Abstract—Hyperbolic discounting is used to explain a wide range of time-related and apparently inconsistent behavioral phenomena, including reluctance to participate in employer-sponsored retirement plans, criminal activity, obesity, drug addiction, compulsive behavior, etc. The motivation for such behavior is termed temporal myopia. Exponential (traditional) discounting models are typically based on the assumption that risk resolves in a consistent manner over time. Hyperbolic discounting models allow for time-varying discount rates relative to payout or consumption. Hyperbolic discounting can explain apparently irrational preference for current relative to delayed consumption. Economic modeling is normally based on assumptions precluding such irrational decision-making. This paper proposes the Certainty Equivalence Model (CEQ) to resolve this conflict. Separation of risk resolution from time decay is essential when risk does not resolve at the same rate as time decay. Thus, the CEQ model allows the economist to employ hyperbolic discounting models along with the Capital Asset Pricing Model.

Keywords—certainty equivalence, hyperbolic discounting, impulse control, intertemporal utility

I. INTRODUCTION

RATIONAL decision-making by individuals and utility maximization are the hallmarks of modern economic science. However, standard economic modeling efforts have been undermined by the widespread observation of irrationality and inconsistency in a variety of different settings, leading to a new branch of economics, commonly referred to as behavioral economics. This paper will focus on one particular aspect of this new field concerning apparent inconsistencies in consumer and investor applications of the time value principle.

The time value of money, or more generally, the time value principle holds that preferences should not depend on the decision date. If an investor or consumer prefers alternative A to alternative B, passage of time will not affect this preference in the absence of extraneous circumstances. For example, suppose that an investor (or consumer) prefers alternative A to alternative B (A>B). The investor estimates the value of alternative A’s cash flow to exceed that of alternative B; that is, CF_A > CF_B with r > 0. Further suppose that alternative A has a higher nominal cash flow (CF_A > CF_B), but is delayed longer (T_A > T_B). Thus, the investor (consumer) decides now that she prefers to consume the larger amount CF_A at a later date T_A rather than the smaller amount CF_B at the earlier date T_B. However, if both alternative consumption levels were advanced by the same increment T_B (i.e., alternative A to time (T_A - T_B) and T_B to time (T_B - T_B) or time zero - now), many decision makers would reverse their preferences. That is, even though they initially prefer the larger cash flow or consumption levels, even if they are delayed longer, if the smaller reward were offered now, they would prefer it to the larger reward with a shorter delay. That is:

\[ CF_A e^{-r(T_A - T_B)} > CF_B e^{-rT_B} \]  
\[ CF_A e^{-r(T_A - T_B)} < CF_B e^{-r(T_B - T_B)} \]

These two statements are obviously mutually inconsistent, and are taken to illustrate temporal myopia. Such myopia is frequently considered to be irrational, and to be associated with unsophisticated investors and consumers. This paper proposes use of the Certainty Equivalence (CEQ) discounting model as a means to resolve this apparent inconsistency.

II. LITERATURE REVIEW

Numerous researchers have explored the temporal myopia phenomenon [1], [2] and others have associated it with a variety of apparent behavioral anomalies. For example, temporal myopia has been associated with respect to criminal behavior and reactions to punishments. For example, the short term effects from immediately enjoying the fruits of a crime clearly offset the heavily discounted longer term effects of deferred punishment. Threats of short jail terms tend to have much more impact on criminal thought processes effect than increments of time added to longer sentences [3]. That is, a one-year jail term is a far better deterrent than adding an eleventh year onto a ten-year term. Similarly, temporal myopia has also been associated with drug addiction, alcoholism and other behaviors related to impulse control such as procrastination [4], unused gym memberships [5], dieting, excessive credit card usage, inadequate retirement savings [2], inadequate insurance commitments [6] and gambling.

Applications of temporal myopia abound in a host of fields. For example, consider that Dr. Edward Miller, Dean of the Johns Hopkins University Medical School and CEO its hospital, claims that over half a million people undergo coronary-artery bypass graft surgery every year in the US, but only about ten percent of these patients make lifestyle changes.
needed to prevent future surgeries, chest pains, and premature death [7]. It is well-known that employees regularly opt not to participate in employer retirement savings plans, even when employers match their contributions. One might argue that contractual pre-commitment or government intervention might play a role in regulating human behavior. For example, O’Donoghue and Rabin [4] suggest that willpower weaknesses might be remedied by taxing potato chips and subsidizing carrots and the U.S. Federal Government provides for tax deferral subsidies for certain employer-sponsored retirement accounts. Long-term care insurance has been a relatively unpopular product in the United States, with numerous observers blaming temporal myopia [6].

Neuroeconomics might offer a physical explanation for temporal myopia [8] and [9]. Consider a scenario where experimental subjects in a laboratory experiment are offered a choice between $10 now and $15 in one month. MRI analysis shows that both the separate limbic (which governs intuitive, affective and emotional cognition) and analytic (which govern analytical, computational and strategic cognition) systems show blood flow activity. Next, change the offer terms such that only two future award alternatives exist: $10 two weeks from now and $15 in one month. The MRI imaging changes such that only the analytic system shows activity. Subjects are more willing to accept the delayed, but larger rewards. Thus, when the choices include a current reward, the limbic system seems to allow the temptation of immediate gratification to dominate the otherwise apparently more rational decision (Eat, drink and be merry, for tomorrow, we may die). Hence, pre-commitment (government policy, monetary deposits, contracts, etc.) to more rational decisions might help overcome this effect. Similarly, reliance on others such as contractual pre-commitment (government policy, monetary deposits, contracts, etc.) or government intervention might also be useful to deal with the problem of temporal myopia.

III. HYPERBOLIC AND QUASI-HYPERBOLIC DISCOUNTING

The discounting functions based on a constant discount rate \( r \) above can be easily generalized to accommodate time-varying discount rates \( r_t \), where the time subscript denotes the wait to investment termination. Again, the first inequality different sets of deferred cash flow series and the second compares the same two series with consumption advanced by \( T_B \) time periods:

\[
CF_A e^{-(r_1 + r_2 + \ldots + r_T + \ldots + r_{T_A})} < CF_B e^{-(r_1 + r_2 + \ldots + r_{T_B})} \quad (3)
\]

\[
CF_A e^{-r(T_A - T_B)} < CF_B e^{-r(T_B - T_B)} = CF_B \quad (4)
\]

These two inequalities are still inconsistent unless some combination of \( r_1 < r_{TB} \) is sufficiently high. Similarly, hyperbolic discounting [1] and quasi-hyperbolic discounting [2], where \( r_1 < r_{TB} \) is also sufficiently high can resolve this inconsistency. Both argue that consumers are more impatient with respect to short-run current/delayed consumption trade-offs than to long-run trade-offs. The hyperbolic discounting function proposed by [1] and [10] is:

\[
(1 + \alpha t)^{-\gamma \alpha / z}, \quad (5)
\]

where the parameters \( \alpha, \gamma > 0 \), implying that cash flow values decay over time \( t \). As \( \alpha \rightarrow 0 \), the discounting function approaches \( e^{-r^T} \), the standard exponential discounting function. As \( \alpha \) increases, the investor experiences a greater temporal myopia with a present bias.

The quasi-hyperbolic discounting function in terms of current utility \( U_0 \) of intertemporal consumption \( c_t \) proposed in [2] is:

\[
U_0 = E_0 \left[ u(c_0) + \beta \sum_{t=1}^T \delta^t u(c_t) \right] \quad (6)
\]

The parameter \( \beta \leq 1 \) might be interpreted as an indicator of impulse control issues. When \( \beta < 1 \), the investor experiences temporal myopia with a present bias. Many authors refer to this quasi-hyperbolic discount function [2] as a hyperbolic discount function, though its effects might be quite different from the more traditional hyperbolic discounting function proposed earlier. We will discuss other interpretations of this function shortly.

Consider the example illustrated in Table I. A consumer has the opportunity to decide between consuming $50 five years from now and $100 ten years from now. If she discounted consumption with an exponential function at an annual risk adjusted discount rate (RADR) of ten percent (PV = \( CF e^{-0.107} \)), she would prefer to consume $100 ten years from now rather than $50 five years from now. That is, at time zero, \( PV_A > PV_B \). At each year, standard exponential discounting leads to the consumer preferring alternative A to alternative B. This standard exponential discounting is consistent with the time value principle.

Alternatively, suppose that the consumer had "impulse issues," and that her discount rate were 50 percent for one year immediately prior to consumption and 5.56 percent for all other years: \( PV = CF e^{-0.0556 \alpha = \ldots + 0.0556 + 5} \). Still, the

| \( t \) | \( PV(CFB), r=0.1 \) | \( PV(CFB), r=0.1 \) | \( PV(CFA), Hyperbolic \) | \( PV(CFA), Hyperbolic \) |
|---|---|---|---|
| 0 | 36.7879 | 30.3265 | 36.7864 | 24.2831 |
| 1 | 40.6569 | 33.5160 | 38.8881 | 25.6705 |
| 2 | 44.9328 | 37.0409 | 41.1099 | 27.1371 |
| 3 | 49.6585 | 40.9365 | 43.4586 | 28.6875 |
| 4 | 54.8811 | 45.2418 | 45.9415 | 30.3265 |
| 5 | 60.6530 | 50 | 48.5663 | 50 |
| 6 | 67.0320 | 51.3410 | 51.3410 | 51.3410 |
| 7 | 74.0818 | 54.2742 | 54.2742 | 54.2742 |
| 8 | 81.8730 | 57.3750 | 57.3750 | 57.3750 |
| 9 | 90.4837 | 60.6530 | 60.6530 | 60.6530 |
| 10 | 100 | 100 | 100 | 100 |
consumer would prefer to commit to spending $100 in 10 years to spending $50 in 5 years. Furthermore, in each year prior to the 5th, the consumer still prefers the more delayed consumption of the larger sum to the less delayed consumption of the smaller sum. However, if the consumer were permitted to make her decision in the fifth year, her preference ranking would reverse: $PV_A = 48.47 < PV_B = 50. This reversal in the fifth year contradicts the time value principle, suggesting that the consumer is irrational.

Thus, Table I suggests that the consumer will prefer option A in every period except when the consumption of option B is immediate, which might be interpreted as a potential impulse control problem. The preference ranking changes because immediate consumption is considered (discounted) differently from deferred consumption. However, this impulse applies only when one of the options is immediate. Hyperbolic discounting can imply that consumers and investors will make more far-sighted decisions when planning in advance, but when one set of outcomes are immediate, the consumer's decisions will be more short-sighted.

IV. DELAYED RISK RESOLUTION AND HYPERBOLIC DISCOUNTING

For our purposes, in the quasi-hyperbolic utility function $U_t = E_t [\beta^T u(c_T)]$, $\beta \leq 1$, $\beta \leq 1$ might be interpreted as the hazard function, a discount function for risk, and $\delta \leq 1$ as a simple time discounting function. In this formulation, risk resolves only at time $T$. On the other hand, the risk-adjusted discount rate (RADR) model $PV = CF e^{-RADR \times T}$ is based on the assumption that the hazard rate is a function of time; that is, risk or uncertainty diminishes continuously over time. While this may well be true for many risks, it certainly is not for many others (e.g., lotteries, certain research intensive projects and government contract bidding outcomes). Now, suppose that consumption is deferred until time $T$, and no risk is resolved until time $T$. On the other hand, the risk-adjusted discount rate (RADR) model $PV = CF e^{-RADR \times T}$ is based on the assumption that the hazard rate is a function of time; that is, risk or uncertainty diminishes continuously over time. While this may well be true for many risks, it certainly is not for many others (e.g., lotteries, certain research intensive projects and government contract bidding outcomes). Now, suppose that consumption is deferred until time $T$, and no risk is resolved until time $T$, such that our intertemporal utility function is written:

$$U_0 = E_0 [\beta^T u(c_T)]$$

Similarly, in one time period subsequent, the intertemporal utility function would be written as:

$$U_1 = E_1 [\beta^T u(c_T)]$$

which, when $\beta \leq 1$, is consistent with unresolved risk but obviously inconsistent with the RADR/exponential discounting methodology underlying Table I. When $t = 5$ in Table I, $\beta_t = 1$; all risk has been resolved.

The results in the last two columns of Table I are consistent with the quasi-hyperbolic discounting function, where $\beta_5 < 0.66667$ and $\delta = 0.947368$ (consistent with a riskless rate equal to five percent). A sufficiently low $\beta$ leads to a consumer preference for the longer-delayed consumption at every point in time except for time 5, when Project B terminates. A sufficiently high level of risk and/or risk aversion might well justify this low $\beta$. With delayed resolution of risk, such discounting need not be associated with irrationality, but merely a high level of risk or risk aversion. Hence, such quasi-hyperbolic discounting is perfectly consistent with rationality.

As a side note, we also point out that not all discounting is with positive rates $r$. For example, Loewenstein [11] elicited from laboratory subjects monetary valuations of several outcomes that included a "kiss from the movie star of your choice," and "a nonlethal 110 volt electric shock" occurring at different points in time. On average, subjects paid the most to delay kisses three days and were eager to get their shocks over with as quickly as possible. Apparently, anticipation of rewards and losses affected their time discounting, with negative discount rates.

V. THE CERTAINTY EQUIVALENCE MODEL

A. The CEQ Model and Risk Resolution

Many types of investments present risks that are not resolved until the project terminates. Constant risk-adjusted discount rates are inappropriate for such investments. In this case, the analyst should not discount with the exponential discounting function that diminishes over time to adjust for risk. Even when no risk is resolved until the project terminates, the time exponent compounding the discount rate will diminish as time goes by. For example, if a target firm had invested in a federal government lottery for oil drilling rights, no uncertainty associated with the cash flows for the drilling project initiation would be resolved until the results of the lottery are known. Thus, the discounting mechanism should not allow for smaller risk discounts as the lottery date draws closer.

The Certainty Equivalence Model [12], [13] offers an alternative approach for dealing with this delayed risk resolution problem. With the Certainty Equivalence Model, the NPV associated with a series of cash flows with time-dependent risk adjustments $\beta_t$ is as follows:

$$NPV = \sum_{t=0}^{n} \frac{E[CEQ_t]}{(1 + r_f)^t} = \sum_{t=0}^{n} E[CF_t] \beta_t \delta_t$$

where

$$\delta_t = \frac{1}{(1 + r_f)^t}$$

The riskless discount rate is $r_f$. The cash flow Certainty Equivalents $CEQ_t$ are simply $E[CF_t] \beta_t$ for each period $t$. Unlike in the RADR discounting model, risk adjustments $\beta_t$ to each expected cash flow over time can be made independently of one another. Hence, in all periods prior to that where risk resolution occurs, $\beta_t = 0$.

B. CEQ and CAPM

There are many mechanisms to estimate the Certainty Equivalence, one of the most fundamental being based on the Capital Asset Pricing Model [14]. Lintner derived the Capital
Asset Pricing Model (CAPM) in CEQ form. In this Lintner CAPM formulation, the CEQ is calculated as follows:

\[ E[CF_t] - \lambda \text{COV}(CF_t, r_m) \]  

where \( \lambda = E[R_m - r_f] / \sigma_m^2 \)  

The term \( \lambda \) is normally interpreted as the CAPM market price per unit of risk, where \( R_m - r_f \) is the risk premium on the market portfolio (or average investment) and \( \sigma_m^2 \) is the variance of returns associated with this market portfolio. In terms of the Quasi-hyperbolic discounting function, we obtain \( \beta_i \) as follows:

\[ \beta_i = 1 - \lambda \text{COV}(r_i, r_m) \]  

The covariance between investment cash flows \( CF_t \) and returns on the market portfolio \( r_m \) is \( \text{COV}(CF_t, r_m) \); the covariance between investment returns \( r_t \) and returns on the market portfolio is \( \text{COV}(r_t, r_m) \). For computational purposes, this covariance might be based on a historical covariance or otherwise forecasted.

The Lintner and Sharpe [15] variations of the CAPM were derived as a single time-period valuation framework. However, is periods characterized by the absence of risk resolution, the Lintner formulation of the CAPM is easily extended to valuing assets with risk resolution only at investment termination. That is, in all periods prior to investment termination at time \( T \), CEQ \( \tau = E[CF_t] \).

**VI. CONCLUSIONS**

Temporal myopia is a form of irrationality that violates the time value principle. However, temporal myopia has been inappropriately attributed in a wide variety of circumstances simply because of the combination of risk and time delay in the same decision-making settings. Surely temporal myopia can be associated with a number of actions and preference relations, such as the natural human proclivity to procrastinate completing necessary tasks, the obvious need but failure to maintain healthy diets and exercise, etc. However, many scenarios, such as those that involve cash flows with some level of uncertainty may exhibit reversals that appear consistent with temporal myopia, but actually in involve non-continuous risk resolution. These are the scenarios considered in this paper. This paper briefly reviews the hyperbolic discounting literature, discusses the separation of risk from time value in the discounting function, proposes the CEQ approach for rationally discounting risky cash flows, and illustrates the consistency of the CAPM, CEQ and hyperbolic discounting mechanisms, all in an environment with rational consumers.

**REFERENCES**


The development of Academic Achievement Model of Lecturer in East Java

Marsudi Lestarininghis, Triyonowati, and Sulisty Budi Utomo

Abstract—The Academic achievement is one of the performance indicators of lecturer at Universities; the academic achievement has influence either directly or indirectly for professors as well as for University. This research is conducted for 124 lecturers, from the 10 universities of East Java. The research result show that the independent variable has simultaneously influence towards dependent variable. While, partially variable Motivation, Ability, Problems has a significant influence towards lecturer’s efforts in order to improve the academic achievement, while the opportunities variable, Organization Commitment, Population density, distance of residence with College is not significant against efforts to improve academic achievement. Motivation variable is a dominant variable that has influence towards lecturer’s efforts in order to improve the academic achievement.

Keywords— Motivation, Problems, Ability, Organization Commitment, Population density, distance of residence, Academic Achievement.

I. INTRODUCTION

To develop achievement lecturer optimal then required lecturer in efforts to improve academic merit and location for. Less support location will affect work performance, mood, and change behavior. There is a phenomenon that shows some lecturers do not take advantage of the opportunity and time to improve their academic achievement in term of academic, according to the time that has been set by the government, namely at least 1 of lecturer is done in a year, tenure and promotion is done after at least 2 years.

Possibilities in improving the position of academic efforts can be also caused by factors in improving the achievement efforts lecturer which include: motivations, capabilities, opportunities, barriers, and organizational commitment, as well as the location of the lecturers include population, and distance from lecturer residence to the their Universities.

Therefore, this research will focus on the development of Model of characteristics and accomplishments of the Academic Lecturer in East Java.

II. PROCEDURE FOR PAPER SUBMISSION

1. Literature Review

Effort is the willingness, sincerity and the spirit of cooperation in achieving goals, needs, expectations and rewards.

Motivation has an important role in improving the academic achievement of a lecturer with high motivation, then it would encourage lecturer to conduct activities that could support in improving academic achievement.

[2] stated that motivation has a significant and positive impact towards the lecturers’ performance. Motivation is a personality and human behavior, something that comes from within the concerned of humans [20]. Maslow [5] suggests five needs: Physiological Needs, Sense of security needs, social needs, self esteem needs, and self-actualization needs. Opportunity interacts with the ability and motivation in creating a performance but as ability and motivation, opportunity cannot stand on its own to create a performance. In this problem situation when someone facing a wide range of obstacles in their efforts to achieve a goal. Process and effort to overcome problems in order to achieve the goal illustrate the magnitude of motivation [14]. Barriers are external environmental factors from individuals which are not support for an organization and individuals in improving academic term [14]. Commitment to the organization reflected workers beliefs about the company purpose and mission, the ability to devote the effort and achievements of his ability to work, and the intention to continue work in such companies [16]. The research population is universities’ lecturers who are spread to over 10 institutions. This research is using a sample of representative that will provide results that can be able to be generalized.

II. MULTIPLE REGRESSION ANALYSIS

Multiple Regression Model (F Test, dan t Test) is used. Regression Model is as follows:

\[ Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + c_1 x_6 + c_2 x_7 + \epsilon \]

Description:

- \( Y \) = Lecturer efforts improving the academic achievement
- \( X_1 \) = Motivation; \( X_2 \) = Ability; \( X_3 \) = Opportunities; \( X_4 \) = Barriers; \( X_5 \) = Organization Commitment; \( X_6 \) = Population density and size of the college; \( X_7 \) = Distance respondents place to the college
- \( b_1, b_2, b_3, b_4, b_5 \) = The regression coefficient the individual characteristics factor, \( c_1, c_2 \) = The regression coefficient the location factor, \( \epsilon \) = Error

This model is used to find out whether the influence of Motivation, Ability, Opportunities, Barriers, Organization Commitment, population density, and the distance between the place of residence with the location of the College on Lecturers’ Efforts in improving academic achievement at universities in East Java.

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