Career Concerns, Long-Term Contracts and Short-Maturity Investments in Mutual Funds

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Abstract. An important puzzle in financial economics is why fund’s managers invest in short-maturity assets when they could obtain larger profits in assets with longer maturity. This work provides an explanation for this fact based on the labor contracts signed between institutional investors and fund’s managers. Using the career concerns setup, we examine how the optimal contract design, in the presence of both explicit and implicit incentives, affects the fund manager’s decisions on investment horizons. Conditions under which young (old) managers prefer short-maturity (long-maturity) positions are stated and the robustness of these results to some extensions is evaluated. Our main findings suggest that the framework considered in this work may be a good starting point for explaining episodes of overreaction in stock prices.

Keywords: Contract Theory, Career Concerns, Momentum Strategies, Financial Markets, Asset Pricing.

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1 Introduction

One of the most puzzling results in financial economics is why fund’s managers invest in short-maturity assets even though they could obtain larger profits in assets with longer maturity. This puzzle may become particularly important as long as the large recurrence of this phenomenon may eventually affect the equilibrium prices in financial markets. In this paper, we propose an explanation for this puzzling behavior based mainly upon two facts. First, during the last decades the institutional investors have increased dramatically their participation in the financial system. Consequently, it is reasonable to conjecture that the labor contracts signed by this class of investors and their managers may play an important role as determinants of the stock prices’ dynamics. Second, there is a recent evidence supporting the fact that young fund’s managers exhibit a clear bias in favor of short-maturity securities. This suggests thus the usefulness of considering a theoretical framework in which decisions on investment maturities may be driven by an age-based agent heterogeneity.

We combine these two facts in a career concerns-based model in which the institutional investor (the principal) designs an optimal contract that considers the explicit and implicit incentives of two class of fund’s managers (the agents): young and old traders. The former is a trader which care about how the current performance affect his future compensation and the latter is a trader without career concerns. The major prediction of our model is that, under certain conditions, this optimal contract leads the young (old) managers to prefer short-maturity (long-maturity) investments. Within the career concerns set-up, the intuition behind this result is quite simple. Since the history of old traders’ performance have already been revealed, the principal’s prediction about their ability is better than that made when they are young. This implies that the fund’s owner exhibits more reliability on old traders than the young ones, authorizing therefore the formers to hold bolder positions.

The main implication of our model is that such an investment horizon bias may eventually explain some episodes of stock price overreactions observed in practice. This means therefore that our setting is able to shed light on a very relevant financial puzzle by characterizing an interesting and so far unexplored link between both the labor market and the financial market. In this sense, our final extension takes into account the impact of including career concerns in stock

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1For instance, on the New York Stock Exchange, the percentage of outstanding corporate equity held by institutional investors has increased 7.2% in 1950 to 49.8% in 2002 (NYSE Factbook 2003).
markets equilibrium, based on Hong (1998).

Furthermore, we extend our model by performing a sensibility analysis of the results whether we include both career-risk concerns - how the agent’s current performance affects the variation in his future compensation - and training on-the-job costs. On the one hand, our findings suggest that the main results hold when the managers’ career concerns prevail, i.e., when the substitutability between explicit and implicit incentives is still observed. On the other hand, the training on-the-job costs increase the probability that young managers prefer non-contingent long-term contracts, i.e., increases the incentives to hold long-maturity assets. However, as long as the difference between the short-maturity investments variance and the long-maturity one is sufficiently large, the young manager’s short-term contract surplus becomes eventually greater than the long-term one, reversing therefore the horizon decisions.

Our work is in connection with a plenty of literature, both theoretical and applied one. For instance, one of the works that supports empirically the fund’s managers preferences for short-maturity positions is that of Chevalier and Ellison (1999). They find that young fund’s managers are more risk averse in selecting their portfolios -by choosing short-maturity securities- than the old ones, even though in this way, they obtain less profits by comparison with what they could get holding more mature assets. Furthermore, their results suggest a nonlinear relationship between managerial turnover and mutual fund’s performance. This means that for young traders the managerial turnover is more performance-sensitive than the old ones and they observe a U-shape in the relationship between managerial turnover and trader’s performance. Chevalier and Ellison explain this fact through the differences in the career concerns among them. In this way, as well as Dutta and Reichelsen (2003) and Sabac (2006), our work tries to explain theoretically this empirical evidence through the differences in the pay-for-performance sensitivity between young and old managers.

Moreover, a large literature in economics and finance have studied the determinants of the executive compensation contracts. Nevertheless, only a minority part has focused on how the fund managers’ implicit incentives affect the design of these contracts, and through this, the investment horizon decisions. The exceptions are Gibbons and Murphy (1992), Meyer and Vickers (1997), Dutta and Reichelsen (2003), Christensen et al. (2005) and Sabac (2006). All of these works study how optimal contracts including manager’s career concerns can explain the aforementioned nonlinear managerial turnover-performance relationship for young and old managers. In general, this literature analyzes dynamic settings with short-term contracts based on the career concerns model developed by Holmström (1999).
For instance, Gibbons and Murphy (1992) assume that the principal’s bargaining power is null, i.e. that the principal’s expected surplus is zero in equilibrium. On the contrary, Meyer and Vickers (1997) develop a model in which the bargaining power is on the principal’s hands, i.e., in equilibrium the agent’s certainty equivalent is zero at each contracting date. Another difference between both works is that while the former shows the equivalence between short-term contracts and renegotiation-proof contracts, the latter proves that the agent’s effort in equilibrium and the total surplus are independent of the bargaining power. Trying to encompass these models, Sabac (2006) characterizes the optimal short-term contract which satisfies renegotiation-proof including long-term actions, when today actions affect not only today but also tomorrow performance. Unlike all this literature, we attempt to explain how the fund manager’s horizon investment decisions are determined by the design of his optimal labor contracts regarding both short and long-term actions.

Finally, our paper is also related to some corporate finance literature. In particular, Von Thadden (1995) constructs a dynamic model with asymmetric information between risk neutral investors and firms. Under his framework, it make impossible to implement long-term projects under certain circumstances which are more profitable. This work then tries to explain why some myopic lenders could induce to their borrowers -an entrepreneur firm- to invest in short-term projects. However, unlike our setting, Von Thadden takes only into account the risk-neutral agent’s explicit incentives but not his implicit incentives.

The paper is organized as follows. Section 2 sets up a principal-agent model that predicts under which circumstances the optimal contract induces to the fund’s manager to make some investment horizon decision. In Section 3, we examine the robustness of the results in front of human capital risk and training on-the-job costs. As an extension of the previous result, Section 4 examines the Hong and Stein (1999)’s model by analyzing the behavior of asset returns when we consider the different incentives resulting from contracts signed by young and old momentum traders. Finally, Section 5 summarizes and discusses other possible extensions. All the proofs are contained in the Appendix.

2 The Model

The output performance process

Consider an agency model in which the principal is the mutual fund’s owner and the agent corresponds to the trader, who for simplicity we assume that is the
mutual fund’s manager as well. The trader works for two periods. In period 1, the trader selects his investment portfolio. The output performance of this process corresponds to the variation of the value of the investments (i.e. the gains of capital) denoted by \( z_t \), and is given by an additive formulation of the trader’s ability (\( \eta \)), the trader’s non-negative effort (\( a_t \)) and a noise (\( \mu_t \)), as follows

\[
z_t \equiv \Delta I_t = \eta + a_t + \alpha a_{t-1} + \mu_t
\]

We suppose that \( \eta \) is normally distributed with mean \( m_0 \) and variance \( \sigma_0^2 \). Similarly, we assume that the noise \( \mu_t = \mu_t^H + \delta_t \) is normally distributed with mean \( \mu_t^H \) and variance \( \sigma_0^{2H} \) as \( \delta_t \) is zero-mean normally distributed with variance \( \sigma_0^{2H} \). Here, the index \( H \) denotes the horizon of the investment so that \( H = S, L \) means short-term -managers trade short-maturity securities- and long-term investment -managers trade long-maturity securities-, respectively. Moreover, independence among \( \mu_t \)’s and with ability \( \eta \) is assumed. In addition, as it is standard in the career concerns literature, we assume that the true ability of the trader is unknown even for himself. As a consequence, the principal only adjusts her beliefs on the mean and the variance of this ability based upon the information revealed through the investment returns observed in the previous period.

We assume the principal design a set of contracts: long-term and short-term labor contracts which depend linearly of his investments. Therefore, the kind of contracts affect directly the stochastic production process through his random part. Given this setup, the agent decides not only about the effort but also the horizon of his investments (short-maturity assets versus long-maturity ones). The differences in returns in the set of contracts are incorporated through the mean and the variance of the investment’s noise part. Following Von Thadden (1995), we assume that the short-term investment gives more benefits in the first-period than the long-term one. However, regarding the total gains for the two periods, long-term assets are more profitable than short-term ones. Furthermore, we suppose that the long-term investment is more risky than the short-term one. These ideas are formalized by means of the next additional assumptions: (i) \( \mu_1^S > \mu_1^L \), (ii) \( \mu_2^S < \mu_2^L \), (iii) \( \mu_1^S + \gamma \mu_2^S < \mu_1^L + \gamma \mu_2^L \) and (iv) \( \sigma_0^{2S} < \sigma_0^{2L} \), where \( \gamma \) represents a discount factor.

Unlike Holmstrom (1999) or Gibbons and Murphy (1992), we also consider a lag of effort in the stochastic production process (i.e. the investment return). When \( \alpha \) is equal zero, the agent’s action is short-term, in the sense, only affects the today performance; otherwise, it is a long-term one since could explain the future performance. The rationale of this assumption is that the return of the investments depends in part on the trader’s ability to interpret correctly the trends of the stock market. This ability can be seen as a learning process that is improved
not only with the effort exerted in the current period, but also that made in the previous period. For instance, suppose that there exists a trader who makes his best effort in studying some economic sector in order to analyze a specific asset of his portfolio. We assume then, the model would be that this effort is not reflected in the current variation of investments, for example, bad news in the macroeconomic variables. However, the information obtained with the previous period effort could help him to interpret the tendency of prices in the next period and he could thus obtain successful results.

**The payoff functions**

Assume that all the bargaining power is on agent’s hands. The trader is risk-averse with the following exponential utility function:

\[
U(w_1, w_2; a_1, a_2) = -\exp\left(-r\left\{\sum_{t=1}^{2} \gamma^{t-1} [w_t - g(a_t)]\right\}\right)
\]

where \(w_t\) is the agent’s wage, \(g(.)\) measures the disutility of effort and \(r\) corresponds to the absolute risk-aversion index. We assume that \(g(.)\) is convex and satisfies \(g'(0) = 0, g'(\infty) = \infty\) and \(g'''' \geq 0\).

The fund’s owner is risk-neutral with a profit function given by\(^2\)

\[
\pi = \sum_{t=1}^{2} \gamma^{t-1} \{z_t - w_t\}
\]

**Type of Employment Contracts**

We assume throughout the paper that all employment contracts offered by fund’s owners to traders corresponds to linear contracts of the form \(w_t(z_t) = c_t + b_t z_t\). In this reward scheme, \(c_t\), the fixed part, represents the insurance wage since traders are risk averse.and \(b_t\), the variable component, is called the pay-for-performance sensitivity.

Within this linear formulation, we additionally specify four different types of labor contracts. First, we characterize two general class of contracts according to its duration: long-term and short-term contracts. In this set-up, a long term contract lasts for two periods and a short-term one only lasts for one-period. Consequently, the trader only invests in long-maturity assets under long-term labor contracts and he only chooses short-maturity securitites under short-term ones. This is the main characteristic of this model. In this sense, the long-term labor contract

\(^2\)We normalize the price of output to unity.
uncertainty is different than the short-term one. Second, we additionally consider two types of labor contracts according to whether they are either contingent or non-contingent to the first-period results.

All of this results in four classes of labor contracts. Nevertheless, notice that short-term labor contracts with non-contingent continuation are always strictly dominated by long-term ones. The reason is mainly because two short-term labor contracts imply less expected returns than one long-term labour contract since long-maturity assets are more profitable than short-maturity ones.

In order to our model account for empirical facts which show us different investment horizon decisions among traders, we only consider two kind of employment contracts:

(1) Long-term contract with continuation after $z_1 \leq \bar{z}(LC)$.

This is a two-period labor contract in which it does not matter what happens to the first-period output. In this sense, it is non-contingent because the continuation of the labor contract to the second-period does not depend on the first-period results. This contract allows then the trader to perform long-term investments.

(2) Short-term contract with termination after $z_1 < \bar{z}$ ($ST$). In this contract, we include two short-term labor contracts, each one for every period. However, if the first period results are less than certain threshold $\bar{z}$, the whole contract finishes and is not renewed to the second period. In this sense, it is a contingent labor contract because under the condition $z_1 > \bar{z}$, the second-period short-term contract is exerted. This contract allows the trader to perform only short-term investments.

Now, to characterize more clearly the optimal contract, let us define $y(z_1)$, an indicator function refered as to continuation decision variable, as follows

$$y(z_1) = \begin{cases} 
0 & \text{if the contract is terminated} \\
1 & \text{if the contract is continued}
\end{cases}$$

Timing of the contracting game

3We do not consider the long-term contract with termination after $z_1 \leq \bar{z}(LT)$. This is originally a two-period labor contract. However, if the first period results are less than certain threshold $\bar{z}$, the contract finishes and is not renewed to the second period. In this sense, it is a contingent labor contract because under the condition $z_1 > \bar{z}$, the contract lasts for two periods. This contract also allows the trader to undertake long-term investments.

This is a kind of contract between non-contingent long-term labor contracts and contingent short-term labor contracts. In this sense, we get similar results in several cases as first type of contract, i.e., non-contingent long-term labor contract.

4For instance, $\bar{z}$ could be equal zero. Thus, after bad results, the contract is not renegotiated.
The timing of this game depends on the type of contract offered by the principal. On the one hand, in the case of short-term labor contracts, the timing is as follows. At the beginning of the first period, prospective employers simultaneously offer the trader single-period linear wage contracts \( w_1(z_1) \) as defined before and he chooses the most attractive one. At the end of the first period, the principal and the market observe the output \( z_1 \). At the beginning of period 2, if they observe good results, they simultaneously offer the trader another single-period linear wage contract \( w_2(z_2) \). This contract allows the trader to invest only in short-maturity securities.

On the other hand, there also exists long-term labor contracts in which employers simultaneously offer \( w_1(z_1) \) and \( w_2(z_2) \) in the first period, and the trader chooses the best reward plan.

**Characterization of the Optimal Contract**

Given these compensation contracts, the trader’s expected utility is a function of the first and second period effort as follows

\[
-E \left\{ \exp(-r [w_1(z_1) - g(a_1)]) - r \gamma [I_z [w_2(z_2) - g(a_2)]] \right\} \tag{2}
\]

where \( I_z \equiv [(I_{z_1 > z}) + y(z_1)I_{z_1 \leq z})I_{z_2 > z}] \). Notice that we include the indicator function \( I_{z_2 > z} \) in order to shrink only to the cases with positive second-period results since if the trader obtains zero results in the final session, he also obtains zero wage. Furthermore, we include \( I_{z_1 > z} \) and \( I_{z_1 \leq z} \) in order to encompass in this expression not only non-contingent contracts but also the contingent ones.\(^5\)

The main difference between the contract \( LT \) and \( ST \) is given by both \( P(z_1 > z) \) and \( P(z_2 > z) \). On the one hand, in the short-term labor contract the trader only (can select?) invests in short-term investments. Thus, \( P(z_1 > z) \) only depends on the uncertainty of this class of investments. On the other hand, since the long-term labor contract allows the trader to hold long-term positions, this probability depends on the (different) characteristics of the distribution of this type of investments.\(^6\)

In order to solve this problem, consider the Subperfect Nash Equilibrium (SPNE) concept. Consequently, we apply backward induction so that we begin characterizing the second-period effort problem.

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\(^5\)With a non-contingent and contingent contracts and good results in period 2, \( I_z = I_{z_1 > z}I_{z_2 > z} = P(z_1 > z)P(z_2 > z) \) if \( z_1 > z \) but \( I_z = I_{z_1 \leq z}I_{z_2 > z} \) if \( z_1 \leq z \) in the non-contingent contract and \( I_z = 0 \) if \( z_1 \leq z \) in the contingent one.

\(^6\)\( P(z_1 > z) \) in the short-term investments is larger than \( P(z_1 > z) \) in the long-term ones given the differences in the uncertainty.
First-period contract. From the perspective of the second-period trader, after the first-period effort \( a_1 \) and horizon investment \( H \) have been chosen and \( z_1 \) has been observed, his effort choice problem is given by

\[
\max_{a_2} -E \{ \exp(-r [I_z [c_2 + b_2 z_2 - g(a_2)])] | z_1 \}
\]

Hence, \( a^*_2(b_2) \), the optimal second-period agent’s effort choice satisfies\(^7\)

\[
g'(a_2) = b_2
\]

Note that we assume that all the bargaining power is on the agents’ hands. This means that competition among prospective second-period employers implies that the contract the trader accepts for the second period must generate zero expected profits. Therefore, the principal’s zero profit condition at period 2 is given by

\[
\pi_2 = E \{ z_2 | z_1 \} - I_z [c_2^*(z_1, b_2) + b_2 E \{ z_2 | z_1 \}] = 0
\]

Hence, the optimal fixed part of the second-period wage can be obtained using the following condition

\[
I_z c_2^*(z_1, b_2) = (1 - I_z b_2) E \{ z_2 | z_1 \} = (1 - I_z b_2) \left[ E \{ \eta | z_1 \} + a_2^*(b_2) + \alpha \hat{a}_1 + \mu_2^H \right]
\]

where \( \hat{a}_1 \) corresponds to....Using De Groot (1970), it can be stated that the conditional distribution of \( \eta \) given the observed first-period output \( z_1 \) is Normal with mean

\[
E \{ \eta | z_1 \} = m_1(z_1, \hat{a}_1) = \frac{\sigma^H_\delta (m_0 + \mu_1^H) + \sigma^2_0 (z_1 - \hat{a}_1)}{\sigma^2_0 + \sigma^2_\delta^H}
\]

and variance

\[
V \{ \eta | z_1 \} = \sigma^2_\eta = \frac{\sigma^2_0 \sigma^2_\delta^H}{\sigma^2_0 + \sigma^2_\delta^H}
\]

Let \( \Sigma^H_2 \equiv \sigma^2_\eta + \sigma^2_\delta^H \), the conditional variance of \( \eta + \mu_2 \) given the observed first-period output \( z_1 \).

Therefore, for an arbitrary \( b_2 \), given the first-period output \( z_1 \), the market believes that:

\[
-E \{ \exp(-r [I_z c_2^*(z_1, b_2) + I_z b_2 z_2 - I_z g(a_2^*(b_2))]) | z_1 \} = m_1(z_1, \hat{a}_1) + a_2^*(b_2) + \alpha \hat{a}_1 + \mu_2^H - I_z g(a_2^*(b_2)) - 1/2r \left[ I_z b_2^2 \Sigma^H_2 \right]
\]

\(^7\)In order to solve this model, we consider some statistical assumptions. See Appendix 1.
Now, using the first order conditions of this optimization problem, we get the following expression for $b_2$:

$$b_2^C = \frac{1}{1 + r\Sigma^2 g''(a_2)} I_z$$

where $C = LC$ and $ST$.

**Second-period contract.** Given the optimal second-period contract derived above, the trader’s first-period incentive problem is to choose $a_1$ to maximize:

$$-E \{ \exp(-r [c_1 + b_1 z_1 - g(a_1)] - r\gamma I_z [c_2^*(z_1, b_2) + b_2^* z_2 - g(a_2^*(b_2))]) \}$$

(8)

From the first-order condition of this problem, we obtain

$$g'(a_1) = b_1 + \gamma \frac{\partial c_2^*(z_1, b_2)}{\partial a_1}$$

$$= b_1 + \gamma (1 - I_z b_2) \left( \frac{\sigma_0^2}{\sigma_0^2 + \sigma_2^2} - \alpha \right)$$

$$= B_1$$

(9)

So far we have taken $\hat{a}_1$ as given. Thus, the last expression characterizes implicitly the trader’s best response to the market’s second-period conjecture about the first-period effort, $\hat{a}_1$. Since equation (11) does not depend on $\hat{a}_1$, in equilibrium, the market’s conjecture coincides with the optimal first period effort. Therefore, the equilibrium conjecture is

$$\hat{a}_1 = a_1^*(b_1)$$

As was established before, the principal’s expected profit must be zero in each period. Hence, assuming $a_0 = 0$, we have that

$$c_1(b_1) = (1 - b_1)E \{ z_1 \}$$

$$= (1 - b_1)(m_0 + a_1^*(b_1) + \mu_1^H)$$

(10)

Substituting $a_1^*(b_1)$ and $c_1(b_1)$ into (10) yields the first-period trader’s expected utility for an arbitrary $b_1$:

$$-\exp(-r [m_0 + a_1^*(b_1) + \mu_1^H - g(a_1^*(b_1))])$$

$$-r\gamma [(m_0 + a_2^*(b_2) + a a_1^* + \mu_2^H)/I_z - g(a_2^*(b_2))]]$$

$$-r\gamma (1/2) r \left( (B_1 + \gamma b_2^* \Sigma^2 - 2 B_1 \gamma b_2^* \sigma^2) \right)$$

(11)
with $\Sigma_{1}^{B} = \sigma_{0}^{2} + \sigma_{1}^{2}$. The first-order condition of this problem with respect to $b_{1}$ gives us the following expression:

$$b_{1}^{C} = \frac{1}{1 + r \Sigma_{1}^{B} g''(a_{1}(b_{1}))} - \gamma \left(1 - I_{z}b_{2}^{C}\right) \left(\frac{\sigma_{0}^{2}}{\sigma_{0}^{2} + \sigma_{1}^{2}} - \alpha \right) - r \gamma b_{2}^{C} \sigma_{0}^{2} g''(a_{1}(b_{1})) \frac{1 + r \Sigma_{1}^{B} g''(a_{1}(b_{1}))}{1 + r \Sigma_{1}^{B} g''(a_{1}(b_{1}))}$$

(12)

**Comments on characteristics of the optimal contract.** We observe three effects which affect the variable part of the compensation or pay-for-performance part: (i) *noise reduction effect* which represents the higher the conditional variance of output, the smaller the variable compensation, i.e., principal prefers less noise in the production process, (ii) *career concerns effect* which reflects the substitutability between explicit and implicit incentives, the higher the implicit incentives measures through $b_{2}$ and the contingency or not of the contract $I_{z}$, the smaller the pay-for performance part and finally, (iii) *human capital risk effect* which represents risk averse trader wants to be compensated by high variances in his performance due to low realizations of ability.

It is worthy to note how the differences in the type of contracts affect mainly this substitutability between explicit and implicit incentives. Therefore, we observe different first-period and second-period linear wages depending on contingency or non-contingency in the contracts and its horizon - short-term or long-term. In this sense, different wages for each kind of contract.

In the next section, we endogeneize the career-risk concerns (or human capital risk) in the model which mainly affect this substitutability.

**Surplus and Investment Horizon Decisions**

First, we analyze the old trader’s surplus, $S_{\text{Old}}$, when he signs the two different aforementioned class of contracts: non-contingent long-term labor contracts ($LC$) and contingent short-term ones ($ST$). In our setup, old trader is who do not care about his future career and young one is who have career concerns.

Notice that the optimal incentives depend on the variances of the horizon investment and the variances of the manager’s ability, then, both of them determine also the agent’s total surplus. However, not only the volatility of the projects are the main components of the surplus but also the expected returns of these ones. We can see how these two effects, hereafter, term of contract effect, influence in the horizon investment’s decisions.

**Proposition 2.1** The following inequality holds $S_{\text{Old}}^{LC} > S_{\text{Old}}^{ST}$ if

(i) $z_{1} > 0$
(ii) $\sigma_3^S = \sigma_3^L$ and for any $\zeta > 0$ large enough where
\[ \mu_1^L + \gamma \mu_2^L > \zeta (\mu_1^S + \gamma \mu_2^S) \]
(iii) $\mu_1^L + \gamma \mu_2^L = \mu_1^S + \gamma \mu_2^S$ and for any $\zeta > 0$ large enough where $\sigma_3^L > \zeta \sigma_3^S$

Proof: See Appendix 1.

In the case $z_1 \leq 0$, we have $S_{ST}^{Old} < S_{LC}^{Old}$, this means the old managers prefer long-term projects with continuation after bad news because they are cover not only his risk aversion but also the risk of the project since long-maturity assets are more risky than short-maturity ones.

On the other hand, when $\sigma_3^S = \sigma_3^L$ and $z_1 > 0$, old managers prefer to invest in long-maturity projects as long as the differences in total expected returns of long-maturity assets versus short-maturity ones are large enough. In this way, if the bargaining power were at principal’s hands, fund’s owner will design a non-contingent long term labor contract such that manager chooses to put the money on long-maturity securities.

It is worthy to notice that the main difference with Von Thadden work’s is that when we include implicit incentives, long-maturity investments are preferred to short-term ones for managers without career concerns, old traders under certain conditions in expected returns of long-maturity projects and short-maturity ones.

Now, we analyze the young manager’s surplus, $S_{young}$, when he accepts our two type of labor contracts, long-term and short-term. Notice that, young traders care about how his current performance affect his future compensation, i.e., traders who have career concerns.

**Proposition 2.2** The following inequality holds $S_{ST}^{young} > S_{LC}^{young}$ if

(i) $z_1 > 0$
(ii) $\sigma_3^S < \sigma_3^L$ and for any $\zeta > 1$ large enough such that $\mu_1^L + \gamma \mu_2^L > \zeta (\mu_1^S + \gamma \mu_2^S)$

Proof: This result is obtained using the fact $b_{ST}^1 > b_{LC}^1$ explained by $\sigma_3^S < \sigma_3^L$ and the implicit incentives.

In sum, under certain conditions about differences in volatility and expected returns between long-term investments and the short-term ones, young managers can choose short-term investment’s decision and old managers can make long-term

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8As far as the variances of the two kind of projects are equal.
ones. The intuition behind this result is that since the history of old traders’ performance have been revealed, then, the mutual fund owners’ prediction about their ability is better that when they are young. This result implies that owners have more reliability in old traders than the young ones. Therefore, owners authorize old traders to hold positions by more time compared with young momentum traders.

**Proposition 2.3** Under certain conditions about expected returns and volatility between short-maturity assets and long-maturity ones, traders without career concerns prefer long-term labor contracts and traders with career concerns prefer short-term ones.

Inside the empirical literature, Chevalier and Ellison (1999) show the old managers hold their positions for large horizons because they are bolder in their investments strategies in mutual fund markets which reaffirm our theoretical results.

### 3 Extensions

#### 3.1 Including Human Capital Risk

In the last section, we only take into account reputation concerns, i.e., how the manager’s current performance affects the level of his future compensation, however, the agent’s current performance also affects the variation in his future compensation, hereafter, career-risk concerns or human capital risk. The main implication of this extension is we could observe complementarity between implicit and explicit incentives instead of substitutability as we seen before, which affects the last two propositions in different ways.

In order to implement this extension, we introduce a correlation in the ability process. Now, the ability or productivity measure follows a Normal Stationary AR(1) process. In this way, $\eta_i$ is correlated over time through the next system:

\begin{align}
\eta_1 &= \theta \\
\eta_2 &= \rho \theta + \sqrt{1 - \rho^2} \epsilon
\end{align}

\footnote{Mukherjee (2005) and Chen and Jiang (2004).}
As in the last section, we assume both the principal and the agent share the common prior that \( \theta \) is zero mean normal distributed with variance \( \sigma_\theta \). Further, \( \epsilon \) is a zero mean gaussian normal process independent of \( \theta \) but with variance equal to \( \sigma_\theta \). Therefore, \( \eta_1 \) and \( \eta_2 \) have the same unconditional variance. Notice that \( \rho \) has an important role in this process because when \( \rho = 1 \), we are in the benchmark case without career-risk concerns. In addition, \( \rho \) captures the degree of persistence of the agent’s career concerns since a higher \( \rho \) implies higher sensitivity of the agent’s future compensation to current-period performance. Then, introducing \( \rho \in [0,1] \), we analyze the relationship between the pay-for-performance sensitivity and the degree of the agent’s career concerns, which in some specific cases it could be a positive relationship. For simplicity, from now on, we assume \( E(\theta) = m_0 = 0 \).

Now, following Chen and Jiang (2004), we introduce a new kind of effort: information collection effort, \( e \in [0,1] \). In this way, the manager can exert another effort in order to produce a publicly verifiable report, \( r \), about his ability \( \eta \). There exists some linear relationship between the report and the ability: \( r = \eta_1 + \Delta \), where \( \Delta \) is a zero mean normal innovation term orthogonal to \( \eta_1 \) with variance \( \frac{(1-e)}{e} \sigma_\delta \). This variance implies that the higher information collection effort, the higher the precision of the report to forecast \( \eta_1 \). We assume that the principal only uses the report \( r \) for contracting goals.

As in the previous section, we assume the contract takes the linear form: \( w_t = c_t + b_t z_t + \lambda_t r \) where \( c_t, b_t \) and \( \lambda_t \) are constants. Notice that we introduce \( r \) as a variable that can help the principal to forecast the next period ability. In this way, the wage system can rewrite as:

\[
\begin{align*}
  w_1 &= c_1 + b_1 z_1 + \lambda_1 r \\
  w_2 &= c_2(r, z_1) + b_2 z_2
\end{align*}
\]

We assume \( e \) is not contractible, i.e., it is chosen by the agent after the contract is offered to him. Therefore, the timeline has the next figure:
In order to solve the model, we consider again SPNE concept. Then, using backward induction, at the beginning of the second-period after $z_1$ and $r$ are observed, $a_1$, $e$ and $H$ has been chosen, the principal chooses $c_2$ and $b_2$ to maximize the expected profit subject to the agent’s participation and the incentive compatibility constraint. Then, the second period effort choice problem is:

$$\max_{a_2} -E \{ \exp(-r [w_2 - g(a_2)] I_z | r, z_1) \}$$

thus, $a_2^*(b_2)$ satisfies $g'(a_2) = b_2$. As in the previous section, normalizing the price of output to unity and using zero profit condition, we obtain $c_2(z_1, b_2)$:

$$I_z c_2(z_1, b_2) = \{ 1 - I_z b_2 \} \cdot \left[ \rho E \{ \eta / z_1 \} + a_2^*(b_2) + a a_1 + \mu_2^H \right] \quad (17)$$

With

$$E(\eta | z_1, r) = m_1(z_1, r, a_1) = \frac{(1 - e) \sigma_0^2(z_1 - a_1) + e \sigma_0^2 \mu_1^H r + (1 - e) \sigma_0^2 \mu_1^H}{(1 - e) \sigma_0^2 + \sigma_0^2 \mu_1^H} \quad (18)$$

and variance

$$V(\eta | z_1, r) = \sigma_1^2 = \frac{(1 - e) \sigma_0^2 \sigma_0^2 \mu_1^H}{(1 - e) \sigma_0^2 + \sigma_0^2 \mu_1^H} \quad (19)$$

In this way, we observe how the reputation concerns, $\rho$, and career-risk concerns, $e$, affect the agent’s fixed wage. Now, replacing $c_2^*(z_1, b_2)$ and $a_2^*(b_2)$ in the agent’s maximization problem, we obtain $b_2^*$.
\[ b_2 = \frac{1}{1 + r \Sigma^u g''(a_2)} I_z \]

(20)

with \( \Sigma^u = \sigma^2 + \sigma^2_z \). We observe a positive implicit relationship between information collection effort and second-period explicit incentives through the the total conditional variance.

Given the optimal second-period contract derive above, the trader’s first-period incentive problem is to choose \( a_1 \) to maximize the following problem:

\[ -E \{ \exp(-r [c_1 + b_1 z_1 - g(a_1)] - r I_z [c_2^*(z_1, b_2) + b_2^* z_2 - g(a_2^*(b_2))] ) \} \]

Then, we obtain:

\[
g'(a_1) = b_1 + \gamma \frac{\partial c_2^*(z_1, b_2)}{\partial a_1}
\]

\[
= b_1 + \gamma \left\{ 1 - I_z b_2 \right\} \left[ \frac{\rho(1-e) \sigma_0^2}{(1-e) \sigma_0^2 + \sigma^2_z} - \alpha \right] \equiv B_1
\]

(21)

So far we have taken \( \hat{a}_1 \), as given. Thus, the last expression characterizes the worker’s best response to the market’s second-period conjecture about first-period effort, \( \hat{a}_1 \). Since equation (23) does not depend on \( \hat{a}_1 \), in equilibrium, the market’s conjecture coincides with the optimal first period effort.

Therefore, the equilibrium conjecture is:

\[ \hat{a}_1 = a_1^*(b_1) \]

As we established before, owners’ expected profits must be zero in each period. Hence, assuming \( a_0 = 0 \),

\[ c_1^*(b_1) = (1 - b_1) E \{ z_1 \} = (1 - b_1) \left[ m_0 + a_1^*(b_1) + \mu_1^H \right] + \lambda_1 E(r) \]

(22)

but \( E(r) = 0 \), then we obtain the same expression as our benchmark case.

Substituting \( a_1^*(b_1) \) and \( c_1^*(b_1) \) in the first-period maximization problem yields the first-period worker’s expected utility for an arbitrary \( b_1 \):
\[-\exp(-r \left[ m_0 + a_1^* (b_1) + \mu_1^H - g(a_1^* (b_1)) \right]) - r \gamma \left[ \frac{1}{2} r \left[ (B_1 + \gamma b_2^*)^2 \sum_1^{2H} - 2B_1 \gamma b_2^* \sigma_1^{2H} + (\lambda + \gamma b_2^2) \sigma_0^2 + \lambda^2 \left[ \frac{1 - e}{e} \right]^2 \sigma_0^{2H} - \gamma^2 b_2^2 \sigma_0^2 \right] \right] \]

with \( \sum_1^{2H} = \sigma_0^2 + \sigma_1^{2H} \).

Then, the first order condition with respect to \( b_1 \) gives us the following expression:

\[
\left[ b_1^{*C} = \frac{1}{1 + r \sum_1^{2H} g'' (a_1^* (b_1))} \left\{ 1 - I_z b_2^{*C} \right\} \left\{ \frac{\rho (1 - e) \sigma_0^2}{(1 - e) \sigma_0^2 + \sigma_1^{2H}} - \alpha \right\} - \frac{r \gamma b_2^* \sigma_0^2 g'' (a_1^* (b_1))}{1 + r \sum_1^{2H} g'' (a_1^* (b_1))} \right] \right) \]

with \( C = LC \) and \( ST \).

**Proposition 3.1** Since the substitutability of the explicit and implicit incentives is weaker with the presence of career-risk concerns, under the case \( z_1 > 0 \), the following inequality holds \( S_{Old}^{LC} > S_{Old}^{ST} \).

Proof: Under the assumptions \( \sigma_0^2 < \sigma_1^{2L} \) and for any \( \zeta > 1 \) large enough such that \( \mu_1^L + \gamma \mu_2^L > \zeta (\mu_1^S + \gamma \mu_2^S) \), when \( e \) is large enough, the implicit incentives vanishes, getting, in some cases, the following inequality \( b_1^{LC} > b_1^{ST} \) which assure the old managers surplus in the long-term contracts will be greater than the short-term ones.

**Proposition 3.2** The following inequality \( S_{young}^{ST} > S_{young}^{LC} \) holds if

(i) \( z_1 > 0 \) and \( e \) is small enough
(ii) \( \sigma_0^2 < \sigma_1^{2L} \) and for any \( \zeta > 1 \) large enough such that \( \mu_1^L + \gamma \mu_2^L > \zeta (\mu_1^S + \gamma \mu_2^S) \)

Proof: With the assumption that implicit incentives are strong, i.e. \( e \) is small enough, the first-period short-term labor contract surplus is greater than the long-term one. The fact implicit incentives take an important role guarantees the young managers variable compensation in the non-contingent long-term contracts.
will be smaller than the short-term ones, i.e., there exists a substitutability of implicit incentives and explicit incentives as in our benchmark case.

In sum, including career-risk concerns, there exist some cases in which both young and old managers could invest in long-maturity projects, in particular, when the implicit incentives no longer prevail.

3.2 With Training on-the-Job Spendings

First, we assume reductions in the effort costs by training on-the-job spendings only appear in the second-period contract. Let the training on-the-job costs be a linear function of the first period output, $lz_1$. In this way, young managers do not obtain advantage of this kind of benefits. Second, old managers improve their utilities when they are trained by the mutual fund only in their productivity through the reduction in their effort cost.

As in the previous section, we assume contract takes the linear form: $w_t = c_t + b_t z_t$. where $c_t$ and $b_t$ are constants. Using again SPNE concept, at the beginning of the second-period, after $z_1$, $a_1$ and $H$ has been chosen, the principal chooses $c_2$ and $b_2$ to maximize the expected profit subject to the agent’s participation and the incentive compatibility constraint. Then, the second period effort choice problem is:

$$
\max_{a_2} -E \left\{ \exp \left( -r \left[ w_2 - (1-l^2)g(a_2) \right] I_z | z_1 \right) \right\}
$$

where $l$ is the training on-the-job cost function’s parameter.

thus, $a_2^*(b_2)$ satisfies $g'(a_2) = \frac{b_2}{1-l^2}$. Since the convexity of the effort cost function, the intuition is old managers increases their effort as long as marginal training on-the-job cost increases. Now, since all the bargaining power is on the agents’ hands, i.e., competition among prospective second-period employers implies that the contract the workers accept for the second period must generate principal’s zero expected profits.

Therefore, normalizing the price of output to unity, principal’s zero profit condition is:

$$
\pi_{principal} = E \left\{ \frac{z_2}{z_1} \right\} - I_z \left[ c_2^*(z_1, b_2) + b_2 E \left\{ \frac{z_2}{z_1} \right\} + lz_1 \right] = 0
$$

Then, the optimal fixed part of the second-period wage can be obtained using the
following condition:

$$I_z c^*_2(z_1, b_2) = \{1 - I_z b_2\} \cdot \left[ E \{\eta/z_1\} + a^*_2(b_2) + \alpha \hat{a}_1 + \mu^H_2\right] - I_z l z_1$$  \hspace{1cm} (24)

$E \{\eta/z_1\}$ and $V \{\eta/z_1\}$ have the same expression as in the benchmark case without career-risk concerns.

Now, replacing $c^*_2(z_1, b_2)$ and $a^*_2(b_2)$ in the agent’s maximization problem, we obtain $b^*_2$:

$$b_2 = \frac{1}{[1 + r \Sigma^2_2 g''(a_2)] I_z}$$  \hspace{1cm} (25)

with $\Sigma^2_2 = \sigma^2_1 + \sigma^2_3$. In the same way, using the last maximization problem, we obtain $l^*$:

$$l^* = \frac{-I_z z_1}{2g(a^*_2)}$$  \hspace{1cm} (26)

Since $z_1$ is a signal about the agent’s ability, when $z_1$ is high, the principal reduces his training on-the-job spendings due to his belief the trader is a high type. It is worth remarking since $\mu^S_1 > \mu^L_1$ and $a^S_1 > a^L_1$ by the substitutability of implicit and explicit incentives, both inequalities imply $z^S_1 > z^L_1$. Using the last expression, we obtain $l^S < l^L$ which implies if we only take into account this training on-the-job effect, the non-contingent long-term contract variable compensation are greater than the contingent short-term ones in the second period, i.e., for old managers. In this way, this effect reinforce the proposition 2.2. Hereafter, we assume $l^S = 0$, because there are no incentives to the principal to invest in training on-the-job due to the term of the contract.

Given the optimal second-period contract derive above, the trader’s first period incentive problem is to choose $a_1$ to maximize:

$$-E \left\{ \exp (-r [c_1 + b_1 z_1 - g(a_1)] - r \gamma I_z \left[ c^*_2(z_1, b_2) + b^*_2 z_2 - (1 - l^2)g(a^*_2(b_2)) \right] \right\}$$

Then, we obtain:
\[ g'(a_1) = b_1 + \gamma \frac{\partial c^*_2(z_1, b_2)}{\partial a_1} \]

\[ = b_1 + \gamma \left\{ \{1 - I_z b_2\} \left[ \frac{\sigma^2_0}{\sigma^2_0 + \sigma^2_{\delta}} - \alpha \right] \right\} - \gamma l^* \equiv B_1 \quad (27) \]

So far we have taken \( \hat{a}_1 \), as given. Thus, the last expression characterizes the worker’s best response to the market’s second-period conjecture about first-period effort, \( \hat{a}_1 \). Since equation (29) does not depend on \( \hat{a}_1 \), in equilibrium, the market’s conjecture coincides with the optimal first period effort. Therefore, the equilibrium conjecture is: \( \hat{a}_1 = a^*_1(b_1) \).

As we established before, owners’ expected profits must be zero in each period. Hence, assuming \( a_0 = 0 \),

\[ c^*_1(b_1) = (1 - b_1) E \{ z_1 \} = (1 - b_1) \left[ m_0 + a^*_1(b_1) + \mu^H \right] \quad (28) \]

Substituting \( a^*_1(b_1) \) and \( c^*_1(b_1) \) in the first-period agent’s maximization problem yields the first-period worker’s expected utility for an arbitrary \( b_1 \):

\[ - \exp(-r [m_0 + a^*_1(b_1) + \mu^H - g(a^*_1(b_1))]) \]

\[ - r \gamma \left[ (m_0 + a^*_2(b_2) + \alpha a^*_1 + \mu^H_2) / I_z - (1 - l^*) g(a^*_2(b_2)) \right] + (1/2) r \left[ (B_1 + \gamma b_2^2 \Sigma^2_1 - 2B_1 \gamma b^2_2 \sigma^H_{\delta}) \right] \]

with \( \Sigma^2_1 = \sigma^2_0 + \sigma^2_{\delta} \).

Then, the first order condition with respect to \( b_1 \) gives us the following expression:

\[ b^*_1 = \frac{1 + \gamma l^*}{1 + r \Sigma^2_1 g''(a_1(b_1))} - \gamma \left\{ 1 - I_z b^*_2 \right\} \left\{ \frac{\sigma^2_0}{\sigma^2_0 + \sigma^2_{\delta}} - \alpha \right\} - \frac{r \gamma b^*_2 \sigma^2_0 g''(a_1(b_1))}{1 + r \Sigma^2_1 g''(a_1(b_1))} + \frac{r \gamma l^* \Sigma^2_1 g''(a_1(b_1))}{1 + r \Sigma^2_1 g''(a_1(b_1))} \quad (29) \]

The main implication of this extension is even young managers could prefer non-contingent long-term labor contract because the increasing of the training
on-the-job costs goes up their utility -through the increasing in their variable compensation-, there still exist some cases when the large difference between short-maturity projects variance and the long-maturity one implies young managers short-term labor contract surplus is greater than the long-term one.

We summarize the last result in the following proposition:

**Proposition 3.3** The following inequality holds $S_{ST_{young}} > S_{LC_{young}}$ if

(i) $z_1 > 0$

(ii) for any $\kappa > 0$ such that $\sigma^2_S - \sigma^2_L < \kappa$ and for any $\zeta > 1$ large enough such that $\mu^1_S + \gamma \mu^2_L > \zeta (\mu^1_S + \gamma \mu^2_L)$

4 Implications to the Financial Market Efficiency

4.1 Only Newswatchers Traders

In this section, using Hong and Stein’s model, we begin by describing how is the price formation when only newswatchers are present. The model considers that at every time $t$, the newswatchers trade claims on a risky asset. This asset pays a single liquidating dividend at time $T$. This value can be written as:

$$D_T = D_0 + \sum_{j=0}^{T} \epsilon_j$$  \hspace{1cm} (30)

where all the $\epsilon$'s are zero mean gaussian white noise random variable with variance $\sigma^2$. Now, we consider that news move gradually through the newswatchers which mainly explain the observed underreaction in asset returns$^{10}$.

**Assumption 4.1** We assume that information moves gradually across the newswatcher population. But, in $t + z - 1$ the dividend innovation will be common knowledge for all the groups.

In order to incorporate this assumption, we divide the population into $z$ equal-sized groups and that every dividend innovation can be decomposed into $z$ independent sub-innovations, $\epsilon_j = \epsilon^1_j + ... + \epsilon^z_j$, each with the same variance $\sigma^2/z$.

$^{10}$See Hong(2005).
In this sense, the timing of information release is as follows. At time $t$, $\epsilon_{t+z-1}$ begins to spread, particularly, the first newswatcher group observes $\epsilon_{t+z-1}^1$, the second group observes $\epsilon_{t+z-1}^2$, and so forth, through the last group, $z$ group, which observe $\epsilon_{t+z-1}^z$. Then, at time $t+1$, in order to diffuse the information, the first group now observes $\epsilon_{t+z}^1$, the second group observes $\epsilon_{t+z}^2$, and so forth, through the last group, which observes $\epsilon_{t+z}^1$. This rotation process continues until $t+z-1$, at which point everybody has directly observed each of the sub-innovations, i.e., $\epsilon_{t+z-1}$ has become completely public by time $t+1$.

In other words, in $t+z-1$ the dividend innovation will be common knowledge for all the groups. In order to understanding this concept, we first need to define the knowledge operator.

**Definition 4.1** The Knowledge Operator is

$$
\kappa^i(E) = \{ \omega : P^i(\omega) \subseteq E \} \quad \text{where} \quad P^i(\omega) \text{ is a partition of } \Omega.
$$

This is an alternative concept for representing agent i’s information. Knowledge operator reports all the states of the world, that is an event, in which agent i considers a certain event $E$ posible. Second, now, we will introduce the group knowledge operator.

**Definition 4.2** The Group Knowledge Operator is

$$
\kappa^G(E) \equiv \bigcap_{i \in G} \kappa^i(E)
$$

In general terms, the intersection of all events reported by the individual knowledge operators gives us the states of the world in which all members of the group $G$ know an event $E$. Thirdly, we will define the $n$th order mutual knowledge.

**Definition 4.3** The $n$th order mutual knowledge is

$$
\kappa^{G(n)}(E) = \underbrace{\kappa^G(\kappa^G(\ldots(\kappa^G(\kappa^G(E)))))}_{n\text{-times}}
$$

For $n = 2$, we have:

---

11Consider the following example. There are five states $\omega_1 = \{d_{\text{high}}, p_{\text{high}}\}$, $\omega_2 = \{d_{\text{high}}, p_{\text{low}}\}$, $\omega_3 = \{d_{\text{low}}, p_{\text{high}}\}$, $\omega_4 = \{d_{\text{low}}, p_{\text{low}}\}$, $\omega_5 = \{d = 0, p = 0\}$. The event $E$ could be "dividend is high", then, $E = \{\omega_1, \omega_2\}$. Suppose that individual i knows event $E$ only in state $\omega_1$, this means that $\kappa^i(E) = \omega_1$. 

---
This means, if an event \( E \) is \( n \)th order mutual knowledge, then everybody knows \( E \) and everybody knows that everybody knows \( E \) and so on. Finally, an event is common knowledge if everybody knows that everybody knows that everybody knows and so on ad infinitum that event \( E \) is true\( ^{12} \).

**Definition 4.4** \( E \) is common knowledge if

\[
ck(E) \equiv \cap_{n=1}^{\infty} \kappa^{G(n)}(E) = \kappa^{G(\infty)}(E)
\]

It is worthy to note that this rotation process implies that even as information moves slowly across population, everybody is on average equally well-informed. Then, the parameter \( z \) is a proxy for the rate of information flow because higher values of it implies slower information diffusion.

In order to solve this model, we need to establish two additional asumptions.

**Assumption 4.2** At every time \( t \), newswatchers formulate their asset demands based on the static-optimization notion.

This static-optimization notion consists in the assumption that they buy and hold the risky asset until the liquidating dividend at time \( T \).

**Assumption 4.3** While newswatchers can condition on the information sets described above, they do not condition on current or past prices.

Finally, we assume that all newswatchers have constant absolute risk aversion (CARA) utility function with the same risk-aversion parameter, and all of them live until the ending date \( T \). For simplicity, we assume that the riskless interest rate is normalized to zero, and the supply of the asset is fixed at \( Q \).

**Lemma 4.1** Under the assumptions 4.1, 4.2, 4.3, and the main characteristics of the assets and newswatchers. Given that the conditional variance of fundamentals is the same for all newswatchers, the price at time \( t \) is:

\[
P_t = D_t + \left\{ (z-1)\epsilon_{t+1} + (z-2)\epsilon_{t+2} + ... + \epsilon_{t+z-1} \right\} / z - \theta Q \tag{31}
\]

\( ^{12} \)For more detail, see Brunnermeier (2001).
Proof: The result is obtained using the equilibrium concept of Walrasian equilibrium with private valuations.

This proposition asserts that the new information works its way linearly into the price over $z$ periods. For simplicity, given that $\theta$ is a function of the newswatchers’ risk aversion and the variance of shocks - both exogenous parameters-, hereafter, $\theta$ is equal one.

4.2 Momentum Traders and Newswatchers

The main characteristic of the momentum traders is they live for finite horizons which is opposite to the newswatchers behavior. However, we assume that momentum traders have a CARA utility function as well.

The microstructure of our model is the following one. The momentum traders transact with the newswatchers by means of market orders. They submit quantity orders, without the knowledge of the price at which these orders will be executed. Given that newswatchers double as market-makers in this framework, the price thus is determined by the competition among these traders.

In our model, at every time $t$, a new generation of momentum traders enters the market taking a position, and holds it for $j$ periods, i.e., until $t+j$. For simplicity, we consider $j$ as exogenous parameter.

Assumption 4.4 Momentum traders make forecasts based on past price changes where the only conditioning variable is the cumulative price change over the last period, that is, $P_{t-1} - P_{t-2}$. In this sense, we restrict momentum traders to making univariate forecasts.

This is the way we introduce a bounded rationality in this kind of agents because momentum traders do not have the computational horsepower to run complicated multivariate regressions.

Now, we incorporate the notion of career concerns in the momentum traders in order to explain how the existence of this career concerns produces more overreaction in asset returns. Unlike Hong’s model, we consider the heterogeneity in the optimal incentives contracts between young and old momentum traders which affect their investment horizons and the prices dynamic. It is worthy to note that this relationship between incentives contracts and overreaction in asset returns has not been regarding in the recent literature. Then, we consider the following assumption in order to incorporate this innovation.
Assumption 4.5 We assume every momentum trader born in \( t \) live for \( j \), if \( j \geq k \), and for \( k \) periods, if \( k > j \). We thus define as young momentum trader who borns in \( t \) and lives for \((j - s)\) periods and as old momentum trader who lives for \( k - (j - s) \) periods, where \( s \) is the number of old traders at time \( t \).

Then, including career concerns concept, young momentum traders take a position, and hold it for \( j - s \) periods, however, old momentum traders take a position, and hold it for \( k - (j - s) \) periods, where \( k > j \). As we made mention before, given the history of old traders’ performance have been revealed, then, the mutual fund owners’ prediction about their ability is better than when they are young. This result implies that owners have more reliability in old traders than the young ones. Therefore, an optimal contract design by the mutual fund owner could authorize old traders to hold positions by more time compared with young momentum traders as we prove in the last section. We assume again \( k \) and \( j \) are exogenous parameters.

Under the assumption 4.4 which includes the career concerns concept and the aforementioned main characteristcs of momentum traders, we can obtain the different order flows for both young and old momentum traders.

Lemma 4.2 Under the assumption 4.4 and 4.5, the order flow from generation-\( t \) young momentum traders, \( F^y_t \), is of the form:

\[
F^y_t = A + \phi_1 \Delta P_{t-1}
\]  

so long as the order flow from generation-\( t \) old momentum traders, \( F^o_t \), is of the form:

\[
F^o_t = A + \phi_2 \Delta P_{t-1}
\]  

with \( \phi_1 > \phi_2 \)

Proof: Notice that this result is directly obtained using the mean-variance preferences of these investors\(^{13}\). On the other hand, the difference between young and old momentum traders \(-\phi_1 > \phi_2-\) is due to their different investments strategies. They hold their positions for different horizons of time \(- k > j -\).

Both elasticities have to be determined from optimization on the part of young and old momentum traders.

\(^{13}\)For more detail, see appendix 2.
It is worth to emphasize that newswatchers only take into account the news of fundamentals, this implies newswatchers treat the momentum traders’ order flow as an uninformative supply shock. If we assume that this not happens, we then will be inconsistent with assumption 2.3, newswatchers do not condition on prices. This means we do not allow these traders learn from prices.

**Lemma 4.3** Under the assumptions 4.1, 4.2, 4.3, 4.4, and the main characteristics of the assets and newswatchers. Given that the conditional variance of fundamentals is the same for all newswatchers and there are \( j \) generations of momentum traders (young and old traders) in the market, the price at time \( t \) is:

\[
P_t = D_t + \left\{ \sum_{i=1}^{j-s} \phi_1 \Delta P_{t-i} + \sum_{i=1}^{k-(j-s)} \phi_2 \Delta P_{t-i-(j-s)} \right\} + \left\{ (z-1)\epsilon_{t+1} + (z-2)\epsilon_{t+2} + \ldots + \epsilon_{t+z-1} \right\} / z - Q + (j-s)A + (k-(j-s))A \]

where \( s \) is the number of old traders at time \( t \).

**Proof:** The result is obtained using the equilibrium concept of Walrasian equilibrium with private valuations as Lemma 4.1, however, in this case, the aggregate supply \( S_t \) absorbed for the newswatchers is now given by \( S_t = Q - \sum_{i=1}^{j-s} F^y_{t-i+1} - \sum_{i=1}^{k-(j-s)} F^o_{t-i-(j-s)+1} \).

From now on, given that the constants \( Q \) and \( A \) play no role, we disregard them. If we assume that \( \phi_1 \) and \( \phi_2 \) are known, we can proof that prices are covariance stationary (See Appendix 2).

**4.3 The nature of Equilibrium**

Now, we will find the elasticities determined from optimization of the part of the young and the old momentum traders. Disregarding constants, i.e., \( F^y_t = \phi_1 \Delta P_{t-1} \) and \( F^o_t = \phi_2 \Delta P_t \), the optimal condition for young momentum trader is:

\[
\phi_1 = \frac{\varphi_{cov}(P_{t+j} - P_t, \Delta P_{t-1})}{\text{Var}(\Delta P_{t-1})\text{Var}(P_{t+j} - P_t/\Delta P_{t-1})} \quad (35)
\]

so long as for old momentum trader is:
\[
\phi_2 = \frac{\varphi \text{cov}(P_{t+k} - P_t, \Delta P_{t-1})}{\text{Var}(\Delta P_{t-1}) \text{Var}(P_{t+k} - P_t/\Delta P_{t-1})}
\]  

(36)

Where \( \varphi \) is the risk tolerance.

In this way, the definition of equilibrium is a fixed point such that \( \phi_1 \) and \( \phi_2 \) are given by the two last equations, while at the same time price process satisfy lemma 2.3.

Given that the asset returns are covariance stationary, this implies we will consider risk tolerance parameter \( \gamma \) less than one, since this in turn ensures that \( |\phi_1| \) and \( |\phi_2| \) are sufficiently small which guarantees the stationarity of these processes.

Now, we can make several observations about nature of equilibrium. First, we have:

**Lemma 4.4** In any covariance stationary equilibrium, \( \phi_1 > 0 \) and \( \phi_2 > 0 \). That is, young and old momentum traders, must behave as trend-chasers.

**Proof:** Suppose \( \phi_1 = 0 \) and \( \phi_2 = 0 \), then, prices are determined by equation (33), when only the newswatchers are in the market. However, in this case, \( \text{cov}(P_{t+j}, \Delta P_{t-1}) > 0 \) and \( \text{cov}(P_{t+k}, \Delta P_{t-1}) > 0 \), then, by equations (37) and (38), \( \phi_1 \) and \( \phi_2 \) are greater than zero, establishing a contradiction.

second, as we will see later with a computational algorithm, the impulse response of prices can be seen decomposing the price at any time into two components: effects attributable to the newswatchers and those attributable to the momentum traders. Given a positive shock, these effects into the prices path are summarized in the following proposition.

**Proposition 4.1** Under lemma 4.2 and 4.3, assumptions 4.1, 4.2, 4.3, 4.4 and 4.5, in any covariance stationary equilibrium, given a positive shock \( \epsilon_{t+z-1} \) that first to begin to diffuse at time \( t \):

(i) There is always overreaction, i.e., the cumulative impulse response of prices peaks at a value which is strictly greater than one.

(ii) If \( j < k < z - 1 \), the cumulative impulse response peaks no earlier than \( t + j \), eventually converging to one.

(iii) If \( k > j > z - 1 \), the cumulative impulse response peaks at \( t + j \), eventually converging to one.
Proof: From time $t$ to time $t + z - 1$, all the newswatchers estimate $D_T$, however, in the time $t + z - 1$, they have completely incorporated the news shocks into their forecasts. Therefore, in the absence of momentum traders’ order flows, the price is just right at this time. But, by lemma 4.4, any positive news shock must generate an initially positive impulse to momentum traders’ order flow. Furthermore, the cumulative order flow must be increasing until at least time $t + k$, given $k > j$, since none of the old momentum traders hold their positions until $t + k + 1^{14}$.

Due to the difficulty to solve the model in closed form, we resort to computational algorithm to find the fixed point. In the next section, we show the prices impulse responses in front of news regarding variations in momentum traders’ horizons and we perform numerical comparative statics when the risk tolerance parameter changes and when the diffusion of information is more quickly.

4.4 Numerical Comparative Statics

In this section, we perform a variety of numerical comparative statics exercises. Given the information diffusion, $z = 12$, the risk tolerance parameter, $\varphi = 1/3$, the standard deviation of shocks equal to 0.5 per month and $s$ which varies according to changes in $k$ and $j$, we compute the equilibrium value of $\phi$ and the cumulative impulse response of prices to one-unit shock.

First, we examine how our model change in front of different values of momentum traders’ horizon, $j$ and $k$, under the condition that $k > j$. We then experiment with values of $k$ ranging from 3 to 9 months, given $j = 3$.

When we introduce the distortion in incentives contracts for the old momentum traders, we obtain more overreaction in prices than the model with only newswatchers - benchmark case -. However, as $k$ increases, we observe that this effect decreases, in the sense that the prices return more quickly to the benchmark case (See Figure 1). Then, if we had incentives contract such that both young and old momentum traders can hold their positions for long horizons, this would imply that we observe less overreaction in prices.

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14Using the computational algorithm, we obtain the same results, see Figure 1 in the following section.
In sum, the main result is the larger the differences in holding of assets by young and old momentum traders, the higher the overreaction of asset returns.

second, in figure 2, we analyze the effect of changing momentum traders’ risk tolerance. We set \( j = 6 \) and \( k = 9 \), and allow \( \varphi \) to vary. By equations (37) and (38), we expect as risk tolerance increases, young and old momentum traders respond more aggressively to past prices changes, then, \( \phi_1 \) and \( \phi_2 \) increases. This effect causes the impulse respond function to reach higher peaks values.

Figure 1: Cumulative Impulse Responses and Momentum Traders’ Horizons
Finally, in figure 3, we set again $j = 6$ and $k = 9$, and allow $z$ to vary. As $z$ increases, $\phi$ increases, this means that there exists a monotonic relationship between this two variables because the slower the newswatchers are to figure things out, the greater the profit opportunities for young and old momentum traders.
5 Summary and Extensions

This paper addresses an important puzzle in financial economics: why fund’s managers invest in short-maturity assets even though they could obtain more profits by holding positions in securities with longer maturity. We provide an explanation for this phenomenon based on the labor contracts signed between institutional investors and their traders.

In particular, we examine how differences in the pay-for-performance’s sensitivity of young and old traders affect their investment horizon decisions when career concerns are considered. In our framework, young traders only care about their career concerns. By analyzing the tension between explicit and implicit incentives contained in the optimal labor contracts, we then characterize the conditions under which young (old) traders prefer short-maturity (long-maturity) assets. The intuition behind this result is as follows. Since the history of old traders’ performance have already been revealed, the principal’s prediction about their ability is better than that made on the young ones. As a consequence, the fund’s owners will have more reliability on old traders, and thereby, they will authorize them to hold bolder positions by comparison with young ones. Interestingly, this prediction is consistent with the recent evidence found by empirical literature focused on the U.S. stock market (see Chevalier and Ellison (1999)).

Furthermore, we extend our model by performing a sensitivity analysis of the results whether we include both career-risk concerns - how the agent’s current performance affects the variance of his future compensation - and training on-the-job costs. On the one hand, our findings suggest that the main results hold when the trader’s career concerns prevail, i.e., when the substitutability between explicit and implicit incentives is still observed. On the other hand, the training on-the-job costs increase the probability that young traders select non-contingent long-term labor contracts, raising thus their incentives to hold long-term positions. However, as long as the difference between the variance of long-maturity and short-maturity investments is sufficiently large, the young trader’s surplus stemming from short-term labor contracts becomes eventually larger than the long-term ones, reversing therefore the horizon decisions.

The major implication of our central result is that the bias induced by the labor contracts on young momentum traders to prefer short-term securities may cause episodes of overreaction in stock prices observed in the real world. Therefore, we provide an alternative explanation for this market phenomenon based on the incentive composition embodied in the optimal labor contracts designed by institutional investors. All of this suggests that we will likely observe more and higher
overreactions in stock prices as an increasing importance of institutional investors in the whole financial system is expected.

Some extensions of this work may take into account other aspects of the optimal contracts: switching costs when traders decide to change the job; other kind of remunerations in order to know more about the trader’s ability, for instance, stock options; and so on. Furthermore, it should be considered other classes of performance process which also imply differences in the pay-for-performance sensitivity between young and old managers. For instance, the variation of investments could follow a stationary autoregressive or a long memory process instead of a normal one which are more closed to the empirical works which have found that investment follows a long memory process\textsuperscript{15}.

6 Appendix 1

6.1 Proof of Proposition 2.1

Let

$$D \equiv S_{Old}^{ST} - S_{Old}^{LC} = [m_0 + a_1^{ST} + \mu_1 - g(a_1^{ST})] + \gamma \cdot [m_0 + a_2^{ST} + \mu_2 - g(a_2^{ST})] - \frac{1}{2} r \left[ \sigma_2^{ST} \right] - \frac{1}{2} r \left[ \sigma_2^{LC} \right] - \frac{1}{2} [m_0 + a_1^{LC} + \mu_1 - g(a_1^{LC})] - \gamma \cdot \left[ m_0 + a_2^{LC} + \mu_2 - g(a_2^{LC}) \right]$$

Using Lemma 2.1 and Lemma 2.2 and the previous definition, we have that:

(i) Since $\sigma_2^{ST} = \sigma_2^{LC}$, which implies $a_1^C = B_1^C$ and $a_2^C = B_2^C$ with $C = ST, LC$ and for any $\zeta > 1$ large enough where $\frac{1}{2} \mu_1 + \gamma \mu_2 > \zeta (\mu_1^S + \gamma \mu_2^S)$, then, $D < 0$.

(ii) When $\sigma_2^{LC} > \zeta \sigma_2^{ST}$ for any $\zeta > 1$ and $\mu_1 + \gamma \mu_2 = \mu_1^S + \gamma \mu_2^S$, we need the following condition in order to $D < 0$:

$$\frac{r \gamma}{2} b_2^{ST} B_1^{ST} \sigma_2^{ST} - \frac{r \gamma}{2} b_2^{LC} B_1^{LC} \sigma_2^{LC} - 2 r \gamma b_2^{ST} B_1^{ST} \Sigma_2^{ST} + 2 r \gamma b_2^{LC} B_1^{LC} \Sigma_2^{LC} - \frac{1}{2} B_1^{ST} + \frac{1}{2} B_1^{LC} - \frac{1}{2} \gamma b_2^{ST} + \frac{1}{2} \gamma b_2^{LC} - r B_1^{ST} \Sigma_2^{ST} + r B_1^{LC} \Sigma_2^{LC}$$

$$- r \gamma b_2^{ST} \Sigma_2^{ST} + r \gamma b_2^{LC} \Sigma_2^{LC} < 0 \quad (37)$$

\textsuperscript{15}See Mayoral (2004).
Notice that old traders do not have career concern, this implies, only exist explicit incentives in their surplus.

### 6.2 Statistical Functions of an Indicator Function

Density of an Indicator Function of $X$ is:

$$ f(x|x \geq \bar{x}) = \frac{f(x)}{P(x \geq \bar{x})} = \frac{f(x)}{\int_{\bar{x}}^{\infty} f(x) \, dx} = k f(x) $$

Then,

$$ E(-\exp(-x I_{x \geq \bar{x}})) = \int_{\bar{x}}^{\infty} -\exp(-x) f(x|x \geq \bar{x}) \, dx $$

$$ = -k \exp(-\mu - \frac{\sigma^2}{2}) \left[ \frac{1}{(2\pi)^{0.5}} \int_{\bar{x}}^{\infty} \exp(-0.5 \frac{(x + \sigma^2 - \mu)^2}{\sigma}) \, dx \right] $$

Let $z \equiv x + \sigma^2$ with normal distribution with mean $\mu$ and variance $\sigma$. Therefore,

$$ E(-\exp(-x I_{x \geq \bar{x}})) = -\exp(-\mu - \frac{\sigma^2}{2}) \frac{P(z \geq \bar{x})}{P(x \geq \bar{x})} $$

Since $\frac{P(z \geq \bar{x})}{P(x \geq \bar{x})} > 1$, in particular, when $\bar{x} = \mu$,

$$ E(-\exp(-x I_{x \geq \bar{x}})) = -\exp(-\mu - \frac{\sigma^2}{2}) 2P(z \geq -1) $$

Then, $E(-\exp(-x I_{x \geq \bar{x}}))$ is an increasing function of $\mu - \frac{\sigma^2}{2}$, therefore, in the same way, we maximize the CARA utility function, we maximize the utility function with an indicator function.
7 Appendix 2

7.1 Proof of Lemma 3.2

For simplicity, we assume $k = j$ and disregard constants. Then, we denote:

$$h = F_t * (P_{t+j} - P_t) \quad (A1)$$

where $F_t = \phi \Delta P_{t-1}$.

Using mean-variance preferences of this investors, this means:

$$Max \ E(h) - (1/2) r Var(h) \quad (A2)$$

We obtain the following first Order Condition:

$$\phi \Delta P_{t-1} = \frac{\varphi E(P_{t+j} - P_t)}{Var(P_{t+j} - P_t)} \quad (A3)$$

where $\varphi = 1/\rho$ is the risk tolerance.

Rewriting this condition, we obtain:

$$\phi = \frac{\varphi Cov(P_{t+j} - P_t, \Delta P_{t-1})}{Var(\Delta P_t)Var(P_{t+j} - P_t)} \quad (A4)$$

7.2 Prices are covariance stationary

First, we specify the ARMA representation of the returns process. Removing constants for simplicity and using equation (24), the process of $\Delta P_t$ is:

$$\Delta P_t = \sum_{i=0}^{z-1} \frac{\epsilon_{t+i}}{z} + \phi_1 \Delta P_{t-1} - \phi_2 \Delta P_{t-(j+1)} + (\phi_0 - \phi_1)\Delta P_{t-(j-1)} \quad (A5)$$

We assume $j = k$ instead of $k > j$ in order to simplify the proof. Assuming that $\phi$ satisfies proper conditions to be specified, $\Delta P_t$ is a covariance stationary process. Let
\[ \alpha_h = E [\Delta P_t \Delta P_{t-h}] \]  

(A6)

When \( h = 0 \), we have the unconditional variance. The autocovariances of this process satisfy the following known Yule-Walkers equations:

\[ \alpha_0 = E \left[ \sum_{i=0}^{z-1} \frac{\epsilon_{t+i}}{z} \Delta P_t \right] + \phi_1 \alpha_1 - \phi_2 \alpha_{j+1} + (\phi_2 - \phi_1) \alpha_{j-1} \]  

(A7)

and for \( h > 0 \), we have

\[ \alpha_h = E \left[ \sum_{i=0}^{z-1} \frac{\epsilon_{t+i}}{z} \Delta P_{t-h} \right] + \phi_1 \alpha_{h-1} - \phi_2 \alpha_{h-(j+1)} + (\phi_2 - \phi_1) \alpha_{h-(j-1)} \]  

(A8)

For \( k > z - 1 \), the first part of the right hand side is zero. But, when \( k \leq z - 1 \), solving the Yule-Walker equations, we can see if \( \phi_1 \) and \( \phi_2 \) satisfies proper conditions to be specified, then, these autocovariances do not depend on time. This means, the return process is covariance stationary.

Since, we know that the optimal strategies of young and old momentum traders are given by the following equilibrium conditions:

\[ \phi_1 = \frac{\varphi \text{Cov}(\Delta P_{t-1}, P_{t+j} - P_t)}{\text{Var}(\Delta P_t)\text{Var}(P_{t+j} - P_t)} \]  

(A9)

and

\[ \phi_2 = \frac{\varphi \text{Cov}(\Delta P_{t-1}, P_{t+k} - P_t)}{\text{Var}(\Delta P_t)\text{Var}(P_{t+k} - P_t)} \]  

(A10)

furthermore, we know that

\[ P_{t+j} - P_t = \Delta P_{t+j} + \ldots + \Delta P_{t+1} \]  

(A11)

Notice that we consider in this part, \( k = j \) which implies in this case that \( \phi_1 \) is equal to \( \phi_2 \).

Then, using the previous steps, it follows that:

\[ \text{Cov}(\Delta P_{t-1}, P_{t+j} - P_t) = \alpha_{j+1} + \ldots + \alpha_2 \]  

(A12)
and

\[ \text{Var}(P_{t+j} - P_t) = j\alpha_0 + 2(j-1)\alpha_1 + \ldots + 2(j-(j-1))\alpha_{j-1} \quad (A13) \]

But, if \( k > j \), then, we have the following relationship:

\[ \text{Cov}(\Delta P_{t-1}, P_{t+j} - P_t) > \text{Cov}(\Delta P_{t-1}, P_{t+k} - P_t) \quad (A14) \]

and

\[ \text{Var}(P_{t+k} - P_t) > \text{Var}(P_{t+j} - P_t) \quad (A15) \]

which implies \( \phi_1 > \phi_2 \).

Using these formulas, the problem is reduced to finding a fixed point in \( \phi_1 \) and \( \phi_2 \) that satisfies A9 and A10.

Finally, the return process is covariance stationary when \( \phi_1 \) and \( \phi_2 \) are less than one, because the asset return follows an ARMA(\( j+1, z \)). For instance, suppose \( k = j = 1 \) (in this case, \( \phi_1 = \phi_2 \)) and \( h = 1 \), then, the condition is just that the roots of

\[ 1 - \phi x + \phi x^2 = 0 \quad (A16) \]

lie outside the unit circle\(^{16}\). Thus, the conditions are: \(-2\phi < 1\) and \(-1 < \phi < 1\).

In the case when \( j = h \), then, the roots \( x \) of

\[ 1 - \phi x + \phi x^{h+1} = 0 \quad (A17) \]

must lie outside the unit circle, obtaining

\[ |1 - \phi x| = |\phi| |x|^{h+1} \quad (A18) \]

Therefore, in order to equation (A18) holds, as \( h \) increases, \(|\phi|\) should be decreases.

\(^{16}\)See Hamilton (1994)
8 References


Von Thadden, E. (1995): Long-Term Contracts, Short-Term Investment and