising such influence is the manager's control over discretionary accounting adjustments which affords him some ability to control reported earnings. Whether the manager's control over reported earnings influences the firm's value depends on how investors use reported earnings to infer latent earnings, which in turn depends on their assumptions about the manager's use of discretionary adjustments. In order to minimize the manager's ability to deceive investors, assume that investors know whether *DA* is positive or negative. In order to further reduce the manager's scope for deception, assume that investors conjecture that the manager is using all of his discretion, setting *DA* equal to its maximum absolute value. The analysis below demonstrates the validity of this conjecture. If investors conjecture that the manager is using all of his discretion, the manager will rationally use all of his discretion.

The problem facing investors is how to combine their prior knowledge of the distribution of latent earnings and managerial discretion, with the manager's disclosure of reported earnings to form an updated estimate of reported earnings. The method for solving the problem is provided by Greene (1990).

At the end of the first period, investors use RE_1 to update their estimates of LE_1 and *MAXDA*.

Lemma 1. An increase in RE_1 causes an increase in $E_1(LE_1)$ and $E_1(DA)$.

Investors use their knowledge to update their expectations of LE_1 as follows:

$$\mathrm{E}_1(LE_1 \mid RE_1) = \mathrm{E}\left(LE_1\right) + \left(RE_1 - E\left(RE_1\right)\right)\left(\sigma_\varepsilon^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right)\right) \tag{20}$$

Thus, an increase in RE_1 induces investors to increase in their time 1 estimate LE_1:

$$\partial \mathrm{E}_1(LE_1 \mid RE_1) \Big/ \partial RE = \sigma_\varepsilon^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right) > 0\,. \tag{21}$$

Similarly, investors update their estimate of *DA*:

$$\mathrm{E}_1(DA_1 \mid RE_1) = \mathrm{E}\left(DA_1\right) + \left(RE_1 - E\left(RE_1\right)\right)\left(\sigma_{DA}^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right)\right) \tag{22}$$

and an increase in RE_1 causes an increase in the updated estimate of DA:

$$\partial \mathrm{E}_1(DA \mid RE_1) \Big/ \partial RE = \sigma_{DA}^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right) > 0\,, \tag{23}$$

Proof: See the appendix.

The change in the respective estimates of LE_1 and DA depends on the ratio of their two variances. As the ratio $\sigma_{DA}^2 \big/ \sigma_\varepsilon^2$ goes to 0, virtually all of an increase in RE_1 gets attributed to latent earnings. As the ratio goes to infinity, virtually all of an increase would be attributed to discretionary adjustments.

Investors receive additional information at time 2 in the form of RE_2 and use this information to update their expectations of LE_1, LE_2 and DA.

Lemma 2. An increase in RE_1 and RE_2 causes an increase in investors' expectations of LE_1,, and LE_2. An increase in RE_1 causes a decrease in the expected value of DA, but an increase in RE_2 cause a decrease in the expected value of DA.

Investors update their prior expectations of LE_1, LE_2 and DA as follows:

$$\mathrm{E}_2(LE_1 \mid RE_1, RE_2) = \frac{\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + RE_1\left(\sigma_\varepsilon^2 + 2\sigma_{DA}^2\right) + 2RE_2\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{24}$$

$$\mathrm{E}_2(LE_2 \mid RE_1, RE_2) = \frac{-\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + 3RE_1\sigma_{DA}^2 + RE_2\left(\sigma_\varepsilon^2 + 3\sigma_{DA}^2\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{25}$$

$$\mathrm{E}_2(DA \mid RE_1, RE_2) = \frac{\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + \sigma_{DA}^2\left(2RE_2 - 3RE_1\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{26}$$

Both of the latent earnings expectations are positive functions of the reported earnings in their respective periods.

$$\frac{\partial \mathrm{E}_2(LE_1 \mid RE_1, RE_2)}{\partial RE_1} = \frac{\left(\sigma_\varepsilon^2 + 2\sigma_{DA}^2\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{27}$$

and

$$\frac{\partial \mathrm{E}_2(LE_2 \mid RE_1, RE_2)}{\partial RE_2} = \frac{\sigma_\varepsilon^2 + 3\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2}. \tag{28}$$

Both latent earnings are also positive functions of reported earnings in the other period

$$\frac{\partial \mathrm{E}_2(LE_1 \mid RE_1, RE_2)}{\partial RE_2} = \frac{2\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{29}$$

and

$$\frac{\partial \mathrm{E}_2(LE_2 \mid RE_1, RE_2)}{\partial RE_1} = \frac{3\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2}. \tag{30}$$

The two variables have opposite affects on *DA*:

$$\frac{\partial \mathrm{E}_2(DA \mid RE_1, RE_2)}{\partial RE_1} = \frac{-3\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{31}$$

but

$$\frac{\partial \mathrm{E}_2(DA \mid RE_1, RE_2)}{\partial RE_1} = \frac{2RE_2\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{32}$$

Proof: See the Appendix

All three expectations at time 2 are conditioned on both RE_1 and RE_2 even though LE_1 is uncorrelated with LE_2. One way of thinking about this is that both RE_1 and RE_2 contain information about the value of DA. The revised estimate of DA using RE_2 causes investors to change their expectations of LE_1 and the revised DA is also used to generate their expectation of LE_2.

Proposition 5. If the manager must sell his shares at time 1, he obtains the maximum proceeds by setting

DA = MAXDA.

Proof.

Using equations (18) and (21).

$$\frac{\partial SP_1}{\partial LE_1} = 3\left(\frac{\partial E_1(LE_1|RE_1)}{\partial LE_1}\right) = 3\sigma_\varepsilon^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right) > 0 \qquad (33)$$

Thus, upon observing RE_1, investors attribute part of the report to the firm's latent earnings and the rest to the firm's use of discretionary adjustments. An increase in reported earnings would change investors' estimate of LE_1 and DA.

Proposition 6. If the manager must sell his shares at time 2, he obtains the maximum proceeds by setting *DA* equal to –*MAXDA* at time 1 and *MAXDA* at time 2 to maximize RE_2.

Proof.

Setting DA to maximize RE_2 implies an equal reduction in the value of RE_1. The net effect of the two changes on $E_2(LE_1| RE_1, RE_2)$ is

$$\frac{\partial \mathrm{E}_2(LE_1 \mid RE_1, RE_2)}{\partial RE_2} - \frac{\partial \mathrm{E}_2(LE_1 \mid RE_1, RE_2)}{\partial RE_1} = \frac{2\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} - \frac{\left(\sigma_\varepsilon^2 + 2\sigma_{DA}^2\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} = \frac{-\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{34}$$

Similarly, the net effect on $\mathrm{E}_2(LE_2 \mid RE_1, RE_2)$ is

$$\frac{\partial \mathrm{E}_2(LE_2 \mid RE_1, RE_2)}{\partial RE_2} - \frac{\partial \mathrm{E}_2(LE_2 \mid RE_1, RE_2)}{\partial RE_1} = \frac{\sigma_\varepsilon^2 + 3\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} - \frac{3\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} = \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} \tag{35}$$

Substituting equations (34) and (35) into equation (19) yields:

$$\frac{\partial SP_2}{\partial RE_2} - \frac{\partial SP_2}{\partial RE_1} = \frac{-\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} + \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} + \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} = \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2} > 0 \tag{36}$$

.

Thus, an increase in *DA* to boost RE_2 increases $\mathrm{E}_2(LE_2|RE_1,RE_2)$ but it causes an equally large decrease in $\mathrm{E}_2(LE_1|RE_1, RE_2)$. The reason that the firm's stock price increases is that

$$\mathrm{E}_3(LE_3|RE_1,RE_2) = \mathrm{E}_2(LE_2|RE_1,RE_2)$$

implying that the increase in the investors' estimate of period 2 latent earnings increases their estimate of future latent earnings and thus boosts the firm's stock price. QED.

Thus, senior managers can use their accounting discretion to increase the price at which they sell their shares even in an environment where shareholders know that earnings are being

managed, know the direction of the management and rationally conjecture that management is using all of its accounting discretion. Moreover, this holds even if the manager must reduce reported earnings at time 1 to build up accounting discretion to be used at time 2.

5.4 Equity-linked IC and the Interagency Guidance

The senior managers of large, publicly traded firms, including banks, often hold equity positions in their firm that are material to their personal wealth. The Board of Governors et al. (2010) interagency guidelines encourages banks to increase senior managers' exposure to their bank's stock price moves by calling for more IC payments to take the form of equity linked instruments. To the extent that banks replace cash with equity and this increased equity motivates managers to increase their bank's share price, these results suggest that the guidelines will also encourage increased earnings management on the part of banks. In particular, senior executives will have an incentive to use their accounting discretion to maximize reported earnings shortly before converting their equity instruments in cash.

The impact of this incentive to manage earnings on countercyclical buffers also depends on when senior managers sell their shares. If managers tend to build accounting discretion during periods of high latent earnings and sell their shares at the trough of latent earnings, the resulting earnings management will have a countercyclical impact on the buffer. However, to the extent that the sales tend to occur at the peak of latent earnings, such earnings management would tend to make the buffers countercyclical.

We are unaware of any study that empirically analyzes the timing of management stock sales in relationship to the business cycle properties of bank earnings. Our conjecture would be that a disproportionate share of the volume of sales takes place around the peaks of latent earnings. Looking beyond the formal model presented above, a reasonable assumption would be that senior

managers know more about the true distribution of latent earnings than investors. To the extent this is true; managers have an incentive to sell when latent earnings are at the upper end of the manager's estimated earnings distribution. Assuming our conjecture is correct, the impact of the Board of Governors et al. (2010) encouragement for senior management bonuses to be paid in equity based compensation will tend to result in the use of accounting discretion in ways that make capital more procyclical.

6. Conclusion

Bank supervisors are engaged in a variety of parallel efforts to reduce the probability of future financial crises. Some of the efforts are likely to have unintended implications both good and bad for other efforts. This study highlights one such case, that of the impact of incentive compensation guidelines for efforts to have banks build capital buffers during good times which can absorb losses during periods of economic weakness.

The results suggest that the part of Board of Governors et al. (2010) interagency guidelines dealing with accounting based incentive compensation are likely to supportive of efforts to build countercyclical buffers. Especially noteworthy is the call for banks to implement deferred compensation that is subject to reduced vesting (or malus). The limited available evidence suggests that accounting income based penalties were rare prior to the crisis. An accounting earnings based penalty creates unambiguous incentives to use earnings management to reduce earnings during good periods which would have the effect of causing banks to build a capital buffer during good times.

However, the part of the guidance that encourages the use of equity-linked instruments can have the effect of encouraging banks to use accounting discretion to report higher earnings during good times when the senior managers seek to cash in a substantial part of their equity. The result

of using discretion to report higher earnings during good times would be to reduce the capital available to absorb subsequent losses. The impact of this part of the guidance on practice is unclear as equity-linked compensation is already a substantial portion of senior management compensation in the U.S.

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Appendix

Proof of Lemma 1

Let x_1 and x_2 be matrices of random variables (including the possibility that both matrices contain only a single vector) with mean vectors of μ_1 and μ_2. and a variance-covariance matrix of

$$\Sigma = \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix} \qquad (37)$$

Assume the marginal distributions are

$$x_1 \sim N(\mu_1, \Sigma_{11}) \qquad (38)$$

and

$$x_2 \sim N(\mu_2, \Sigma_{22}).$$

Then according to Greene (1990), the conditional distribution of x_1 given x_x is normal with a distribution of

$$x_1 \mid x_2 \sim N(\mu_{1,2}, \Sigma_{11,2}) \qquad (39)$$

where

$$\mu_{1,2} = \mu_1 + \Sigma_{12}\Sigma_{22}^{-1}\left(x_2 - \mu_2\right) \qquad (40)$$

First let x_1 be LE_1 and x_2 be RE_1 then

$$\mu = \begin{bmatrix} E(LE_1) \\ E(RE_1) \end{bmatrix} \qquad (41)$$

and

$$\Sigma = \begin{bmatrix} \sigma_\varepsilon^2 & \sigma_\varepsilon^2 \\ \sigma_\varepsilon^2 & \sigma_\varepsilon^2 + \sigma_{DA}^2 \end{bmatrix} \qquad (42)$$

Then applying equation (40) yields

$$\mathrm{E}_1(LE_1 \mid RE_1) = \mathrm{E}\left(LE_1\right) + \left(RE_1 - E\left(RE_1\right)\right)\left(\sigma_\varepsilon^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right)\right). \tag{43}$$

Next, let x_1 be *MAXDA* and x_2 be RE_1 so that

$$\mu = \begin{bmatrix} E(MAXDA) \\ E(RE_1) \end{bmatrix} \tag{44}$$

and

$$\Sigma = \begin{bmatrix} \sigma_{DA}^2 & \sigma_{DA}^2 \\ \sigma_{DA}^2 & \sigma_{DA}^2 + \sigma_{DA}^2 \end{bmatrix} \tag{45}$$

Then applying equation (40) yields

$$\mathrm{E}_1(DA_1 \mid RE_1) = \mathrm{E}\left(DA_1\right) + \left(RE_1 - E\left(RE_1\right)\right)\left(\sigma_{DA}^2 \Big/ \left(\sigma_\varepsilon^2 + \sigma_{DA}^2\right)\right). \tag{46}$$

QED.

Proof of Lemma 2

Define

$$\mu_1 = \left[E(LE_1)\right],$$

(47)

$$\mu_2 = \begin{bmatrix} E(LE_2) \\ E(MAXDA) \\ E(RE_1) \\ E(RE_2) \end{bmatrix},$$

(48)

and

$$\Sigma = \begin{bmatrix} \sigma_\varepsilon^2 & 0 & 0 & \sigma_\varepsilon^2 & \sigma_\varepsilon^2 \\ 0 & \sigma_\varepsilon^2 & 0 & 0 & \sigma_\varepsilon^2 \\ 0 & 0 & \sigma_{DA}^2 & -\sigma_{DA}^2 & \sigma_{DA}^2 \\ \sigma_\varepsilon^2 & 0 & -\sigma_{DA}^2 & \sigma_\varepsilon^2 + \sigma_{DA}^2 & \sigma_\varepsilon^2 - \sigma_{DA}^2 \\ \sigma_\varepsilon^2 & \sigma_\varepsilon^2 & \sigma_{DA}^2 & \sigma_\varepsilon^2 - \sigma_{DA}^2 & 2\sigma_\varepsilon^2 + \sigma_{DA}^2 \end{bmatrix}$$

(49)

Then plugging (47), (48), and (49) into (40) and solving for LE_1 using MatLab yields

$$\mathrm{E}_2(LE_1 \mid RE_1, RE_2) = \frac{\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + RE_1\left(\sigma_\varepsilon^2 + 2\sigma_{DA}^2\right) + 2RE_2\sigma_{DA}^2}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2}$$

Similarly, the vectors in equations (47), (48), and (49) can be realigned to solve for LE_2 and DA, plugged into equation (40) and solved to yield

$$\mathrm{E}_2(LE_2 \mid RE_1, RE_2) = \frac{-\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + 3RE_1\sigma_{DA}^2 + RE_2\left(\sigma_\varepsilon^2 + 3\sigma_{DA}^2\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2}$$

and

$$\mathrm{E}_2(DA \mid RE_1, RE_2) = \frac{\mathrm{E}(MAXDA)\sigma_\varepsilon^2 + \sigma_{DA}^2\left(2RE_2 - 3RE_1\right)}{\sigma_\varepsilon^2 + 5\sigma_{DA}^2}.$$

QED.