Essays in Finance

by

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ABSTRACT

In the first chapter, I develop a representative agent model in which the purchase of consumption goods must be planned in advance. Volatility in the agent's portfolio increases the risk that a purchase cannot be implemented. This implementation risk causes the agent to make conservative consumption plans. In the model, this leads to persistent and negatively skewed consumption growth and a slow reaction of consumption to wealth shocks. The model proposes a novel explanation for the negative relation between volatility and expected utility. In equilibrium, prices of risky assets must compensate for the utility loss. Hence, the model suggests a new mechanism for generating the equity risk premium. Importantly, because implementation risk does not rely on the co-movement of asset prices with marginal utility, the resulting equity premium does not require concavity of the intratemporal utility function. In the second chapter, I challenge the view that equity market timing always benefits shareholders. By distinguishing the effect of a firm's equity decisions from the effect of mispricing itself, I show that market timing can decrease shareholder value. Additionally, the timing of equity sales has a more negative effect on existing shareholders than the timing of share repurchases. My theory can be used to infer firms' maximization objectives from their observed market timing strategies. I argue that the popularity of stock buybacks, the low frequency of seasoned equity offerings, and the observed post-event stock returns are consistent with managers maximizing current shareholder value.

DEDICATION

To my advisors YURI TSERLUKEVICH and ILONA BABENKO

for guiding me to research

To my advisor OLIVER BOGUTH

for nurturing my mind

To my MOM

for believing that I do the greatest research in the world

To my CAT FRIEND

for lying on my keyboard and keeping me from doing the greatest research

To TIME

for taking me to all of you

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Chapter 1

PRE-BUDGETING OF CONSUMPTION

1.1 Introduction

The canonical consumption-based asset pricing model presented by Lucas (1978) does not connect consumption growth with market returns in the real world. The low volatility of consumption growth and its moderate correlation with equity returns cannot justify the magnitude of the observed equity premium (see Mehra and Prescott (1985) and Hansen and Jagannathan (1991)). At the same time, consumption growth appears to react too slowly to ex post market returns, and it is only weakly correlated with equity return.[1]

A common assumption in the current literature is that consumption can be adjusted instantaneously so that shocks to an individual's investment returns are immediately reflected in his or her consumption. But, in reality, getting ready to make a purchase can be a lengthy process. It requires the consumer to search for relevant information, compare products, reach a decision about what to buy, arrange

[1] Lettau and Ludvigson (2001) point out that the consumption-wealth ratio should be at a constant level when market return is unpredictable. However, given the observed high volatility of the equity market and low volatility of consumption growth, it is impossible to have a constant consumption-wealth ratio. Campbell and Deaton (1989) document that consumption reacts too little to household income innovations and is sensitive to lagged income innovations. Marshall and Parekh (1999) document that most consumption series are only weakly positively correlated with equity returns and some even move in the opposite direction from equity returns.

financing and close the deal.[2] Thus, consumption must be planned in advance ("pre-budgeted").[3] In this paper, I model consumer decisions when immediate consumption adjustment is not possible and demonstrate that uncertainty in future wealth results in the inefficient allocation of money to consumption and investment. This result implies that the difficulty in planning for future consumption can be an important factor in resolving the tension between equity returns and consumption growth. In my model, the consumption growth that is generated has lower volatility and a lower correlation with market returns than it does in the conventional models. Consistent with the data, the model generates a positive autocorrelation and negative skewness in consumption growth, and a high correlation between consumption growth and lagged market returns. Pre-budgeting technology also makes consumption to react slowly to wealth fluctuations. Therefore, wealth shocks can easily drive consumption and investment away from the desired paths.[4] This risk of inefficient allocation provides a novel channel for the agent's risk-aversion. To avoid wealth fluctuations, the agent underinvests in risky assets. Thus, a risk premium can be generated through market volatility in addition to the co-movement of market returns and consumption growth.

The key intuition is that a consumer makes a conservative purchase plan when faced with uncertainty in future wealth. For example, consider the decision to purchase an automobile. Even if the consumer can afford to purchase an automobile now,

[2]Campbell and Deaton (1989) find that consumption growth is positively correlated with lagged income growth. Similarly, Caballero (1990) shows that a slow reaction to shocks helps to fit a PIH model in the consumption data.

[3]The term "pre-budget" comes from HM Treasury reports in the UK. From 1997 to 2009, the HM Treasury submitted a pre-budget statement every year including an update on the state of the government's finances and the national economy, as well as the proposals under consideration for the final budget.

[4]In other words, the consumption-wealth ratio is predicted to vary over time owing to the uncertainty of market return.

finding the right model and negotiating the terms of the deal can take substantial time, during which the consumer's financial status is subject to deterioration. Because of this wealth uncertainty, he may optimally choose a less expensive automobile than he would if he could make the purchase immediately or if there were no wealth uncertainty.

This idea is first formalized in a simple two-period model.[5] A consumer is modeled with a non-satiated utility function. Initially, he is endowed with a certain amount of cash and durable goods in stock. Since the consumer cannot buy durable goods immediately, he has to invest the money and schedule a future purchase with the goal of maximizing his future utility. Nevertheless, the implementation of the durables purchase is subject to the realization of his future wealth level. When his investment return is not sufficient to pay for the purchase, the consumer has to abandon the purchase and consume only the durables he has in stock. In contrast, if his future wealth turns out to be larger than the planned consumption expenditure, he will

[5] To illustrate the main economic mechanism in the model, I focus on durable goods consumption in my model settings. Planning for durables consumption is an important decision for most of the consumers since it typically requires a large lump-sum payment and can have far-reaching consequences for their well-being. Most people need to gather information about the best available products before making a purchase. Completing the transaction can also take time. Moreover, because most of the durable purchases are indivisible, it is likely that the whole purchase will need to be postponed or dropped if it cannot be fully implemented. I later discuss how the model and its implications can be changed when non-durables consumption is incorporated. However, it does not exclude the interpretation under a different context. For example, durables in stock can be interpreted as a default consumption plan of non-durable consumption.

proceed with the purchase. But his residual cash will not result in any additional utility.[6]

A trivial case occurs when the consumer invests entirely in risk-free assets which makes his future wealth deterministic. To maximize the expected utility, the consumer would then plan for a purchase that costs all his future wealth and is certain to be implemented. In contrast, holding risky assets substantially complicates the consumer's decision-making about the consumption purchase plan. If the consumer is rich enough in the future, he will derive high utility from a large durable goods purchase. But uncertainty of the payoffs from risky assets can lead to failure to make the purchase with a nonzero probability. Therefore, the consumer is essentially faced with a trade-off between greater consumption and a higher probability of making a successful purchase given the distribution of asset payoffs. I find that the consumer optimally plans his purchase expenditure to be lower than his expected future wealth. The difference between the expenditure on the purchase and the consumer's expected wealth increases with the variance of the investment return and decreases with the quantity of initial durables in stock. Intuitively, high volatility of future wealth would lead the consumer to make a highly conservative purchase plan because a sizable downgrade of the planned expenditure would be necessary to effectively boost the success rate of the purchase when the states of future wealth are dispersed. When the initial stock of durables is low, missing a purchase opportunity is painful. Thus, the consumer would be more concerned about the success rate and underweight the magnitude of the consumption increment.

[6] Assuming that residual wealth will be wasted is a simplification. In reality, the unplanned part of wealth can generate some utility, but still it would be lower than if expenditure had been planned in advance. Hence the qualitative predictions are not changed by this simplification.

The model generates important implications for both consumption dynamics and asset prices. First, this model fits the observed consumption data better. Similar to models with consumption adjustment costs, such as those developed by Grossman and Laroque (1990) and Chetty and Szeidl (2010), the conservative consumption policy in my model causes a lower volatility of consumption growth relative to the canonical model used by Mehra and Prescott (1985). Moreover, a low correlation between market return and the contemporaneous consumption growth is enforced through several channels. In addition to direct effects, such as conservative planning and delayed consumption adjustment, restricting realized consumption growth to the planned level also matters. Since consumption growth in the model is bounded from above by the purchase plan laid out in the previous period, a large positive shock in wealth cannot be fully transmitted to the consumption growth in the near future.

Importantly, the model implies that the risk premium—or equivalently, investors' preference for risk-free assets—does not rely on the concavity of the intratemporal utility function. Consider a pair of assets with the same expected returns but different risk profiles, one risky and the other risk-free. When an instantaneous adjustment of consumption is allowed, investors' preference for the risk-free asset can only arise through Jensen's inequality. Thus, concavity of the utility function is necessary to generate risk aversion and an equity premium. However, when instantaneous consumption adjustment is not possible, risk-aversion can be generated through the inefficiency of consumption plan. With the risk-free asset, investors can perfectly plan for future consumption and make use of all their wealth. In contrast, holders of risky assets have to stick with one consumption plan, which leads to a waste of wealth in almost all future states. The waste thus reduces the investors' expected utility and does not depend on the concavity of the utility function. Nonetheless, the concavity of the utility function magnifies this effect by causing the consumption growth to be more conservative. I show that a risk premium is present regardless of the curvature of the utility function, and it increases with concavity of the intratemporal utility function.

Several other predictions can be obtained from the comparative statics of the model. Because higher volatility and a lower initial durables endowment leads to larger distortions in consumption, the utility lost due to wasted wealth increases with market volatility and decreases with initial durable goods in stock. Hence, the risk premium of one asset moves together with its return volatility. Similarly, more durables in stock predicts a lower risk premium. It further means that the risk-premium can be predictable when market volatility or the consumption of the economy changes over time. This prediction is consistent with the evidence documented in the asset pricing literature.[7]

The same idea is further developed in an intertemporal model that can enrich the results on a dynamic and quantitative base. An infinitely-lived representative agent is modeled with a time-additive power utility. In each period he maximizes his expected utility by choosing the current consumption level according to his current wealth and the consumption plan proposed in the previous period. He decides whether to adjust his consumption according to his plan from the previous period. At the same time, he plans for his next-period consumption adjustment. Unlike in the two-period model, unexpended wealth can be saved or invested for future use. Therefore, wealth is not wasted, and the goal of the consumption plan is to achieve an optimal consumption-wealth relation in the next period rather than to expend all wealth. Nonetheless, failure to implement a consumption purchase will still lead to utility

[7]For example, French *et al.* (1987) document that the expected market volatility positively predicts the equity premium. Lettau and Ludvigson (2001) observe that consumption-wealth ratio predicts market returns.

loss due to the deviation from the optimal consumption path, or more specifically, due to a delay in consumption.[8] Therefore the main results obtained in the two-period model are qualitatively preserved in the infinite-period model, although the magnitude of pre-budgeting's effects can be different. Indeed, the solution shows that investors holding risky assets schedule purchases that are too conservative relative to the optimal consumption implied by their expected future wealth. The difference between planned and optimal consumption depends on the volatility of asset returns and the distance of current consumption from the optimal level.

While the main results remain unchanged, the intertemporal model offers additional implications for the dynamics of consumption and market returns. In a risky economy, a market portfolio holder almost never achieves his optimal consumption-wealth relation.[9] First, shocks to the economy have a highly persistent effect: a large positive shock can influence consumption for several periods. More specifically, once the consumption-wealth ratio falls below the optimal level because of a positive wealth shock, consumption growth is constrained to take very small steps over multiple periods to catch up with past wealth growth. This result can explain why consumption growth data sometimes exhibit positive autocorrelation and why consumption growth has a high correlation with past equity returns. Additionally, although instantaneous

[8]More precisely, failure to implement a consumption plan occurs whenever the consumer's wealth realization does not lie in the optimal range for proceeding with his consumption plan. This happens more often than the failure of implementation due to lack of financing. Because in the intertemporal model the consumer will *choose* not to implement the plan whenever his consumption plan would drive his consumption-wealth relation even further away from the ideal target, even if he has enough money to make the consumption adjustment.

[9]It is in contrary to canonical models and models with consumption adjustment cost. For example, in Grossman and Laroque (1990), a consumer achieves his optimal consumption-wealth ratio whenever an adjustment is conducted.

adjustment is not allowed, there remains a moderate correlation between the realized market return and the contemporaneous consumption growth. For instance, a high market return may lead to successful implementation of a purchase plan with a high probability, i.e. positive consumption growth, while low market returns are likely to induce zero or negative consumption growth. Hence, the model does not exclude the predictability of consumption growth by market return but loosens the tight link implied by the earlier literature.

The rest of this paper is organized as follows. After the literature review in Section 1.2, Section 1.3 presents a simple two-period model to illustrate the basic intuition. Section 1.4 sets up a representative-agent model with intertemporal consumption and portfolio choices that characterizes a consumer's choices, and discusses the implications for asset prices and consumption dynamics. The final section concludes the paper.

1.2 Literature Review

This paper contributes to the consumption-based asset pricing literature by extending the canonical model with a novel friction, namely the pre-budgeting of consumption, and discussing its implications for asset prices. The canonical consumption-based asset pricing model, studied by Lucas (1978), Rubinstein (1976), and Hansen and Singleton (1983), models risk as the covariance of stock returns and consumption growth. However, Mehra and Prescott (1985) present the equity premium puzzle by showing that the magnitude of excess equity returns cannot be justified by the low historical covariance between market returns and consumption growth when a reasonable level of risk-aversion is imposed. A large literature attempts to resolve the equity premium puzzle. One strand of literature works through new assumptions on the agent's utility function. For example, studies by Abel (1990), Constantinides

(1990), Heaton (1993) and Campbell and Cochrane (1999) propose a variety of habit-formation models. Epstein and Zin (1989) and Weil (1989) generalize the power utility to allow a separation between elasticity of intertemporal substitution and relative risk aversion. Subsequently, Bansal and Yaron (2004) develop a model that combines the Epstein-Zin preferences with long-run risks in consumption growth in order to match the magnitude of the equity premium. In contrast, the risk premium in my model does not require any specific features in the utility function, not even concavity. Another strand of the literature, represented by Rietz (1988), Barro (2006), and Gabaix (2008), investigates whether the equity premium might be driven by unobserved rare disasters and tail risks. In contrast, I model normally distributed shocks.

Recent literature has drawn attention to the consumption of durable goods and luxuries. In particular, Yogo (2006) models durable goods consumption together with non-durables and shows success in explaining time-variation in the equity premium. Pakoš (2004) studies the interaction of durables and non-durables in a similar setting and concludes that the equity premium puzzle is alleviated if the two goods are perfect compliments. Aït-Sahalia *et al.* (2004) show that the inclusion of luxury goods consumption can help to mitigate the equity premium puzzle. Yang (2011) proposes a solution to the equity premium puzzle through long-run risks in durables consumption based on the empirical persistence of durables growth. My study also links asset prices to durable goods consumption. Eraker and Wang (2013) introduce a model with inflation risk with persistent durables consumption growth. In contrast to these earlier works, I start with a micro friction and generate consumption growth endogenously, while they treat consumption growth in the pricing kernel as an exogenous input. For example, related to Yang (2011) and Eraker and Wang (2013), the innovation of consumption growth in my model may also exhibit persistence. The persistence in my model is not assumed, however, but results from the pre-budgeting friction.

My model is not the first to address frictions in consumption adjustments. Grossman and Laroque (1990) develop a model in which consumers are allowed to adjust consumption instantaneously but with a fixed cost. In their model, consumption is predicted to be adjusted infrequently in large steps. Marshall and Parekh (1999) show in a simulation that Grossman and Laroque's (1990) model can partially fill the gap between equity premium and consumption volatility.

Similar to Grossman and Laroque (1990), Hindy and Huang (1993) and Cuoco and Liu (2000) study an economy with adjustment costs but assume divisible durable goods. Hindy and Huang (1993) emphasize the implications of asymmetric adjustment costs for durable goods consumption, while Cuoco and Liu (2000) characterize an economy with a more general setting under which adjustment costs can be freely chosen. The asymmetric costs modeled in Hindy and Huang (1993) are also perceived as a general case of consumption adjustment irreversibility because the asymmetric costs make selling consumption goods are more difficult than new purchases.[10] My paper shares the implication of low volatility of consumption growth with the above papers. [11] In contrast to the literature of adjustment costs, my model does not impose any financial costs to adjustment and generates different dynamics of consumption growth, such as the predictability of consumption growth.

Among the recent innovations in the literature of adjustment costs, Chetty and Szeidl (2010) decompose consumption into two components — one that can be ad-

[10]The irreversibility added in brings new insights about consumption good durability when selling costs exist — long durability leads to less smooth purchases. In contrast, my paper does not generate any implications related to consumption goods durability because consumption adjustment does not incur any cost to the consumer in this paper.

[11]However, unlike the papers model adjustment cost, the low consumption volatility is not directly driven by infrequent adjustment. The adjustments in my model do not occur every period, but happen very frequently.

justed freely, and another, namely consumption commitments, that is subject to adjustment cost. A crucial assumption of their model is that the commitments have to be non-durables consumption or generate comparable level of expenditures in each period. In this way, the future expenditure commitments lever up the consumer's exposure to wealth shocks. In my model, no obligation is imposed to the consumer's future expenditure because the pre-budgeted purchase can be abandoned without any financial penalty.

One set of studies is dedicated to reconciling the smooth consumption growth and its correlation with wealth shocks through consumption aggregation. Caballero (1990) imposes slowness in reaction to consumers and argues that it is consistent with the durables consumption data. Caballero (1993) further attributes the heterogeneity of reaction speed to the arrivals of households' idiosyncratic shocks. Lynch (1996) and Gabaix and Laibson (2001) customize the aggregation of individual consumption through non-synchronous and infrequent adjustments. These four studies all model heterogeneous agents and their corresponding results hold only at the aggregate level. Besides our differences in the micro foundation of slowness in reaction, my work focuses on a representative agent. I obtain all the similar predictions at the individual-consumer level, such as the positive autocorrelation of consumption growth, low correlation between consumption growth, and market returns and high correlation between consumption growth and past market returns.

The literature intensively discusses the impact of institutional investors on asset prices ever since the financial crisis in 2008-2009 (for example, see Manconi *et al.* (2012)). As institutional investors are substituting the consumers as the primary traders in the market recently, there are concerns that consumers are losing the power of setting the price on the market. This paper does not explicitly model institutional investors. However, the institutional investors are hired by consumers for wealth management. They should aim on tracking the consumers' preference and mimicking the choices of the consumers in order to maintain their business. Therefore, although the institutional investors might help the consumer on hedging idiosyncratic risks in the stocks, the price of systematic risks that consumers are faced with should still be reflected in the asset prices.

1.3 A Two-Period Model

In this section, I present a simple two-period model that illustrates how uncertainty in future wealth influences one's consumption plan. In the next section, I extend the same idea to an intertemporal setting.

Consider a consumer who lives for one period only and receives utility $u(\cdot)$ for service generated by a single durable consumption good. Initially, the consumer is endowed with wealth W_0 and consumption goods in stock D_0 at time 0. Since he cannot buy new consumption good immediately, he has to invest all the money and plan a durable purchase for his time-1 consumption. The investment return is exogenously given, and only the distribution is known at time 0. At time 1, he receives the realized investment payoff and makes the planned purchase if it is affordable. For simplicity, I assume that the consumer does not receive any other income in addition to his investment payoffs at time 1. In the end, the consumer receives utility from his durable good in stock and the new purchased good together. Note that the consumer's goal is to maximize his expected utility at time 1 and that he is aware of the risk in his investment when he chooses the consumption plan at time 0.

The assumption that the consumer cannot adjust his consumption immediately but has to plan for it is the unique feature of this study. I call it the "pre-budgeting of consumption". This assumption is meant to capture the time cost of consumption adjustment. It usually takes time for an individual to alter his consumption habits and find a proper product that meets his needs. The prevailing research in macroeconomics and finance usually assumes that consumption expenditure is sufficient to summarize the parameters of a utility function. Thus people may mistakenly assume that making decisions about one's consumption is simply a matter of choosing how much to spend. In fact, one consumer may find that his utility of similar products varies even if the products are sold at the same price. Also, costs may differ according to the channel of purchase. Therefore, to maximize one's utility at a given level of expenditure, the consumer must choose the least expensive product in the market that serves him best. This often-ignored step of consumption optimization can take a substantial amount of time. To learn one's preferences among the different products, the consumer may have to gather relevant information from the product markets and experiment with the products. Meanwhile, it may be difficult to find an acceptable price for the preferred products, if, for example, the product market is not very liquid, such as the second-hand automobile and housing markets, or discounts are offered only for early reservations (e.g., air-tickets and hotels).[12]

The consumer's plan for time-1 consumption expenditure is denoted as D_p.[13] At time 1, the value of the consumer's durables in stock depreciates to $D_0(1-\delta)$, where δ

[12]Of course, some of the time cost can be exchanged for financial cost. For example, one can pay a premium to get a deal closed faster. But many people may prefer to pay with time instead of money. In this paper, to stay focused on the time cost and keep the model tractable, I assume that people always choose to pay with time instead of money; i.e., I am not modeling the decision between spending more time and spending more money.

[13]I restrict the consumer's planning to a single level of expenditure D_p, instead of multiple levels. Although a consumer may consider several products, all of them are usually in a similar price range. For example, a consumer may plan to purchase an automobile produced by either BMW or Audi, but it is unlikely that he would consider purchasing either an automobile or a bicycle. Second, given an individuals limited amount of energy, one well-thought-out plan is likely to be more efficient than several fuzzy plans.

is the depreciation rate. His ex post consumption D_1 depends on the realization of his wealth by then. Only when the realization of his future wealth is enough to pay for the durables does it increase from $D_0(1-\delta)$ to D_p, has he the option to consume D_p at time 1. Otherwise, he has to consume his durables in stock $D_0(1-\delta)$.[14] Hence, when he is holding a risky asset, the implementation of the consumption plan is uncertain ex ante and depends on his investment return $\widetilde{R}$. Therefore the optimization problem of the consumer at time 0 can be written as follows:

$$V_0(W_0, D_0) = \max_{D_p} \mathbb{E}u(D_1)$$
$$s.t.\ D_1 = \begin{cases} D_p,\ if\ W_0\widetilde{R} > p(D_p - (1-\delta)D_0) \\ (1-\delta)D_0,\ otherwise \end{cases} \tag{1.1}$$

where p is the price of durable goods and D_1 is the level of the consumer's time-1 consumption.

To solve this optimization problem, one should search for the best plan D_p given the distribution of the portfolio return $\widetilde{R}$. It is natural to consider two polar cases: (i) when the consumer invests all his wealth in the risk-free security; and (ii) when he invests in a portfolio of risky assets.

[14]Note that there is an implicit assumption that consumption goods are indivisible. In addition keeping the model simple, I have attempted to make the assumptions realistic. Adjusting consumption may not be a singular decision. We know that consumption goods are not independent from each other, so a large consumption adjustment usually reflects a change of life style. When one consumption good is adjusted, its substitutes and complements may also have to be adjusted. For instance, buying a new video game may require a consumer to upgrade his TV. Moving to a bigger house might entail relocation expenses, the purchase of new furniture, the need for a new vehicle. The purchase of an automobile will also require a new insurance policy and perhaps a new parking plan.

If the consumer holds a risk-free security only, solving for the best plan D_p is straightforward. Since time 1 is the last period in this simple model, the consumer would like to spend as much as possible on his consumption. When the consumer holds the risk-free asset, his wealth at time 1 is equal to $W_0 R_f$. In this case, the consumer plans to increase durables from $D_0(1-\delta)$ to $D_1 = D_0(1-\delta) + \frac{W_0 R_f}{p}$. Since it is certain that the plan will be implemented, his time-1 utility has a deterministic value, i.e.

$$V_0(W_0, D_0) = u(D_0(1-\delta) + \frac{W_0 R_f}{p}). \tag{1.2}$$

In contrast, holding the market portfolio can substantially complicate consumption planning. Because the payoff of market portfolio is uncertain, there is a risk that the consumption plan cannot be implemented. When the market return is low, an aggressive consumption plan (a high D_p) is not affordable, so the consumer will miss the opportunity to spend his wealth and will have to consume $D_0(1-\delta)$. Likewise, if the consumption plan is too conservative (a low D_p), the consumer's time-1 consumption will have an upper bound of D_p; hence he may waste a good part of his investment earnings if his investment return is high. Thus there is a tradeoff between the plan's feasibility and the additional utility provided by a successful purchase implementation. To quantify this tradeoff, I substitute D_1 into the objective function and obtain the FOC

$$u'(D_p^*)(1-F(\frac{p(D_p^* - (1-\delta)D_0)}{W_0})) = \frac{p}{W_0} f(\frac{p(D_p^* - (1-\delta)D_0)}{W_0})(u(D_p^*) - u((1-\delta)D_0)), \tag{1.3}$$

where $F(\cdot)$ and $f(\cdot)$ are the cumulative distribution function and the probability density function of the portfolio return $\widetilde{R}$.[15]

[15] Please refer to appendix for details of the derivation.

The FOC reflects the tradeoff faced by a risky asset holder. The left-hand side of the equation measures the marginal benefit of increasing the consumption plan D_p. When the consumer plans for a larger purchase, his utility increases in good states of the world when the consumption plan can be implemented. However, as captured by the right-hand side of the equation, because a larger consumption plan requires a higher realization of investment return, his utility drops from $u(D_p)$ to $u(D_0)$ in some of the states. Thus the right-hand side represents the cost of raising D_p. At the optimal point D_p^*, marginally raising the consumption plan induces the same amount of costs and benefits.

1.3.1 Conservative Planning

First, I introduce an important property of the optimizer D_p^* and then analyze the sufficient condition for this property in Proposition 1.

Definition A consumption plan D_p^* is **conservative** if it aims to spend *less* than the consumer's expected wealth, or mathematically, $p(D_p^* - (1-\delta)D_0) < (1+\mu)W_0$.

Proposition 1 (Conservative Planning) *Suppose the (gross) investment return follows a distribution $F(\cdot)$ and has an expected value $1+\mu$ and the consumer has a continuous utility function $u(\cdot)$ satisfying $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$, then his plan for date-1 consumption is conservative, if $\forall\ x \geq 1+\mu,\ 1-F(x) < xF'(x)$.*[16]

This is a key result of the paper because all further implications for consumption dynamics are based on conservative consumption plans. The proposition provides a sufficient condition that needs to be imposed on investment returns in order to guarantee that the consumer makes a conservative consumption plan. To illustrate that this condition is typically satisfied in practice, I discuss what it implies for

[16] Mathematical proof is available in the appendix.

the first and second moment of returns when asset returns are either uniformly or normally distributed. I show in the appendix that for a uniform distribution $U[a, b]$, the sufficient condition is equivalent to $a > 0$.[17] In the context of gross investment return, $a > 0$ holds for all assets that have limited liability.

Normal distribution may be a more interesting case as it characterizes the returns of most investment assets. In appendix, I show that for a normal distribution $\mathcal{N}(1 + \mu, \sigma^2)$ the sufficient condition in Proposition 1 is satisfied if $1 + \mu > \sqrt{\frac{\pi}{2}}\sigma$. This criterion requires that volatility is low relative to the mean, which implies that the return distribution cannot be too dispersed. Nevertheless, this criterion is satisfied for most non-insurance assets in the market. For example, for the gross market return that has a mean of $1 + \mu = 1.08$ and volatility of $\sigma = 0.20$ over an annual horizon, this condition is satisfied with slack, i.e., $1 + \mu = 1.08 >> \sqrt{\frac{\pi}{2}}\sigma = 1.25 * 0.20 = 0.25$. Furthermore, unless an asset provides some insurance to consumers, it should have a gross expected return greater than 1. Thus the results of Proposition 1 can be applied to any risky portfolio with volatility $\sigma < 80\%$.[18]

With the bell curve of a normal distribution, it is easy to understand why the optimal consumption plan is conservative. Recall that lowering D_p from the expected return generates two opposite marginal effects — increasing the probability of a successful plan implementation and lowering the utility level upon implementation. The probability density of the normal distribution is high around its mean. Therefore,

[17] In the appendix I also show that the same condition guarantees that the optimal plan D_p is unique in the case of uniform distribution or normal distribution.

[18] To be more realistic, expected return μ should increase with σ. For example, if I assume that CAPM holds, and the market portfolio has $\mu = 0.08$ as a reward for $\sigma = 0.20$. Extrapolating this reward ratio, $1+\mu > \sqrt{\frac{\pi}{2}}\sigma$ requires that $\sigma < 1.18$. One would rarely want a portfolio with $\sigma > 1.18$, because the probability is higher 10% that the portfolio will eat up every penny in his account before next Christmas Day.

it is better for a consumer to lower his potential consumption D_p in exchange for a large increase in the success rate of plan implementation.

As in many other consumption models, the optimization of consumption in my model depends on many parameters, such as the shape of the asset return distribution and consumer preferences. I focus on the normal distribution $\mathcal{N}(1+\mu, \sigma^2)$ and consider an agent with a power utility $u(D) = D^{(1-\gamma)}/1-\gamma$. In this case, the asset return volatility, σ, the agent's risk-aversion, γ, and the initial durables in stock D_0 are all important variables that affect the optimal consumption plan D_p^*. The model predicts that the optimal consumption plan D_p^* decreases with asset return volatility. Intuitively, a holder of risky assets chooses to set his consumption plan below the expected level of wealth in order to achieve a higher probability that the plan will be implemented successfully. However, the high volatility of asset returns makes the distribution of expected wealth more dispersed, so the probability of successful implementation is less sensitive to a change in D_p. Hence, asset payoffs are more volatile, the consumption plan has to be reduced by a greater magnitude. I also predict that D_p^* increases with the initial durables in stock $(1-\delta)D_0$. Given the tradeoff between the probability of implementation and consumption level upon implementation, a consumer with a larger initial endowment of durables in stock feels less upset about missing a new purchase opportunity. Hence, the lower probability of plan implementation is of less concern, and the planned consumption can be set at a higher level. Finally, a higher level of risk aversion, γ, leads to a more conservative plan. When γ is increased, the marginal utility at D_p is smaller, and therefore it is less costly for the consumer to lower plan D_p in exchange for a higher success rate. Thus the consumer would optimally choose a more conservative plan D_p.

1.3.2 Implications for the Risk Premium

In addition to explaining the relation between consumption growth and volatility, my model provides new predictions for the equity risk premium. Proposition 2 and Corollary 1 of this subsection show that uncertainty of asset payoffs decreases the consumer's expected utility and generates a risk premium in the market. The unique feature of my model that distinguishes it from previous work is that the risk premium exists even if the utility $u(\cdot)$ is linear in consumption.

Proposition 2 (Utility Loss) *Suppose a consumer has a continuous utility function $u(\cdot)$ with $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$, then his expected utility is lower when he holds a risky asset than when he holds a risk-free asset with the same expected return.*[19]

The finding that a consumer dislikes payoff uncertainty is not surprising; most asset pricing models find a similar result. However, the mechanism in this paper's analysis is different. In most current models, the expected utility of the agent is lower when he holds risky assets because of Jensen's inequality. In other words, risky asset pays well when the marginal utility of the agent is low and pays poorly when it is high. This implies that the variation in marginal utility, which comes from the concavity of the utility function, is crucial for obtaining this result. In contrast, my model generates the same prediction even if the utility function $u(\cdot)$ is linear. In fact, the consumer's utility loss due to payoff uncertainty can be decomposed into two components in my model. First, pre-budgeting restricts future consumption of the agent. Specifically, the agent cannot consume more than he planned previously and also can consume only durables in stock if the realized investment return is insufficient to implement the consumption plan. Because consumption cannot exceed the realized wealth, wealth is underutilized in most future states. This waste of wealth exists as

[19]Mathematical proof is available in appendix.

long as the intratemporal utility function $u(\cdot)$ is non-decreasing.[20] Second, similar to the traditional models, the concavity of the utility function $u(\cdot)$ further reduces the expected utility through Jensen's inequality. Obviously, this effect does not exist when a linear utility function is considered.

In order to discuss the comparative statics, I consider a consumer with a power utility who holds a risky asset with a normally distributed return. The difference in expected utility of a consumer between holding risky portfolio and holding the risk-free asset depends on the volatility of investment return, σ, the consumer's preferences, described by parameter γ, as well as durables in stock, D_0. Recall that the volatility of asset returns reduces the expected utility of the consumer through two effects: the Jensen's inequality and wasted wealth. Obviously, the first effect is more pronounced when volatility goes up. However, the second effect is also amplified by volatility σ. In particular, the optimal consumption plan D_p^* becomes more conservative when volatility increases, which in turns leads to more wasted wealth. Overall, higher volatility lowers the expected utility of the consumer. In addition, as in the

[20]It is a somewhat unrealistic assumption of the model that the unplanned component of wealth is completely wasted. In reality, unused wealth can be consumed in an inefficient way or can generate utility through a bequest. But in any case, the unplanned consumption generates a lower utility than when the same amount of expenditure is planned in advance. Therefore, the qualitative results of the model are not changed by this simplifying assumption. In the intertemporal model that I develop in Section IV, I allow the consumer to save unused money for the next period. I show that the utility loss is then generated by a delay in consumption or inefficiency in the consumption/investment allocation rather than by a waste of wealth. Another alternative is to set up the model in a two-good economy and require one of the consumption goods to be pre-budgeted. In this case, all the qualitative results discussed here still holds as long as the two consumption goods are not perfect substitutes. In the two-good model, unplanned money will not be wasted but spent on the free-adjusted good. However, the inefficiency of consumption allocation to the two goods plays the same role as the waste of money does in the current one-good model.

classical models, the expected utility at time 1 with respect to wealth realizations depends on the curvature of the utility function, which is represented by parameter γ. The difference in expected utility between holding a risky asset and a risk-free asset is magnified as γ goes up. Finally, a larger initial stock of durables, $(1-\delta)D_0$, reduces the exposure of the consumer's future wealth to shocks from investment returns. As a result, durables in stock have exactly the opposite effect from that of volatility, which means that expected utility increases with the initial durables in stock.

Other things being equal, the expected utility of the consumer increases with the expected return of the investment asset. Therefore, the following corollary can be directly obtained from Proposition 2.

Corollary 1 (Risk Premium) *Suppose a consumer has a continuous utility function $u(\cdot)$ with $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$, then he is indifferent between holding a risky asset and holding a risk-free asset only if the expected return of the risky asset is higher than that of the risk-free asset.*

The difference in expected utility between holding a risky asset and a risk-free asset will be eliminated in a market through the price of risk. As a result, the comparative statics on expected utility discussed above can be used to make several predictions for the risk premium. In my setting, the risk premium of an asset increases with its volatility and the intratemporal risk-aversion of investors, and it decreases with the initial amount of durables in stock. This means that the equity premium is predictable if the market return volatility or the aggregate consumption varies over time.

1.3.3 Numerical Examples

To better illustrate the model's predictions, I present here a simple numerical example. I assume that the gross return of the asset is normally distributed $\widetilde{R} \sim \mathcal{N}(1+\mu, \sigma^2)$ and model an agent with a power utility $u(D) = D^{(1-\gamma)}/1-\gamma$. I use these assumptions in the rest of the paper because they allow for better model tractability and are commonly used in the current literature.

To convey the main points more efficiently, I assign trivial values to some parameters. Without loss of generality, the initial wealth W_0 and price of durable consumption p are both normalized to 1, and the depreciation rate δ is set to 0.[21]

In the first numerical example, I assign parameter values that match the annual equity market returns, $D_0 = 1$, $\gamma = 5$, $\mu = 1.08$, and $\sigma = 0.20$. In Figure 1.1, I plot expected utility at time 1 vs. the choice of consumption plan D_p. The concavity of the plotted function reflects the tradeoff between the higher probability of a successful plan implementation and a potential increase in consumption. When consumption plan is low, the future utility is also low. When the plan is high, however, the plan implementation often fails because it requires a high investment return. The optimal consumption plan therefore lies in-between. In the example, the optimal consumption plan is 1.70 and the corresponding expected utility is -0.036. With the consumer's

[21] Depreciation rate is not a parameter of interest in the two-period model because it is always possible to adjust level D_0 to $(1-\delta)D_0$ if a certain depreciation level is desired. In the appendix, I prove that the value function $V_0(W_0, D_0)$ is homogenous of degree $1-\gamma$ and the maximizer $D_p^*(W_0, D_0)$ is homogenous of degree 1. That means, the value of the max utility increases exponentially with wealth W_0 and the optimal consumption expenditure increases linearly with W_0. Therefore I assume $W_0 = 1$ without loss of generality. The optimal consumption plan conditioned on $W_0 = 1$ can be also interpreted as the proportion of total wealth to be spent.

expected net worth of $D_0 + W_0\mu = 1 + 1.08 = 2.08$, the consumption plan D_p^* of 1.70 is therefore conservative, as stipulated in Proposition 1.

To examine the effect of asset payoff uncertainty, let us call the consumer in the above case consumer A and assume that consumer B holds a risk-free asset that pays the same rate of return, 1.08. Hence consumers A and B have the same level of initial wealth and the same expectation of future wealth. According to (1.2), consumer B chooses to consume the expected wealth of 2.08 and earns (expected) utility of -0.013, which is much higher than consumer A's expected utility. The comparison shows that the uncertainty of asset payoffs lowers the expected utility of its holder. In equilibrium, market clearing will increase the return of risky asset or suppresses the risk-free rate, which means a risk premium must exist.

Second, I solve the model at different levels of volatility σ while holding the rest of parameters steady. The optimal consumption plan D_p^* and expected utility are plotted against values of σ in Figure 1.2. Note that the dashed lines represent the consumption plan and the expected utility of a consumer who holds the risk-free asset In Panel A, increasing σ induces more conservative consumption plans. Panel B shows that expected utility also declines with an increase of the volatility of asset returns.

In addition to σ, D_0 is also a parameter of interests. The model predicts that both the purchase plan and expected utility increase with D_0. Figure 1.3 displays the predictions by showing an ascending trend for purchase plan $D_p - D_0$ and increasing expected utility along D_0. Here I show the purchase plan $D_p - D_0$ vs. D_0 instead of D_p vs. D_0, because the increment of D_p may be attributed to the fact that D_0 increases the consumer's net worth. To disentangle this from the wealth factor, it is informative to look at the purchase plan $D_p - D_0$. In addition, higher D_0 leads to higher expected utility due to the same wealth effect. This is shown for the risk-free case in Panel B. Comparing the risk-free and the risky case, I find that the difference in expected utility in these two cases narrows down when D_0 increases.

Last, I study the role of the intratemporal risk-aversion γ. In almost all classical consumption models it is the most important parameter. Figure (1.4) shows that it also matters here, and a high value leads to a more conservative plan.[22]

I visualize the model predictions for the risk premium by calculating the risk premium of the risky asset with a normally-distributed return (see Figure 1.5). It is reasonable to consider this risky asset as the market portfolio because the volatility mimics the equity market return. Thus, in the following paragraphs, the risk premium is also called equity premium . I calculate the equity premium here in the following way. Assuming a risk free rate of 2% per year, the expected market return of the risky asset has to be high enough to compensate for its uncertainty such that people are indifferent between holding a market portfolio or receiving the risk-free rate.[23] In other words, given that market return has volatility of 20% per year, I want to find its expected return which matches its certainty equivalence to the risk-free rate. The variation in the premium shown in the figure perfectly reflects our predictions except in its magnitude.[24] Due to the limitation of the two-period setting, the magnitude of the risk premium is not very informative. For example, in the two-period model, the wealth wasted cannot be utilized at all whereas in reality people may be able to use

[22]Here I do not show expected utility with respect to γ as I do for σ and D_0, because a change in γ leads to changes in the utility function. Since "utility function" is a relative concept, it is not economically meaningful to discuss how changes in γ move the expected utility.

[23]Unfortunately, I cannot solve the risk-free rate and equity return together because there is no adjustment for current consumption in this model.

[24]For example, the equity premium in the example at the beginning of this section is as high as 48% and all the numbers in Figure 1.5 are astonishingly high.

it less efficiently or save it for future use. Hence I address only the qualitative feature only in this section and leave the magnitude-related questions to next section.

Besides the trends of equity premium, one more qualitative feature worth noting is the positive value when $\gamma = 0$; i.e., the risk premium does not rely on the curvature of the intra-temporal utility function. As discussed in subsection 1.3.1.3.2, risk-aversion or an aversion to asset payoff uncertainties can exist because of the waste of wealth when the consumer's future wealth is uncertain. To demonstrate this point, I replicate the previous example with a linear utility function. I set $D_0 = 1$, $\mu = 1.08$, $\sigma = 0.20$ as before, but $\gamma = 0$. Similar to the case with positive γ, the consumption plan is conservative. D_p is solved to be 1.85 (which is smaller than the expected wealth of 2.08) and the expected utility is 1.74. In comparison with risk-free case in which utility is 2.08, the consumer is obviously harmed by holding the risky asset. With the consumption plan $D_p = 1.85$, I am able to sketch the future consumption for each asset return realization as in Figure 1.6. The realized wealth is far from fully utilized in almost all the states of the asset return. In contrast, a consumer holds a risk-free asset does not waste any of his wealth because he can perfectly plan his future consumption without any concerns about uncertainty. Thus the waste of wealth leads directly to the inferiority of risky assets.

1.4 Optimization in an Intertemporal Model

So far I have shown that the optimal consumption plan is determined by a tradeoff between a higher success rate of plan implementation and a higher utility level upon implementation. I also find that in a two-period model, the holder of risky asset chooses to set his plan for future consumption below his expected wealth. However, the unrealistically large equity risk premium generated by the two-period model reveals the limits of modeling the real world according to such a simple setting. For example, in real life there should no wasted wealth. People are able to save any unused money to spend later. Therefore, I develop an intertemporal model that allows for more realistic assumptions. The advantage of the intertemporal model is that I can calibrate it and use it to make quantitative predictions.

There is an infinite-lived representative agent in the economy. He has an intratemporal utility $u(D) = \frac{D^{1-\gamma}}{1-\gamma}$ for service flows generated by durable consumption goods. The consumer maximizes the expected lifetime utility given by

$$\max \mathbb{E} \sum_{t=0}^{\infty} \beta^t \frac{D_t^{1-\gamma}}{1-\gamma}$$

where β is the time-preference of the consumer. γ measures the relative risk-aversion of the consumer, when he is allowed to adjust consumption instantaneously, as well as the intertemporal elasticity of substitution. I use this utility function form to retain the model tractability but the intuition is applicable to a more general setting such as Epstein-Zin utility.

There are risky investment assets available for saving. The investment returns, denoted by the vector $\widetilde{R}$, are exogenously given. This is an abstraction from a production economy where firms are invested in by households and the outputs are subject to stochastic productivity shocks. The risk-free rate is denoted by R_f.

The agent enters each period with wealth W_o, already-owned durables in stock D_o, as well as a consumption plan D_p that is ready to implement immediately. Besides his portfolio allocation a on investment assets, he is faced with two decisions. First, for the current period consumption D, he can choose between adjusting his consumption to D_p or consuming only the durables in stock D_o. Let W_o' denote his initial wealth for next period, then budget constraint can be written as

$$\widetilde{W_o'} = (W_o - p(D - D_o))(a^T \widetilde{R} + (1 - a^T \mathbf{1}) R_f). \tag{1.4}$$

Unlike in the two-period model, this budget constraint replaces the previous restriction on implementing a purchase if his wealth is not great enough to pay for it.

The consumer's second decision is to choose a consumption plan D_p' for the next period. At the beginning of next period, his durables in stock depreciate by δ and his investment return realizes. He repeats the two consumption decisions with his new state described by D_o', W_o' and D_p'. Since every period is the same for the representative agent, his optimization problem can be written in a Bellman Equation as follow:

$$\begin{aligned} V(W_o, D_o, D_p) = \max_{\{D\in\{D_o,D_p\},a,D_p'\}} \ & \frac{D^{1-\gamma}}{1-\gamma} + \beta\mathbb{E}V(\widetilde{W_o'}, D_o', D_p') \\ s.t. \qquad & {D_o}' = (1-\delta)D, \\ & \widetilde{W_o'} = (W_o - p(D - D_o))(a^T\widetilde{R} + (1 - a^T\mathbf{1})R_f). \end{aligned} \tag{1.5}$$

where p is the price of durable goods, $\mathbf{1}$ is a vector of ones. The last constraint is the transition equation for wealth. Wealth in the next period depends on the expense/revenue from durables adjustment and the investment return for this period, which introduces the uncertainty of future wealth. Unlike in the two-period model, the wealth left after a purchase can be invested and used for future consumption. As a result, the goal of the consumption adjustment plan here is to achieve a favorable consumption wealth relationship in the next period without expending all wealth. This optimal relation of consumption and wealth reflects the balance between the investment earnings and the consumer's time-preference on consumption, so will not be as extreme as in the two-period model. Therefore, the consumer may want to adjust consumption up or down depending on the current state and the optimal consumption level, whereas in the two-period model the desire to spend all the cash assures any reduction of consumption to be suboptimal.

1.4.1 *The Solution for a Single-Asset Economy and Implications*

Here I discuss an economy with only one risky asset in order to confirm the qualitative results shown in the two-period model. In this economy, there is one risky asset available, so I can call it the market portfolio. I assume its return is independently and identically distributed (i.i.d.) in each period and follows the distribution $\mathcal{N}(1+\mu, \sigma^2)$ with $\mu = 0.08$ and $\sigma = 0.15$.

With only the market portfolio available, the agent's portfolio choice is trivial and thus I can focus on his consumption policy. The optimization problem is observed to be homogeneous in the initial wealth W_o with degree of $1-\gamma$; hence the optimal choices do not depend on the initial wealth level and our discussion can be based on ratios normalized by wealth. For example, an initial durables ratio can be defined as $d_o = \frac{D_o}{W_o}$. Note that W_o and D_o are the states of the agent at the beginning of one period, and his consumption of this period is subject to the implementation of his plan D_p. So his consumption-wealth ratio in this period has to be defined as $d = \frac{D}{W}$ where D is how much he consumes and $W = W_o - p(D - D_o)$ is the money invested in this period. When the agent chooses not to adjust his consumption or his wealth limits him from adjusting his consumption, his consumption-wealth ratio is unchanged from the initial value: i.e., $d = d_o$. Otherwise they are different.

The solution is found numerically. Because of the multi-dimensionality of states and choice variables, it is not straightforward to show and understand the solution. As a reminder, in each period, the consumer has to make two decisions regarding his consumption. He has to decide whether to implement his current consumption plan D_p and he has to choose a future consumption plan D'_p. The two decisions are made simultaneously and are closely related to each other. Specifically, the implementation decision will determine the amount of wealth left for investment in this period, so the future expenditure has to be planned accordingly. On the other hand, the implementation decision alters not only the current period consumption, but also the feasible set of future consumption possibilities. So the consumer has to consider the effect of implementation on future utility, which also relies on his consumption planning of next period. However, in spite of these complications, the two consumption decisions serve one purpose, which is to smooth the consumption.[25] In the rest of this subsection, I discuss how these two decisions are made in different states with the spirit of consumption smoothing.

Plans are not always implemented as illustrated in Figure 1.7, where the implementation policy is shown as a scattered plot. Because the consumer's optimization problem is homogeneous in W_o, only two state variables (i.e., $\frac{D_o}{W_o}$ and $\frac{D_p}{W_o}$) are crucial. The x-axis is ordered by $\frac{D_o}{W_o}$ which is the amount of consumption in stock, and the y-axis corresponds to the consumption plan $\frac{D_o}{W_o}$, which is optional to implement. For each state, if the consumption plan is implemented, its corresponding spot is marked as a dark(blue) point, otherwise blank. The two-dimensional state space is marked by two blue triangles approximately and there is a critical point at the conjunction of the two triangles. No sales plan (i.e., $D_p < D_0$) is implemented to the left of the critical point and no purchase plan is implemented to the right of this point. At the critical point, no plan will be considered for implementation. I call this critical point the ideal ratio, since a consumer does not want to adjust his consumption when he

[25]Consumption smoothing, or keeping a stable consumption-wealth ratio, is the key element of utility maximization because power utility is assumed here. When other utility function assumed, a smoothed consumption might not be the preferred. But as long as there exists a preferred consumption-wealth relation corresponding to the utility, the results of this paper hold.

enters a period with consumption-wealth ratio at this value.[26] As seen in the two blue triangles, the consumer tries to get as close to the ideal ratio as possible, when the ideal ratio is not granted to him at the beginning of the period. In particular, he implements the plan only if the consumption-wealth ratio after implementation is not farther away from the ideal ratio.[27] Therefore, the closer to the ideal ratio one period starts, the fewer helpful plans there are.

One can also find two main differences related to the implementation policy between the intertemporal model and the two-period model. First, a sales plan can be valuable in the intertemporal model because a consumer may want to reduce consumption and save for the future. In a two-period model, saving cannot lead to any additional utility so a sales plan is never optimal. Nevertheless, a sales plan is still not as valuable as purchase plans. Note that in Figure 1.7, the triangle on the right is much thinner than the one on the left. That is because consumption good depreciation keeps the consumption-wealth decline over time, hence high consumption-wealth ratio may correct itself naturally in the next period. So a high consumption-wealth ratio is less harmful than a low consumption-wealth ratio. In other words, sales plans can be partially substituted by depreciation.

[26] I do not call it the "optimal ratio" because the word "optimal" usually refers to the solution of an optimization problem. Hence an optimal ratio should be a feasible value of a choice variable. In the setting of this paper, the consumption-wealth ratio is not always fully in control due to the pre-budgeting requirement. Therefore, the ideal ratio is not always achievable although the consumer tries his best to get close.

[27] The state variable $\frac{D_p}{W_o}$ can be misleading if one takes it as the consumption-wealth ratio after D_p is implemented. However, note that when consumption switches from D_o to D_p, wealth will change from W_o to $W = W_o - p(D_p - D_o)$. Thus the new consumption-wealth ratio $\frac{D_p}{W} < \frac{D_p}{W_o}$ when a purchase plan is implemented, and $\frac{D_p}{W} > \frac{D_p}{W_o}$ for sales. Had it been displayed in a graph similar to Figure 1.7 but rescale y-axis with post-implementation ratio $\frac{D_p}{W}$, the marked area would look narrower along the y-axis.

More importantly, when we assume the consumer has to hold a positive share of the market portfolio, his budget constraint imposes that $W_o \geq D_p - D_o$. However, the financial constraint $W_o \geq D_p - D_o$ of the optimization problem is not binding in the intertemporal model. Recall that in the two-period model, the financial constraint is extremely distressing because it is the only factor that keeps the consumer from consuming as much as possible. Here, however, the consumption-smoothing motivation plays a more important role in keeping the consumption below a certain level. Therefore, a consumer might abandon his purchase plan either to smooth the consumption or in response to the financial constraint. Checking the boundaries in Figure 1.7, one can see that the consumer abandon the purchase plan before a binding financial constraint takes effect. In fact, the financial constraint $W_o \geq D_p - D_o$ is equivalent to $\frac{D_p}{W_o} - \frac{D_o}{W_o} \geq 1$. If the financial constraint is binding, the upper boundary of the blue area should fall on the line $y = x + 1$. However, in Figure 1.7 the real boundary is far below $y = x + 1$.[28]

More interesting than the implementation decision, is the consumption planning decision. To better illustrate the optimal consumption planning, I focus on the relation between the agent's consumption-wealth ratio and his planned future consumption-wealth ratio (see Figure 1.8). Several relevant variables need to be constructed in order to facilitate my discussion. As defined earlier, the agent's consumption-wealth ratio d is the ratio after he completes the consumption adjustment in the current period. Several aspects of this ratio deserves attention. Together with the uncertainty of investment payoffs, it decides the future initial consumption-wealth ratio.[29] Meanwhile, his plan for future consumption-wealth ratio can be in-

[28] I do not plot $y = x + 1$. Had it been plotted, it would be found far from the current scope in Figure 1.7.

[29] Thus it is comparable to the D_0 in the two-period model.

ferred from D'_p and W. However, his future consumption-wealth ratio is not fully in his control, as his future wealth will depends on investment returns, as well as whether he would implement D'_p. To focus on the aim of his consumption plan, I define his intended consumption-wealth ratio d'_i as the ratio when the investment return realizes at its expectation and D'_p is implemented. It is mathematically derived as

$$d'_i = \frac{D'_p}{1 + \mu W - (D'_p - D(1-\delta))}$$

where the denominator reflects the cost or income of adjusting consumption to D'_p in the next period.

How should one evaluate the agent's consumption plan based on his intended consumption-wealth ratio d'_i? Recall that in the two-period model, conservative planning means that the consumer does not aim to spend all his wealth when the expected return is realized. In the two-period model, there is no benefit from holding any cash at the end of the period, so ideally (or if no uncertainty exists in his wealth), the agent would like to consume all of his investment payoffs. In the intertemporal model, in contrast, the ideal level of consumption is decided differently; holding cash has the benefit of generating investment revenues. I solve the ideal consumption-wealth ratio by finding the agent's intended consumption-wealth ratio when the asset return is $1 + \mu$ without uncertainty in the current period.[30] Then I can compare whether the agent aims at the ideal level when he is faced with uncertainty in the future.[31]

[30] I call this ratio as the "ideal ratio" because the agent does not have full control over his future consumption-wealth ratio.

[31] Note that the procedure for computing the ideal level is similar to the risk-free case in the two-period model, however I assume that the risk-free asset exists only in the current period instead of assuming that it exists forever. The reason is that the long-run existence of risk-free asset will change the economy. In a different economy, the value function will be changed, and thus the intended consumption-wealth ratio will no longer be comparable to that in an economy with one risky asset only.

As shown in Figure 1.8, the ideal ratio is constant even though the current consumption-wealth ratio varies from 0.15 to 0.27. This is not unexpected. When the agent's future wealth is known, he is able to plan and implement the next period's consumption at the exact optimal level. In other words, the future consumption-wealth ratio can be chosen freely regardless of the current state. Given the homogeneity of the optimization problem, the optimal level of consumption must be proportional to wealth, which means the consumption-wealth ratio will be chosen at an unique level. Therefore, to maximize his future value function, he would keep the consumption-wealth ratio constant.

Nonetheless, the agent holding a market portfolio does not aim his future consumption-wealth ratio at the ideal level. He plans conservatively all the time. It means he aims at a low consumption-wealth ratio when he starts with a consumption-wealth ratio lower than the ideal level, and a high consumption-wealth ratio when his current ratio is above ideal. The reason for this conservative deviation is very similar to the tradeoff in the two-period model. Although in this model there is no wasted wealth, failure to implement a purchase will still lead to utility loss because the consumption is postponed. Therefore, making a consumption plan in this model still entails a tradeoff between coming closer to optimal consumption and a successful rate of adjustment. It means the consumer plans conservatively as in the two-period model.

Therefore the main intuition and implications of the two-period model are qualitatively preserved in this model. Similar predictions can be generated with the corresponding economic variables. As the roles of σ and γ remain the same in this model, they should increase the distance between the intended plan and the ideal ratio. The role of D_0 in the two-period model is replaced by the current distance between the consumption-wealth ratio and the ideal ratio. Therefore, as shown in the graph, the closer the current ratio is to the ideal level, the closer the intended ratio is to the ideal value.

Moreover, one implication is that a risk premium exists even when linear intratemporal utility is adopted. As interpreted in the two-period model, the risk premium is generated because wealth is subject to waste while a risky asset is held. Similarly, the risk premium in this model is generated because of the unavoidable deviation from the ideal consumption level. Inflexible adjustment exposes holders of risky assets to the risk of either delaying consumption or over-consume when the return does not realize around it expected value.

1.4.2 Dynamics of Consumption

In addition to identifying the implications for asset prices, it is interesting and important to discuss the dynamics of consumption growth in the model. In this subsection, I introduce the predictions of my models for consumption growth and its relation to market return. For demonstration purposes, I simulate an investor who starts with the ideal consumption-wealth ratio. Because I use the same parameter values as in the previous subsection, the same solution is obtained for the investor's dynamic consumption decisions. I model the consumer's decisions for a time-series of simulated market returns and display the properties of the ex post consumption growth. A large-sample simulation is conducted and summarized in Table 1.1. Table 1.3 documents empirical estimations from historical data as a complement to Table 1.1. To help demonstrate the mechanism, I use real annual asset returns from 1927 to 2012 as the simulated asset returns and show the consumption path in Figure 1.9.

The corresponding summary statistics of this consumption path can be found in the first line of Table 1.1.[32]

In a risky economy, a market portfolio holder in my model almost never arrives at his ideal consumption-wealth ratio, as shown in Panel 2 of Figure 1.9. This is also part of how my model differs from the canonical model and models with consumption adjustment cost, such as Grossman and Laroque (1990) and Chetty and Szeidl (2010).[33] Even when the investor starts with an ideal consumption level, he cannot ensure his later consumption at the ideal level. In the model, no matter how well he plans for adjustments, his period-2 consumption is restricted to two specific levels: his old durables in stock or his planned consumption. In period 2 the shock of investment return will drive him away from his optima unless the realized investment return is exactly its expectation. More important, once his consumption-wealth ratio is no longer ideal, he will schedule a consumption plan lower than the ideal level because ad-

[32]Here there are two reasons that I use the realized market return as an experiment. First, it is easier for curious reader to compare with the historical consumption growth. Secondly, the realized market return is not strictly the same as a normal distribution, for example, there are the well-known fat tails, whereas I simulate asset returns from normal distributions only. Therefore, the ex post consumption growth might exhibit different features. There are different advantages of looking at realized market return vs. simulated normal returns. Since the investor's consumption strategy is solved under the normality solution, it is preferred to look at normally-distributed asset returns when model consistency is of concern. However, I can only observe the consumption growth corresponding to the realized market returns. So it might be interesting to take a look at the realized market returns. Therefore I choose to bear with the inconsistency or resolve to bounded-rationality assumption on the investor.

[33]In the canonical model, the optimal level of consumption is always maintained because consumption can be freely and immediately adjusted. In Grossman and Laroque (1990) and Chetty and Szeidl (2010), the consumer incurs the adjustment cost and returns to the optimal level every couple of periods.

justment plans are made conservatively. After he experiences a large positive wealth shock at the beginning of period 2, he would be able to implement his consumption purchase plan from period 1 but still end up with consumption lower than the ideal level. As shown in Figure 1.9, he never returns to the ideal consumption-wealth level afterward.[34]

Note that the consumption growth is relatively persistent after period 1. In period 2, with the conservative plan discussed in subsection 1.4.1.4.1, the low consumption-wealth ratio leads the investor to aim at another lower-than-ideal consumption-wealth ratio. Therefore his consumption level at period 3 is also low. With the same argument, the low consumption in period 3 may also extend to low consumption in the next period, and so on and so forth until one or more reverse shocks in the market bring the consumption-wealth ratio to the opposite side of the ideal line. Therefore, because of the conservative consumption plan, a large wealth shock will translate to a series of smaller and persistent innovations in consumption growth. The graph shows similar consumption patterns after large shocks at several places, such as period 49 and period 77. As a result, the autocorrelation of consumption growth here is a slightly positive 0.04 as reported in Table 1.1 (0.10 when the market returns are bootstrapped) while the annual market return does not exhibit significant autocorrelation (-0.01).[35]

[34]Therefore, in this model, the variations in the consumption-wealth ratio may not be solely attributed to innovations in expected consumption growth and market return as in Lettau and Ludvigson (2002). As shown in Figure 1.9 Panel 2, the pre-budgeting friction itself is able to drive large variations in the consumption-wealth ratio.

[35]The persistence of consumption growth is another feature that distinguishes my model from other consumption-based models. In the canonical model, consumption growth always matches equity returns exactly. In models with adjustment costs, consumption growth is also expected to be i.i.d.. Autocorrelation of aggregate consumption growth is generated in several papers, including

While a large positive shock to asset return leads to a series of small increases of consumption growth, a large reverse shock does not. In Panel A of Figure 1.9, when a reverse shock happens at period 31, consumption growth responds immediately in the same period. This asymmetry in response leads to a negative skewness of consumption growth. In fact, consumption in stock depreciates as fast as 0.24 per period. Thus a large reduction in consumption can be completed passively, i.e., foregoing a consumption purchase plan. Indeed, in 14 years of large reductions in consumption, only once was it done by actively implementing a sale plan.[36] In the other 13 years, the investor simply let his consumption decline through depreciation. Therefore, the skewness of consumption growth is closely related to the depreciate rate δ in the model. As δ grows from a small value, the skewness of consumption growth goes further negative. However, when δ grows too much beyond the market return, the skewness pulls back. When the consumption depreciates too fast, the magnitude of passive adjustment would be too large relative to wealth shocks. The negative skewness of consumption growth has been documented in the literature, for example Yang (2011), but studies have rarely provided an explanation.

The most interesting factor related to consumption growth might be its volatility, because it has been stressed in the literature from time to time. It is an issue whenever the question is how people react to wealth shocks or how risk is priced accordingly. In the simulation, I can see that consumption moves along a smoother path than the market; its standard deviation is about 25% lower than the market return. As I

Caballero (1990), Caballero (1993), Lynch (1996) and Gabaix and Laibson (2001), through the aggregation of individual actions. But these are not based on a representative agent model. In models of long-run risks, such as in Bansal and Yaron (2004), the autocorrelation is assumed at a certain level but not derived from an optimal consumption choice.

[36] A large consumption reduction is defined as consumption growth< -0.2, which is one standard deviation of the market returns.

discussed earlier, large positive shocks to market returns are going to lead to a series of small adjustments due to conservative consumption plans. Meanwhile, residual consumption demand after a large shock might be canceled out by a reverse shock in future periods before it is realized in consumption growth. These two effects together smooth the impact of wealth spikes on consumption growth.[37][38]

Next I turn my attention to the correlation of equity returns and consumption. Note that equity returns are endogenously given in this simulation exercise, so the correlation only measures how consumption responds to wealth shocks. At the first glance, Panel A of Figure 1.9 seems to show a lagged market return. The correlation of the simulated consumption growth and lagged market return is 0.73. In other words, the equity return predicts future consumption growth in the short-run. It is no surprising. Given that the immediate reaction to wealth shocks is limited by the consumption planned made in the previous period, the investor has to delay part of his consumption adjustment to the next period. On the other hand, while instantaneous adjustment is prohibited in my model, there remains a moderate relationship between realized market return and contemporaneous consumption growth (their correlation is 0.34 in the current example). A high market return leads to implementation of the purchase plan or cancellation of the sale plan—i.e., to positive or zero consumption growth—while a low market return induces zero or negative

[37] Low consumption volatility is also generated as Grossman and Laroque (1990) and Chetty and Szeidl (2010) through the financial adjustment cost of consumption. But their friction does not lead to conservative adjustments as in my model. Instead, the duration between two adjustments is prolonged to reduce the volatility of consumption growth.

[38] Note that financial constraints (wealth/cash cannot be negative) do not really play a role here. Recall that in the last subsection, I showed that financial constraints are rarely binding. A consumer will abandon his purchase plans when the purchase would drive him too far away from the ideal consumption-wealth ratio, which always happens before a financial constraint is violated.

consumption growth. Hence the model does allow the predictability of market return on consumption growth but in a weak form. At the same time, the asymmetric response of consumption to positive and negative shocks also leads to an asymmetric correlation of consumption and market returns. Consumption co-moves with wealth more during recessions than it does in expansionary times.[39]

Although correlation of consumption and equity is testable and observable, the implications of my model cannot be easily distinguished from some of the prevailing models. For example, lower contemporaneous correlation and short-run predictability can both be achieved in a slow-reaction model or a heterogeneous-agents model.[40] My model also has these disadvantages. For instance, these models are usually criticized for their low-frequency performance. Similar to my model, the frictions carried in these models always get weaker over longer horizons hence consumption is still expected to co-move with wealth growth at low frequency. However, the literature has documented a mismatch between consumption and wealth even for low-frequency observations.[41] For longer horizons, the impact of planning consumption one year ahead is diluted in my model. The correlation of market return and consumption growth drifts up gradually with the length of the horizons, moving from 0.34 over one year to 0.76 over four years.

The preceding discussion of model predictions can be summarized by two groups of observable statistics. First, the model predicts positive autocorrelation, negative skewness, and low volatility. Second, the contemporaneous correlation of market return and consumption growth is low while a lagged market return might co-move with

[39] I do not discuss this prediction in statistics, because it is not easily quantified in a simple and robust way.

[40] Caballero (1990), Caballero (1993), Lynch (1996) and Gabaix and Laibson (2001) all share this feature or can be extended to generate this result.

[41] One example can be Cochrane and Hansen (1992).

consumption growth. Since one simulation in Figure 1.9 might not be persuasive, I have supplemented with a larger sample (see Table 1.1). Simulations are conducted in three ways. First, as explained above, I input the historical market return directly. Secondly, I generate 1000 time-series of simulated market returns with the same number of periods from a normal distribution. And last, I bootstrap market returns 1000 times from the historical annual returns, so that special features of market returns, such as fat tails, are reserved in the simulated wealth shocks. Panel A reports simple summary statistics for simulated market returns and their corresponding consumption growth. Low standard deviation and negative skewness of consumption growth are found uniformly in the three simulations.[42] It is worth noting that negative skewness does not rely on the skewness of the market return itself because it is found and strong in the normal-distribution simulation. In contrast, autocorrelation of consumption is not observed in the normal simulation, but found in the other two simulations, because large shocks in market returns are necessary—i.e., fat tails of wealth shocks are important. In Panel B, all the implications for low contemporaneous correlation and short-run predictability between consumption and market return are confirmed in the three pools.

Subsequently, I estimate the moments of consumption growth for historical data 1952–2012 and report in Table 1.3. Although the model used in this paper is based on durables consumption, it may also have similar implications for non-durable and other consumption which may also be subject to pre-budgeting friction. The total consumption expenditure, non-durables consumption and durables consumption are all considered in the table. Total consumption per capita is obtained directly from Federal Reserve Economic Database (FRED) which includes personal expenditures

[42]Here we say the standard deviation is low whenever consumption growth is smoother than simulated market returns. I compare it to the empirical estimation in the next paragraph.

of non-durable goods, durable goods, and services. Personal expenditures on non-durables goods and services are combined as non-durables consumption. Durables consumption is constructed following Yogo (2006) and assumes that the depreciation rate is 24% per year.[43][44] I choose a starting year of 1952, following Yogo (2006) and Yang (2011), to avoid the unusual growth in durables consumption immediately after WWII.[45]

As shown in Table 1.3, I find that consumption growth is highly autocorrelated and negatively skewed, findings that are consistent with the documentation in Yang (2011). For example, the first-order autocorrelation ranges from 0.31 to 0.69 and skewness can be as low as -0.52 during the period 1952–2012. In comparison with the results shown in Table 1.1 and 1.2, my model is sufficient to explain the negative skewness and generate a third observed autocorrrelation. It is not surprising that my model, in a representative agent setting, does not explain all the autocorrelations of the aggregate consumption growth. As discussed in the literature, such as Gabaix and Laibson (2001) and Lynch (1996), a large share of the autocorrelation might be due to the aggregation of non-synchronous moves by all the agents.

Predictions for single-period cross-correlations of consumption growth and market return in my model are well matched to the empirical observations. In the historical data, the correlation is very low contemporaneously (nearly zero) and large when

[43] Yogo (2006) estimates the depreciation rate at 6% per quarter.

[44] Also note that, ideally, we should calculate total consumption as imputed durables consumption plus the non-durables consumption. However, since the imputation of durables consumption magnifies the magnitude of expenditure, it would be over-weighted if we simply added it to non-durables to obtain the total. However, the imputation is good for the purpose of calculating durables growth rate, because the magnification of durables expenditure is proportionally thus does not deteriorate its growth rate.

[45] In fact, it is pointed out in Ogaki and Reinhart (1998) that the durables consumption data in the period 1947–1951 is subject to unusual restocking growth immediately after WWII.

lagged market return is considered (0.29 to 0.57). The same pattern has been found in simulations, although the observed correlation is slightly higher in the simulation.

Two limitations of my model show up when one compares Tables 1.1, 1.2 and 1.3. First, although the volatility of consumption growth is lower relative to market volatility in my model, the observed volatility (0.01 to 0.04) is still much lower than my model prediction (higher than 0.34). This again demonstrates the difficulty of describing the behavior of aggregate consumption through a represent-agent model. Aggregating individual consumption is not a trivial task and deserves careful considerations as in Gabaix and Laibson (2001), Lynch (1996) and Caballero (1990). Second, as discussed earlier, my model is not able to explain the low-frequency behavior of consumption growth. In the simulation, the correlation of market return and consumption growth increases sharply from 0.34 over one year to 0.76 over four years. In the real data, I find this correlation to be lower than 0.20 for all horizons reported in Panel B of Table 1.3.

1.5 Conclusion

This paper introduces a new friction for consumption adjustment over time. A consumer cannot instantaneously adjust their consumption, but must plan for adjustment in advance. I show that when this friction is modeled, the consumer chooses to adjust consumption in a smooth way and exhibits aversion to holding risky assets. Importantly, consumer prefers assets with lower volatility even if his intratemporal utility is linear. One of the key theoretical results of my analysis is that a holder of risky assets chooses to make conservative purchase plans, which results in sticky consumption growth in the model. When a large shock to wealth arrives, a risky-asset holder adjusts his consumption in small steps, and the reaction to a shock therefore takes a long time to materialize. Because of this delayed reaction, the agent who holds risky assets can deviate from the ideal consumption-wealth ratio for multiple periods, which lowers his utility relative to the risk-free case.

The endogenous consumption growth obtained in my model has properties that are observed in the real data. In a representative-agent model, I am able to generate a positive autocorrelation in consumption growth and a low correlation of consumption growth with the contemporaneous market return, while the previous literature usually obtains the same results only by modeling heterogeneous agents. My model also generates negative skewness of consumption growth, which is observed in the historical data but has not been explained by the existing literature.

My model also generates implications to asset prices. The pre-budgeting friction distorts the consumption growth path and leads to utilty loss to the consumer. Therefore, it generates a new source of risk premium in addtion to the classical model. This risk premium exists even if a linear utility function is applied.

Figure 1.1: The Consumer's Objective Function in the One-Period Model.
Value of the objective function of the consumer in the one-period model is plotted as a function of his choice of consumption plan D_p. Initial wealth W_0 and the price of durable consumption p are both normalized to 1, and the depreciation rate δ is zero. The rest of parameters are set as follows: $D_0 = 1$, $\gamma = 5$, $\mu = 0.08$, and $\sigma = 0.20$.

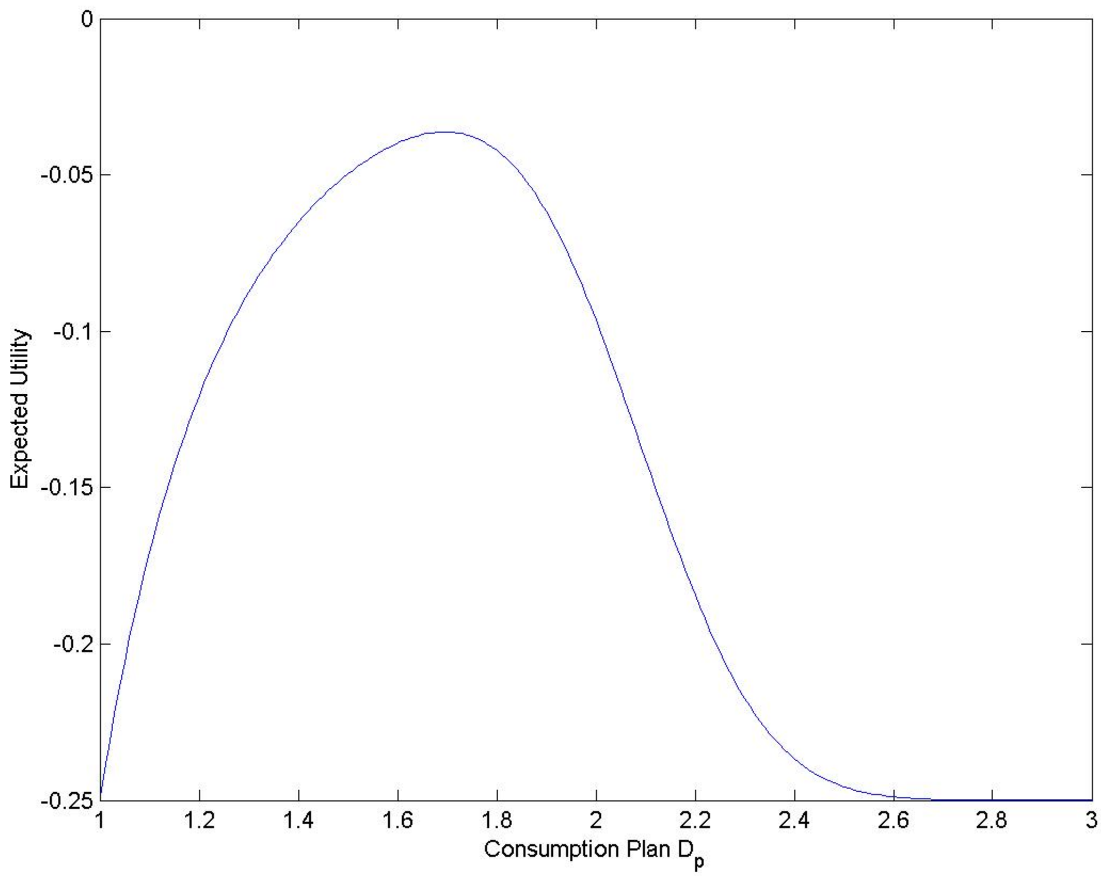

Figure 1.2: Consumption Plan and Expected Utility vs. Return Volatility.

This figure contains two graphs. Panel A is optimal consumption plan D_p as a function of volatility in the consumer's investment return σ. Panel B shows the corresponding expected utility of the consumer for each value of σ. Assume $\delta = 0$. Initial wealth W_0 and price of durable consumption p are both normalized to be 1. The rest of the parameters are set as follows. $D_0 = 1$, $\gamma = 5$ as the intratemporal utility function is specified by a power utility, $\mu = 0.08$. Dashed lines are for risk-free case, i.e. $\sigma = 0$ while keeping other parameters the same.

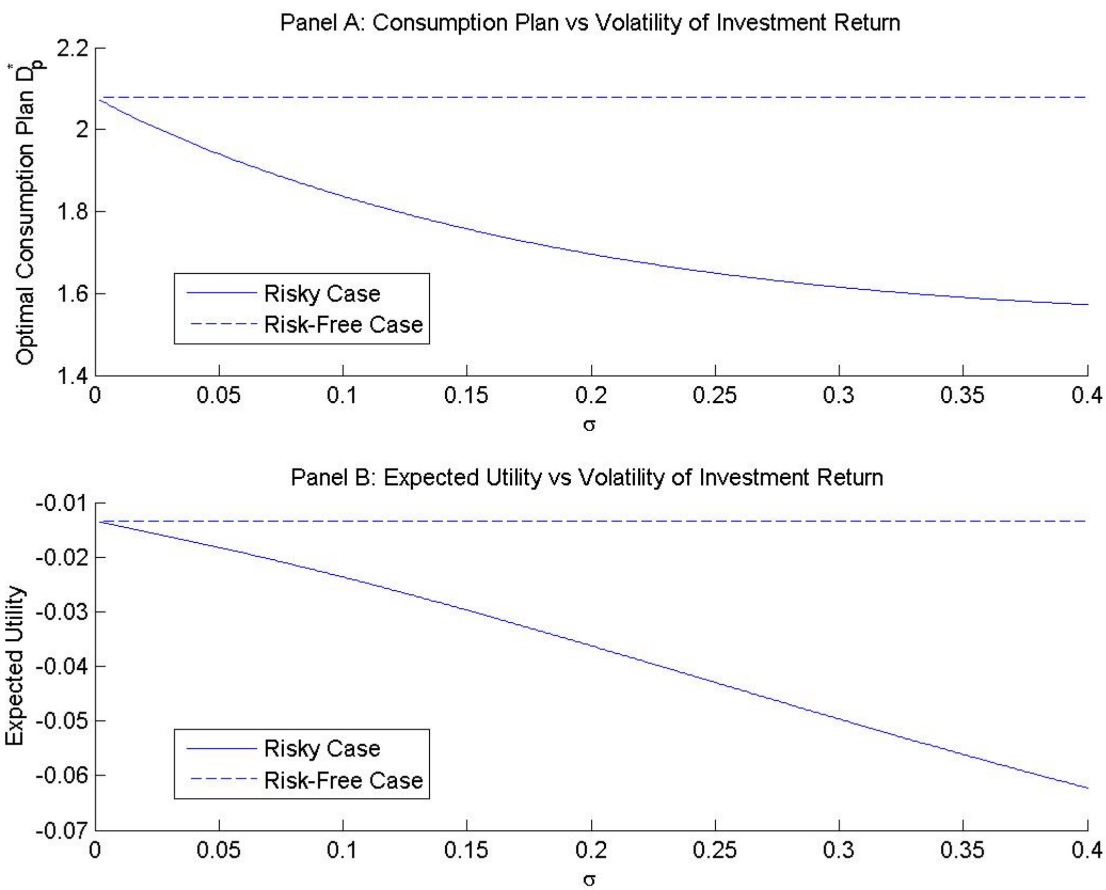

Figure 1.3: Consumption Plan and Expected Utility v.s. Initial Durables in Stock. Panel A displays how optimal consumption plan D_p varies with the initial durables in stock D_0. Panel B shows the corresponding expected utility that the consumer can achieve. No depreciation is assumed, i.e. $\delta = 0$. Initial wealth W_0 and price of durable consumption p are both normalized to be 1. The rest of the parameters are set as follows. $\gamma = 5$ as the intratemporal utility function is specified by a power utility, $\mu = 0.08$ and $\sigma = 0.20$. Dashed lines are for risk-free case, i.e. $\sigma = 0$ while keeping other parameters the same.

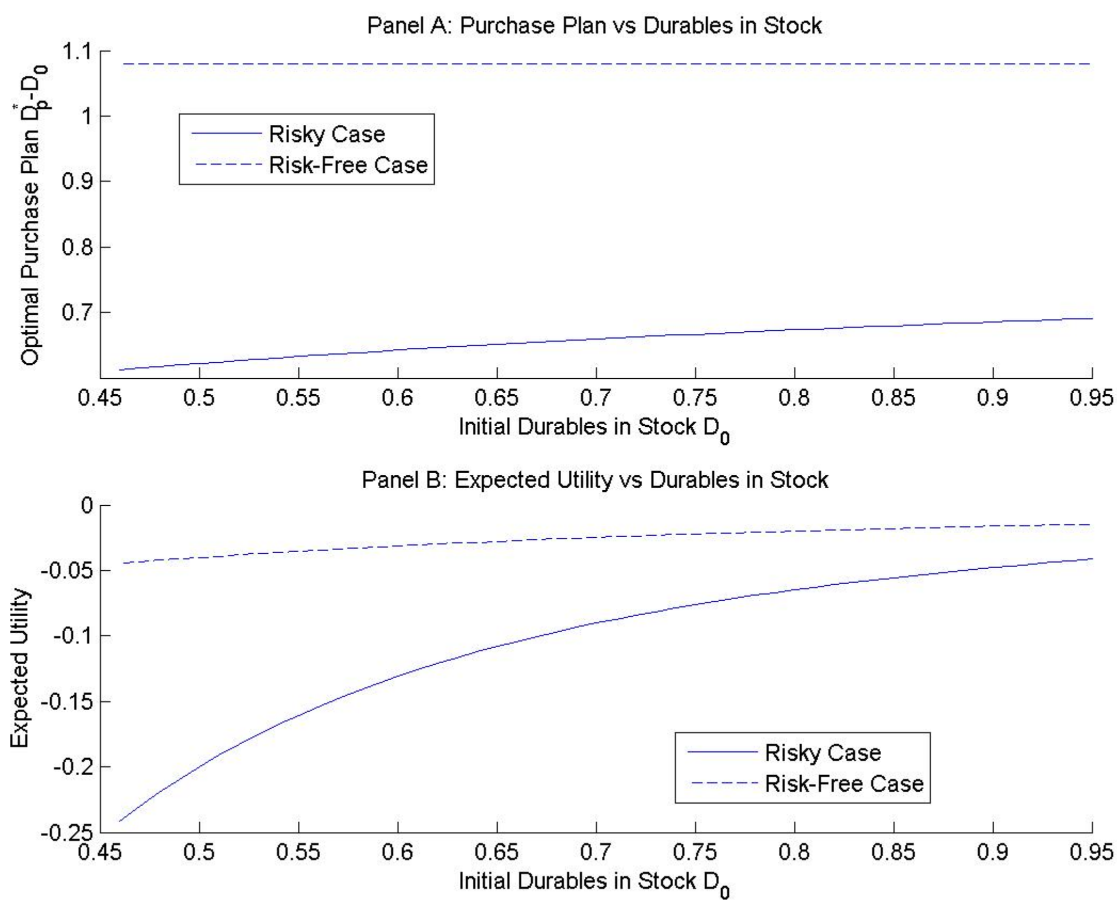

Figure 1.4: Expected Utility v.s. Intratemporal Risk-Aversion.

The figure plots the optimal consumption plan D_p when different levels of intratemporal risk-aversion γ is assumed. The other parameters are set as follows. $\delta = 0$. Initial wealth W_0 and price of durable consumption p are both normalized to be 1. $D_0 = 1$, $\mu = 0.08$ and $\sigma = 0.20$. Dashed lines are for risk-free case, i.e. $\sigma = 0$ while keeping other parameters the same.

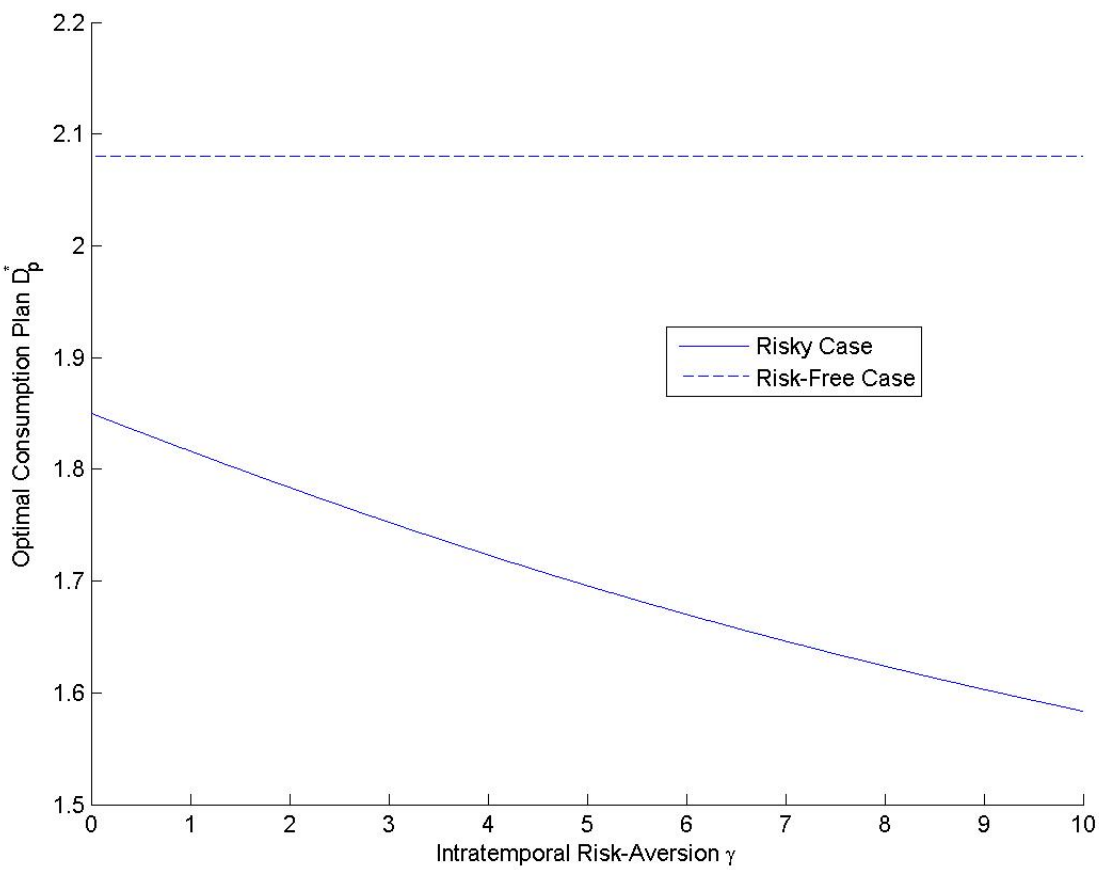

Figure 1.5: Comparative Statics of Equity Premium.

Equity Premium generated in the one-period model is shown in this figure. Parameters of interests, including the volatility of market return σ, intratemporal risk-aversion γ and initial durables in stock D_0 are chosen in corresponding ranges. For the rest of the parameters, depreciation rate $\delta = 0$, and initial wealth W_0 and price of durable consumption p are both normalized to be 1. Equity premium here is calculated by equating the expected utility of a market portfolio holder and the risk-free asset holder assuming that risk free rate 2% per year is exogenously given and σ is the volatility of market return.

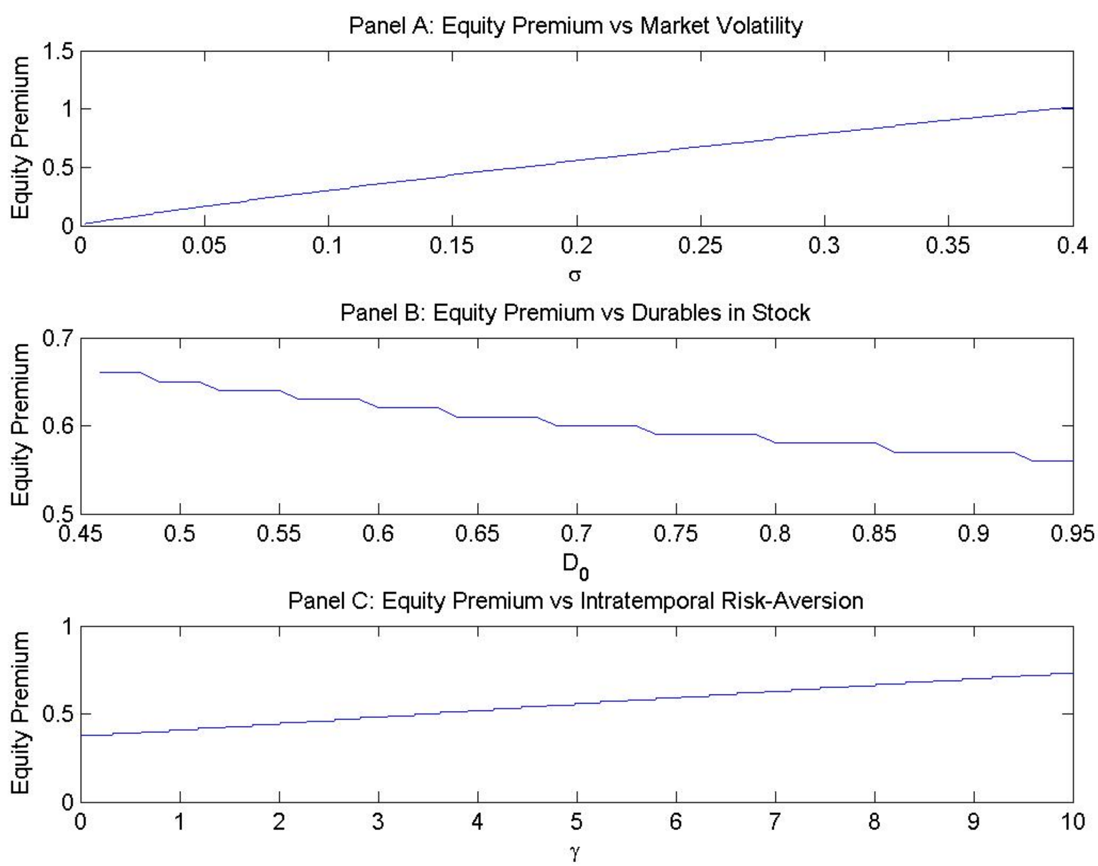

Figure 1.6: Inefficient Utilization of Wealth with Uncertainty.

Consumption expenditure in states of investment return realization within five standard deviations are shown. Dashed line is the corresponding level of future wealth. Investment return realizations. $\delta = 0$. Initial wealth W_0 and price of durable consumption p are both normalized to be 1. The rest of the parameters are set as follows. $D_0 = 1$, $\gamma = 5$ in the power utility function, $\mu = 0.08$ and $\sigma = 0.20$.

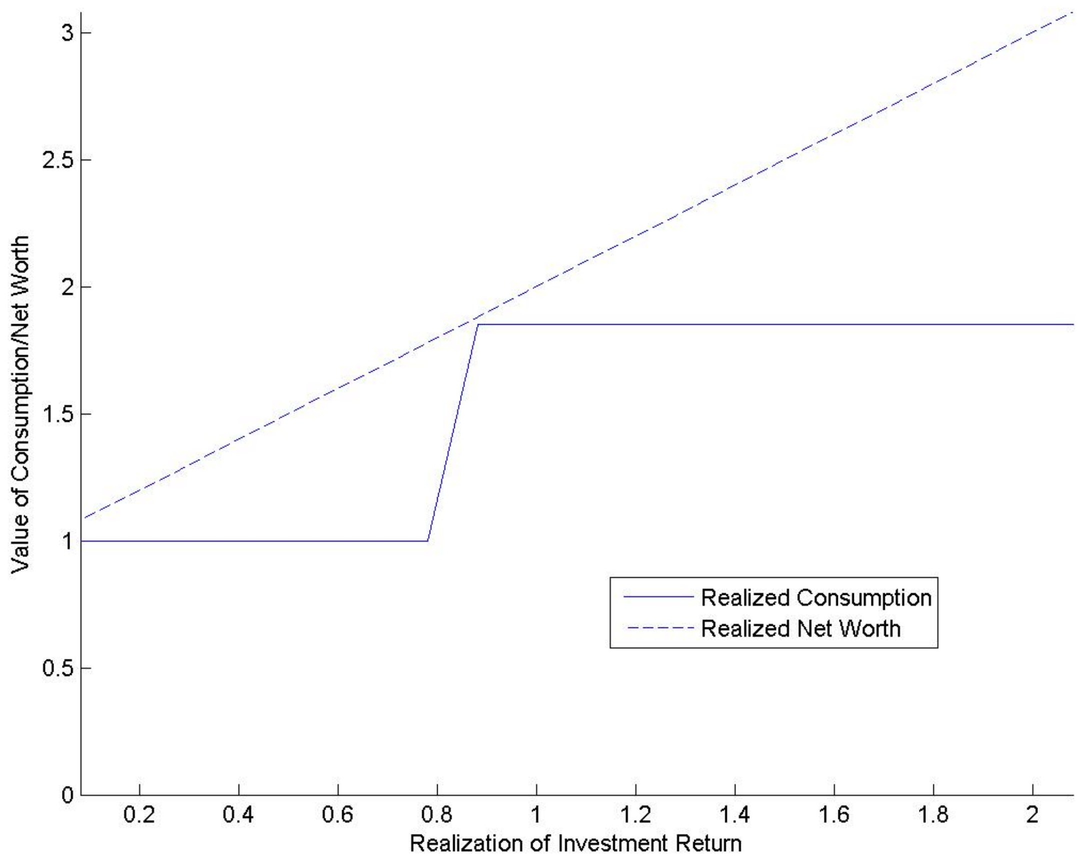

Figure 1.7: Implementation of Consumption Plan under the Intertemporal Setting. This figure shows us the consumer's implementation decision when he enters a new period with states (W_o,D_o,D_p) in the intertemporal model. The states can be reduced to a two-dimensional space - ($\frac{D_o}{W_o}$,$\frac{D_p}{W_o}$). Implementation decision can be represent as a binary variable which allows the function to be shown in a scattered plot as follow. The x-axis is ordered by $\frac{D_o}{W_o}$ which is the amount of consumption in stock, whereas y-axis corresponds to the consumption plan $\frac{D_o}{W_o}$, which is optional to implement. In the scattered plot, the dark(blue) part is referred to the states when consumption plan D_p is implemented.

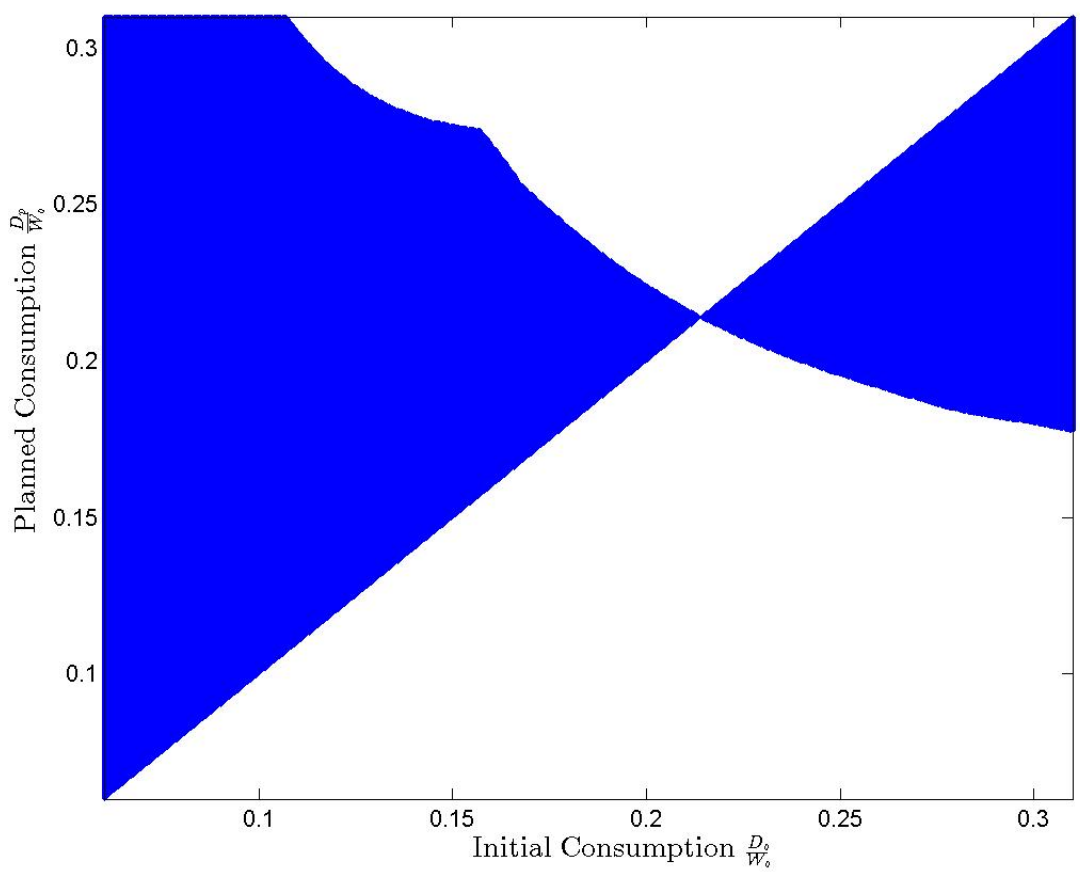

Figure 1.8: Intended Consumption-Wealth Ratio of the Consumer.

Intended consumption-wealth ratio d_i' is plotted as a function of current consumption-wealth ratio d for a consumer modeled under the intertemporal setting. Both the dashed line and dotted line are to mark the ideal ratio under the same set of parameters. $d = \frac{D}{W}$ where D is how much he consumes and $W = W_o - p(D - D_o)$ is the money invested in this period. $d_i' = \frac{D_p'}{1+\mu W-(D_p'-D(1-\delta))}$ which reflects the future consumption-wealth ratio in case that the investment return realizes at its expectation and D_p' is implemented. I solve the ideal consumption-wealth ratio by finding the agent's intended consumption-wealth ratio when the asset return is μ but without uncertainty in the current period.

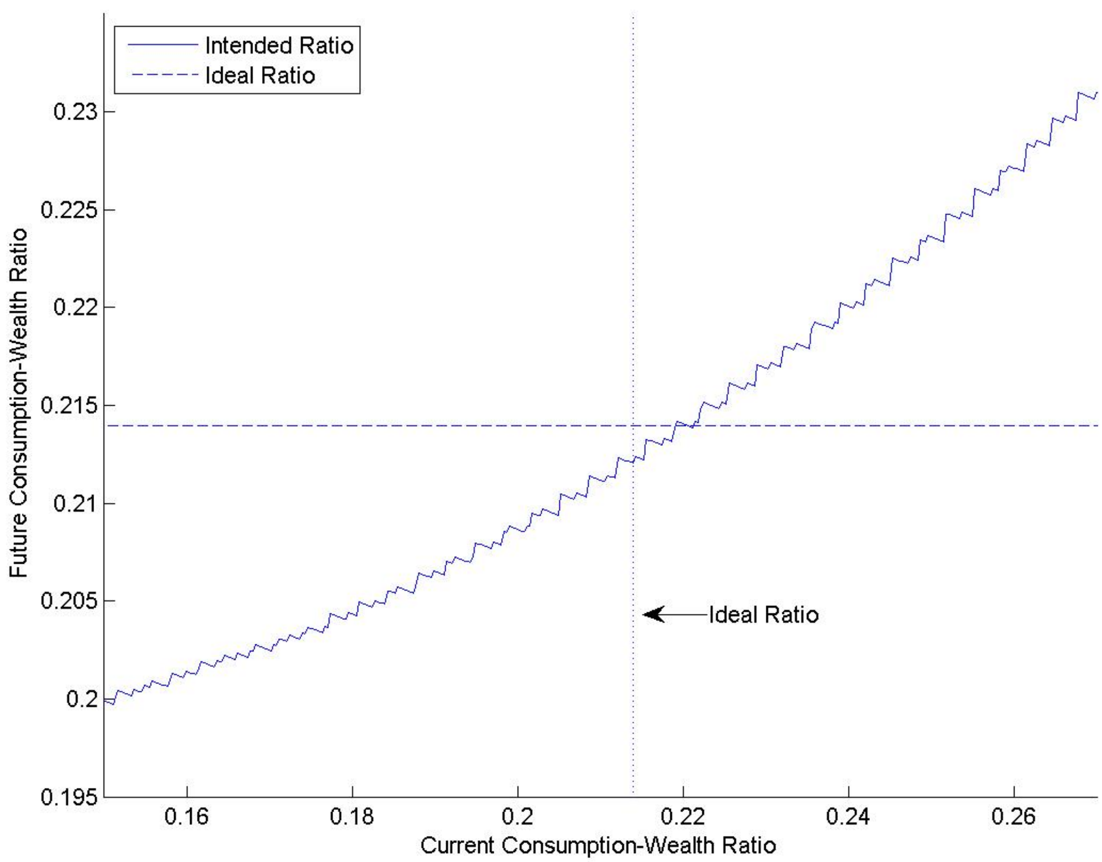

Figure 1.9: Simulation of Consumption Growth.

Simulated time-series of consumption growth is displayed together with market returns in Panel A. The corresponding dynamics of consumption-wealth ratio is plotted in Panel B, where the dotted line marks the ideal consumption-wealth ratio. For the initial period, I set the consumption-wealth at its ideal level. In this figure, I simply used the real annual returns of market during 1927–2012 to replace the simulated asset returns for illustration purpose. Note that a larger sample of simulation exercise is continued in table 1.1.

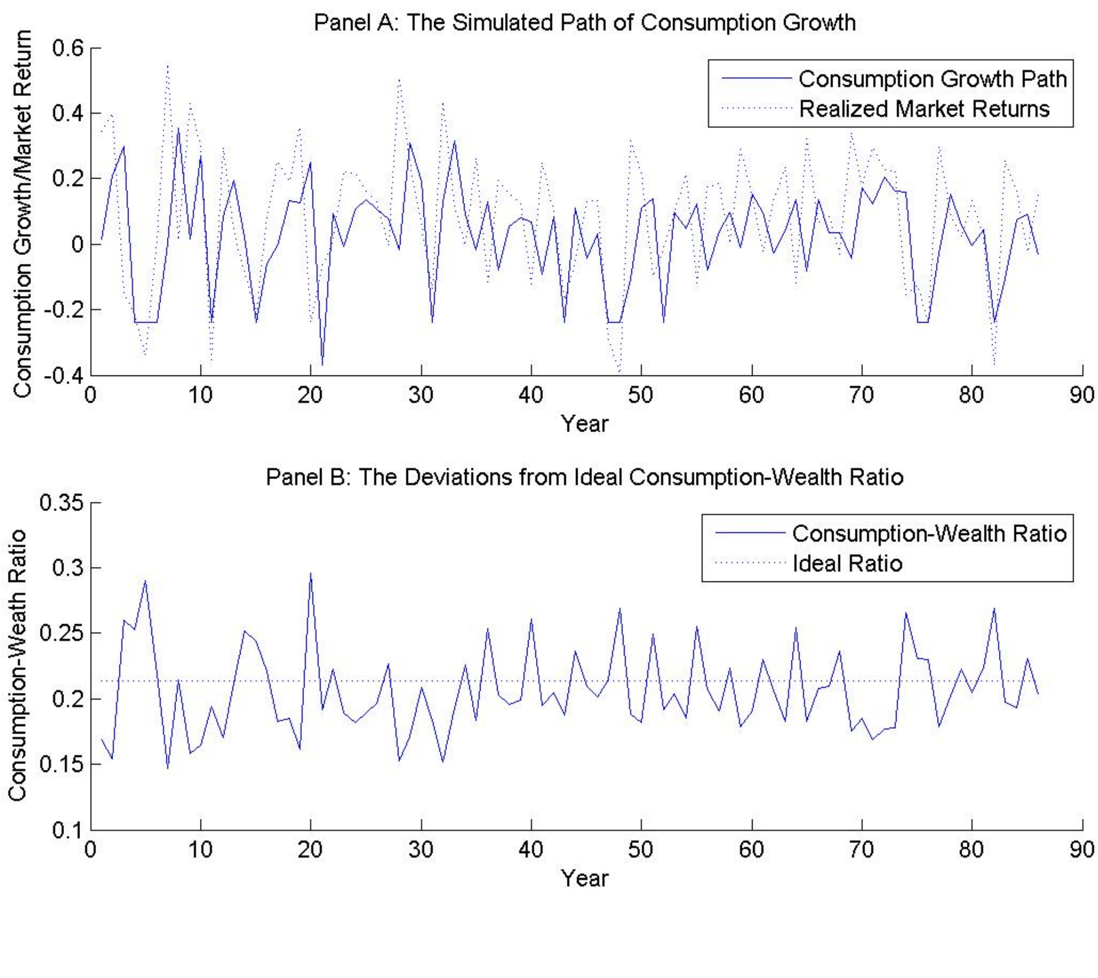

Table 1.1: Summary Statisitcs of Simulated Consumption Growth

Panel A reports the simple summary statistics of simulated market returns. Panel B contains summary statistics of consumption growth. When the sample includes more than one time-series, standard deviation of the statistics is reported below the mean within a pair of parentheses. Acf1 is the first order autocorrelation.

Panel A: Simple Summary Statistics of Simuated Market Return				
	Mean	STD	Skewness	Acf1
1927-2012	0.085	0.206	-0.261	-0.008
Simulation	0.080	0.150	-0.003	-0.013
	(0.016)	(0.012)	(0.250)	(0.106)
Bootstrap	0.085	0.204	-0.262	-0.009
	(0.021)	(0.014)	(0.196)	(0.106)
Panel B: Simple Summary Statistics of Consumption Growth				
	Mean	STD	Skewness	Acf1
1927-2012	0.027	0.155	-0.461	0.041
Simulation	0.025	0.124	-0.618	-0.003
	(0.013)	(0.010)	(0.206)	(0.105)
Bootstrap	0.028	0.157	-0.373	0.100
	(0.018)	(0.011)	(0.174)	(0.104)

Table 1.2: Corss-Correlation of Simulated Consumption Growth and Market Returns

The table reports correlation between consumption growth and market returns. When the sample includes more than one time-series, standard deviation of the statistics is reported below the mean within a pair of parentheses. $Corr(R, C)$ is the contemporaneous one-period correlation of consumption growths and market returns. $Corr(Lag(R), C)$ is the cross-correlation of consumption and lagged market returns. $Corr(Lag2(R), C)$ is the second-order cross-correlation. $Corr(Rn, Cn)$ is n-period long-horizon correlations.

Correlation of Market Return and Consumption Growth						
	$Corr(C, R)$	$Corr(Lag(R), C)$	$Corr(Lag2(R), C)$	$Corr(R2, C2)$	$Corr(R3, C3)$	$Corr(R4, C4)$
1927-2012	0.343	0.726	-0.087	0.641	0.727	0.759
Simulation	0.342	0.583	0.048	0.630	0.745	0.802
	(0.108)	(0.117)	(0.114)	(0.070)	(0.057)	(0.051)
Bootstrap	0.450	0.565	0.069	0.692	0.789	0.838
	(0.101)	(0.115)	(0.107)	(0.063)	(0.050)	(0.044)

Table 1.3: Historical Consumption Growth

Panel A reports the simple summary statistics of historical consumption growth. Similar to Table 1.1, Acf1 is the first order autocorrelation. $Corr(R, C)$ is the contemporaneous one-period correlation of consumption growths and market returns. Panel B contains correlation between consumption growth and real market return. $Corr(Lag(R), C)$ is the cross-correlation of consumption and lagged market returns. $Corr(Lag2(R), C)$ is the second-order cross-correlation. $Corr(Rn, Cn)$ is n-period long-horizon correlations.

Panel A: Simple Summary Statistics of Consumption Growth

	Mean	STD	Skewness	Acf1
Total	0.022	0.018	-0.421	0.310
Non-Durables	0.020	0.013	-0.521	0.443
Durables	0.038	0.036	-0.234	0.690

Panel B: Correlation of Market Return and Consumption Growth

	$Corr(C, R)$	$Corr(Lag(R), C)$	$Corr(Lag2(R), C)$	$Corr(R2, C2)$	$Corr(R3, C3)$	$Corr(R4, C4)$
Total	0.024	0.565	-0.120	0.171	0.148	0.118
Non-Durables	0.033	0.489	-0.039	0.130	0.116	0.113
Durables	-0.130	0.294	0.125	-0.077	-0.054	-0.057

Chapter 2

IS MARKET TIMING GOOD FOR SHAREHOLDERS?

2.1 Introduction

The question of whether managers can time the market in making share repurchase and equity issuance decisions has been hotly debated in the literature.[1] Yet, a more important question that has not been addressed before is whether managers should want to time the market. In this paper, we aim to fill this gap in the literature by analyzing wealth transfers between a firm's selling, ongoing, and new shareholders that are caused by market timing.[2] Surprisingly, we find that in many instances successful market timing does not benefit existing shareholders. Furthermore, shareholders fare worse when the manager issues overpriced equity than when she repurchases undervalued stock.

Our main insight is that current/existing shareholders are net sellers of a firm's stock and are affected by mispricing even if a firm does not issue or repurchase equity. For example, current shareholders are already better off during a temporary overpric-

[1] Brockman and Chung (2001) and Dittmar and Field (2014) conclude that managers exhibit substantial timing ability in executing repurchases. In survey of executives, Graham and Harvey (2001), and Brav *et al.* (2005) find that the perception of mispricing is one of the most important factors driving repurchase and issuance decisions. Additionally, a large literature documents stock return patterns that could be symptomatic of market timing (Baker and Wurgler (2000); Jenter *et al.* (2011); Ikenberry *et al.* (1995), and Loughran and Ritter (1995)). The market timing interpretation of these results is disputed by Eckbo *et al.* (2000); Butler *et al.* (2005), and Dittmar and Dittmar (2008).

[2] Throughout the paper, we focus on the distributional effects of market timing and do not consider situations where it creates or destroys total value (e.g., by affecting a firm's investment policy).

ing because some of them are able to sell the stock at a higher price. To accurately assess the effect of market timing, therefore, one needs to measure the incremental changes in shareholder value that are caused by repurchase and issuance decisions. Instead, financial economists have traditionally thought about the combined effect of stock mispricing and firms' actions triggered by this mispricing.

When we measure the net effect of firm's market timing, we find that the casual intuition is often wrong. For example, we show that a firm selling overpriced shares can hurt its existing shareholders rather than investors buying these shares. This is because by issuing additional equity, the firm conveys some of its negative information to the market, which decreases the stock price. Furthermore, the firm is now competing with its own shareholders for potential buyers of the stock. As a result, a firm's shareholders are able to sell fewer overpriced shares than they otherwise might and also must sell them at a lower price. Both of these effects make the firm's selling shareholders worse off. As we further show in the model, all current shareholders (who will become either selling or ongoing shareholders) can be worse off as a group. But if the firm buys back its undervalued stock, current shareholders benefit at the expense of new investors because the latter are able to buy fewer underpriced shares and must buy them at a higher price.

We develop our argument by building a theoretical model in the rational expectations framework. In the model, we require only that prices reflect all publicly available information–i.e., the investors recognize that the repurchase or equity sale conveys news about stock mispricing–and that the market clears additional demand for or supply of shares from the firm.[3] A firm manager is endowed with private information and can use it to trade on the firm's behalf. All shareholders and new investors

[3]Specifically, we do not require any temporary market imperfections, such as liquidity dry-ups, simultaneous trading, or price pressure.

are fully rational: they can learn from the firm's decisions and trade their stock accordingly. Because some firms in the economy issue or repurchase equity for non-informational reasons, the equilibrium is not fully revealing and informed managers can take advantage of stock mispricing.

We show that the result of a firm's equity market timing on existing shareholders can be described by three effects–which we label as the quantity effect, the price effect, and the long-term gain effect. The quantity effect appears because a firm's additional demand for shares must be accommodated by either current shareholders or new investors. For example, suppose that, in a typical year, current shareholders sell 1,000 shares to new investors. If the firm decides to repurchase 100 shares during this year, it is plausible that current shareholders will have to sell 1,050 shares and new investors will buy only 950. The quantity effect in this example reduces the wealth of selling shareholders and new investors by the amount of mispricing multiplied by 50 shares. Because the quantity effect is a result of adverse selection, it negatively affects all uninformed parties.

An important piece of intuition comes from the price effect, which takes place because a firm's decision to repurchase or issue stock conveys new information to the market and permanently affects the stock price. Unlike the quantity effect, the price effect creates asymmetric changes in the wealth of the firm's current shareholders and new investors. For example, the price drop at the announcement of a seasoned equity offering (SEO) protects new investors from buying into an overpriced firm, but at the same time it also decreases the expected profit of selling shareholders.

Finally, the long-term gain effect applies to those investors who hold the firm's stock until all information is revealed, i.e., ongoing shareholders and new investors who join the firm. In particular, a share repurchase conducted by an informed manager generates the trading profit for a firm and allows its stockholders to sell shares at a higher price in the future. Importantly, the extent to which current shareholders benefit from this effect depends on the magnitide of net selling because some stockholders liquidate their positions before the long-term gain is realized.

The model generates two new results. First, we show that current shareholders prefer share repurchase timing to new issuance timing. This result is driven by the price effect. Because current shareholders are net sellers, they benefit when the firm corrects underpricing but sometimes prefer to leave overpricing uncorrected. We demonstrate that the manager who wants to maximize current shareholder value will use share repurchases more often than new equity sales. In particular, she will repurchase stock when it is fairly priced or even somewhat overpriced, but will not always issue overvalued equity.[4] Repurchases by informed managers will then be followed by a smaller magnitude of abnormal returns and generate a smaller average profit than new equity sales. Therefore, the continuing popularity of stock buybacks that do not appear to exploit large undervaluation can be rationalized by the preference of managers for current shareholders. To the best of our knowledge, this explanation for repurchases has not been previously explored in the literature, and we view it as complementary to the commonly cited motives of redeploying excess cash, managing earnings, improving alignment between management and shareholders, and counteracting dilution from equity-based compensation plans.[5]

Second, we show that in many circumstances current shareholders are worse off because of market timing. One such circumstance is when a firm issues overvalued

[4]Here it is important to see the difference between our study and the much simpler idea that share repurchases raise the price for selling shareholders. First, the remaining shareholders are negatively affected by excessive repurchases or repurchases made during the overpricing. More important, by creating an additional demand for stock, a share repurchase changes the number of the firm's selling and remaining shareholders.

[5]See, e.g., Kahle (2002); Grullon and Michaely (2004), and Huang and Thakor (2013).

stock and the mispricing is relatively small. In this case, the decrease in wealth of selling shareholders caused by the price and quantity effects is larger than the long-term gains to ongoing shareholders, so that current shareholders are collectively worse off. Another situation when market timing is value destroying for current shareholders is when the share turnover is relatively high. In this case, the wealth of current shareholders always decreases with the timing of equity sales and can also decrease with the timing of share repurchases. The intuition for this result is that the high share turnover strips current shareholders of some long-term gains and the quantity effect works against them. We show that in this situation current shareholders prefer a manager who never times the equity market to a manager who systematically responds to mispricing by issuing shares and repurchasing stock.

Determining how different shareholder groups are affected by market timing is not only interesting in and of itself; it can also give us insights into the firm's implicit value maximization objectives. By observing *how* the manager of a particular firm uses her information to time the market, it is possible to infer what shareholder group's wealth the manager really cares about. Given the theoretical predictions of the model, the data suggest that an average large U.S. firm times the market as if it were trying to create value for *current* shareholders. First, there are larger post-event abnormal returns following equity issuances than following repurchases. Specifically, over the period 1982-2010, the average three-year abnormal return after seasoned equity offerings is -12.6%, but only 3.4% after repurchases. Second, the average measure of profit from SEO timing is considerably larger than the profit from repurchase timing. We document this result by using a new empirical measure of profit from market timing, calculated as the additional return earned from equity timing by a shareholder holding one share. The difference between issuance and repurchase profits captures the imbalance in timing by a particular firm, with positive values indicating a relative preference by the manager for current shareholders. We find that an SEO adds on average 0.37% in return to ongoing shareholders, while a repurchase adds only 0.04%. Finally, it appears that repurchases are more frequent than SEOs, with 36.8% of all firm-years posting a repurchase and 4.0% having an SEO. These results do not support the view that the average firm acts in the interest of ongoing or future shareholders, but are consistent with current shareholder value maximization.

The rest of this paper is organized as follows. The next section provides a brief overview of the literature. Section 2 solves for the equilibrium in the presence of informed trading by a firm and analyzes wealth transfers between current shareholders and new investors. The data sources and empirical results are described in Section 3. The final section offers concluding remarks.

2.2 Literature Overview

Our model has its roots in the theoretical literature on share issuance and repurchase decisions under asymmetric information. There are two main differences from prior work. First, most earlier studies do not focus on the welfare of existing and new shareholders of a firm's stock, which is at the heart of our theoretical analysis.[6] Instead, related studies usually derive the manager's optimal policy given a particular objective function, such as maximizing a weighted average of the current market price and expected intrinsic value (e.g., Persons (1994) and Ross (1977)). In comparison with the approach in these papers, the maximization problem for current shareholders in our model has variable weights; that is, the manager's timing has an

[6] Lucas and McDonald (1990) do recognize that shareholders may disagree about the desired equity issue policy. However, they further assume that there is a sufficient number of long-term shareholders so that management acts in their interest.

effect not only on the prices, but also on the number of current shareholders who will sell stock at each date. Second, the prior literature often assumes shareholders and other investors are passive. This assumption ignores the fact that shareholders and investors who are able to learn from the firm's decisions can optimally rebalance their portfolios, which has a feedback effect on managerial decisions.

The literature on optimal issuance decisions usually analyzes a firm seeking external financing for new investment projects (see Heinkel (1982); Brennan and Kraus (1987); Leland and Pyle (1977); Williams (1988); Myers and Majluf (1984), and Morellec and Schurhoff (2011)). Our paper differs from this strand of literature because there is no investment in the model, and the issuance decisions are motivated solely by mispricing. The repurchase signaling literature shows that stock repurchases can signal positive information to investors (see, e.g., Vermaelen (1981); Ofer and Thakor (1987); Hausch and Seward (1993); Persons (1994), and Buffa and Nicodano (2008)).[7] For example, in the model of Constantinides and Grundy (1989), a manager can use a positive signal conveyed by repurchases to issue equity-like securities. These studies are not primarily concerned with the wealth transfers between different groups of investors.

Two studies give special attention to conflict of interests between different groups of shareholders in repurchases. Brennan and Thakor (1990) show that repurchases lead to a wealth transfer from uninformed to informed shareholders. They argue that since the costs of gathering information are larger for small shareholders, a repurchase is expected to benefit large shareholders. Unlike Brennan and Thakor

[7] Signaling with both issuance and repurchases is explored in a number of structural dynamic models. For example, Hennessy *et al.* (2010) build a dynamic equity signaling model, where signaling is achieved through higher leverage and, consequently, higher bankruptcy costs. Bolton *et al.* (2013) assume that firms exploit the opportunity to issue equity at a lower cost, but they also assume an exogenous time-varying cost of financing.

(1990), we assume that all of a firm's investors and current shareholders have the same information and that only the manager has access to private information. In another study, Oded (2005) shows that repurchases can hurt those shareholders who need to sell the mispriced stock after a liquidity shock.

Some of the earlier studies reach different conclusions than ours because they assume that equity timing originates from differences in beliefs among investors rather than from information (Huang and Thakor (2013) and Yang (2013)). Firms can also take advantage of aggregate market mispricing (Baker and Wurgler (2002)) or react with their repurchase and issuance decisions to a change in the overall business environment (Dittmar and Dittmar (2008)). In contrast, the predictions of our model are based on mispricing across firms.

Our study contributes to a large empirical literature that documents and explains equity mispricing around new equity issuances and repurchases. For example, Ikenberry *et al.* (1995) document positive abnormal returns following the announcement of open market share repurchases and Loughran and Ritter (1995, 1997) provide evidence on the underperformance of firms conducting IPOs and SEOs. Additionally, Pontiff and Woodgate (2008) document that share issuance exhibits a strong cross-sectional ability to predict stock returns. Baker *et al.* (2007) provide a thorough overview of this literature. We contribute to this line of research by developing a new measure of profit from market timing. We also show that it is important to simultaneously analyze repurchase and issuance decisions. For example, based on the issuance data alone, a researcher cannot separate the manager's timing ability from her preferences.

2.3 Model

2.3.1 Setup

In this section, we build a model of market timing based on the rational expectations framework of Grossman (1976). The economy is populated with a proportion $\lambda < 1/2$ of firms that are controlled by informed managers who are able to time the market ("timing firms"), and a proportion $1 - \lambda$ of firms that sell and repurchase equity for reasons that are unrelated to misvaluation. For example, firms might repurchase stock to distribute excess cash, manage earnings, adjust leverage, increase the pay-performance sensitivity of employee contracts, or counteract the dilution from exercises of employee stock options (Grullon and Michaely (2004); Skinner (2008), and Babenko (2009)). Similarly, new equity issuance can be motivated by the need to finance new investment. For example, DeAngelo *et al.* (2010) find that, without SEO offer proceeds, 63% of issuers would run out of cash the year after an SEO.[8]

We assume that the demand for shares by firms that issue and repurchase equity for exogenous reasons is normally distributed

$$F \sim N(\mu_u, \sigma_u^2). \tag{2.1}$$

We show that it is possible to choose the parameters μ_u and σ_u^2 in such a way that investors who observe a manager's actions cannot distinguish whether the demand comes from an informed or uninformed manager (we use the same notation F for the demand by the informed manager).[9] Thus the equilibrium is not fully revealing, and informed managers are able to take advantage of mispricing.

[8]Additionally, Hertzel *et al.* (2012) find that timing of SEOs can be determined by market perception of a potential overinvestment problem, as opposed to equity mispricing.

[9]Formally, the distribution of demand by the informed managers is the same in equilibrium as the exogenous distribution of demand by the uninformed managers. This assumption helps us to significantly simplify the learning problem by individuals who observe firm action F, but do not

Each timing firm is endowed with a risk-neutral manager who receives private information at date 1 and can trade on the firm's behalf. The true per share value of the firm is drawn from a normal distribution and is realized at date 2

$$P_2 \sim N(\overline{P}, \sigma_p^2). \tag{2.2}$$

The manager has a noisy signal v about the future firm value and can use this information to buy or sell stock for the firm

$$v = P_2 + \varepsilon, \text{ where } \varepsilon \sim N(0, \sigma_\varepsilon^2). \tag{2.3}$$

Note that the long-term price can change if the manager repurchases or issues stock; we denote this price by P_2'

$$P_2' = P_2 + \frac{F\,(P_2 - P_1)}{N - F}, \tag{2.4}$$

where N is the initial number of outstanding shares, and P_1 is the market price of the stock at date 1. We assume that a firm's decision to repurchase or issue equity and the market-clearing price are fully observable by everyone in the market. Note, however, that whether investors observe repurchases and equity issuances is not important in our setting since the same information can be inferred from the market price. In this way, our model differs from the one used by Oded (2005), who assumes that both prices and repurchases are unobservable and that investors submit their bids for stock through an auction in which a firm receives priority over other participants.

There are n current shareholders holding the firm's shares and m outside investors interested in buying the firm's stock.[10] All shareholders and potential investors are

know whether the firm is timing the market or acting for exogenous reasons. Appendix A provides the fixed-point solution for parameters μ_u and σ_u^2.

[10]In our model, each shareholder can hold a different number of shares, so that the number of current shareholders does not need to coincide with the number of outstanding shares.

rational and can trade in the firm's stock at any point in time. Shareholders and new investors maximize their expected wealth given the available information, but also have specific preferences for buying or selling shares, modeled through the following objective function

$$EU_i \equiv \max_{X_i} E(W_i|F) - \frac{\theta}{2}\left(X_i - Q_i\right)^2, \tag{2.5}$$

$$\text{where } W_i = \left(N_i + X_i\right) P_2' - X_i P_1. \tag{2.6}$$

Here $i \in \{1, 2, ..., n+m\}$ indexes different investors, with $i \in \{1, ..., n\}$ referring to current shareholders and $i \in \{n+1, ..., n+m\}$ to new investors, W_i is the investor's wealth, N_i is the initial number of shares held by the investor, and X_i is the optimal demand for shares at date 1. Specifically, at date 1 investor i buys X_i shares at the price P_1 and sells all his holdings $N_i + X_i$ on the final date at the price P_2'. The quadratic term in the objective function (2.5) is introduced for modeling convenience. It serves two purposes: to induce shareholders and new investors to trade and to ensure that the demand for stock is finite in equilibrium. Q_i is the investor's preference for buying shares (i.e., the number of shares the investor would buy absent any new information), and the parameter θ captures the elasticity of the investor's demand.

Our assumption of the utility function (2.5) is identical to specifying the investor's optimal demand as

$$X_i^* = Q_i + \frac{E\left(P_2'|F\right) - P_1}{\theta} \approx Q_i + \frac{E\left(P_2|F\right) - P_1}{\theta}. \tag{2.7}$$

The first term, Q_i, is the investor's status quo demand for stock, and the second term is the additional demand triggered by the information contained in the firm's trade, similar to the one in the model by Grossman (1976). Because the investor's profit decreases in price P_1, the demand by individual investors is downward sloping in equilibrium, and the market can clear.[11]

In line with actual experience and to ensure that the shareholder base changes over time, we assume that the average parameter Q_i is positive for new investors who prefer to buy the firm's stock (e.g., to complement and diversify their portfolios) and negative for current shareholders who prefer to sell the stock (e.g., for liquidity or diversification reasons). If this assumption were not true, trading would be possible only between current shareholders. Section III.A provides empirical evidence supporting the validity of this assumption. We normalize the average Q_i of all individual investors and shareholders to zero, so that the equilibrium market-clearing price when the firm is not trading in its stock is $P_1 = \overline{P} = E(P_2)$.[12]

Next, we specify the equilibrium and examine how the welfare of current shareholders is affected by the firm's market timing strategies.

2.3.2 Symmetric Market Timing: Implications for Current Shareholders

We first analyze the basic case in which the manager maximizes the expected profit from trading F shares conditional on her signal. A priori this seems to be a natural choice of the objective function since it leads to a symmetric market timing strategy: repurchase stock when it is undervalued and issue stock when it is overvalued. It is also consistent with the usual assumption in the literature that the manager cannot

[11]The downward-sloping demand functions can also be justified by differences in shareholder beliefs (Bagwell (1991) and Huang and Thakor (2013)), the investor trades being processed sequentially through the limit order book (Biais *et al.* (1995)), or the firm's stock having no close traded substitutes (Wurgler and Zhuravskaya (2002)). Empirical evidence in support of downward-sloping demand functions is provided in Greenwood (2005) and Shleifer (1986).

[12]Note that if the average Q_i were not zero or there were a non-zero demand by an uninformed firm, F, the market would still clear, but at a different price P_1.

tender her own shares during a repurchase or participate in a seasoned equity offering (e.g., Morellec and Schurhoff (2011) and Constantinides and Grundy (1989)) and wants to maximize the value of a fixed equity stake. We allow the manager to be strategic in her trades; i.e., she takes into account the effect of her trade on the stock price,

$$\max_{F} E\left[\left(P_2 - P_1\left(F\right)\right) F | v\right]. \tag{2.8}$$

Positive values of F indicate stock buybacks and negative values capture stock issuances. The following proposition describes the linear equilibrium.

Proposition 3 *Suppose the manager maximizes the expected trading profit. There exists a unique linear rational expectations equilibrium with the price and demand for shares given by*

$$P_1 = \overline{P} + \beta F, \tag{2.9}$$

$$F^* = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\varepsilon^2} \frac{v - \overline{P}}{2\beta}, \tag{2.10}$$

$$X_i^* = Q_i - \frac{F}{n+m}, \tag{2.11}$$

where $\beta > 0$ is a constant given in the Appendix.

The intuition for Proposition 3 is as follows. First, if the firm places a positive order F for stock, the equilibrium price increases because investors infer that with some probability the order is coming from an informed manager and thus signals positive information. Second, the firm's optimal demand for shares F^* is directly proportional to stock mispricing and increases with the precision of the manager's signal. Therefore the optimal market timing strategy for a profit-maximizing manager is symmetric, with the manager being equally likely to time share repurchases and equity sales. Finally, it is somewhat counterintuitive that the individual demand for shares X_i^* decreases with the firm's order size F. This is because, for the market to clear, a firm's trade must be accommodated by uninformed shareholders and new investors. Uninformed individuals are willing to take the other side of the firm's trade because the equilibrium price is such that they make up for their losses from trading against timing firms with gains from trading with non-timing firms.

The next proposition compares the observable characteristics of stock repurchases and equity sales for this equilibrium.

Proposition 4 *Assume that the manager maximizes the expected trading profit. Then the following claims hold.*

(i) The frequency and volume of share repurchases are equal, respectively, to those of share issuances

$$\Pr(F^* > 0) = \Pr(F^* < 0), \tag{2.12}$$

$$E[F|F^* > 0]\Pr(F^* > 0) = E[-F|F^* < 0]\Pr(F^* < 0). \tag{2.13}$$

(ii) The profit from share repurchase timing is equal to the profit from share issuance timing

$$E[(P_2 - P_1)F|F^* > 0] = E[(P_2 - P_1)F|F^* < 0]. \tag{2.14}$$

(iii) The price drift following share repurchases is equal, in absolute value, to the price drift following equity issuances

$$|E[P_2 - P_1|F^* > 0]| = |E[P_2 - P_1|F^* < 0]|. \tag{2.15}$$

We now analyze how the firm's market timing affects its existing shareholders. Note that we do not consider how timing by one firm affects shareholders of another firm. This is because firm managers take the policies of other firms as given and cannot influence them in any way.

Recall that, when the firm times the market, i-th shareholder wealth is given by (2.6). When the firm does not time the market, the shareholder buys Q_i shares at price $\overline{P}$ and can later sell these shares along with original N_i shares at price P_2, so that his wealth is $(N_i + Q_i)\, P_2 - Q_i \overline{P}$. Therefore the change in wealth of shareholder i caused by the firm's market timing is

$$\Delta W_i = \underbrace{(N_i + X_i)\, P_2' - X_i P_1}_{\text{wealth with timing}} - \underbrace{\left((N_i + Q_i)\, P_2 - Q_i \overline{P}\right)}_{\text{wealth without timing}}. \tag{2.16}$$

We can rewrite this expression in the more intuitive form

$$\Delta W_i = \underbrace{(X_i - Q_i)\,(P_2 - P_1)}_{\text{quantity effect}} + \underbrace{Q_i \left(\overline{P} - P_1\right)}_{\text{price effect}} + \underbrace{(N_i + X_i)\,(P_2' - P_2)}_{\text{long-term gain}}. \tag{2.17}$$

It follows then that the effect on shareholders of trading by a firm in its own stock can be described by three effects: a quantity effect, a price effect, and a long-term gain effect. The first term in (2.17) captures the *quantity effect*, which occurs when shareholders change their demand for stock as a result of the firm's timing actions. The number of shares traded by individuals can be affected because they infer information from the firm's decisions and also because the market needs to clear additional trades by the firm. The second term in (2.17) is the *price effect*, which occurs when the firm's timing actions change the stock price and shareholders buy or sell stock at this new price. Because current shareholders are net sellers (negative Q_i on average), the price effect is positive for stock repurchases and negative for stock issuances. The third term is the *long-term gain effect*. It captures the fact that shareholders who hold the stock until its true value is revealed benefit from the appreciation in the long-term price.

It is the quantity and price effects that distinguish our approach from previous studies. For example, it is well understood that successful market timing increases the wealth of a shareholder with a fixed number of shares. However, this does not need to imply that a manager working in the interest of all ongoing shareholders should time the market. The issue is that the number of ongoing shareholders is not fixed; it is determined in a market-clearing equilibrium and depends on how many shares the manager issues or repurchases. Each of the ongoing shareholders is better off with equity market timing, but the number of these shareholders decreases with repurchases and increases with issuances.

Intuitively, the wealth implications of market timing depend on the number of current shareholders who remain with the firm and benefit from the long-term gains. We first consider the case in which the aggregate number of shares that current shareholders normally sell (and new investors buy), $Q^+ \equiv \sum_{i=n+1}^{n+m} Q_i$, is small. For brevity, we will refer to Q^+ as the share turnover.

Proposition 5 *Denote by* $W = \sum_{i=1}^{n} W_i$ *the current shareholder value and assume that the share turnover is not too large, i.e.,* $Q^+ < \overline{Q}$, *where*

$$\overline{Q} = \frac{N}{2}\frac{m}{n+m}. \tag{2.18}$$

Then the following claims hold.

(i) Issuance of overvalued stock decreases shareholder value when overpricing is small. Specifically, there exists a threshold $\overline{v}$

$$\overline{v} \equiv \overline{P} - \frac{Q^+ N}{2\gamma\left(\overline{Q} - Q^+\right)}. \tag{2.19}$$

such that for $\overline{P} > v > \overline{v}$

$$E\left(W|v,\ v < \overline{P},\ F^* < 0\right) < E\left(W|v,\ v < \overline{P},\ F = 0\right). \tag{2.20}$$

(ii) Share repurchase of undervalued stock always increases shareholder value.

(iii) Given a fixed magnitude of mispricing $|v - \overline{P}|$, *current shareholders gain more*

when the manager times share repurchases than when she times equity sales

$$E\left(W|v, v > \overline{P}, F^* > 0\right) - E\left(W|v, v > \overline{P}, F = 0\right) > \qquad (2.21)$$
$$E\left(W|v, v < \overline{P}, F^* < 0\right) - E\left(W|v, v < \overline{P}, F = 0\right).$$

(iv) In expectation, current shareholders benefit from market timing, i.e.,

$$E\left(W|F^*\right) > E\left(W|F = 0\right). \qquad (2.22)$$

This proposition is central to our study and discusses the implications of the symmetric market timing strategy for shareholder value. The proof of the proposition exploits the fact that dollar gains and losses for all shareholders and new investors must sum to zero. The results can be summarized as follows. When the share turnover is small, many current shareholders remain with the firm until the true value is revealed, and therefore they capture the benefits of timing through the long-term gain effect. However, current shareholders are affected differentially by share repurchases and equity sales. Share repurchases of undervalued stock always make them better off. But, new share sales of overvalued stock can make them worse off. To understand the intuition behind the latter result, recall that current shareholders are net sellers. When a firm issues equity, shareholders who are now competing with the firm end up selling fewer overpriced shares. Additionally, they sell those shares at a lower price. The expected losses of selling shareholders are partially offset by the long-term gains of the ongoing shareholders. The proposition shows that current shareholders as a group are worse off in the region of small overvaluation, where the price and quantity effects dominate the long-term gain effect.

The last result in the proposition shows that, in comparison with a manager who does nothing, current shareholders prefer a manager who always repurchases stock whenever her information is positive and issues shares whenever her information is negative. Because repurchases increase price P_1, and equity sales decrease it, and because the market timing strategy is symmetric with respect to stock mispricing, it must be that the price effect averages out for current shareholders. Given a low share turnover, the current shareholders capture the benefits of market timing. As we show later, this result reverses for large turnover.

In Appendix B, we discuss how the results of Proposition 5 change if we consider how market timing affects the full objective function of current shareholders, U, instead of shareholder value, W. Intuitively, because by trading on the firm's behalf the manager conveys new information to the market, shareholders adjust their demand for the firm's stock and deviate from their preferred trades, Q_i. Therefore, they experience additional disutility from market timing.

We next discuss the case in which the share turnover is large.

Proposition 6 *If the share turnover is large, i.e.,* $Q^+ > \overline{Q}$, *then:*
(i) Issuance of overvalued stock always decreases shareholder value

$$E\left(W|v,\ v<\overline{P},\ F^*<0\right) < E\left(W|v,\ v<\overline{P},\ F=0\right). \tag{2.23}$$

(ii) A share repurchase of undervalued stock decreases shareholder value when underpricing is large; i.e., there exists a threshold $\overline{v}$

$$\overline{v} \equiv \overline{P} + \frac{Q^+ N}{2\gamma\left(Q^+ - \overline{Q}\right)}, \tag{2.24}$$

such that for $v > \overline{v} > \overline{P}$

$$E\left(W|v,\ v>\overline{P},\ F^*>0\right) < E\left(W|v,\ v>\overline{P},\ F=0\right). \tag{2.25}$$

(iii) If $Q^+ > 2\overline{Q}$, *then, in expectation, current shareholders are worse off with market timing, i.e.,*

$$E\left(W|v,\ F^*\right) < E\left(W|v,\ F=0\right). \tag{2.26}$$

The proposition posits that, when the share turnover is high, current shareholders can become worse off when the manager times the equity market. Specifically, shareholder wealth always decreases with the issuance of overvalued stock and can decrease with the repurchase of undervalued stock if mispricing is large. Overall, shareholders in a high-turnover firm prefer a manager who does nothing to the manager who systematically uses private information when issuing and repurchasing stock.

Intuitively, this result obtains because the high share turnover strips current shareholders of most long-term gains associated with market timing. When many new investors purchase the firm's shares, they are the ones who benefit from the long-term price appreciation. When the long-term gain is small, shareholder wealth is primarily affected through the quantity and/or price effects. The price effect is symmetric with respect to repurchases and share issuances and is therefore zero in expectation. In contrast, the quantity effect makes shareholders worse off because they sell more shares during underpricing and fewer shares during overpricing.

2.3.3 Optimal Market Timing Strategy for Current Shareholders

Thus far we have focused on the effects of a symmetric market timing strategy on a firm's current shareholders. We now derive the optimal market timing strategy by a manager maximizing the current shareholder value. (Appendix B shows that the results are qualitatively similar if the manager maximizes the current shareholders' full objective function).[13] Relying on the results in the previous section–that market

[13]If the manager maximizes the full current shareholders' objective function, the optimal market timing strategy is less sensitive to the manager's information because, intuitively, the manager would like to minimize the shareholders' disutility associated with deviations of their trades from initial preferences.

timing decreases shareholder value when the share turnover is large–we only consider the case when the turnover is moderate, $Q^+ < \overline{Q}$.

Recall that under a symmetric timing strategy (i.e., the strategy that maximizes the trading profit of the informed firm and calls for a repurchase when the stock is undervalued and share issuance when it is overvalued), current shareholders can be made worse off. Specifically, we established in Proposition 5 that a share issuance by the firm when its stock is overpriced sometimes hurts its current shareholders. We therefore anticipate that a manager creating value for current shareholders would favor market timing with share repurchases rather than with equity sales. The next proposition establishes this result formally.

Proposition 7 *Suppose the manager wants to maximize current shareholder value, W, and the share turnover is not large, $Q^+ < \overline{Q}$.*
Then, for any mispricing, $v - \overline{P}$, the equilibrium price, the firm's demand, and individuals' demand for stock are

$$P_1 = \overline{P} - \alpha + \beta F. \tag{2.27}$$

$$F^* = \overline{F} + \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\varepsilon^2} \frac{v - \overline{P}}{2\beta}, \tag{2.28}$$

$$X_i^* = Q_i - \frac{F}{n+m}, \tag{2.29}$$

where constants $\overline{F} > 0$, $\alpha > 0$, and $\beta > 0$ are given in the Appendix.

The important result established by the proposition above is that a manager who wants to maximize current shareholder value repurchases more (and issues less) stock than the one who wants to maximize the trading profit by following a symmetric strategy. In particular, the optimal timing strategy calls for repurchasing a positive number of shares, $\overline{F}$, and then amending the demand in a way that is proportional to mispricing. Note also that the equilibrium price P_1 is adjusted downward because investors realize that the manager over-repurchases. In particular, when the manager neither repurchases nor issues equity ($F = 0$), the price is below average. Note, however, that because the optimal demand for stock by the firm increases with mispricing, a larger repurchase still conveys better news.

Having derived the optimal market timing strategy for a manager who wants to create value for the firm's existing shareholders, we can now examine the frequency and volume of stock repurchases and equity sales, the profit from stock repurchases and equity sales, and post-event stock returns.

Proposition 8 *Assume that the manager wants to maximize current shareholder value. Then the following claims hold.*

(i) The frequency and volume of share repurchases are larger, respectively, than those of equity issuances

$$\Pr\left(F^* > 0\right) \quad > \quad \Pr\left(F^* < 0\right), \tag{2.30}$$

$$E\left[F|F^* > 0\right]\Pr\left(F^* > 0\right) \quad > \quad E\left[-F|F^* < 0\right]\Pr\left(F^* < 0\right). \tag{2.31}$$

(ii) The profit from share repurchases is smaller than that from equity issuances

$$E\left[\left(P_2 - P_1\right)F|F^* > 0\right] < E\left[\left(P_2 - P_1\right)F|F^* < 0\right]. \tag{2.32}$$

(iii) The price drift following repurchases is smaller, in absolute value, than that following equity issuances

$$\left|E\left[P_2 - P_1|F^* > 0\right]\right| < \left|E\left[P_2 - P_1|F^* < 0\right]\right|. \tag{2.33}$$

As established in the previous proposition, managers acting in the interest of current shareholders conduct repurchases even if they do not believe that the stock is significantly undervalued. In contrast, they issue equity highly selectively. From this observation it follows that the profit conditional on share repurchase is smaller than the profit conditional on equity issuance. The proposition further states that the average post-event stock returns must be higher following an equity sale than following a share repurchase. This is because the magnitude of stock mispricing needed to trigger an equity sale is much larger than the one required for a stock repurchase.

These results are important in light of some stylized empirical facts, such as a relatively low frequency of SEOs, a high frequency of stock buybacks, and the evidence that some repurchases are conducted at prices seemingly above fundamental values. For example, managers announcing new stock repurchase programs often claim that their goal is to enhance shareholder value, yet it is not unusual to observe low stock returns after a repurchase. In particular, Bonaime *et al.* (2014) find that managers repurchase when stock prices are high and valuation ratios (book-to-market and sales-to-price) are unfavorable; they conclude that managers do not appear to successfully time the market with share repurchases.

Our theory provides a simple new explanation for this circumstance. The extant literature focuses on other reasons for doing buybacks, which are outside the scope of our model, such as distributing unneeded cash and managing earnings per share. Equivalently, the lack of a large volume of SEOs is usually explained by large underwriting fees and other fixed costs.

2.4 Empirical Analysis

In this section, we use data to validate our assumption that current shareholders are net sellers of a firm's stock and then test the main predictions of the model by analyzing the volume and frequency of repurchases and equity issuances, post-event stock returns, and the profit from market timing.

2.4.1 Are Current Shareholders Net Sellers?

Our model relies on the important assumption that current shareholders are net sellers. Although this assumption is natural, two situations, issuance of new shares and short selling, merit discussion. First, the additional issuance of shares by the firm may result in current shareholders increasing their holdings. Note that this is consistent with our model since we only require shareholders to be net sellers in an inactive firm. Second, shares can be sold short by new investors, particularly by institutions that have different information or beliefs. This may temporarily increase the holdings of stock by current shareholders. However, one does not expect institutions to short-sell stock most of the time, and even when they do so on occasion, it is unlikely that all new investors as a group (including new retail investors) will sell the firm's stock. It is therefore likely that current shareholders remain net sellers in these situations as well.

To evaluate whether data support our assumption of net selling by current shareholders and to assess the magnitude of such selling, we empirically examine trades by one group of current shareholders–institutions. We focus on this group of shareholders because data on their positions are readily available, unlike, e.g., data on retail investors. The data are obtained from the institutional holdings database (Thomson Reuters) for the period January 1980 to January 2014. Each quarter t we consider all institutions with non-zero holdings of a firm's stock and define them as current shareholders. We then calculate the changes in the number of shares held by these institutions from this quarter to the next and sum across all institutions that had stock at date t. If the resulting number is negative, it means the current (institutional) shareholders sell the security as a group during this quarter and we classify them as net sellers.

As an alternative, we repeat the same procedure at the annual frequency and also for the changes in normalized holdings–i.e., the number of shares held by institutions normalized by the number of shares outstanding. The results are reported in Table 2.1. Most of the time (78.1% of all quarters and 81.3% of all years), the current institutional shareholders are net sellers. The percentage of net sellers is even higher if we focus on the changes in the normalized holdings rather than a raw number of shares (81.5% of all quarters and 87.7% of all years). On average, institutions sell 3.8% of outstanding shares each quarter and 9.0% each year, and these numbers are statistically different from zero. Thus our empirical results strongly support our assumption that current shareholders are net sellers. One caveat, of course, is that we capture trading by only one group of current shareholders, and there are likely to be systematic differences between institutions, venture capitalist/founders, and retail investors. Nevertheless, institutions hold, on average, a considerable fraction of the firm's stock (approximately 27%). Additionally, other groups of current shareholders, such as private equity, venture capitalists, and firm employees, may have a greater need for diversification and therefore a greater tendency to sell the stock.

2.4.2 Data and Main Variables

Next, we analyze volume, frequency, post-event stock returns, and the profit from market timing to see whether they can be rationalized based on managers' preference for current shareholders. We use standard measures of volume and post-event abnormal stock returns. However, in our search of the academic literature, we could not find any measures of profit from market timing. Therefore we motivate and develop a new measure that empirically assesses the success of market timing strategies.

Our sample includes the universe of Compustat firms with non-missing balance sheet data for the period 1982-2010. We start in 1982 because the safe harbor provisions under the Securities and Exchange Act were adopted at this time and firms could repurchase stock without facing any legal uncertainty. Following Stephens and Weisbach (1998), we proxy for share repurchases with the monthly decreases in split-adjusted shares outstanding reported by the Center for Research in Security Prices (CRSP). This method assumes that the firm has not repurchased any shares if the number of shares increased or remained the same during the month. We take the last day of the month as the repurchase date and calculate the stock return over a period of either one or three years from that date. The fraction of shares repurchased in each month is the number of shares repurchased during the month divided by the number of shares outstanding at the end of the previous month.

A potential problem with this measure is that it tends to underestimate the amount of true share repurchases (see, e.g., Jagannathan *et al.* (2000)). For example, if a company buys back stock and issues equity during the same month, we can record a zero repurchase. This is particularly important for small firms since they tend to issue more equity though broad-based equity compensation programs (Bergman and Jenter (2007)) and also do more SEOs. We therefore also employ a commonly used alternative approach to calculate the actual repurchases by using the Compustat quarterly data on the total dollar value spent on repurchases. These data can contain information unrelated to repurchases of common stock (see, e.g., Kahle (2002)). Nevertheless, the advantage of Compustat repurchase data is that they are not systematically understated and provide the least biased estimate of true repurchases (Banyi *et al.* (2008)). Using Compustat data to calculate the number of shares repurchased each quarter, we divide the total dollar amount spent on repurchases during a quarter by the average monthly stock price.

The sample of SEOs is from the Securities Data Company (SDC) new issues database. We look only at primary issues of common stock. Although the SDC database provides the exact stock issuance date, we use the last day of the calendar month as the issuance date in calculating the one-year and three-year stock returns after an SEO. This procedure ensures that post-SEO stock returns are directly comparable to post-repurchase returns.

We also compute the new equity issuances using the changes in the number of shares outstanding. Similar to the calculation of our repurchase measure, we track the increases in the total number of shares each month. The advantage of this measure is that it captures, in addition to SEOs, other ways in which firms sell shares. According to Fama and French (2005), the issuance of stock through SEOs constitutes only a small fraction of the total issuance activity, and is smaller in magnitude than the issuance of stock due to mergers financing. For example, Fama and French (2005) report that approximately 86% percent of all firms issued some form of equity over the period 1993 to 2002. This number contrasts sharply with the low frequency of SEOs over the same period. It may be argued that M&A activity financed by stock is one of the ways in which firms time the equity market. For example, Shleifer and Vishny (2003) present a model showing how rational managers can use stock as a means of payment in mergers and acquisitions to take advantage of stock mispricing, and Loughran and Vijh (1997) find evidence of negative long-run abnormal returns for bidders making stock acquisitions.

However, a disadvantage of this measure is that it includes the issuance of shares that is not triggered by the firm, but occurs because firm investors chose a particular action and thereby cause the equity issuance. For example, convertible debt holders can choose to convert their debt into equity. Similarly, firm employees can buy the company stock through employee stock purchase plans or exercise their stock options, which leads to an increase in the number of outstanding shares. There are two reasons why such items should not be included in the total share issuance. First, since investor-initiated issuance is not directly triggered by the firm manager, we cannot infer whether the manager intended to time the market. Second, the benefits from market timing of employee stock option exercises and other similar investor actions do not accrue to firm shareholders, but benefit employees, bondholders, or other parties. Therefore, the wealth transfers induced by market timing would be different than those we discussed in the context of the model. To mitigate these concerns, we follow McKeon (2013) and exclude equity issuance with monthly proceeds below 1% of market value of equity.[14]

Our measures of profit from market timing aim to capture the additional abnormal return earned by a shareholder with a fixed number of shares because of equity market timing. For each month, we calculate the proportion of equity repurchased during a month, α_i, and then multiply it by either one- or three-year post-repurchase risk-adjusted returns, r_i. We then sum the resulting measures over the 12 months of the year to obtain the total,

$$\text{Repurchase timing} = \sum_{i=1}^{12} \alpha_i r_i. \tag{2.34}$$

For example, if a manager buys back 5% of the firm's outstanding shares in May, and shares appreciate by 10% from June to May of the following year, the measure of repurchase timing will be equal to 0.5%. Prior to calculating the market timing measures, we adjust the raw stock returns for risk using the Fama and French 100 portfolios formed on size and book-to-market deciles. Each month, we match firms in our sample to the comparable size and book-to-market portfolios based on the

[14]McKeon (2013) works with quarterly data and classifies issuances that are greater than 3% of the market value of equity as firm-initiated. Since we use monthly data, we chose a 1% cutoff.

break points available on Kenneth French's web site and calculate the difference in buy-and-hold returns for our firms and these portfolios.[15] Using a risk-adjustment measure is justified by our theoretical model, in which mispricing is based on firm-specific information and therefore is cross-sectional by design. Note, however, that the risk adjustment necessarily removes the aggregate component, or "whole-market" mispricing, from our timing measure. Therefore, such measures cannot be used to identify whether executives can predict the long-term market trends.

Sales timing is defined in a similar manner to repurchase timing, with the difference that we track the proportion of equity sold each month, s_i,

$$\text{Sales timing} = -\sum_{i=1}^{12} s_i r_i. \tag{2.35}$$

Note that timing measures can be positive or negative, with larger positive values indicating more successful timing by the firm. We also calculate repurchase and sales timing measures using quarterly data. Appendix provides further detail on the construction of timing measures and their link to theory.

2.4.3 Empirical Results for Profit from Market Timing

Panel A of Table 2.2 presents the summary statistics for the total profit from market timing, calculated as the additional return earned by shareholders when the company sells or repurchases a fraction of its stock.

It appears from the table that, on average, firms time the market well. For example, the average additional return from timing equity sales and repurchases is positive 0.24% over a one-year period (t-stat = 13.79) and the corresponding number for a three-year period is 0.65% (t-stat = 18.62). Since many firm-years do not have

[15] This method is preferred over risk adjustment using the market model since using cumulative abnormal returns over a long period may yield positively biased test statistics (Barber and Lyon (1997)).

a single repurchase, SEO, or equity sale, we also present the summary statistics only for those observations that have a timing event (Panel B of Table 2.2). Naturally, when we condition on these events, the profit from market timing becomes larger. We find that timing with repurchases and sales provides an additional return of 0.40% over a one-year period, which means that an average firm trading 10% of its equity earns 4% in abnormal returns for the following year.

We next analyze whether profit from market timing comes primarily through share repurchases or issuances. As is evident from Table 2.3 and 2.4, the profit from stock repurchases appears to be considerably smaller than the profit from SEOs and other equity sales. For example, the average profit from repurchase timing is only 0.04% per year (t-stat = 4.78) when we use the CRSP-based measure, and 0.05% (t-stat = 6.11) when we use the Compustat-based measure, whereas the average profit is 0.36% (t-stat = 2.38) for SEO timing. Since SEOs represent only a small proportion of newly issued equity, we also repeat the estimation using the measure based on general equity sales (increases in the number of outstanding shares). This measure produces similar results, with robust evidence of successful market timing of equity sales with one- and three-year horizons. Specifically, the profit from timing equity sales is 0.62% per year and is statistically different from zero (t-stat = 12.84). The difference between profit from repurchase and profit from issuance timing appears even more striking if we compare the medians instead of the means.

In Table 2.4, we present the formal tests for the difference in means (t-test) and medians (non-parametric Wilcoxon sum rank test) between the profit from repurchase timing and issuance timing. We observe that both the average and median profits from issuance timing are significantly different from those from repurchase timing. This result does not depend on whether we measure issuance using the seasoned equity offerings from SDC or equity sales based on the increases in shares outstanding.

Overall, we find that issuance timing is more profitable than repurchase timing. In conjunction with our theory, this implies that managers act as if they were maximizing value for current shareholders:–they repurchase too often and issue equity selectively.

2.4.4 Empirical Results for Post-Event Returns and Volume

We next present the summary statistics for the post-event abnormal stock returns (Table 2.5). Firms in our sample experience 1.51% in abnormal returns the year after the repurchase and 3.36% three years after the event.[16] SEOs tend to be followed by a larger magnitude of abnormal stock returns, earning -2.11% the following year or -12.57% over three years. Following equity sales, the risk-adjusted returns are also negative, on average, at -1.71% in the year following the event.

Recall from Proposition 8 that if managers maximize current shareholder value, we would expect to see smaller post-event returns (in absolute magnitude) following repurchases than following issuances. In general, we find that to be the case, but the difference does not appear to be statistically significant, with exception of the difference in average returns after SEOs and repurchases over a one-year period (Table 2.6). However, we do find that in all cases the difference in median abnormal returns following an event is both statistically and economically significant. Overall, our results are broadly consistent with current shareholder value maximization.

A potential alternative explanation for these return dynamics comes from the investment literature. Specifically, it is known that sales of equity often precede new capital investment and can be used to finance the exercise of real options (see, e.g., DeAngelo *et al.* (2010)). In turn, the exercise of real options may decrease the

[16]The abnormal returns after the repurchases in our sample are not directly comparable to those in previous studies (e.g., Ikenberry *et al.* (1995) because we look at actual repurchases rather than at announcements of intent to buy back the stock).

systematic risk of the firm and result in lower expected returns. This could be because options are exercised in anticipation of the low cost of capital (Cochrane (1991)) or because the exercise transforms riskier options into less risky assets in place (Carlson *et al.* (2006)). Therefore, if we fail to adjust properly for the change in expected returns, we may mistakenly attribute the evidence of post-issuance abnormal returns to mispricing. Although the risk-adjustment technique that we employ does not match firms on investment rates, we anticipate that the bias associated with risk adjustment due to the exercise of real options is small. First, the connection between investment and returns may be pronounced for equity issuance, but it is more difficult to build a similar risk-based explanation for stock repurchases. Second, as Lyandres *et al.* (2008) explain, new investment is often financed by methods other than SEOs, such as initial public offerings (IPOs), straight debt, and convertible debt.

To see whether our results for equity sales and SEOs are driven by different real investment dynamics in these firms, we sort all firms in our sample by their investment rates, defined as capital expenditures in the year of the SEO divided by the beginning-of-year book assets. Table 2.7 and 2.8 shows our results. The pattern that timing with general equity sales results in a higher profit than timing with share repurchases is evident across all groups of investment rates, and the difference does not vary consistently with investment rates. Similarly, profit from SEO timing is larger than the profit from repurchase timing in the lowest and highest investment samples. For stock returns, investment also does not appear to be a major explanation. This suggests that our results are unlikely to be driven solely by expected return dynamics due to investment.

Next, we show the statistics for volume and frequency of stock repurchases and issuances (see Table 2.9). Perhaps unsurprisingly, few firms conduct an SEO in a given year; the average frequency of these events is 4.03%. Consistent with Fama and

French (2005), general equity sales are much more common, with the average firm having a 35.80% propensity to sell equity during a year. Stock repurchases, however, occur more frequently than both SEOs and general equity sales, with the probability of a buyback at 36.86% per year. Likewise, the average annual inflation-adjusted volume of repurchases is larger than that of SEOs ($26.94 million vs. $5.95 million). However, the volume of general equity sales is also large at $42.23 on average. In sum, the evidence on volume of issuances and repurchases is mixed, whereas the frequency of events of the two types is consistent with managers acting in the interest of current shareholders.

2.5 Conclusion

We examine the conflicts of interest between shareholders and new investors in a firm's market timing decisions. By recognizing that a firm's shareholders are affected by stock mispricing even in the absence of share repurchases and equity sales by the firm, we disentangle the effects of exogenous mispricing and firm actions on existing shareholders. Using this insight, we show theoretically that a market timing strategy that exploits under- and over-pricing of a firm's stock can reduce the wealth of the current shareholders. Additionally, current shareholders are relatively better off with share repurchase timing than with share issuance timing.

According to the theory developed in this paper, if managers act in the interest of existing shareholders, share repurchases should be more frequent than equity sales, repurchases should be followed by a lower magnitude of abnormal returns, and shareholders will earn a smaller profit from repurchase timing than from issuance timing. Our empirical findings provide support for these predictions, which suggests that most managers in the United States appear to be looking out for their firms' current shareholders.

Table 2.1: Net Sales of Shares by Current Shareholders

The sample is obtained from the institutional holdings database (Thomson Reuters), which collects data from 13F filings and covers the period from January 1980 to January 2014.

Panel A. Proportion of firms where current shareholders are net sellers

	Based on raw number of shares			Based on normalized holdings		
Variable	Total	Net sellers	Seller/Total	Total	Net sellers	Seller/Total
Firm-quarters	1,162,924	908,065	0.781	1,028,120	837,447	0.815
Firm-years	294,758	239,764	0.813	259,509	227,716	0.877

Panel B. Normalized holdings and change in normalized holdings by current shareholders

Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}	T-test
Holdings (firm-quarters)	1,028,120	0.268	0.326	0.002	0.153	0.732	N/A
Holdings (firm-years)	259,509	0.270	0.321	0.002	0.155	0.734	N/A
Change in holdings (firm-quarters)	1,028,120	-0.038	0.127	-0.110	-0.007	0.004	-304.68^{***}
Change in holdings (firm-years)	259,509	-0.090	0.188	-0.249	-0.032	0.001	-243.94^{***}

Table 2.2: Summary Statistics on Total Profit from Market Timing

The sample covers the period 1982-2010. Panel A presents statistics for all firm-years with non-missing data. Panel B displays the summary statistics only for those firm-years where there was at least one timing event.

Panel A. Total profit from market timing (all firm-years)							
Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}	T-test
Timing repurchases and SEOs (1-year)	130,578	0.030	2.498	-0.334	0	0.288	4.39^{***}
Timing repurchases and SEOs (3-year)	104,309	0.130	4.519	-0.712	0	0.514	9.29^{***}
Timing repurchases and sales (1-year)	130,578	0.239	6.254	-1.262	0	2.325	13.79^{***}
Timing repurchases and sales (3-year)	104,309	0.657	11.397	-2.051	0	4.530	18.62^{***}
Panel B. Total profit from market timing (firm-years with timing events)							
Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}	T-test
Timing repurchases and SEOs (1-year)	52,023	0.076	3.948	-1.718	-0.003	2.083	4.39^{***}
Timing repurchases and SEOs (3-year)	40,282	0.337	7.267	-3.537	-0.015	4.580	9.29^{***}
Timing repurchases and sales (1-year)	77,306	0.403	8.124	-3.040	0.017	5.226	13.80^{***}
Timing repurchases and sales (3-year)	59,677	1.149	15.049	-5.221	0.058	10.514	18.65^{***}

Table 2.3: Profit from Market Timing with Equity Issuances and Share Repurchases

Timing SEOs is equal to the post-SEO risk-adjusted return in %, calculated over a period of one or three years and multiplied by the proportion of newly issued equity. *Timing sales* is equal to the risk-adjusted return in %, after an increase in shares outstanding (as identified in the CRSP), and multiplied by the fraction of equity issued. *Timing repurchases* is equal to the post-repurchase risk-adjusted return in % after a decrease in shares outstanding (as identified in CRSP), and multiplied by the fraction of equity repurchased. *Timing repurchases Compustat* is equal to the post-repurchase risk-adjusted stock return in % multiplied by the fraction of equity repurchased (as identified from Compustat).

Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}	T-test
Timing SEOs (1-year)	5,244	0.365	11.106	-9.025	0.660	10.382	2.38^{**}
Timing SEOs (3-year)	3,892	2.542	18.560	-14.090	2.811	21.430	8.55^{***}
Timing sales (1-year)	46,748	0.623	10.496	-5.652	0.297	8.636	12.84^{***}
Timing sales (3-year)	35,704	1.817	19.573	-9.126	0.799	17.054	17.55^{***}
Timing repurchases (1-year)	48,128	0.043	1.951	-1.343	-0.004	1.281	4.78^{***}
Timing repurchases (3-year)	37,351	0.098	4.650	-3.049	-0.022	2.647	4.07^{***}
Timing repurchases (Compustat) (1-year)	37,718	0.054	1.718	-1.309	-0.007	1.314	6.11^{***}
Timing repurchases (Compustat) (3-year)	29,919	0.127	4.000	-2.907	-0.037	2.770	5.49^{***}

Table 2.4: Difference in Profit from Market Timing with Equity Issuances and Share Repurchases

This table displays the two-sample t-test for the difference in means and the non-parametric Wilcoxon rank-sum test for the difference in medians.

Variable	means	medians	T-test	Wilcoxon z-statistic
Timing SEOs minus repurchases (1-year)	0.322	0.664	5.62***	16.77***
Timing SEOs minus repurchases (3-year)	2.445	2.833	20.11***	28.86***
Timing sales minus repurchases (1-year)	0.581	0.301	12.27***	42.16***
Timing sales minus repurchases (3-year)	1.720	0.821	16.50***	52.24***

Table 2.5: Risk-Adjusted Stock Returns Following Equity Issuances and Share Repurchases

The numbers in the table are the risk-adjusted returns in %, calculated over a period of one or three years after the timing event. The last column in the table gives t-test statistics for the difference of the mean from zero.

Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}	T-test
Returns after SEO (1 year)	5,244	-2.116	45.297	-51.622	-6.449	48.184	-3.38^{***}
Returns after SEO (3 year)	3,892	-12.568	83.001	-97.556	-25.653	80.028	-9.45^{***}
Returns after sale (1 year)	46,748	-1.710	53.189	-56.923	-8.396	55.414	-6.95^{***}
Returns after sale (3 year)	35,704	-2.696	109.43	-103.93	-23.092	110.89	-4.65^{***}
Returns after repurchase (1 year)	48,128	1.513	45.720	-46.967	-3.488	50.380	7.26^{***}
Returns after repurchase (3 year)	37,351	3.362	102.71	-94.620	-13.241	109.98	6.33^{***}
Returns after repurchase (Compustat) (1 year)	37,718	0.945	43.439	-44.809	-3.746	47.971	4.24^{***}
Returns after repurchase (Compustat) (3 year)	29,919	1.624	99.554	-95.368	-13.488	104.84	2.82^{***}

Table 2.6: Difference in Stock Returns after Market Timing

The numbers in the table are the risk-adjusted returns in %, calculated over a period of one or three years after the timing event. This table displays the two-sample t-test for the difference in means and the non-parametric Wilcoxon rank-sum test for the difference in medians.

Variable	means	medians	T-test	Wilcoxon z-statistic
Returns after SEOs versus repurchases (1-year)	-0.603	-9.936	-0.91	-14.58***
Returns after SEOs versus repurchases (3-year)	-9.206	-11.884	-5.41***	-23.50***
Returns after sales versus repurchases (1-year)	-0.196	-38.895	-0.61	-36.25***
Returns after sales versus repurchases (3-year)	0.667	-36.333	0.85	-44.15***

Table 2.7: Investment Patterns and Market Timing

The numbers in the table are based on the risk-adjusted returns, calculated over a horizon of one or three years after the timing event. To make the adjustment for risk, we use the Fama and French 100 portfolios formed on size and book-to-market deciles. Each month, we match firms in our sample to the comparable size and book-to-market portfolios. The last column in the table gives t-test statistics for the difference of the mean from zero.

	Low investment rate			Medium investment rate			High investment rate		
	Mean	Median	T-test	Mean	Median	T-test	Mean	Median	T-test
Timing SEOs (1-year)	0.500	0.701	1.87*	-0.034	0.691	-0.11	0.586	0.683	2.35**
Timing SEOs (3-year)	2.442	2.604	4.62***	1.869	3.063	3.06***	3.084	2.988	6.41***
Timing sales (1-year)	0.892	0.366	8.93***	0.515	0.268	5.93***	0.714	0.331	7.74***
Timing sales (3-year)	2.108	0.919	10.71***	1.759	0.770	10.04***	1.804	0.790	9.51***
Timing rep (1-year)	0.032	-0.007	1.97**	0.067	-0.005	4.19***	0.005	-0.005	0.31
Timing repurchases (3-year)	0.074	-0.034	1.69*	0.100	-0.023	2.37**	0.159	-0.020	3.44***
Timing rep (Compustat) (1-year)	0.059	-0.009	3.80***	0.086	-0.004	5.63***	0.012	-0.008	0.77
Timing rep (Compustat) (3-year)	0.127	-0.052	3.11***	0.108	-0.032	2.80***	0.137	-0.027	3.31***

Table 2.8: Investment Patterns and Market Timing

The numbers in the table are the risk-adjusted returns in %, calculated over a horizon of one or three years after the timing event. To make the adjustment for risk, we use the Fama and French 100 portfolios formed on size and book-to-market deciles. Each month, we match firms in our sample to the comparable size and book-to-market portfolios. The last column in the table gives t-test statistics for the difference of the mean from zero.

	Low investment rate			Medium investment rate			High investment rate		
	Mean	Median	T-test	Mean	Median	T-test	Mean	Median	T-test
Returns after SEO (1 year)	-3.000	-6.225	-3.13^{***}	-0.114	-6.929	-0.08	-2.881	-7.593	-2.60^{***}
Returns after SEO (3 year)	-11.863	-22.287	-5.48^{***}	-11.513	-27.166	-4.10^{***}	-14.170	-30.025	-6.20^{***}
Returns after sale (1 year)	-2.056	-9.303	-4.65^{***}	-1.123	-8.503	-2.49^{**}	-2.477	-9.771	-5.43^{***}
Returns after sale (3 year)	-4.518	-24.671	-4.38^{***}	-2.896	-23.973	-2.72^{***}	-1.543	-24.763	-1.42
Returns after rep. (1 year)	1.406	-4.725	3.71^{***}	2.201	-3.423	5.74^{***}	0.543	-4.377	1.35
Returns after rep. (3 year)	1.865	-15.789	1.95^{*}	3.145	-13.470	3.24^{***}	5.512	-13.115	5.23^{***}
Returns after repurchase (Compustat) (1 year)	0.968	-4.062	2.57^{***}	1.749	-2.556	4.62^{***}	0.042	-4.542	0.10
Returns after repurchase (Compustat) (3 year)	0.908	-14.653	0.94	1.707	-11.848	1.76^{*}	2.550	-13.603	2.38^{**}

Table 2.9: Volume of Equity Issuances and Share Repurchases.

The table presents summary statistics for volume and frequency of stock repurchases and equity sales over the period 1982-2010. All firm-year observations are included in the sample.

Variable	Obs.	Mean	St. dev.	10^{th}	Median	90^{th}
Fraction of firm-years with SEOs (%)	130,578	4.034	N/A	N/A	N/A	N/A
Fraction of firm-years with sales (%)	130,578	35.800	N/A	N/A	N/A	N/A
Fraction of firm-years with repurchases (%)	130,578	36.858	N/A	N/A	N/A	N/A
Annual volume of SEOs (in 2010 $M')	130,578	5.953	57.156	0	0	37.639
Annual volume of sales (in 2010 $M')	130,578	42.230	209.50	0	0	61.027
Annual volume of repurchases (in 2010 $M')	130,578	26.938	159.401	0	0	22.456
Annual volume of repurchases (Compustat) (in 2010 $M')	130,578	33.382	218.168	0	0	18.261
Annual fraction of equity issued in SEO (%)	130,578	1.215	45.720	-46.967	-3.488	50.380
Annual fraction of equity issued in sale (%)	130,578	5.104	102.71	-94.620	-13.241	109.98
Annual fraction of repurchased equity (%)	130,578	0.803	43.439	-44.809	-3.746	47.971

REFERENCES

Abel, A., "Asset prices under habit formation and catching up with the Joneses", American Economic Review **80**, 38–42 (1990).

Aït-Sahalia, Y., J. A. Parker and M. Yogo, "Luxury goods and the equity premium", Journal of Finance **59**, 2959–3004 (2004).

Babenko, I., "Share repurchases and pay-performance sensitivity of employee compensation contracts", Journal of Finance **64**, 1, 117–151 (2009).

Bagwell, L. S., "Shareholder heterogeneity: Evidence and implications", American Economic Review **81**, 1, 218–221 (1991).

Baker, M., R. Ruback and J. Wurgler, "Behavioral corporate finance: A survey", In Espen Eckbo, ed.: Handbook of Corporate Finance: Empirical Corporate Finance (Elsevier, North Holland) (2007).

Baker, M. and J. Wurgler, "The equity share in new issues and aggregate stock returns", Journal of Finance **55**, 5, 2219–2257 (2000).

Baker, M. and J. Wurgler, "Market timing and capital structure", Journal of Finance **57**, 1, 1–32 (2002).

Bansal, R. and A. Yaron, "Risks for the long run: A potential resolution of asset pricing puzzles", Journal of Finance **59**, 1481–1509 (2004).

Banyi, M. L., E. A. Dyl and M. Kahle, "Errors in estimating share repurchases", Journal of Corporate Finance **14**, 4, 460–474 (2008).

Barber, B. M. and J. D. Lyon, "Detecting long-run abnormal stock returns: The empirical power and specification of test statistics", Journal of Financial Economics **43**, 3, 341–372 (1997).

Barro, R. J., "Rare disasters and asset markets in the twentieth century", Quarterly Journal of Economics **121**, 823–866 (2006).

Bergman, N. and D. Jenter, "Employee sentiment and stock option compensation", Journal of Financial Economics **84**, 667–712 (2007).

Biais, B., P. Hillion and C. Spatt, "An empirical analysis of the limit order book and the order flow in the Paris Bourse", Journal of Finance **50**, 5, 1655–1689 (1995).

Bolton, P., H. Chen and N. Wang, "Market timing, investment, and risk management", Journal of Financial Economics **109**, 1, 40–62 (2013).

Bonaime, A. A., K. W. Hankins and B. D. Jordan, "Is managerial flexibility good for shareholders? Evidence from share repurchases", University of Kentucky working paper (2014).

Brav, A., J. R. Graham, C. R. Harvey and R. Michaely, “Payout policy in the 21st century”, Journal of Financial Economics **77**, 3, 483–527 (2005).

Brennan, M. and A. Kraus, “Efficient financing under asymmetric information”, Journal of Finance **42**, 1225–1243 (1987).

Brennan, M. and A. V. Thakor, “Shareholder preferences and dividend policy”, Journal of Finance **45**, 993–1018 (1990).

Brockman, P. and D. Y. Chung, “Managerial timing and corporate liquidity: Evidence from actual share repurchases”, Journal of Financial Economics **61**, 3, 417–448 (2001).

Buffa, A. M. and G. Nicodano, “Should insider trading be prohibited when share repurchases are allowed?”, Review of Finance **12**, 4, 735–765 (2008).

Butler, A. W., G. Grullon and J. P. Weston, “Can managers forecast aggregate market returns?”, Journal of Finance **60**, 2, 964–986 (2005).

Caballero, R. J., “Expenditure on durable goods: A case for slow adjustment”, Quarterly Journal of Economics **105**, 727–743 (1990).

Caballero, R. J., “Durable goods: An explanation for their slow adjustment”, Journal of Political Economy **101**, 351–384 (1993).

Campbell, J. and A. Deaton, “Why is consumption so smooth?”, Review of Economic Studies **56**, 357–373 (1989).

Campbell, J. Y. and J. H. Cochrane, “By force of habit: A consumption-based explanation of aggregate stock market behavior”, Journal of Political Economy **107**, 2, 205–251 (1999).

Carlson, M., A. J. Fisher and R. Giammarino, “Corporate investment and asset price dynamics: Implications for SEO event studies and long-run performance”, Journal of Finance **61**, 3, 1009–1034 (2006).

Chetty, R. and A. Szeidl, “Consumption commitments: Neoclassical foundations for habit formation”, Working Paper (2010).

Cochrane, J., “Production-based asset pricing and the link between stock returns and economic fluctuations”, Journal of Finance **46**, 209–237 (1991).

Cochrane, J. H. and L. P. Hansen, “Asset pricing lessons from macroeconomics”, NBER Macroeconomics Annual **7** (1992).

Constantinides, G. M., “Habit formation: A resolution of the equity premium puzzle”, Journal of Political Economy **98**, 519–543 (1990).

Constantinides, G. M. and B. D. Grundy, “Optimal investment with stock repurchase and financing as signals”, Review of Financial Studies **2**, 4, 445–465 (1989).

Cuoco, D. and H. Liu, "Optimal consumption of a divisible durable good", Journal of Economic Dynamics & Control **24**, 561–613 (2000).

DeAngelo, H., L. DeAngelo and R. Stulz, "Seasoned equity offerings, market timing, and the corporate lifecycle", Journal of Financial Economics **95**, 275–295 (2010).

Dittmar, A. and R. Dittmar, "The timing of financing decisions: An examination of the correlation in financing waves", Journal of Financial Economics **90**, 59–83 (2008).

Dittmar, A. and L. Field, "Can managers time the market? evidence using repurchase price data", Journal of Financial Economics p. forthcoming (2014).

Eckbo, B. E., R. W. Masulis and O. Norli, "Seasoned public offerings: Resolution of the new issues puzzle", Journal of Financial Economics **56**, 251–291 (2000).

Epstein, L. and S. Zin, "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework", Econometrica **57**, 4, 937–969 (1989).

Eraker, I. S., Bjorn and W. Wang, "Durable goods, inflation risk and the equilibrium asset prices", Working paper (2013).

Fama, E. F. and K. R. French, "Financing decisions: who issues stock?", Journal of Financial Economics **76**, 3, 549–582 (2005).

French, K. R., G. W. Schwert and R. F. Stambaugh, "Expected stock returns and volatility", Journal of Financial Economics **19**, 1, 3–29 (1987).

Gabaix, X., "Variable rare disasters: A tractable theory of ten puzzles in macro-finance", American Economic Review **98**, 64–67 (2008).

Gabaix, X. and D. Laibson, "The 6d bisas and the equity-premium puzzle", NBER Macroeconomics Annual (2001).

Graham, J. R. and C. R. Harvey, "The theory and practice of corporate finance: Evidence from the field", Journal of Financial Economics **60**, 187–243 (2001).

Greenwood, R., "Short- and long-term demand curves for stocks: Theory and evidence on the dynamics of arbitrage", Journal of Financial Economics **75**, 3, 607–649 (2005).

Grossman, S., "On the efficiency of competitive stock markets where traders have diverse information", Journal of Finance **31**, 2, 573–585 (1976).

Grossman, S. J. and G. Laroque, "Asset pricing and optimal portfolio choice in the presence of illiquid durable consumption goods", Econometrica **58**, 25–51 (1990).

Grullon, G. and R. Michaely, "The information content of share repurchase programs", Journal of Finance **59**, 651–680 (2004).

Hansen, L. P. and R. Jagannathan, "Implications of security market data for models of dynamic economies", Journal of Political Economy **99**, 2, 225–262 (1991).

Hansen, L. P. and K. J. Singleton, "Stochastic consumption, risk aversion, and the temporal behavior of asset returns", Journal of Political Economy **91**, 249–268 (1983).

Hausch, D. B. and J. K. Seward, "Signaling with dividends and share repurchases: A choice between deterministic and stochastic cash disbursements", Review of Financial Studies **6**, 1, 121–154 (1993).

Heaton, J., "The interaction between time-non separable preferences", Econometrica **61**, 353–385 (1993).

Heinkel, R., "A theory of capital structure relevance under imperfect information", Journal of Finance **37**, 5, 1141–1150 (1982).

Hennessy, C. A., D. Livdan and B. Miranda, "Repeated signalling and firm dynamics", Review of Financial Studies **23**, 1981–2023 (2010).

Hertzel, M. G., M. R. Huson and R. Parrino, "Staging in public equity markets", Journal of Financial Economics **106**, 1, 72–90 (2012).

Hindy, A. and C.-F. Huang, "Optimal consumption and portfolio rules with durability and local substitution", Econometrica **61**, 85–121 (1993).

Huang, S. and A. V. Thakor, "Investor heterogeneity, investor-management disagreement, and open-market share repurchases", Review of Financial Studies **26**, 10, 2453–2491 (2013).

Ikenberry, D., J. Lakonishok and T. Vermaelen, "Market underreaction to open market share repurchases", Journal of Financial Economics **39**, 2, 181–208 (1995).

Jagannathan, M., C. P. Stephens and M. S. Weisbach, "Financial flexibility and the choice between dividends and stock repurchases", Journal of Financial Economics **57**, 3, 355–384 (2000).

Jenter, D., K. Lewellen and J. B. Warner, "Security issue timing: What do managers know, and when do they know it?", Journal of Finance **66**, 413–443 (2011).

Kahle, K., "When a buyback isn't a buyback: Open market repurchases and employee options", Journal of Financial Economics **63**, 235–261 (2002).

Leland, H. E. and D. H. Pyle, "Information asymmetries, financial structure, and the intermediation", Journal of Finance **32**, 2, 371–387 (1977).

Lettau, M. and S. Ludvigson, "Consumption, aggregate wealth, and expected stock returns", Journal of Finance **56**, 3, 815–849 (2001).

Lettau, M. and S. Ludvigson, "Time-varying risk premia and the cost of capital: An alternative implication of the q theory of investment", Journal of Monetary Economics **49**, 1, 31–66 (2002).

Loughran, T. and J. R. Ritter, “The new issue puzzle”, Journal of Finance **50**, 23–51 (1995).

Loughran, T. and J. R. Ritter, “The operating performance of firms conducting seasoned equity offerings”, Journal of Finance **52**, 5, 1823–1850 (1997).

Loughran, T. and A. M. Vijh, “Do long-term shareholders benefit from corporate acquisitions?”, Journal of Finance **52**, 5, 1765–1790 (1997).

Lucas, D. J. and R. L. McDonald, “Equity issues and stock price dynamics”, Journal of Finance **45**, 4, 1019–1043 (1990).

Lucas, R. E., Jr., “Asset prices in an exchange economy”, Econometrica **46**, 6, 1429–1445 (1978).

Lyandres, E., L. Sun and L. Zhang, “The new issues puzzle: Testing the investment-based explanation”, Review of Financial Studies **21**, 6, 2825–2855 (2008).

Lynch, A. W., “Decision frequency and synchronization across agents: Implications for aggregate consumption and equity return”, Journal of Finance **51**, 1479–1497 (1996).

Manconi, A., M. Massa and A. Yasuda, “The role of institutional investors in propagating the crisis of 20072008”, Journal of Financial Economics **104**, 491518 (2012).

Marshall, D. A. and N. G. Parekh, “Can costs of consumption adjustment explain asset pricing puzzles?”, Journal of Finance **54**, 623–654 (1999).

McKeon, S. B., “Firm-initiated versus investor-initiated equity issues”, University of Oregon working paper (2013).

Mehra, R. and E. C. Prescott, “The equity premium: A puzzle”, Journal of Monetary Economics **15**, 145–161 (1985).

Morellec, E. and N. Schurhoff, “Corporate investment and financing under asymmetric information”, Journal of Financial Economics **99**, 262–288 (2011).

Myers, S. C. and N. S. Majluf, “Corporate financing and investment decisions when firms have information that investors do not have”, Journal of Financial Economics **13**, 2, 187–221 (1984).

Oded, J., “Why do firms announce open-market repurchase programs?”, Review of Financial Studies **18**, 271–300 (2005).

Ofer, A. A. and A. V. Thakor, “A theory of stock price responses to alternative corporate cash disbursement methods: Stock repurchases and dividends”, Journal of Finance **42**, 2, 365–394 (1987).

Ogaki, M. and C. M. Reinhart, “Measuring intertemporal substitution: The role of durable goods”, Journal of Political Economy **106**, 1078–1098 (1998).

Pakoš, M., “Asset pricing with durable goods and non-homothetic preferences”, Working paper (2004).

Persons, J. C., “Signaling and takeover deterrence with stock repurchases: Dutch auctions versus fixed price tender offers”, Journal of Finance **49**, 4, 1373–1402 (1994).

Pontiff, J. and A. Woodgate, “Share issuance and cross-sectional returns”, Journal of Finance **63**, 2, 921–945 (2008).

Rietz, T. A., “The equity risk premium: a solution”, Journal of Monetary Economics **22**, 117–131 (1988).

Ross, S. A., “Capital asset pricing model (capm), short-sale restrictions and related issues”, Journal of Finance **32**, 1, 177–183 (1977).

Rubinstein, M., “The valuation of uncertain income streams and the pricing of options”, The Bell Journal of Economics **7**, 407–425 (1976).

Shleifer, A., “Do demand curves for stocks slope down?”, Journal of Finance **41**, 579–590 (1986).

Shleifer, A. and R. W. Vishny, “Stock market driven acquisitions”, Journal of Financial Economics **70**, 3, 295–311 (2003).

Skinner, D. J., “The evolving relation between earnings, dividends, and stock repurchases”, Journal of Financial Economics **87**, 3, 582–609 (2008).

Stephens, C. P. and M. S. Weisbach, “Actual share reacquisitions in open-market share repurchase programs”, Journal of Finance **53**, 1, 313–333 (1998).

Vermaelen, T., “Common stock repurchases and market signaling”, Journal of Financial Economics **9**, 139–183 (1981).

Weil, P., “The equity premium puzzle and the risk-free rate puzzle”, Journal of Monetary Economics **24**, 401–421 (1989).

Williams, J., “Efficient signaling with dividends, investment, and stock repurchases”, Journal of Finance **43**, 3, 737–747 (1988).

Wurgler, J. and E. Zhuravskaya, “Does arbitrage flatten demand curves for stock?”, Journal of Business **75**, 4, 583–608 (2002).

Yang, B., “Dynamic capital structure with heterogeneous beliefs and market timing”, Journal of Corporate Finance **22**, 254–277 (2013).

Yang, W., “Long-run risk in durable consumption”, Journal of Financial Economics **102**, 45–61 (2011).

Yogo, M., “A consumption-based explanation of expected stock returns”, Journal of Finance **61**, 539–580 (2006).

APPENDIX A

APPENDIX FOR CHAPTER 1

A.1 DERIVATION OF FOC FOR THE TWO-PERIOD MODEL

First I want to denote the intial stock of durables as $D_0' = (1-\delta)D_0$ for short and use it throughout the whole appendix for convenience.

The optimization problem (1.1) can be rewritten as follows:

$$
\begin{aligned}
V_0(W_0, D_0) &= \max_{D_p} \int_{R=-\infty}^{\frac{p(D_p-D_0')}{W_0}} u(D_0')\ dF(R) + \int_{R=\frac{p(D_p-D_0')}{W_0}}^{+\infty} u(D_p)\ dF(R) \\
&= \max_{D_p}\ u(D_0') \int_{R=-\infty}^{\frac{p(D_p-D_0')}{W_0}} dF(R) + u(D_p) \int_{R=\frac{p(D_p-D_0')}{W_0}}^{+\infty} dF(R) \\
&= \max_{D_p}\ u(D_0') F\left(\frac{p(D_p-D_0')}{W_0}\right) + u(D_p)\left(1 - F\left(\frac{p(D_p-D_0')}{W_0}\right)\right).
\end{aligned}
\tag{A.1}
$$

Taking the first order derivative of (A.1) with respect to D_p, the FOC is obtained as follow:

$$
u'(D_p^*)(1-F(\frac{p(D_p^*-D_0')}{W_0})) - \frac{p}{W_0} f(\frac{p(D_p^*-D_0')}{W_0})(u(D_p^*) - u(D_0')) = 0, \tag{A.2}
$$

where $F(\cdot)$ is the cumulative distribution function of $\widetilde{R}$, and $f(\cdot)$ is the probability density function of $\widetilde{R}$.

A.2 PROOF OF PROPOSITION 1 — CONSERVATIVE PLANNING

Proof The FOD (First order derivative) of the optimization problem (1.1) is

$$
FOD = u'(D_p)(1-F(\frac{p(D_p-D_0')}{W_0})) - \frac{p}{W_0} f(\frac{p(D_p-D_0')}{W_0})(u(D_p) - u(D_0')). \tag{A.3}
$$

Note that $FOD > 0$ when $D_p \leq D_0'$. It directly follows from (A.3) because $u'(\cdot) > 0$.

Next, I show that $FOD < 0$ when $\frac{p(D_p-D_0')}{W_0} \geq 1+\mu$.

Since $u''(\cdot) \leq 0$,

$$
u(D_p) - u(D_0') = \int_{c=D_0'}^{D_p} u'(c)dc \geq \int_{c=D_0}^{D_p} u'(D_p)dc = u'(D_p)(D_p - D_0). \tag{A.4}
$$

$$
\begin{aligned}
FOD\ &\leq u'(D_p)(1-F(\frac{p(D_p-D_0')}{W_0})) - \frac{p}{W_0} f(\frac{p(D_p-D_0')}{W_0}) u'(D_p)(D_p - D_0) \\
&= u'(D_p)((1-F(\frac{p(D_p-D_0')}{W_0})) - \frac{p(D_p-D_0')}{W_0} f(\frac{p(D_p-D_0')}{W_0})).
\end{aligned}
\tag{A.5}
$$

Therefore, given $1 - F(x) < xf(x)\ \forall x \geq 1 + \mu$ and $u'(\cdot) > 0$, $FOD < 0$ when $\frac{p(D_p - D_0')}{(}W_0) \geq 1 + \mu$.

By now, we know that $FOD > 0$ when $D_p \leq D_0'$ and $FOD < 0$ when $\frac{p(D_p - D_0')}{W_0} \geq 1+\mu$. By the continuity of FOD observed in A.3, there must exist $D_p^* \in (D_0', \frac{(1+\mu)W_0 - D_0'}{p})$. ∎

A.3 PPROOF OF PROPOSITION 1 — CONSERVATIVE PLANNING IN THE CASE OF UNIFORM DISTRIBUTION

First, I show that for a uniform distribution on $U[a, b]$, $a > 0$ is sufficient for $1 - F(x) < xf(x)\ \forall x \geq 1 + \mu$.

Proof For the uniform distribution, $1 - F(x) = 1 - \frac{x-a}{b-a} = \frac{b-x}{b-a}$ and $xf(x) = \frac{x}{b-a}$. If $a > 0$ and $x \geq 1 + \mu$, where $1 + \mu = \frac{a+b}{2}$

$$1 - F(x) = \frac{b - x}{b - a} < \frac{b - \frac{a+b}{2}}{b - a} = \frac{1}{2} < \frac{a + b}{2}\frac{1}{b - a} < xf(x). \quad ∎ \tag{A.6}$$

Secondly, I prove a stronger version of Proposition 1: Suppose the (gross) investment return follows a uniform distribution $U[a, b]$ and the consumer has a continuous utility function $u(\cdot)$ satisfies $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$, then $\exists! D_p^* \in (D_0', \frac{(1+\mu)W_0 - D_0'}{p})$, i.e. $p(D_p^* - D_0') < (1 + \mu)W_0$, if $a > 0$.

Proof From the above proof, we know that the optimal $D_p^* \in (D_0', \frac{(1+\mu)W_0 - D_0'}{p})$, so I only need to show the uniqueness of the solution. Note that the SOD (second-order derivative) is

$$\begin{aligned} SOD = {} & u''(D_p)(1 - F(\frac{p(D_p - D_0')}{W_0})) - \frac{2p}{W_0}u'(D_p)f(\frac{p(D_p - D_0')}{W_0}) \\ & - \frac{p}{W_0}\frac{p(D_p - D_0')}{W_0}f'(\frac{p(D_p - D_0')}{W_0}). \end{aligned} \tag{A.7}$$

For a uniform distribution, $f'(\cdot) = 0$. Therefore, the SOD is negative when $D_p \in (D_0', \frac{(1+\mu)W_0 - D_0'}{p})$. Uniqueness of the optimal D_p^* follows. ∎

A.4 PROOF OF PROPOSITION 1 — CONSERVATIVE PLANNING IN THE CASE OF NORMAL DISTRIBUTION

First, I show that for a normal distribution $\mathcal{N}(1+\mu, \sigma^2)$, $1+\mu > \sqrt{\frac{\pi}{2}}\sigma$ is sufficient for $1 - F(x) < xf(x)\ \forall x \geq 1 + \mu$.

Proof For a normal distribution $\mathcal{N}(1+\mu,\sigma^2)$, $1-F(x)<\frac{1}{2}$ $\forall x\geq 1+\mu$ and $f(x)<\frac{1}{\sqrt{2\pi}\sigma}\forall x$. Given that $1+\mu>\sqrt{\frac{\pi}{2}}\sigma$, $\forall x\geq 1+\mu$,

$$xf(x)\geq(1+\mu)\frac{1}{\sqrt{2\pi}\sigma}>\sqrt{\frac{\pi}{2}}\sigma\frac{1}{\sqrt{2\pi}\sigma}=1/2>F(x). \quad \blacksquare \tag{A.8}$$

Next, I prove the stronger version of Proposition 1: Suppose the (gross) investment return follows a normal distribution $\mathcal{N}(1+\mu,\sigma^2)$ and the consumer has a continuous utility function $u(\cdot)$ satisfies $u'(\cdot)>0$ and $u''(\cdot)\leq 0$, then $\exists! D_p^*\in(D_0', \frac{(1+\mu)W_0-D_0'}{p})$, i.e. $p(D_p^*-D_0')<(1+\mu)W_0$, if $1+\mu>\sqrt{\frac{\pi}{2}}\sigma$.

Proof $f'(\frac{p(D_p-D_0')}{W_0})>0$ when $D_p\in(D_0', \frac{(1+\mu)W_0-D_0'}{p})$, given the normal-distributed investment return. Thus the SOD as derived in (A.7) is negative. Uniqueness of the optimal D_p^* on $(D_0', \frac{(1+\mu)W_0-D_0'}{p})$ follows. $\blacksquare$

A.5 PROOF OF PROPOSITION 2 — UTILITY LOSS

Proof Suppose, consumer A is holding a risk-free asset with a fixed return R_f and consumer B is holding a risky portfolio with a return $\widetilde{R}$ with a expectation $E(\widetilde{R})=R_f$.

Note that the consumer A's time-1 consumption $D_1^A=D_0'+\frac{W_0R_f}{p}$ before he can plan for the consumption perfectly.

Consumer B's time-1 consumption depends on his investment realization and its expectation can be written as:

$$\begin{aligned}
E(D_1^B) &= \int_{R=-\infty}^{\frac{p(D_p-D_0')}{W_0}} D_0'\,dF(R)+\int_{R=\frac{p(D_p-D_0')}{W_0}}^{+\infty} D_p\,dF(R)\\
&< \int_{R=-\infty}^{\frac{p(D_p-D_0')}{W_0}} \left(D_0'+\frac{W_0R}{p}\right)\,dF(R)+\int_{R=\frac{p(D_p-D_0')}{W_0}}^{+\infty} \left(D_0'+\frac{W_0R}{p}\right)\,dF(R)\\
&= D_0'+\frac{W_0E(\widetilde{R})}{p}\\
&= D_0'+\frac{W_0R_f}{p}\\
&= D_1^A
\end{aligned} \tag{A.9}$$

Therefore, the expected consumption of consumer B is lower than the consumption of consumer A, which means consumer B has a lower expected utility when $u''(\cdot)=0$. By Jensen's inequality, the same statement holds when the utility function is concave ($u''(\cdot)<0$), i.e.

$$E(u(D_1^B))<u(E(D_1^B)))<u(D_1^A). \quad \blacksquare \tag{A.10}$$

A.6 HOMOGENEITY OF THE TWO-PERIOD OPTIMIZATION

Lemma 1 *When power utility is applied, the value function $V_0(W_0, D_0)$ in (1.1) is homogenous of degree $1-\gamma$ and the maximizer $D_p^*(W_0, D_0)$ is homogenous of degree 1.*

Proof Substituting power utility $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$ into the last line of (A.1),

$$V_0(W_0, D_0) = \max_{D_p} \frac{(D_0')^{1-\gamma}}{1-\gamma} F\left(\frac{p(D_p - D_0')}{W_0}\right) + \frac{D_p^{1-\gamma}}{1-\gamma}\left(1 - F\left(\frac{p(D_p - D_0')}{W_0}\right)\right), \tag{A.11}$$

where $F(\cdot)$ is the cumulative distribution function of $\widetilde{R}$.
Multiply both W_0 and D_0 by t, I obtain:

$$\begin{aligned}
V_0(tW_0, tD_0) =& \max_{D_p} \frac{(tD_0')^{1-\gamma}}{1-\gamma} F\left(\frac{p(D_p - tD_0')}{tW_0}\right) + \frac{D_p^{1-\gamma}}{1-\gamma}\left(1 - F\left(\frac{p(D_p - tD_0')}{tW_0}\right)\right) \\
=& \max_{D_p} t^{1-\gamma}\left(\frac{(D_0')^{1-\gamma}}{1-\gamma} F\left(\frac{p(\frac{D_p}{t} - D_0')}{W_0}\right) + \frac{\left(\frac{D_p}{t}\right)^{1-\gamma}}{1-\gamma}\left(1 - F\left(\frac{p(\frac{D_p}{t} - D_0')}{W_0}\right)\right)\right) \\
=& t^{1-\gamma} V_0(W_0, D_0),
\end{aligned} \tag{A.12}$$

and $D_p^*(tW_0, tD_0)/t = D_p^*(W_0, D_0)$, i.e. $D_p^*(tW_0, tD_0) = tD_p^*(W_0, D_0)$. ∎

APPENDIX B

APPENDIX FOR CHAPTER 2

B.1 PROPOSITION PROOFS

Proof of Proposition 1.
Applying the projection theorem for a normal distribution, we obtain the conditional mean of P_2 given a managerial signal

$$E(P_2|v) = \overline{P} + \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\varepsilon^2}\left(v - \overline{P}\right). \tag{B.1}$$

We conjecture that the equilibrium price is as follows

$$P_1 = \overline{P} + \beta F, \tag{B.2}$$

and solve for parameter β in the equilibrium. Substituting the conjecture for P_1 into the manager's problem (2.8), and taking the first-order condition with respect to F, yields

$$F^* = \frac{E(P_2|v) - \overline{P}}{2\beta} = \gamma\left(v - \overline{P}\right), \tag{B.3}$$

where

$$\gamma = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\varepsilon^2}\frac{1}{2\beta}. \tag{B.4}$$

The second-order condition is satisfied whenever λ (proportion of firms that repurchase or sell stock for information reasons) is less than $\frac{1}{2}$. Whenever $\lambda > 1/2$, the linear equilibrium does not exist. For individuals who observe firm's trade F, the conditional mean of P_2 is

$$E(P_2|F) = \lambda E(P_2|F, \text{info}) + (1-\lambda)\, E(P_2|F, \text{no info}) = \overline{P} + 2\lambda\beta F. \tag{B.5}$$

The equilibrium price is set by the market clearing condition. Using $\sum\limits_{i=1}^{n+m} Q_i = 0$ and the individual demand functions (2.7), we can write this condition as

$$F + \sum_{i=1}^{n+m} X_i^* = F + (n+m)\frac{E\left(P_2|F\right) - P_1}{\theta} = 0. \tag{B.6}$$

It follows that the individual investors share the extra demand from the firm equally, i.e.,

$$X_i^* = Q_i - \frac{F}{n+m}. \tag{B.7}$$

Substituting (B.5) into condition (B.6), we obtain the market clearing price

$$P_1 = \overline{P} + \left(\frac{\theta}{n+m} + 2\lambda\beta\right)F. \tag{B.8}$$

Comparing this expression to conjecture (B.2), we can solve for parameter β

$$\beta = \frac{\theta}{(n+m)\,(1-2\lambda)}. \tag{B.9}$$

Finally, we solve for parameters μ_u and σ_u^2, such that the distribution of demand by informed managers is identical to that by managers who repurchase or issue equity for exogenous reasons. Specifically, the mean and variance of the demand by uninformed managers solve a fixed-point problem

$$\begin{aligned} Var(F^*|\mu_u, \sigma_u^2) &= \sigma_u^2, \\ E(F^*|\mu_u, \sigma_u^2) &= \mu_u. \end{aligned} \tag{B.10}$$

Using (B.3), we obtain

$$\mu_u = 0, \tag{B.11}$$

$$\sigma_u^2 = \frac{(n+m)^2 (1-2\lambda)^2 \sigma_p^4}{4\theta^2 \left(\sigma_p^2 + \sigma_\varepsilon^2\right)}. \tag{B.12}$$

Therefore, given any observed value F, the individuals will attribute probability λ that the firm is informed and probability $1-\lambda$ that it is uninformed.

Proof of Proposition 2.
(i) The probability of a stock repurchase minus the probability of an equity sale is

$$\Pr(F^* > 0) - \Pr(F^* < 0) = \int_0^\infty f(x)\, dx - \int_{-\infty}^0 f(x)\, dx = 0. \tag{B.13}$$

where $x = v - \overline{P}$ and $f(x)$ is the normal distribution density function with zero mean and variance $\sigma^2 \equiv \sigma_p^2 + \sigma_\varepsilon^2$. Similarly, we can calculate the difference in total volume

$$\begin{aligned} \text{Volume(Rep)} - \text{Volume(Iss)} &= E[F|F^* > 0]\Pr(F^* > 0) - E[-F|F^* < 0]\Pr(F^* < 0) \\ &= \int_0^\infty \gamma x f(x)\, dx - \left(-\int_{-\infty}^0 \gamma x f(x)\, dx\right) = 0. \end{aligned} \tag{B.14}$$

(ii) Using (B.1)-(B.3), we can write the manager's trading profit conditional on signal as

$$\Pi(x) = \beta\gamma^2 x^2. \tag{B.15}$$

Profit from repurchases minus profit from equity sales is then

$$\frac{\int_0^\infty \Pi(x) f(x)\, dx}{\int_0^\infty f(x)\, dx} - \frac{\int_{-\infty}^0 \Pi(x) f(x)\, dx}{\int_{-\infty}^0 f(x)\, dx} = 2\beta\gamma^2 \left(\int_0^\infty x^2 f(x)\, dx - \int_{-\infty}^0 x^2 f(x)\, dx\right). \tag{B.16}$$

Because of the symmetry of the normal distribution, the expression above is equal to 0.
(iii) The expected post-event price drift given managerial signal can be written as

$$R(x) = E(P_2|v) - P_1 = \beta\gamma x. \tag{B.17}$$

The absolute value of the expected price drift after a repurchase minus that after an equity issuance is

$$\left|\frac{\int_0^\infty R(x) f(x)\,dx}{\int_0^\infty f(x)\,dx}\right| - \left|\frac{\int_{-\infty}^0 R(x) f(x)\,dx}{\int_{-\infty}^0 f(x)\,dx}\right| = 2\beta\gamma\left(\int_0^\infty xf(x)\,dx + \int_{-\infty}^0 xf(x)\,dx\right) = 0. \tag{B.18}$$

Proof of Proposition 3.
(i) Note that any repurchase or equity issuance represents a zero-sum game between the firm's current shareholders and new investors. Thus it suffices to prove that new investors can profit from equity issuance timing. From (2.6), the wealth of new investor i who holds no shares initially is

$$W_i \equiv X_i\left(P_2' - P_1\right). \tag{B.19}$$

Recall that the manager issues shares ($F < 0$) during the overpricing ($v < \overline{P}$). Given a particular signal of the manager v, the change in expected wealth of all new investors after stock issuance by the firm is

$$\sum_{i=n+1}^{n+m} E\left[W_i^{F<0} - W_i^{F=0}|v\right] = \sum_{i=n+1}^{n+m} E\left[X_i\left(P_2' - P_1\right) - Q_i\left(P_2 - \overline{P}\right)|v\right]. \tag{B.20}$$

To prove that current shareholders are worse off, we need to show that the sum above is positive. Using the expression for the long-term price (2.4), we obtain

$$\sum_{i=n+1}^{n+m} E\left[W_i^{F<0} - W_i^{F=0}|v\right] = \sum_{i=n+1}^{n+m} E\left[X_i\left(P_2 + \frac{F\left(P_2 - P_1\right)}{N-F} - P_1\right) - Q_i\left(P_2 - \overline{P}\right)|v\right]. \tag{B.21}$$

Substituting the equilibrium price P_1, individual demand functions X_i, and conditional expectation $E\left[P_2|v\right]$, and using notation for mispricing $x = v - \overline{P} < 0$, we can rewrite

$$\sum_{i=n+1}^{n+m} E\left[W_i^{F<0} - W_i^{F=0}|x\right] = \frac{\beta\gamma x}{N - \gamma x}\left[2\gamma x\left(Q^+ - \overline{Q}\right) - Q^+ N\right], \tag{B.22}$$

where Q^+ is the aggregate demand of new investors and $\overline{Q}$ is given by (2.18). The expression (B.22) is positive (current shareholders are worse off) when

$$2\gamma x\left(Q^+ - \overline{Q}\right) < Q^+ N. \tag{B.23}$$

Since $x < 0$ and $Q^+ < \overline{Q}$, the condition above is satisfied when mispricing is not too large. Therefore, we establish that current shareholders are worse off with equity issuance timing by an informed manager (and the new investors are better off) when

$$\overline{v} < v < \overline{P}, \tag{B.24}$$

where

$$\overline{v} \equiv \overline{P} + \frac{Q^+ N}{2\gamma\left(Q^+ - \overline{Q}\right)}. \tag{B.25}$$

(ii) For the case of share repurchases of undervalued equity, the expression for change in wealth of new investors is given by (B.22) with $x > 0$. Since $Q^+ < \overline{Q}$, it is negative. Therefore, according to the zero-sum argument the current shareholder value always increases.

(iii) To establish that current shareholders prefer share repurchases to equity issues, we write the difference between new investors' wealth with repurchase timing and issuance timing, for a given magnitude of mispricing, $|x| = \left|v - \overline{P}\right|$, and show that it is negative. Specifically,

$$\begin{aligned} & \sum_{i=n+1}^{n+m} E\left[W_i^{F>0} - W_i^{F=0}|v, v > \overline{P}\right] - \sum_{i=n+1}^{n+m} E\left[W_i^{F<0} - W_i^{F=0}|v, v < \overline{P}\right] \quad \text{(B.26)} \\ = \; & \frac{\beta\gamma|x|}{N - \gamma|x|}\left[2\gamma|x|\left(Q^+ - \overline{Q}\right) - Q^+ N\right] - \frac{\beta\gamma|x|}{N + \gamma|x|}\left[2\gamma|x|\left(Q^+ - \overline{Q}\right) + Q^+ N\right]. \end{aligned}$$

The expression above is negative when

$$2\gamma^2 x^2\left(Q^+ - \overline{Q}\right) < Q^+ N^2. \tag{B.27}$$

The last condition is true because $Q^+ < \overline{Q}$.

(iv) To see that market timing increases current shareholder value in expectation, it is sufficient to show that the new investors' wealth, averaged over all possible values of mispricing x, decreases. Integrating (B.22) over states x gives the expected change in wealth from market timing for new investors

$$\beta \int_{-\infty}^{\infty} \frac{2\left(\gamma x\right)^2\left(Q^+ - \overline{Q}\right) - Q^+ N\gamma x}{N - \gamma x} f\left(x\right) dx. \tag{B.28}$$

Using the symmetry of the normal distribution, we can rewrite this value as

$$\begin{aligned} & \beta \int_0^{\infty}\left(\frac{2\left(\gamma x\right)^2\left(Q^+ - \overline{Q}\right) + Q^+ N\gamma x}{N + \gamma x} + \frac{2\left(\gamma x\right)^2\left(Q^+ - \overline{Q}\right) - Q^+ N\gamma x}{N - \gamma x}\right) f\left(x\right) dx \\ = \; & 2N\beta \int_0^{\infty} \frac{\left(\gamma x\right)^2\left(Q^+ - 2\overline{Q}\right)}{\left(N + \gamma x\right)\left(N - \gamma x\right)} f\left(x\right) dx. \end{aligned} \tag{B.29}$$

Since $Q^+ < \overline{Q}$, it is negative. Therefore, it must be that current shareholder value increases.

Proof of Proposition 4.

(i) We show in the proof of Proposition 3 that current shareholder wealth decreases with the timing of equity issuance when

$$\sum_{i=n+1}^{n+m} E\left[W_i^{F<0} - W_i^{F=0}|x\right] = \frac{\beta\gamma x}{N - \gamma x}\left[2\gamma x\left(Q^+ - \overline{Q}\right) - Q^+ N\right] > 0. \tag{B.30}$$

Because for issuance $x < 0$ (overvaluation), current shareholders are worse off when

$$2\gamma x\left(Q^{+}-\overline{Q}\right) < Q^{+}N,$$

which is satisfied since $Q^{+} > \overline{Q}$.
(ii) For share repurchases of undervalued stock, we have $x > 0$. From (B.22), the current shareholder value decreases with repurchase timing if

$$2\gamma x\left(Q^{+}-\overline{Q}\right) > Q^{+}N. \tag{B.31}$$

Since $Q^{+} > \overline{Q}$, this condition is satisfied when mispricing is large, i.e., $v > \overline{v}$, where

$$\overline{v} \equiv \overline{P} + \frac{Q^{+}N}{2\gamma\left(Q^{+}-\overline{Q}\right)}. \tag{B.32}$$

(iii) For new investors, the expected change in wealth from market timing is given by (B.29), and it is positive when $Q^{+} > 2\overline{Q}$. Therefore, it must be that current shareholder value is lower with market timing.

Proof of Proposition 5.
The problem of maximizing current shareholder value is equivalent to minimizing value for new investors with respect to F. Using expression for P_2', we have

$$\min_F \sum_{i=n+1}^{n+m} E\left[X_i\left(P_2'-P_1\right)|v\right] = \min_F N \sum_{i=n+1}^{n+m} X_i \frac{\left(E\left(P_2|v\right)-P_1\right)}{N-F}. \tag{B.33}$$

We start with a linear conjecture for the equilibrium price schedule

$$P_1 = \overline{P} - \alpha + \beta F. \tag{B.34}$$

It is easy to check that the solution exists only if

$$\left(2\overline{Q}-Q^{+}\right)\left(N-2\gamma x-\frac{\alpha}{\beta}\right) > 0. \tag{B.35}$$

Using (B.34) and demand functions for individual investors (2.11), the objective function (B.33) can be simplified to

$$\min_F\left(Q^{+}-\frac{Fm}{n+m}\right)\frac{\left(2\gamma x+\frac{\alpha}{\beta}-F\right)}{N-F} \simeq \min_F\left(Q^{+}-\frac{Fm}{n+m}\right)\frac{\left(2\gamma x+\frac{\alpha}{\beta}-F\right)}{N}. \tag{B.36}$$

Solving for optimal demand by the manager gives

$$F^{*} = \frac{n+m}{2m}Q^{+} + \gamma x + \frac{\alpha}{2\beta}. \tag{B.37}$$

For individuals who observe the firm's trade F, the conditional mean of P_2 is

$$E(P_2|F,\text{info}) = \overline{P} - \alpha - \beta Q^+ \frac{n+m}{m} + 2\beta F, \tag{B.38}$$

$$E(P_2|F) = \lambda E(P_2|F,\text{info}) + (1-\lambda)\, E(P_2|F,\text{no info}) \tag{B.39}$$

$$= \quad \overline{P} - \lambda\alpha - \lambda\beta Q^+ \frac{n+m}{m} + 2\lambda\beta F.$$

The equilibrium price is found from the market clearing condition, which can be written as

$$P_1 = \frac{\theta F}{n+m} + E\left(P_2|F\right) = \left(\frac{\theta}{n+m} + 2\lambda\beta\right) F + \overline{P} - \lambda\alpha - \lambda\beta Q^+ \frac{n+m}{m}. \tag{B.40}$$

We compare the expression above to the price conjecture (B.34) and solve for α and β

$$\beta = \frac{\theta}{(n+m)(1-2\lambda)} > 0, \tag{B.41}$$

$$\alpha = \frac{\lambda\theta Q^+}{(1-\lambda)(1-2\lambda)\, m} > 0. \tag{B.42}$$

Substituting parameters in (B.37) yields

$$F^* = \overline{F} + \gamma\left(v - \overline{P}\right), \tag{B.43}$$

$$\overline{F} = \frac{Q^+}{1-\lambda}\frac{n+m}{2m}. \tag{B.44}$$

Since new investors on average buy the stock, $Q^+ > 0$, it follows that $\overline{F} > 0$. Finally, using the fixed-point argument we derive the parameters μ_u and σ_u^2 consistent with the conditional probability λ of the signal coming from the informed manager. Following the same steps as in the first proposition, we obtain

$$\mu_u = \frac{Q^+}{1-\lambda}\frac{n+m}{2m}, \tag{B.45}$$

$$\sigma_u^2 = \frac{(n+m)^2 (1-2\lambda)^2 \sigma_p^4}{4\theta^2\left(\sigma_p^2 + \sigma_\varepsilon^2\right)}. \tag{B.46}$$

Proof of Proposition 6.
(i) The probability of a stock repurchase is larger than the probability of an equity sale because

$$\Pr\left(F^* > 0\right) - \Pr\left(F^* < 0\right) = \int_{-\frac{\overline{F}}{\gamma}}^{\infty} f\left(x\right) dx - \int_{-\infty}^{-\frac{\overline{F}}{\gamma}} f\left(x\right) dx = 1 - 2\Phi(-\frac{\overline{F}}{\gamma\sigma}) > 0, \tag{B.47}$$

where $f(x)$ is the normal distribution density function with zero mean and variance $\sigma^2 \equiv \sigma_p^2 + \sigma_\varepsilon^2$. Similarly, we show that the difference in total volume of stock repurchases and equity sales is positive

$$\begin{aligned} \text{Volume(Rep)} - \text{Volume(Iss)} &= E\left[F|F^*>0\right]\Pr\left(F^*>0\right) - E\left[-F|F^*<0\right]\Pr\left(F^*<0\right) \\ &= \int_{-\frac{\overline{F}}{\gamma}}^{\infty}\left(\overline{F}+\gamma x\right) f(x)\,dx + \int_{-\infty}^{-\frac{\overline{F}}{\gamma}}\left(\overline{F}+\gamma x\right) f(x)\,dx \\ &= \overline{F} > 0, \end{aligned} \tag{B.48}$$

where the last result is by symmetry of x probability distribution function.
(ii) A manager's trading profit when she maximizes current shareholder value is

$$\Pi(v) = E\left[\left(P_2 - P_1\right) F|v\right] \tag{B.49}$$

Substituting the expressions for the firm's optimal demand for shares, F^*, and the equilibrium price schedule, P_1, we have

$$\Pi(x) = \beta\left(\gamma^2 x^2 + 2\lambda\gamma\overline{F}x - \overline{F}^2(1-2\lambda)\right), \tag{B.50}$$

From Proposition 5, we know that the firm will repurchase shares if and only if $x > -\frac{\overline{F}}{\gamma}$. We need to show that expected profit from timing repurchases minus expected profit from timing equity sales is negative, i.e.,

$$\frac{\int_{-\frac{\overline{F}}{\gamma}}^{\infty}\Pi(x) f(x)\,dx}{\int_{-\frac{\overline{F}}{\gamma}}^{\infty} f(x)\,dx} - \frac{\int_{-\infty}^{-\frac{\overline{F}}{\gamma}}\Pi(x) f(x)\,dx}{\int_{-\infty}^{-\frac{\overline{F}}{\gamma}} f(x)\,dx} < 0. \tag{B.51}$$

Note that for standard normal distribution with cumulative density function $\Phi(x)$ we have

$$\int_A^B x^2 f(x)\,dx = \frac{\sigma^2}{\sqrt{2\pi\sigma^2}}\left(-Be^{-\frac{B^2}{2\sigma^2}} + Ae^{-\frac{A^2}{2\sigma^2}}\right) + \sigma^2\left(\Phi(B/\sigma) - \Phi(A/\sigma)\right), \tag{B.52}$$

$$\int_A^B x f(x)\,dx = -\frac{\sigma^2}{\sqrt{2\pi\sigma^2}}\left(e^{-\frac{B^2}{2\sigma^2}} - e^{-\frac{A^2}{2\sigma^2}}\right), \tag{B.53}$$

$$\int_A^B f(x)\,dx = \Phi(B/\sigma) - \Phi(A/\sigma), \tag{B.54}$$

therefore, substituting (B.50), it is easy to show that (B.51) is satisfied for $\lambda < 1/2$.
(iii) The expected post-event price drift given managerial signal v is

$$R(x) = E\left(P_2|v\right) - P_1 = \beta\left(\gamma x - \overline{F}(1-2\lambda)\right). \tag{B.55}$$

Recall that the manager repurchases when $x > -\frac{\overline{F}}{\gamma}$. Therefore, the expected stock returns conditional on issuance and repurchase are, respectively,

$$\frac{\int_{-\infty}^{-\frac{F}{\gamma}} R(x) f(x)\, dx}{\int_{-\infty}^{-\frac{F}{\gamma}} f(x)\, dx} = -\frac{\beta\gamma\sigma}{\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\overline{F}}{\gamma\sigma}\right)^2} / \Phi(-\frac{\overline{F}}{\gamma\sigma}) - \beta\overline{F}(1-2\lambda), \tag{B.56}$$

$$\frac{\int_{-\frac{F}{\gamma}}^{\infty} R(x) f(x)\, dx}{\int_{-\frac{\overline{F}}{\gamma}}^{\infty} f(x)\, dx} = \frac{\beta\gamma\sigma}{\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{\overline{F}}{\gamma\sigma}\right)^2} / \left(1 - \Phi(-\frac{\overline{F}}{\gamma\sigma})\right) - \beta\overline{F}(1-2\lambda). \tag{B.57}$$

The expected stock return following a stock issuance is always negative, while it can be positive or negative following a repurchase. Since $\overline{F} > 0$, it must be that $\Phi(-\frac{\overline{F}}{\gamma\sigma}) < 1/2$ and we have

$$1 - \Phi(-\frac{\overline{F}}{\gamma\sigma}) > \Phi(-\frac{\overline{F}}{\gamma\sigma}). \tag{B.58}$$

Therefore, the absolute value of expected price drift following a repurchase is always smaller than the value of expected price drift following equity issuance.

Here we discuss the implications of a symmetric market timing strategy for the welfare of current shareholders measured by their objective function (2.5). We then analyze the optimal market timing strategy of an informed manager who aims to maximize this objective function.

Recall that an equity issue of overvalued stock can decrease shareholder value. We show below that a similar claim can be made for the expected utility of shareholders. Specifically, we decompose the change in current shareholders' expected utility into a change in their expected wealth and a change in costs associated with deviation from desired positions

$$\sum_{i=1}^{n} E\left[U_i^{F<0} - U_i^{F=0}|v\right] = \sum_{i=1}^{n} E\left[W_i^{F<0} - W_i^{F=0}|v\right] - \sum_{i=1}^{n} E\left[\frac{\theta}{2}\left(X_i - Q_i\right)^2|v\right]. \tag{B.59}$$

As we show in Proposition 3, the first term is negative when the stock overpricing is small. To see that the change in utility is negative as well, note that by timing a firm creates additional disutility for current shareholders because their demands deviate from the initial preferences, i.e., $X_i \neq Q_i$ if $F \neq 0$. Therefore, the second term is negative, and current shareholders are worse off from equity issuance of overvalued stock. Using a similar line of reasoning, one can show that all claims of Proposition 4 also hold if we consider shareholders' utility function instead of wealth.

Next we show that when the share turnover is low, current shareholders prefer share repurchase timing over issuance timing. From the proof of Proposition 3, we have the following relation between the current shareholders' expected wealth changes with repurchase and issuance timing

$$\sum_{i=1}^{n} E\left[W_i^{F>0} - W_i^{F=0}|v, v > \overline{P}\right] > \sum_{i=1}^{n} E\left[W_i^{F<0} - W_i^{F=0}|v, v < \overline{P}\right]. \tag{B.60}$$

Note also that the costs incurred by shareholders, $\frac{\theta}{2}\left(X_i - Q_i\right)^2$, are symmetric with respect to mispricing, $v - \overline{P}$; that is

$$E\left(\frac{\theta}{2}\left(X_i - Q_i\right)^2|v\right) = \frac{\theta\gamma^2\left(v - \overline{P}\right)^2}{2\left(n+m\right)^2}. \tag{B.61}$$

Therefore, when we subtract the respective costs from both sides of (B.60), the inequality remains unchanged, and we have

$$\sum_{i=1}^{n} E\left[U_i^{F>0} - U_i^{F=0}|v, v > \overline{P}\right] > \sum_{i=1}^{n} E\left[U_i^{F<0} - U_i^{F=0}|v, v < \overline{P}\right]. \tag{B.62}$$

We now analyze the optimal market timing strategy of a manager who wants to maximize the expected utility of shareholders. This objective function is equivalent to minimizing the sum of the wealth of new investors and costs of suboptimal trades for current shareholders

$$\min_F N \sum_{i=n+1}^{n+m} X_i \frac{(E(P_2|v) - P_1)}{N - F} + \frac{\theta F^2}{2(n+m)^2}. \tag{B.63}$$

Using the linear conjecture for the equilibrium price schedule

$$P_1 = \overline{P} - \alpha + \beta F, \tag{B.64}$$

we can further rewrite the objective function as

$$\min_F \left(Q^+ - \frac{Fm}{n+m}\right) \frac{(2\gamma\beta x + \alpha - \beta F)}{N} + \frac{\theta F^2}{2(n+m)^2}. \tag{B.65}$$

Taking the first-order condition with respect to F, we obtain

$$F^* = \frac{\alpha + \frac{n+m}{m} Q^+ \beta + 2\gamma\beta x}{2\beta + \frac{\theta N}{m(n+m)}} \equiv \widehat{F} + \widehat{\gamma} x. \tag{B.66}$$

Since the manager's demand is linear in mispricing, we have

$$E(P_2|F) = \overline{P} - \lambda\alpha - \lambda\beta Q^+ \frac{n+m}{m} + F\left(2\beta\lambda + \frac{\lambda\theta N}{m(n+m)}\right). \tag{B.67}$$

The equilibrium price is found from the market clearing condition

$$P_1 = \frac{\theta F}{n+m} + E(P_2|F) = \left(\frac{\theta}{n+m} + 2\lambda\beta + \frac{\lambda\theta N}{m(n+m)}\right) F + \overline{P} - \lambda\alpha - \lambda\beta Q^+ \frac{n+m}{m}. \tag{B.68}$$

We now compare this expression with the price conjecture (B.34) and solve for α and β

$$\beta = \frac{\theta\left(1 + \frac{\lambda N}{m}\right)}{(1-2\lambda)(n+m)} > 0, \tag{B.69}$$

$$\alpha = \frac{\lambda Q^+ \theta\left(1 + \frac{\lambda N}{m}\right)}{(1-\lambda)(1-2\lambda)m} > 0. \tag{B.70}$$

Substituting the solution back into (B.66) yields

$$\widehat{F} = \overline{F} \frac{m + \lambda N}{m + \frac{1}{2}N} < \overline{F}, \tag{B.71}$$

$$\widehat{\gamma} = \gamma \frac{m + \lambda N}{m + \frac{1}{2}N} < \gamma, \tag{B.72}$$

where $\overline{F}$ is given by (B.44). Note that $\widehat{F} > 0$.

B.1.2 MARKET TIMING PROFIT MEASURE

Although the construction of measures of profit from market timing may seem intuitive, let us explain why it makes sense from a theory perspective. Intuitively, the additional return earned on one share of stock as the result of market timing is given by the difference between the realized stock return and the return if the firm not issued or repurchased any stock. The latter return is unobservable, but it can be inferred from the realized return and the cash going out of the firm (into the firm) at the time of stock repurchase (stock issuance).

Specifically, consider a manager who repurchases a fraction α of her firm's stock at today's price P_1, expecting the stock to appreciate to P_2 in the future. Even if the manager's expectation were correct, the future price will change as a result of the repurchase itself. We denote this actual future price with P_2'. If the real policy of the firm is independent of repurchases and issuances, then the non-arbitrage relation between prices implies

$$(1-\alpha)P_2' = P_2 - \alpha P_1. \tag{B.73}$$

Empirically, we observe the actual price, P_2', but not what the price would be had the manager not repurchased any shares. Therefore, we infer P_2 using the expression (B.73) and obtain the additional return from repurchase as

$$\text{Repurchase timing} = \frac{P_2' - P_2}{P_1} = \alpha \left(\frac{P_2' - P_1}{P_1} \right). \tag{B.74}$$

Note that a similar argument can be made for the calculation of market timing with SEOs or general equity sales.