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"Taking Diversity into Account": Real Effects of Accounting Measurement on Asset Allocation

Gaëtan Le Quang

Univ Lyon, Université Lumière Lyon 2, GATE UMR 5824, F-69130 Ecully, France

Address : GATE, 93 chemin des Mouilles, B.P. 167, 69131 ECULLY cedex

E-mail address: g.le-quang@univ-lyon2.fr

Tel.: +33671413644

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Abstract: In the wake of the financial crisis, accounting issues have caught the attention of both economists and regulators. Fair value accounting has indeed been charged of amplifying the procyclicality of the banking system. Real effects of accounting are therefore to be taken into consideration when discussing the issues raised by the crisis. We develop a theoretical model to study what the real effects of accounting on financial institutions' investment decision are. Doing so, we show that fair value accounting may incentivize banks to underinvest in long-term risky assets, while historical cost accounting may incentivize them to invest too much in those assets. At first sight, bank accounting thus appears as a choice between bad and worse. We show that this is not necessarily the case. More precisely, if financial institutions are subject to different accounting rules depending on their time horizon – i.e. long-sighted financial institutions are subject to historical cost accounting while shorter-sighted financial institutions are subject to fair value accounting – the inefficiencies associated with both accounting rules may be softened.

Keywords: real effects of accounting; asset allocation; banks; insurers

JEL classification: G11; G21; G22; M41

1. Introduction

In the wake of the global financial crisis, accounting issues, particularly those related to fair value accounting, have become more and more popular among economists, as suggested by the growing literature on the matter (Beatty and Liao, 2014). In particular, fair value accounting is accused of intensifying and synchronizing financial institutions' responses to changes in their economic environment and consequently to further harm the financial system in times of crisis (Plantin et al., 2008a).

This article aims at assessing the impact of accounting rules on FIs' investment decision. More precisely we study how, on the one hand, fair value accounting (FVA) and, on the other hand, historical cost accounting (HCA) might incentivize FIs to either overinvest or underinvest in a long-term risky asset. To do so we develop a theoretical model where FIs have two successive decisions to make: each FI first chooses the composition of its asset portfolio by allocating an initial endowment between a risky and a riskless asset and then each FI decides whether to hold its risky asset until maturity or not. Real effects of accounting arise when FIs' time horizon is shorter than the duration of the risky asset they want to invest in. We compare two cases: one where FIs are subject to FVA and another where FIs resort to HCA. We show that when FIs' time horizon is shorter than the duration of the risky asset, FIs behave in a procyclical manner when they use FVA. In this case, they indeed underinvest in the risky asset when the return associated with this asset is expected to

be low (as in bust phases), while they overinvest in this asset when its return is expected to be large (as in boom phases). We show in addition that when FIs are subject to HCA, they always overinvest in the risky asset. In particular, the more short-sighted FIs are, the more they tend to overinvest in the risky asset when they resort to HCA.

Our paper belongs to the burgeoning literature on the real effects of accounting regimes (Kanodia, 2008; Kanodia and Sapra, 2016). This literature starts from the hypothesis that measurement and disclosure rules have real effects on the economy in the sense that they have a direct influence on the way managers behave. The fact that different accounting rules have different impacts on FIs' investment decision is a direct consequence of the complex structure of information that shapes financial markets. Let us for instance consider banks' decision to grant loans. Loans are by definition characterized by great information asymmetry since banks are likely to possess private information on them. In this case, it is very unlikely that these loans can be priced adequately by the market. On the contrary, as O'Hara (1993) puts it, it is likely that markets fail to reflect this private information and thus systematically underprice these loans. In this case, banks that resort to FVA are penalized. They are consequently incentivized to focus more on shorter-term assets that are less affected by information asymmetry and thus less likely to be mispriced. This is an example of how the use of FVA can deter banks from investing in long-term assets, while the use of HCA makes it possible for banks to fully benefit from their informational advantage.

In time of crisis, the real effects of accounting measurement on FIs' investment decision are even stronger. This could explain why theoretical works concerning the real effects of FVA have been quite numerous since the 2007-2008 crisis (Freixas and Tsomocos, 2008; Allen and Carletti, 2008; Heaton et al., 2010). When banks resort to FVA, the expectation of distressed sales may incentivize them to sell assets solely because they would otherwise have to adjust the book value of these assets to their distressed prices (Plantin et al., 2008b). On the contrary, HCA makes it possible for banks to disregard short-term prices' fluctuations and to hold their assets to maturity. However, HCA can in turn have an adverse impact on FIs' trading behavior. FIs subject to HCA can indeed be incentivized to engage in gains trading (Ellul et al., 2015). The mechanism is as follows: when FIs' capital requirements are harder to meet because some assets are severely downgraded, FIs often have to sell assets to shore up capital. Under FVA, the assets to sell are those that have been downgraded since such sales have a direct positive impact on both the numerator and the denominator of the risk-based capital ratio. Under HCA, the problem with selling downgraded assets is that it forces FIs to recognize the price decline in their capital. In this case, those FIs may be incentivized to sell assets associated with the largest unrealized gains in order to realize these gains and to make them flow to their capital. These sales could then act as a channel through which market stress propagates from one class of assets to another. More recently, Otto and Volpin (2018) show that mark-to-market accounting can make banks take inefficient investment decisions if the behavior of banks' managers is driven by a reputational motive. Plantin and Tirole (2018) show that mark-to-market accounting can have deleterious effects in terms of liquidity.

As the models of O'Hara (1993) and Otto and Volpin (2018), our model tackles the question of the real

effects of accounting on FIs' investment decision. However the main reason why those real effects materialize in our model is the mismatch between FIs' time horizon and the duration of the asset they want to invest in. As in [Plantin et al. \(2008b\)](#), this mismatch gives rise to self-fulfilling panic sales of the risky asset whose expectation deters FIs to invest in this asset when they are subject to FVA. In this case, the idea is that when FIs choose the composition of their asset portfolio, they try to anticipate the amount of the risky asset that will be sold. The rationale is that if a lot of FIs decided to sell their risky asset, its market price would decrease sharply and it would have been less interesting to have invested in it in the first place. Therefore, the more a FI expects the others to sell their risky asset, the less it invests in this asset. On the contrary, when FIs are subject to HCA, they totally disregard short-term market fluctuations and may thus invest too much in the risky asset. Our model makes it possible to reconcile some results found in the literature that might *a priori* have seemed contradictory. In line with [O'Hara \(1993\)](#) we show that FVA can deter FIs from investing in risky assets especially when the duration of these assets is long. In line with the empirical evidence provided by [Ellul et al. \(2015\)](#), we show that HCA is no more than FVA a panacea since it does not provide FIs with the right incentives to assess properly the risk associated with long-term assets. We therefore agree with the conclusion of [Allen and Carletti \(2008\)](#) and [Otto and Volpin \(2018\)](#) that neither FVA nor HCA is the panacea and that the "one-size-fits-all" approach does not suit accounting issues well. Furthermore we suggest that a mixed accounting regime where long-sighted FIs are allowed to use HCA while shorter-sighted FIs resort to FVA can lead to an asset allocation closer to the one that would arise in the first-best world.

Our theoretical framework is based on [Plantin et al. \(2008b\)](#). We however introduce two features in our model that are not present in the latter: a variable that accounts for the time horizon of FIs and an explicit modeling of the portfolio optimization problem they face. Specifically, FIs are allowed to choose between a risky and a riskless asset. We therefore borrow from the literature on portfolio optimization. In particular, we make great use of the mean-variance analysis put forward by [Markowitz \(1952\)](#) and of its application to the analysis of the behavior of FIs developed by [Pyle \(1971\)](#) and [Hart and Jaffee \(1974\)](#).

The model is presented in the next section. In section [3](#), we study what are the real effects of FVA on the investment decision of FIs. The case of HCA is presented in section [4](#). Section [5](#) discusses our results and their policy implications. Section [6](#) concludes.

2. Model

2.1. General framework

We present here the general framework of the model. We consider a unit continuum of FIs. There are three dates.

In $t = 0$, each FI chooses the composition of its portfolio of assets. FIs have to allocate an initial endowment of 1 between a risky asset that yields a random return θ in $t = 2$ and a riskless asset that yields a return 1. θ is assumed to be positive. Since the risky asset is a long-term asset, its valuation is subject to

uncertainty. We thus assume that FIs do not directly observe θ , but each has a noisy estimation of it. We denote by $x_i = \theta + \varepsilon_i$, where $\varepsilon_i \hookrightarrow \mathcal{U}([- \eta, \eta])$ and $\eta > 0$, the estimation of θ made by FI i . When θ is the true value of the return of the risky asset, x_i is thus uniformly distributed on $[\theta - \eta, \theta + \eta]$. FIs are assumed to maximize in $t = 0$ a weighted average of their short-term (ST) book value and of their long-term (LT) earning. Specifically, the ST book value of the risky asset (i.e. its $t = 1$ value) is given by its accounting value θ_a , which depends on the accounting rule chosen (i.e. either FVA or HCA). The LT earning associated with the risky asset is simply its payoff θ and FIs consequently seek to maximize the following weighted average:

$$(1 - \rho)\theta_a + \rho\theta, \quad (1)$$

where $\rho \in [0, 1]$ accounts for the weight FIs grant to their LT earning. ρ can therefore be interpreted as the time horizon of FIs: the larger ρ , the longer the time horizon of FIs. In particular, when ρ equals 0, FIs are very short-sighted since they only focus on their ST book value, while they are long-sighted when $\rho = 1$ since in this case they maximize their LT earning.

Between $t = 0$ and $t = 1$, each FI has to decide whether to sell the proportion it has invested in the risky asset or to hold it to maturity. We make the assumption that there is no market price for this asset and FIs consequently need to resort to a model to price it. This model yields the following price per unit of the risky asset:

$$p(\theta) = \delta\theta - \gamma\alpha s, \quad (2)$$

where δ is a positive constant that can be interpreted as the liquidity risk associated with the risky asset, γ is a positive constant that captures market liquidity (the larger γ is, the less liquid the market is), s is the proportion of FIs that have sold their risky asset. We assume that $\delta \leq 1$. In this case, sales of the risky asset are only driven by the shortsightedness of FIs. When $\delta \leq 1$ we indeed know that $\theta \geq p(\theta)$: the LT earning associated with the risky asset is always above its market price and a FI that seeks to maximize its LT earning would therefore never find it interesting to sell it. Sales of the risky asset are therefore assumed to be only motivated by the interaction between the incentives coming from accounting rules and those coming from the shortsightedness of FIs.

In $t = 2$ the risky asset pays θ . Figure 1 summarizes the timing of the model.

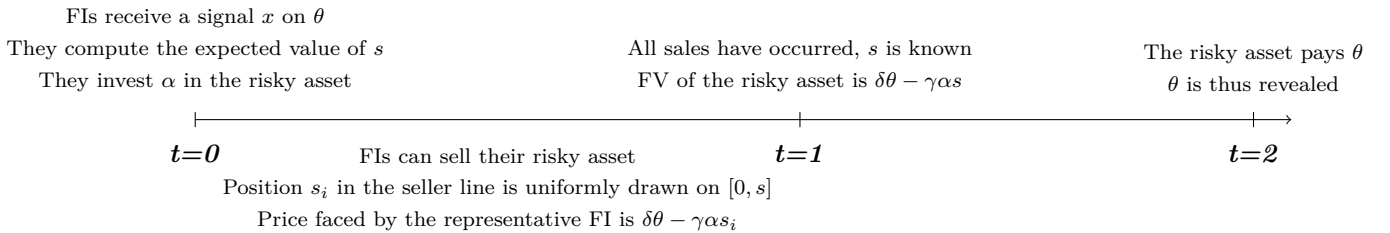


Figure 1: Timing of the model

2.2. Benchmark case

We define the benchmark case as that where FIs' time horizon is equal to the duration of the risky asset. In this case, FIs only focus on the LT earning associated with the risky asset (i.e. $\rho = 1$) and never decide to sell it when $\delta \leq 1$. Since FIs only focus on the return of the risky asset, accounting rules do not play any part in their decision-making process. We assume that each FI behaves like a portfolio manager when deciding which proportion of its asset portfolio to allocate to the risky asset. In particular, we resort to the mean-variance analysis to compute this proportion: we assume that a FI chooses the composition of its portfolio by maximizing a utility function $U(\mu_p, \sigma_p^2)$ where μ_p is the expected value of the portfolio and σ_p^2 its variance. We assume that $\frac{\partial U(\cdot)}{\partial \mu_p} > 0$ and that $\frac{\partial U(\cdot)}{\partial \sigma_p^2} < 0$, meaning that FIs are risk-averse. Let us denote by $\hat{\alpha}$ the proportion of their portfolio FIs invest in the risky asset in the benchmark case. The random value of the asset portfolio of a FI (denoted by $\tilde{\pi}_p$) consists in the proportion $\hat{\alpha}$ it invests in the risky asset times its return plus the proportion invested in the riskless asset (i.e. $1 - \hat{\alpha}$). Since FIs are assumed to maximize their LT earning, we can express $\tilde{\pi}_p$ as follows:

$$\tilde{\pi}_p = \hat{\alpha}(\theta - 1) + 1. \quad (3)$$

Following the mean-variance assumption, the value of $\hat{\alpha}$ is given by the following first-order condition:

$$\frac{\partial U}{\partial \mu_p} \frac{\partial \mu_p}{\partial \hat{\alpha}} + \frac{\partial U}{\partial \sigma_p^2} \frac{\partial \sigma_p^2}{\partial \hat{\alpha}} = 0. \quad (4)$$

Let us denote the expectation operator by $\mathbb{E}[\cdot]$ and the variance operator by $V[\cdot]$. Using equation (3) we can therefore express μ_p and σ_p^2 conditional on x as follows:

$$\mu_p = \mathbb{E}[\tilde{\pi}_p|x] = \hat{\alpha}(x - 1) + 1, \quad (5)$$

and

$$\sigma_p^2 = V[\tilde{\pi}_p|x] = \hat{\alpha}^2 \sigma^2, \quad (6)$$

where $\sigma^2 = V[\theta|x]$. The value of $\hat{\alpha}$ is consequently given by the following expression:

$$\hat{\alpha} = \lambda \frac{x - 1}{\sigma^2}, \quad (7)$$

where $\lambda = -\frac{1}{2} \frac{\partial U}{\partial \mu_p} \left[\frac{\partial U}{\partial \sigma_p^2} \right]^{-1}$ is the risk-aversion coefficient: the greater λ is, the less risk-averse the agent is.

We assume that FIs are not allowed to short-sell the risky asset. In other words, $\hat{\alpha}$ is necessarily positive. Given that nothing ensures in equation (7) that $\hat{\alpha} \geq 0$, we have to refine the definition of $\hat{\alpha}$. We thus have:

$$\hat{\alpha} = \begin{cases} 0 & \text{if } x < 1, \\ \lambda \frac{x-1}{\sigma^2} & \text{if } x \geq 1. \end{cases} \quad (8)$$

3. Fair value accounting

We now assume that FIs' time horizon does not perfectly match the duration of the risky asset. In this case, FIs are no longer only interested in the LT earning associated with the risky asset, but focus on a weighted average of its ST book value and of its LT earning. Accounting therefore plays a role in FIs' decision-making since different accounting rules induce different ST book values. Contrary to the benchmark case, real effects of accounting measurement therefore arise and are the consequence of the mismatch between FIs' time horizon and the duration of the risky asset. In this section we assume that FIs resort to FVA to determine the book value of their portfolio.

To compute the proportion of their asset portfolio that FIs decide to invest in the risky asset, we proceed by backward induction. We first determine in which situations FIs decide to sell their risky asset between $t = 0$ and $t = 1$ and only then do we compute the proportion invested in the risky asset in $t = 0$.

3.1. Selling versus holding

As previously mentioned, each FI can either sell its risky asset or hold it to maturity. A FI holds its risky asset to maturity if the weighted average of its ST book value and of its LT earning is larger than its estimated market price. Since the market is not perfectly liquid (i.e. $\gamma > 0$), the price of the risky asset depends on the proportion s of FIs that decide to sell their risky asset. There consequently is an uncertainty concerning the price a FI would face if it decided to sell its asset between $t = 0$ and $t = 1$. Indeed, since the price responds immediately to the proportion of FIs that decide to sell, the price faced by a particular FI depends on the date on which it decides to sell. The idea is that FIs do not take the decision to sell exactly at the same time, but continuously decide to sell or hold their risky asset between $t = 0$ and $t = 1$. The price expected in $t = 0$ by a particular FI consequently depends on its expected position in the sellers' line – i.e. on the expected proportion of FIs that will already have sold their asset when the FI will decide to do so. We make the assumption that the expected position of a particular FI in the sellers' line follows a uniform distribution on $[0, s]$. Let us denote by s_i the random variable that accounts for the position of FI i in the sellers' line. The price FI i would face if it decided to sell its risky asset between $t = 0$ and $t = 1$ is consequently given by the following equation:

$$p_i(\theta) = \delta\theta - \gamma\alpha_{FV}\mathbb{E}[s_i] = \delta\theta - \gamma\alpha_{FV}\frac{s}{2}, \quad (9)$$

where α_{FV} is the proportion of their asset portfolio FIs invest in the risky asset when they are subject to FVA. Finally, a FI holds its risky asset to maturity if:

$$(1 - \rho)[\delta\theta - \gamma\alpha_{FV}s] + \rho\theta \geq \delta\theta - \gamma\alpha_{FV}\frac{s}{2}. \quad (10)$$

Let us discuss inequality (10) in more details before solving the game. This inequality suggests that FIs decide to fire sell their risky asset based on a target function which they maximize. However, fire sales usually show up as a liquidity constraint in FIs' optimization problem (see for instance [Rochet and Vives \(2004\)](#)).

Inequality (10) can nonetheless be thought of as such a constraint. Assume that FIs fund their asset portfolio solely through short-term deposits that can be early-withdrawn in $t = 1$. In this case, FIs face a liquidity constraint that can force them to fire sell some of their asset portfolio in $t = 1$. This scenario can be captured through the parameter ρ . Assume for instance that ρ is the probability that no depositor withdraws in $t = 1$. In this case, when $\rho = 1$, FIs do not face any liquidity constraint from their depositors and they are never incentivized to fire sell their risky asset. When some depositors decide to withdraw (i.e. $\rho < 1$), FIs can no longer focus only on the $t = 2$ value of their asset portfolio, but are forced to consider their short-term book value. In the extreme case where all depositors decide to withdraw in $t = 1$ (i.e. $\rho = 0$), FIs are forced to focus only on their $t = 1$ book value and to fire sell their risky asset. According to inequality (10), FIs indeed always sell their risky asset when $\rho = 0$. In consequence, FIs' short-sightedness (i.e. ρ is small) can be interpreted as a liquidity constraint coming from potential early withdrawals, and FIs' long-sightedness (i.e. ρ is close to 1) as no such liquidity constraint.

In addition, it can be at first sight surprising that, in inequality (10), the market price ($\delta\theta - \alpha_{FV}\frac{s}{2}$) is not equal to the expected $t = 1$ fair value of the risky asset ($\delta\theta - \alpha_{FV}s$). This is because the fair value of the risky asset in $t = 1$ only depends on the total proportion s of FIs that sell their risky asset between $t = 0$ and $t = 1$ as expected in $t = 0$, while the expected market price depends both on this proportion and on the expected position of the representative FI in the seller line, which is given by the uniform distribution on $[0, s]$. When they use FVA, FIs indeed have more to lose when they wait until sales have all occurred than when they engage in early sales. This is the rationale behind panic sales due to FVA: keeping the risky asset at its fair value forces FIs to recognize a decrease in its price due to all the sales that occur before $t = 1$, while selling the asset makes it possible to benefit from a higher price provided that FIs manage to sell their asset early enough. In fact, if FIs did not expect to benefit from a better price when they manage to sell their asset early enough, they would never be incentivized to sell. Inequality (10) indeed always holds when the expected price of the risky asset between $t = 0$ and $t = 1$ (right hand side in (10)) is equal to the expected $t = 1$ fair value. In other words, what incentivizes FIs to engage in early sales is precisely the opportunity to benefit from the difference between the price they can expect to face if they decide to sell their asset early, and the price that corresponds to the $t = 1$ fair value of the risky asset once all sales have occurred.

Inequality (10) can be rewritten as follows:

$$\theta \geq \frac{\gamma s \alpha_{FV} (\frac{1}{2} - \rho)}{\rho(1 - \delta)}. \quad (11)$$

We notice that sales of the risky asset only occur when the time horizon ρ of FIs is short, that is whenever $\rho < \frac{1}{2}$. In this case, according to (11), when $\theta > \frac{\gamma \alpha_{FV} (\frac{1}{2} - \rho)}{\rho(1 - \delta)}$ FIs always hold their risky asset to maturity. When $\theta \in \left[0, \frac{\gamma \alpha_{FV} (\frac{1}{2} - \rho)}{\rho(1 - \delta)}\right]$, we use the global game technique (Morris and Shin, 1998, 2003; Plantin et al., 2008b) to prove the existence of a unique threshold value of the signal x^* , such that FIs observing a signal below x^* decide to sell their risky asset and FIs observing a signal above x^* decide to hold their asset to maturity.

Lemma 1. When $\eta \rightarrow 0$, there exists a unique threshold value of $x^* \equiv \frac{\gamma\alpha_{FV}(\frac{1}{2}-\rho)}{2\rho(1-\delta)}$ such that:

$$\begin{aligned} \text{when } x < x^* & \quad \text{FIs sell,} \\ \text{when } x \geq x^* & \quad \text{FIs hold to maturity.} \end{aligned} \tag{12}$$

Proof. See [Appendix A.1](#) □

3.2. Portfolio optimization

We now determine which proportion of their asset portfolio FIs decide to allocate to the risky asset. As in section 2.2, we resort to the mean-variance assumption. The random value $\tilde{\pi}_{FV}$ of the portfolio of a FI consists in the proportion α_{FV} it invests in the risky asset times its return plus the proportion invested in the riskless asset. Recall that the $t = 0$ value of the risky asset is given by a weighted average of its long-term value θ and of its ST book value. The ST book value of the risky asset is equal to its $t = 1$ fair value as given by equation (2). Therefore, $\tilde{\pi}_{FV}$ is given by the following expression:

$$\tilde{\pi}_{FV} = \alpha_{FV}\{ (1-\rho)(\delta\theta - \gamma\alpha_{FV}s) + \rho\theta \} + 1 - \alpha_{FV}. \tag{13}$$

Lemma 2. When $\eta \rightarrow 0$, there always exists an equilibrium value of α_{FV} that is as follows:

$$\alpha_{FV} = \begin{cases} 0 & \text{if } x < \frac{1}{A}, \\ \frac{x A - 1}{\lambda^{-1} A^2 \sigma^2 + 2s_x(1-\rho)\gamma} & \text{if } \frac{1}{A} \leq x, \end{cases} \tag{14}$$

where s_x is the expected value of s when the signal x is observed and $A = \delta + \rho(1 - \delta)$.

Proof. See [Appendix A.2](#) □

3.3. Fair value accounting and asset allocation

FVA incentivizes FIs to pay attention to the $t = 1$ expected price of the risky asset. When FIs are long-sighted (i.e. $\rho = 1$) – for instance because they are unlikely to face short-term unexpected liquidity needs –, they can disregard the fluctuations of this short-term price. In this case, FIs thus behave as in the benchmark case as stated by Proposition 1.

Proposition 1. When FIs are long-sighted (i.e. $\rho = 1$), FVA achieves the first-best: no sales of the risky asset occur and $\alpha_{FV} = \hat{\alpha}$.

Proof. Sales of the risky asset only occur when $\rho < \frac{1}{2}$. When $\rho = 1$, no sales of the risky asset are therefore expected. Since $A = 1$ when $\rho = 1$, we have $\alpha_{FV} = \hat{\alpha}$. □

When FIs are very short-sighted (i.e. $\rho = 0$) and the market is illiquid, they anticipate that sales of the risky asset will occur and that its price will therefore decrease. This expected drop in the price of the risky asset causes its fair value to decrease: very short-sighted FIs that focus exclusively on the ST book value of their portfolio will consequently grant less value to the risky asset and invest less in it. In other words, FVA makes FIs overreact to others' behaviors, which gives rise to self-fulfilling sales. Those expected sales in turn incentivize FIs to underinvest in the risky asset (Proposition 2).

Proposition 2. *When FIs are very short-sighted (i.e. $\rho = 0$), FVA incentivizes them to under-invest in the risky asset provided that $\gamma \geq \frac{\sigma^2(1-\delta)}{2\lambda}$ (sufficient condition).*

Proof. When $\rho = 0$, FIs always sell their risky asset between $t = 0$ and $t = 1$ (see equation (10)). We thus have $s = 1$. FIs therefore invest a proportion $\alpha_{FV} = \lambda \frac{\delta x - 1}{\delta^2 \sigma^2 + 2\gamma\lambda}$ of their portfolio in the risky asset provided that $x \geq \frac{1}{\delta}$ and 0 otherwise. Recall that the first-best allocation yields $\hat{\alpha} = \lambda \frac{x-1}{\sigma^2}$ provided that $x \geq 1$ and 0 otherwise. A sufficient condition for $\alpha_{FV} \leq \hat{\alpha}$ is indeed $\gamma \geq \frac{\sigma^2(1-\delta)}{2\lambda}$. \square

However, for greater values of ρ (i.e. $\rho \in]0, 1[$), the relationship between self-fulfilling sales of the risky asset and under-investment in this asset because of the expectation of those sales only occurs as far as the risky asset is expected to pay a low return. When the return associated with the risky asset is large enough, FVA makes FIs understate the risk associated with their asset portfolio. In this case, since the risky asset is expected to pay a high return, few sales are expected, i.e. s_x is small, and thus FIs decide to invest a lot in the risky asset. Assume for example that $s_x = 0$, i.e. no sales of the risky asset are expected. According to Lemma 2, FIs thus invest a proportion $\lambda \frac{x-\frac{1}{A}}{A\sigma^2}$ of their asset portfolio in the risky asset provided that $x \geq \frac{1}{A}$ and 0 otherwise. Recall that the first-best allocation is $\hat{\alpha} = \lambda \frac{x-1}{\sigma^2}$ provided that $x \geq 1$ and 0 otherwise. It is easy to show that $A < 1 \iff \rho < 1$. Thus when $\rho < 1$, i.e. when FIs are short-sighted, the risk σ^2 associated with the risky asset is underestimated since it is multiplied by a factor $A < 1$. When no sales of the risky asset are expected, short-sighted FIs therefore underestimate the risk associated with the risky asset and, provided that the expected return x of this asset is large enough, they overinvest in it.

Proposition 3. *When short-sighted FIs (i.e. $\rho \in]0, 1[$) are subject to FVA:*

- *when the expected return associated with the risky asset is small (i.e. $x < \bar{x}$), FIs overreact to expected drops in the price of the risky asset by under-investing in it (i.e. $\alpha_{FV} < \hat{\alpha}$),*
- *when the expected return associated with the risky asset is large enough (i.e. $x > \bar{x}$), FIs underestimate the risk associated with a high-yield risky asset and overinvest in it (i.e. $\alpha_{FV} > \hat{\alpha}$).*

Proof. See Appendix A.3. \square

Proposition 3 provides some support to one of the main criticisms addressed to FVA: its procyclicality. During expansion phases – i.e. when assets are expected to yield high returns – FVA indeed encourages FIs to overinvest in risky assets, which makes their prices increase further. Yet, in depression phases – i.e. when assets are expected to pay low returns – FVA deters FIs from investing in risky assets, which causes their prices to decrease further.

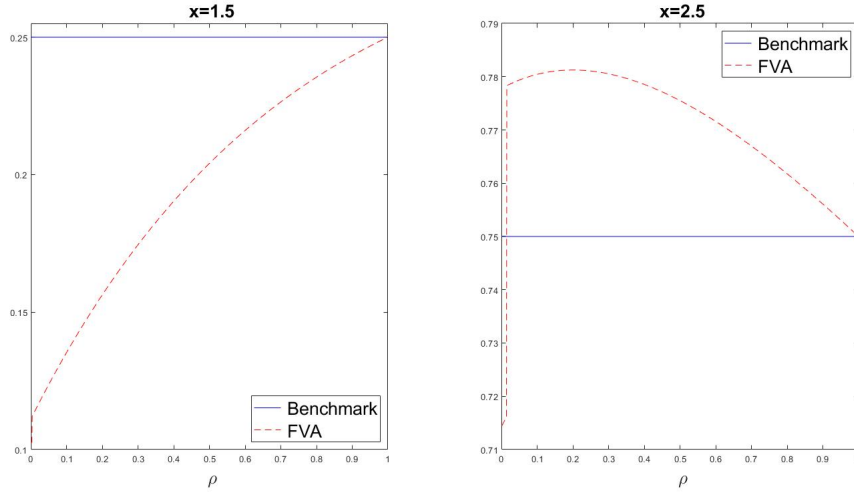


Figure 2: Proportions of the asset portfolio invested in the risky asset in the FVA case and in the benchmark case ($\lambda = 0.5$, $\delta = 0.75$, $\sigma^2 = 1$ and $\gamma = 0.05$)

Figure 2 plots the proportions of their asset portfolio FIs invest in the risky asset when they are subject to FVA (dotted line) and in the benchmark case (solid line) as functions of ρ and for some values of x when the market is rather liquid ($\gamma = 0.05$). In this case, we notice that FIs tend to underinvest in the risky asset when x is small: the dotted curve is indeed below the solid line when $x = 1.5$. When $x = 2.5$, only very short-sighted FIs under-invest in the risky asset while other FIs overinvest in the risky asset: the dotted curve is above the solid line provided that ρ is larger than a certain threshold. When the market is more illiquid ($\gamma = 2$), Figure 3 shows that, when $x = 2.5$, the threshold value of ρ below which FIs underinvest in the risky asset increases. FVA thus deters the most short-sighted FIs to invest in long-term assets, which can prove detrimental to the funding of long-term investments.

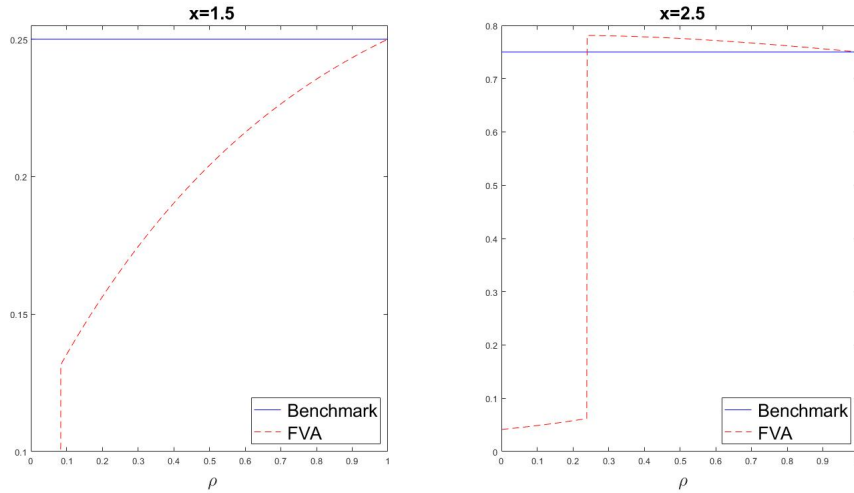


Figure 3: Proportions of the asset portfolio invested in the risky asset in the FVA case and in the benchmark case ($\lambda = 0.5$, $\delta = 0.75$, $\sigma^2 = 1$ and $\gamma = 2$)

4. Historical cost accounting

4.1. Portfolio optimization

We now assume that FIs resort to HCA. In this case, the $t = 1$ accounting value of the risky asset is no more given by its market price but by its historical value θ_0 . When FIs resort to HCA, the weighted average of the ST book value of the risky asset and of its LT earning is therefore equal to:

$$(1 - \rho)\theta_0 + \rho\theta. \quad (15)$$

We assume that the historical value of the risky asset θ_0 is determined in $t = 0$ as the rational expectation of the weighted average of the ST book value of the risky asset and of its LT earning:

$$\theta_0 = \mathbb{E}[(1 - \rho)\theta_0 + \rho\theta|x] \iff \theta_0 = x. \quad (16)$$

As previously we resort to the mean-variance analysis to determine the proportion of their portfolio of assets FIs invest in the risky asset in $t = 0$. The random value $\tilde{\pi}_{HC}$ of the asset portfolio of a representative FI that is subject to HCA is given by:

$$\tilde{\pi}_{HC} = \alpha_{HC}\{(1 - \rho)\theta_0 + \rho\theta - 1\} + 1, \quad (17)$$

where α_{HC} is the proportion of their asset portfolio FIs invest in the risky asset when they resort to HCA. Following the mean-variance assumption and replacing θ_0 by its value, we compute the value of α_{HC} :

$$\alpha_{HC} = \begin{cases} 0 & \text{if } x < 1, \\ \lambda \frac{x-1}{\rho^2\sigma^2} & \text{if } x \geq 1. \end{cases} \quad (18)$$

4.2. Historical cost accounting and asset allocation

When they are subject to HCA, FIs do not take short-term market fluctuations into account. For long-sighted FIs whose business model makes it possible to focus on the long-term earning, the distorting impact of HCA on the allocation between the risky and the riskless asset is therefore expected to be smaller than that for short-sighted FIs. When $\rho = 1$, Proposition 4 indeed states that HCA achieves the first-best allocation.

Proposition 4. *When FIs are long-sighted (i.e. $\rho = 1$), HCA achieves the first-best: no sales of the risky asset occur and $\alpha_{HC} = \hat{\alpha}$.*

Proof. We indeed have $\alpha_{HC} = \lambda \frac{x-1}{\rho^2\sigma^2} = \hat{\alpha}$ when $\rho = 1$. □

When FIs are short-sighted (i.e. $\rho < 1$), HCA makes them understate the real risk associated with the risky asset, which induces them to overinvest in it. Recall indeed that when $x \geq 1$, we have:

$$\alpha_{HC} = \lambda \frac{x-1}{\rho^2\sigma^2} \quad \text{and} \quad \hat{\alpha} = \lambda \frac{x-1}{\sigma^2}. \quad (19)$$

The drift between the first-best allocation and the one that arises when FIs are subject to HCA is measured by $\frac{1}{\rho^2}$: the smaller ρ , the bigger the drift. When FIs' time horizon shortens, the allocation between the

risky and the riskless asset that arises when FIs are subject to HCA goes further away from the first-best allocation. This is what Proposition 5 states.

Proposition 5. *When $\rho < 1$, HCA makes FIs overinvest in the risky asset. In particular, the more short-sighted FIs are (i.e. the smaller ρ is), the more they overinvest in the risky asset (i.e. $\frac{\partial \alpha_{HCA}}{\partial \rho} \leq 0$).*

Proof. When $\rho < 1$, we indeed have $\alpha_{HCA} = \lambda \frac{x-1}{\rho^2 \sigma^2} > \hat{\alpha} = \lambda \frac{x-1}{\sigma^2}$ and $\frac{\partial \alpha_{HCA}}{\partial \rho} \leq 0$ when $x \geq 1$. □

Figure 4 plots the proportions FIs invest in the risky asset when they are subject to HCA (dotted line) and in the benchmark case (solid line) as functions of ρ for some values of x . We notice that the dotted curve is always above the solid line. In addition, the distance between the two lines is indeed bigger for smaller values of ρ – i.e. when FIs are the most short-sighted. Very short-sighted FIs indeed totally disregard the risk associated with the asset when they are subject to HCA and often invest all their endowment in this asset.

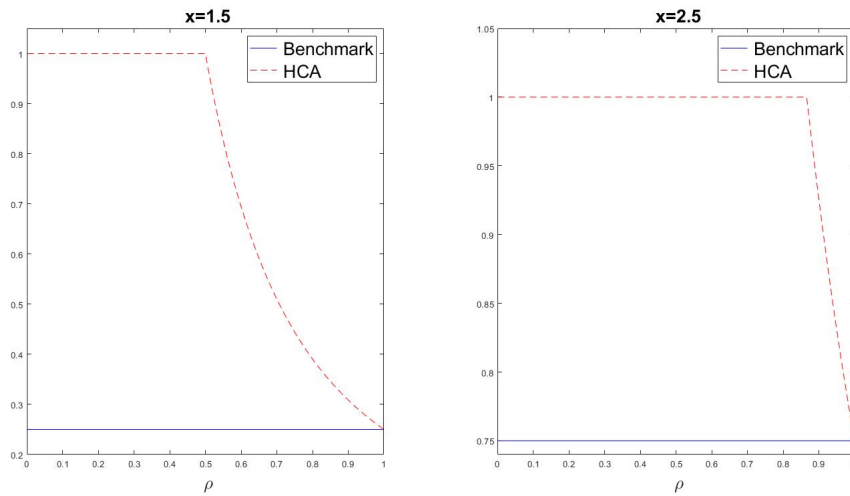


Figure 4: Proportions of the asset portfolio invested in the risky asset in the HCA case and in the benchmark case ($\lambda = 0.5$, $\delta = 0.75$ and $\sigma^2 = 1$)

5. Discussion and policy implications

Neither FVA nor HCA is *per se* a panacea. Most of the time, FVA incentivizes short-sighted FIs to underinvest in long-term assets. HCA, on the contrary, makes FIs ignore short-term market fluctuations and may therefore incentivize them to overinvest in long-term and illiquid assets. In the two cases, problems arise because the time horizon of FIs is shorter than the maturity of the assets they invest in, which is precisely the case as far as banks are concerned. Is bank accounting therefore a choice between bad and worse? We do not think so precisely because banks are not the only FIs acting on financial markets. Long-term investors, such as insurers or pension funds for instance, are characterized by far longer time horizons than banks and are therefore less affected by the problems that arise because of maturity mismatch. Those long-term investors could therefore invest in long-term assets without fearing short-term liquidity needs that could force them to fire sell those assets. On the contrary, these long-term FIs could play the role of market stabilizers by

diminishing the likelihood of such sales happening. The idea is that when prices of long-term assets are collapsing because of self-fulfilling panics rooted in short-sighted FIs' fear of illiquidity, long-term investors could act as buyers of last resort since they are in a position of waiting for those long-term assets to pay. In other words, they are able to deal with the liquidity risk and thus to benefit from the associated risk premium (Persaud, 2015). However, this mechanism is likely to take place only if those long-sighted FIs are permitted to disregard short-term market fluctuations when establishing their financial statements, meaning if they are subject to HCA and do not have to comply with risk-based capital ratios where risk is defined as short-term prices' fluctuations. In other words, when long-sighted FIs, such as insurers or pension funds, resort to HCA and short-sighted FIs to FVA, the inefficiencies associated with accounting rules are likely to be reduced in at least two respects. First, the likelihood of panic sales may be reduced since long-sighted FIs could buy panic sold assets. Second, the asset allocation is likely to be closer to the first-best allocation since the investment behaviors of long-sighted and short-sighted FIs – i.e. over-investment in the former case, under-investment in the latter – may compensate each other.

What is finally implied by our model is that accounting regulation, and more broadly financial regulation, should take FIs diversity into account. This diversity is indeed a natural stabilizer that could ensure the funding of all types of assets without sacrificing financial stability. What is indeed clear from the 2007-2008 crisis is that excessive homogeneity may be the greatest threat to financial stability (Wagner, 2010; Haldane, 2013).

6. Conclusion

This paper presents a theoretical model that assesses the impact of accounting rules on the investment's decision of financial institutions. We show that the mismatch between financial institutions' time horizon and the duration of the risky asset they invest in gives rise to real effects of accounting. Those real effects are not the same whether FIs resort to FVA or to HCA. FVA makes FIs overreact to the expectations they forge concerning the behavior of others. Strategic complementarities arise and they give birth to self-fulfilling sales of the risky asset whose expectation incentivizes FIs to underinvest in the risky asset when its expected return is low. When the expected return associated with the risky asset is on the contrary high enough – and provided that the market is not too illiquid – FVA makes FIs understate the risk associated with the risky asset, which induces them to overinvest in it. When FIs are subject to HCA, they always overinvest in the risky asset. An accounting regime where long-sighted financial institutions are allowed to resort to HCA while shorter-sighted institutions use FVA may make it possible to lessen the distortions induced by the use of FVA.

These results are in line with the idea that accounting rules should be designed in accordance with the nature of the activities led by financial institutions. In this perspective, since insurers are engaged in long-term activities, they should be offered the possibility to use HCA while banks are better off resorting to FVA. This is more or less what is to be found in IFRS 9 since it offers the opportunity for FIs to resort to HCA

for long-term assets that are expected to be held until their maturity. However, under IFRS 9, FVA remains the default option for all FIs, HCA being only an available option for certain types of assets.

Appendix A. Mathematical proofs

Appendix A.1. Proof of Lemma 1

The proof is based on [Plantin et al. \(2008b\)](#). We assume that FIs resort to a threshold strategy. In other words, FI i decides to sell its risky asset whenever $x_i < x^*$ and to hold it to maturity whenever $x_i \geq x^*$. We want to show that, conditional on receiving a signal exactly equal to x^* , the density over the proportion of FIs that sell their risky asset is given by the uniform density provided that $\eta \rightarrow 0$. In this case, we have $s(x^*) = \frac{1}{2}$ and thus the threshold value of x^* presented in Lemma 1.

We know that every signal x_i is uniformly distributed on $[\theta - \eta, \theta + \eta]$. In this case, the proportion of FIs that decide to sell their risky asset is equal to:

$$\Pr[x < x^*] = \frac{x^* - \theta + \eta}{2\eta}. \quad (\text{A.1})$$

Let us denote by z this proportion. Let us denote by θ^* the value of θ that satisfies equation (A.1). We thus have:

$$\theta^* = x^* + \eta(1 - 2z). \quad (\text{A.2})$$

Whenever $\theta \geq \theta^*$, the proportion of FIs that decide to sell is less than or equal to z . On the contrary, when $\theta \leq \theta^*$, this proportion is greater than or equal to z . Let us denote by $G(\cdot)$ the cumulative distribution function over the proportion of FIs that sell their risky asset. $G(z)$ is thus given by the probability that θ is above θ^* :

$$G(z) = \Pr[\theta \geq \theta^*]. \quad (\text{A.3})$$

Since the noise term ε_i is uniformly distributed on $[-\eta, \eta]$, we know that the *posterior* distribution of θ conditional on observing a signal equal to x^* is:

$$\frac{f(\theta)}{\int_{\theta^* - \eta}^{\theta^* + \eta} f(x) dx}. \quad (\text{A.4})$$

The support of this conditional density is $[\theta^* - \eta, \theta^* + \eta]$. Assuming that the *prior* density $f(\theta)$ is continuous, we know that the *posterior* density reaches a maximum $M(\eta)$ and a minimum $m(\eta)$ that meet the following condition:

$$\lim_{\eta \rightarrow 0} (2\eta M(\eta)) = \lim_{\eta \rightarrow 0} (2\eta m(\eta)) = 1. \quad (\text{A.5})$$

Conditional on observing x^* , the probability that $\theta \geq \theta^*$ is equal to the area under the *posterior* density of θ to the right of θ^* . $G(z)$ is equal to this area according to (A.3). We thus have:

$$2\eta m(\eta) \left(\frac{x^* - \theta^* + \eta}{2\eta} \right) \leq G(z) \leq 2\eta M(\eta) \left(\frac{x^* - \theta^* + \eta}{2\eta} \right). \quad (\text{A.6})$$

From the sandwich theorem, we finally have:

$$\lim_{\eta \rightarrow 0} G(z) = z. \quad (\text{A.7})$$

$G(\cdot)$ is thus the identity function when $\eta \rightarrow 0$. In this case, we know that the density function over the proportion of FIs that decide to sell their risky asset is the uniform density.

Appendix A.2. Proof of Lemma 2

According to the mean-variance assumption FIs maximize the following utility function:

$$U(\mu_p, \sigma_p^2), \quad (\text{A.8})$$

where μ_p is the mean and σ_p^2 the variance of the random return $\tilde{\pi}_{FV}$ associated with the asset portfolio:

$$\tilde{\pi}_{FV} = \alpha_{FV} \{(1 - \rho)(\delta\theta - \gamma s_x \alpha_{FV}) + \rho\theta - 1\} + 1. \quad (\text{A.9})$$

We therefore have:

$$\mu_p | x = \alpha_{FV} \{(1 - \rho)(\delta x - \gamma s_x \alpha_{FV}) + \rho x - 1\} + 1, \quad (\text{A.10})$$

and

$$\sigma_p^2 | x = \alpha_{FV}^2 \{(1 - \rho)\delta + \rho\}^2 \sigma^2, \quad (\text{A.11})$$

where $\sigma^2 = V(\theta | x)$. The value of α_{FV} is given by the following first-order condition:

$$\begin{aligned} & \frac{\partial U}{\partial \mu_p} \frac{\partial \mu_p}{\partial \alpha_{FV}} + \frac{\partial U}{\partial \sigma_p^2} \frac{\partial \sigma_p^2}{\partial \alpha_{FV}} = 0 \\ \iff & \frac{\partial U}{\partial \mu_p} \{(1 - \rho)(\delta x - 2\gamma s_x \alpha_{FV}) + \rho x - 1\} \\ & + 2\alpha_{FV} \frac{\partial U}{\partial \sigma_p^2} [(1 - \rho)\delta + \rho]^2 \sigma^2 = 0. \end{aligned} \quad (\text{A.12})$$

We can consequently compute the value of α_{FV} as follows:

$$\alpha_{FV} = - \frac{\frac{\partial U}{\partial \mu_p} \{[\delta + \rho(1 - \delta)]x - 1\}}{2 \frac{\partial U}{\partial \sigma_p^2} [\delta + \rho(1 - \delta)]^2 \sigma^2 - \frac{\partial U}{\partial \mu_p} 2(1 - \rho)\gamma s_x}. \quad (\text{A.13})$$

Therefore, the value of α_{FV} is given by:

$$\alpha_{FV} = \frac{Ax - 1}{\lambda^{-1} A^2 \sigma^2 + 2s_x(1 - \rho)\gamma}, \quad (\text{A.14})$$

where $A = \delta + \rho(1 - \delta)$.

We now want to show that there exists a unique value of α_{FV} that satisfies equation (A.14). Given that α_{FV} is a proportion, we necessarily have $\alpha_{FV} \in [0, 1]$. Thus for α_{FV} to exist we must necessarily have

$\frac{Ax - 1}{\lambda^{-1} A^2 \sigma^2 + 2s_x(1 - \rho)\gamma} \in [0, 1]$. Let us define the following function:

$$g(\alpha_{FV}) = \alpha_{FV} - \frac{Ax - 1}{\lambda^{-1} A^2 \sigma^2 + 2s_x(1 - \rho)\gamma}. \quad (\text{A.15})$$

We have:

- $g(0) < 0$ provided that $Ax - 1 > 0$ (if $Ax - 1 = 0$, we immediately have α_{FV} exists, unique and equal to 0),
- $g(1) \geq 0$,
- $\frac{\partial g(\alpha_{FV})}{\partial \alpha_{FV}} \geq 0$ because s is an increasing function in α_{FV} according to Lemma 1.

The intermediate value theorem ensures that there exists a unique value of $\alpha_{FV} \in [0, 1]$ such that equation (A.14) is satisfied.

Appendix A.3. Proof of Proposition 3

Let us define $A = \delta + \rho(1 - \delta)$ and $B = 2s_x\lambda(1 - \rho)$. In this case, we have $\alpha_{FV} = \frac{Ax-1}{\lambda^{-1}[A^2\sigma^2+B\gamma]}$ and $\hat{\alpha} = \lambda \frac{x-1}{\sigma^2}$. Recall that when θ is the true value of the return of the risky asset, we have x uniformly distributed on $[\theta - \eta, \theta + \eta]$.

We thus have:

$$\begin{aligned} \alpha_{FV} &\geq \hat{\alpha} \\ \iff \left(1 - \frac{\frac{1}{A} - \theta + \eta}{2\eta}\right) \lambda \frac{Ax-1}{A^2\sigma^2+B\gamma} &\geq \left(1 - \frac{1-\theta+\eta}{2\eta}\right) \lambda \frac{x-1}{\sigma^2} \\ \iff \left(2\eta - \left(\frac{1}{A} - \theta + \eta\right)\right) \frac{Ax-1}{A^2\sigma^2+B\gamma} &\geq (2\eta - (1 - \theta + \eta)) \frac{x-1}{\sigma^2}. \end{aligned} \quad (\text{A.16})$$

When $\eta \rightarrow 0$, we have:

$$\begin{aligned} \alpha_{FV} &\geq \hat{\alpha} \\ \iff \left(x - \frac{1}{A}\right) \frac{Ax-1}{A^2\sigma^2+B\gamma} &\geq (x-1) \frac{x-1}{\sigma^2}. \\ \iff \left(x - \frac{1}{A}\right) (Ax-1)\sigma^2 &\geq (x-1)^2 (A^2\sigma^2 + B\gamma) \\ \iff \left[\frac{\left(x - \frac{1}{A}\right)(Ax-1)}{(x-1)^2} - A^2\right] \sigma^2 &\geq B\gamma. \end{aligned} \quad (\text{A.17})$$

Let us define the following function:

$$h(x) = \left[\frac{\left(x - \frac{1}{A}\right)(Ax-1)}{(x-1)^2} - A^2\right] \sigma^2 - B\gamma. \quad (\text{A.18})$$

When $x = \frac{1}{A}$, we have $h(x) < 0$.

We have $\lim_{x \rightarrow \infty} h(x) = (A - A^2)\sigma^2 > 0$, since $\lim_{x \rightarrow +\infty} \frac{\left(x - \frac{1}{A}\right)(Ax-1)}{(x-1)^2} = A$ and $\lim_{x \rightarrow +\infty} B = 0$.

In addition it is easy to show that $\frac{\partial h(x)}{\partial x} > 0$ when $x \geq \frac{1}{A}$.

The intermediate value theorem thus ensures that there exists a unique value of x , denoted \bar{x} , such that $h(x) \geq 0$ when $x \geq \bar{x}$ and $h(x) < 0$ otherwise.

In sum, we have $\alpha_{FV} \leq \hat{\alpha}$ whenever $x < \bar{x}$ is small enough, and $\alpha_{FV} \geq \hat{\alpha}$ when $x \geq \bar{x}$.

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