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Thomas J Chemmanur, S Abraham Ravid

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by Thomas J. Chemmanur* and S.Abraham Ravid**

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* Graduate School of Business, Columbia University
** Graduate School of Business, Rutgers University and Stern School of Business, NYU.

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1. Introduction

In recent years there has been considerable debate both in academic circles and in the popular press concerning the declining competitiveness of American corporations, particularly in manufacturing, relative to their foreign competitors. It is argued that an important reason for this decline has been the short-term planning horizon of American businesses. Corporations with short-term horizons are regarded as less willing to forego earnings today in order to increase performance in the future, which manifests itself in lower long-term R&D investment, lower investments in new product and long-term market development, and lower willingness to invest in the training of workers. In other words, an excessive concern for the next period's earnings figures is supposed to have induced U.S. corporations to take up "short-term" projects at the expense of maximizing long-term firm value.[1]

A recent paper by Poterba and Summers (1991), which presents the results from a survey of CEOs at one thousand of the largest American firms, provides several interesting facts related to this issue. First, a large percentage of American CEOs believe that their firms have systematically shorter time horizons than their major competitors in Europe and Asia (in particular).[2] Second, most CEOs believe that the U.S. equity market undervalues long-term investments.[3] Further, their responses indicate that

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[1]See, for instance, Hayes and Abernathy (1980), and Hayes and Garvin (1982) who argue that this short-term behavior by U.S. corporations has led to a decline in U.S. competitiveness. Jacobs (1991), and Edwards (1993) summarize this debate and suggest possible solutions to the myopia problem.

[2]This belief seems to be shared by Asian managers as well. Sony founder Akio Morita (1986) contends that most U.S corporate managers unduly emphasize short-term profits rather than making their products competitive over the long haul; in contrast, Japanese managers strive to achieve growth targets in order to ensure long-term competitive success, even at the expense of short-term profits.

[3]There is some empirical evidence to support this belief about the U.S stock market. For instance, Jacobson and Aaaker (1993) document that the ratio of the effect of future-term to current-term business performance on stock returns is smaller in the U.S stock market than in the Japanese stock market. They attribute this to the lower degree of asymmetric information in Japan (resulting from the fact that a much larger proportion of stock market investors

model of myopic project-selection in order to examine the argument that corporate myopia is "contagious," and generated by "short-term trading" by portfolio managers and others in the firm's equity. We will make use of this model to examine the impact of a reduction in capital gains tax rates on the corporate planning horizon, and then develop implications for how such a tax cut (if any) should be structured.

In our model, a fraction of the firm's equity holders are long-term share holders while others are short-term traders, who plan to sell their shares early. Corporations have to choose between investing in two kinds of projects: "short-term" projects, in which uncertainty about project quality is resolved faster, and "long-term" projects, where this uncertainty is resolved at a slower pace. For instance, a short-term project may involve the modification of an existing product of the firm, so that management may have a high degree of confidence in the success of the project, and, in any case, the success or failure of the project may become known in a reasonably short period of time; a long-term project, on the other hand, may involve investing large amounts of money in R&D for long periods of time, without a great deal of information becoming available about the project's potential for success. We show that this differential resolution of uncertainty in itself, does not lead to any distortion in corporate investment behavior, or to any need of remedial tax treatment. However, if, in addition, we introduce asymmetric information about project quality between firm insiders and outsiders, even managers whose objective is to maximize stock value are motivated to invest in short-term projects rather than in long-term projects (which maximize true firm value).

Thus, inefficient investment in short-term projects is generated because management places a positive weight on the short-term stock price (management is compelled to care about short-term stock price to some degree because of the desire of a fraction of the firm's shareholders to sell their shares early). Even a manager with a good project may be motivated to undertake a (lower-NPV) short-term project in this setting, since it has a higher probability of generating a good news signal earlier than a smaller slice of a larger pie.

Our research is closely related to the large corporate finance literature which demonstrates how corporations may deviate from policies of long-term value maximization in economic settings characterized by either moral hazard or adverse selection. Two important papers in this literature are Narayanan (1985) and Stein (1989) where myopic corporate behavior results from "signal-jamming" by corporate managers, in an attempt to manipulate stock market reactions.[6] These are "hidden-action" models, where myopic behavior arises from the inability of outsiders to observe some managerial actions. In contrast, our model is a "hidden-information" model, where the manager's choice of project horizon is *fully observable*, and myopic corporate behavior is driven solely by *ex ante* private information about project quality. In another closely related paper, Hirshleifer and Chordia (1991) argue that asymmetric information about managerial ability need not always lead to corporate myopia. In a model in which managers can manipulate the timing of the resolution of uncertainty about their firm's project cash flows, they demonstrate that while high quality managers will be biased toward advancing resolution, low ability managers may favor either advancing or deferring resolution. Thus, in their model, managerial reputation effects may lead to either under- or over-investment in long-term projects, depending on parameter values.[7] Bebcuk and Stole (1993) also analyze a situation of unobservable investment and argue that short-term managerial objectives may lead to either over- or under-investment in long-term projects. Finally, Thakor (1990) provides a rationale for the adoption by firms of capital budgeting procedures which emphasize short-term cash flows, based on the argument that in certain settings, internal cash flow is more valuable to a firm which

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[6]A related paper is Stein (1988), where myopic corporate behavior arises from takeover pressures on firm management faced with an asymmetrically informed equity market.

[7]Another related paper is Paul (1992), in which the stock market observes imperfect signals of the firm's future cash flows and where the firm manager *invisibly* allocates resources between short-term and long-term projects in order to maximize the current stock price. In such a setting, the firm will under- or over-invest in long-term projects, depending on whether short-term cash flows are better or worse predictors of the firm's total profitability than the market's signals about long-term cash flows.

projects (we assume that both types of projects have positive net present values); further, good long-term projects have larger net present values than good short-term projects. In other words, the net present values of the projects available to firms depend both on project horizon, which is chosen by management and is publicly observable, and on firm quality (or "type"), which is private information to management, and which cannot be altered by firm management. Thus:

$$NPV_{GL} \equiv C_{GL} - I_L > NPV_{GS} \equiv C_{GS} - I_S > NPV_{BL} = NPV_{BS} \equiv C_B - I_B. \quad (1)$$

Here C_{GL} and C_{GS} denote the time 2 cash flow from good long-term and good short-term projects respectively; C_B is the corresponding cash flow from bad projects (regardless of whether the project is long-term or short-term). I_L and I_S are the investment amounts required for good long-term and good short-term projects respectively; I_B is the investment amount required to undertake a bad project, whether long-term or short-term. We assume that these investment amounts are not observable by outside investors (therefore, outsiders cannot infer project quality from observing these amounts). Clearly, by assuming that the time 2 cash flows as well as the investment amounts required are the same for all bad projects regardless of project horizon, we have essentially assumed that the net present values are the same for all bad projects. This assumption, however, is made only for modeling simplicity: for the intuition behind our results to go through, all we need is that the difference in NPVs between the bad short-term and the bad long-term project be much smaller than that between good and bad projects.[10]

At time 0, outsiders have only a prior probability assessment about firm (project) quality which

[10]The focus of this paper is on studying the effects of asymmetric information on firms with good projects, and we are therefore interested in studying situations where firms with bad projects have no incentives to separate from those with good projects by their choice of project horizon. Assuming that the bad short-term and the bad long-term projects have identical net present values ensures that managers with bad projects always have an incentive to mimic those with good projects in equilibrium. However, the nature of the equilibrium will remain essentially the same even if we assume that bad short-term projects have smaller NPVs than bad long-term projects, provided that the NPV from the latter is significantly smaller than that from a good short-term project, so that the benefit to bad firms from mimicking good firms is always much higher than that arising from choosing a bad long-term project instead of a bad short-term project. We choose not to adopt the latter modeling approach since it only adds complication to the model without significantly affecting results.

projects).[13] The probabilities of receiving a bad signal at time 1 for each kind of project are clearly given by the complements of the probabilities in (2). Outsiders update the market value of the firm's equity based on this additional information about firm value that becomes available at time 1 (we will discuss this updating in more detail in section 2.1).

From (2), it can be seen that the essential difference between "short-term" and "long-term" projects in this model is that the probability of an earlier (partial) resolution of information asymmetry about project quality is higher for short-term projects than for long-term projects. We have chosen to model the distinction between short-term and long-term projects in this manner (rather than assuming that short-term projects will have earlier cash flows, for instance) since (as we demonstrate later in lemma 1), it is the differential resolution of information asymmetry between the two kinds of projects which induces myopic project selection, rather than any difference in the timing of project cash flows themselves.[14]

At time 1, after the information release, the firm's time 0 equity holders sell a fraction γ of their equity to outsiders, to satisfy their liquidity requirements, at the price prevailing in the equity market at this time. They hold the remaining fraction $(1 - \gamma)$ till time 2, at which time all cash flows from the project undertaken by the firm are realized and distributed to equity holders. We will not model how γ is determined here, and take it to be exogenous: γ can be thought of as a [illegible]re of the extent of equity holding by short-term traders in the firm.[15] Alternatively, one can think of γ as the probability

[13] Again, the assumption that the probability of a good signal is the same for both bad short-term projects and for bad long-term projects, made only for modeling simplicity, can be relaxed by adopting an alternative modeling approach along the lines discussed in footnote 10.

[14] Thus, our results would remain essentially unchanged if we assumed (for instance) that *all* projects (regardless of quality) would yield a certain additional cash flow at time 1, since such a cash flow will not convey any information about project quality.

[15] Stein (1989) uses a similar construct to motivate "market pressure" on firm managers; he provides another way of looking at γ, arguing that such pressure may arise from managers' fear that a raider may take over the firm after buying its equity when it is undervalued. Thus, in general, γ can be thought of as a measure of the degree to which existing equity holders are concerned with their short-term return from the firm's equity (even when they do not necessarily plan to liquidate the equity at time 1) as against the long-term return. One group of equity holders who are concerned with short-term return are portfolio managers of mutual funds, whose compensation depends

$$\text{Prob}(f=GL|s=g) = \frac{\delta_{GL}\theta_L}{\delta_{GL}\theta_L + \delta_B(1-\theta_L)}, \quad \text{Prob}(f=GL|s=b) = \frac{(1-\delta_{GL})\theta_L}{(1-\delta_{GL})\theta_L + (1-\delta_B)(1-\theta_L)}, \tag{3}$$

depending on whether the signal observed is good (s = g) or bad (s = b). The probability that the long-term project is bad will be the complement of the probabilities given by (3): i.e., Prob(f=BL | s=g) = 1 - Prob(f=GL | s=g), and Prob(f=BL | s=b) = 1 - Prob(f=GL | s=b). Using these probabilities, we can compute the market value of a long term project conditional on a good signal (denoted by $V_L(g)$) or a bad signal (denoted by $V_L(b)$) as:

$$V_L(g) \equiv \frac{\delta_{GL}\,\theta_L C_{GL} + \delta_B(1-\theta_L)C_B}{\delta_{GL}\,\theta_L + \delta_B\,(1-\theta_L)}, \tag{4}$$

$$V_L(b) \equiv \frac{(1-\delta_{GL})\,\theta_L C_{GL} + (1-\delta_B)(1-\theta_L)C_B}{(1-\delta_{GL})\,\theta_L + (1-\delta_B)(1-\theta_L)}. \tag{5}$$

Working similarly, the updated time 1 market value for a short-term project conditional on a good signal (denoted by $V_S(g)$) or a bad signal (denoted by $V_S(b)$) are given by:

$$V_S(g) \equiv \frac{\delta_{GS}\,\theta_S C_{GS} + \delta_B(1-\theta_S)C_B}{\delta_{GS}\,\theta_S + \delta_B(1-\theta_S)}, \tag{6}$$

$$V_S(b) \equiv \frac{(1-\delta_{GS})\,\theta_S C_{GS} + (1-\delta_B)(1-\theta_S)C_B}{(1-\delta_{GS})\theta_S + (1-\delta_B)(1-\theta_S)}. \tag{7}$$

2.2 The Insiders' Objective

We assume that, at time 0, the firm selects its project horizon in order to maximize the expected cash flows accruing to its current equity holders (firm insiders). We assume that the firm management's interests are aligned perfectly with that of insiders, since firm insiders can prevent divergence between

$$J_{BS} = \gamma(1-t_S)[\delta_B V_S(g) + (1-\delta_B)V_S(b) - I_S] + (1-\gamma)(1 - t_L)(C_B - I_B). \qquad (11)$$

3. Equilibrium

We will now characterize the equilibrium project horizons chosen by firms in this game. The equilibrium concept we use is based on the sequential equilibrium of Kreps and Wilson (1982). An equilibrium in our model consists of project choices by firm managers and beliefs formed by outsider investors in response to these choices such that: (a) Firms' project horizon choices maximize the insiders' objective, given the equilibrium beliefs of outside investors; (b) outsiders' beliefs are rational given the firms' equilibrium choice of project horizon, and are formed using Bayes' rule along the equilibrium path; and (c) outsiders' beliefs in response to out-of-equilibrium project choices by firms (insiders) are consistent with insiders' equilibrium strategies, and are such that they yield insiders a lower value of their objective compared to that they obtain in equilibrium.

Before characterizing the equilibrium involving myopic project selection, we will first discuss the bench-mark case which obtains when any one of three important ingredients which are needed to generate corporate myopia is absent.

Lemma 1. There will be no corporate myopia in equilibrium, regardless of the relative magnitudes of t_L and t_S, if any one of the following three conditions are satisfied:

(a) There is no asymmetric information about project quality.

(b) Asymmetric information exists, but no insider divests his equity holdings in the firm at time 1 (i.e., $\gamma = 0$).

(c) Asymmetric information exists, but good short-term projects and good long-term projects are identical in terms of the pace of the resolution of information asymmetry (i.e., $\delta_{GS} = \delta_{GL}$, with $\theta_S = \theta_L$).

The intuition behind part (a) is that, if there is no asymmetric information, investors will value the firm's equity correctly even at time 1. This means that the value of the firm's equity at time 1 will *(a) Assume that the capital gains tax rate on both long-term and short-term projects are the same (i.e., $t_S = t_L$). Then, both types of managers will undertake the short term project in equilibrium if $\gamma > \gamma^*$, where*

$$\gamma^* = \frac{(C_{GL} - I_L) - (C_{GS} - I_S)}{[C_{GL} - \{\delta_{GL} V_L(g) + (1 - \delta_{GL}) V_L(b)\}] - [C_{GS} - \{\delta_{GS} V_S(g) + (1 - \delta_{GS}) V_S(b)\}]}. \quad (12)$$

If $\gamma \leq \gamma^*$, the long-term project will be undertaken in equilibrium.

(b) This equilibrium satisfies the Cho-Kreps refinement.[18]

If the extent of short-term trading by insiders in the firm's equity is greater than a certain value γ^*, the benefit of minimizing short-run mispricing by undertaking the short-term project overcomes the fact that the long-term project is intrinsically more valuable, so that the firm undertakes the short-term project. Equation (12) states that this minimum amount of short-term trading required to induce corporate myopia is given by the ratio of the difference in NPVs between the long-term and the short-term project to the difference in the extent of the expected mispricing (conditional on insiders' information) of the firm's equity between the case where the short-term project is chosen and that where the long-term project is chosen. If the resolution of information asymmetry is significantly faster for the short-term project than for the long-term project but the difference in their NPVs is not too large, then γ^* will be small, and a relatively small amount of short-horizon investors among the firm's equity holders will induce the firm to select the short-term project. If, at the other extreme, the difference in NPVs is large, but the

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[18]The Cho-Kreps argument was originally developed in the context of signaling games (see Cho and Kreps (1987)) and later extended to apply, with modifications, to extensive form games in general (see Cho (1987))). In our context, applying such a test consists of checking whether the good firm can make an out-of-equilibrium move, accompanied by the following speech (in essence) to outsiders: "You have to believe that I am a good firm, because you know that a bad firm could not possibly benefit from making such an out-of-equilibrium move (regardless of what you infer about my type from my making this move); only a truly good firm could possibly benefit from doing this." If there are out-of-equilibrium moves for which the above speech would be valid (and which would therefore allow the good firm to reveal its type credibly), the equilibrium fails this test of robustness, since the good firm may de-stabilize the equilibrium by attempting such a move.

tax rate so that, as long as $\gamma > \gamma^*$, corporate myopia will persist even at the lower capital gains tax rate.[19]

Another possibility is to cut the tax rate only on investors who hold equity in the firm for longer periods of time (i.e., till time 2 in our model). Proposition 3 examines the effectiveness of such a cut in long-term capital gains tax rates.

Proposition 3. (Optimal Long-term Capital Gains Tax Rate) *Assume that $\gamma > \gamma^*$, such that if $t_S = t_L$, only the short-term project would be undertaken. Then:*

(a) A differential tax rate for long-term capital gains, $t_L < t_L^*$, given by

$$t_L^* \equiv 1 - \frac{\gamma(1-t_S)[\{\delta_{GS}V_S(g) + (1-\delta_{GS})V_S(b) - I_S\} - \{\delta_{GL}V_L(g) + (1-\delta_{GL})V_L(b) - I_L\}]}{(1-\gamma)\{(C_{GL}-I_L) - (C_{GS}-I_S)\}}, \tag{13}$$

would induce both types of managers to choose the long-term project.

(b) $t_L^* < t_S$.

(c) The optimal long-term capital gains tax rate is decreasing in the extent of short-term investors in the firm, γ (i.e., $dt_L^*/d\gamma < 0$).

If the extent of short-horizon investors in the firm is larger than γ^*, only an added benefit to the long-term project in the form of cut in the long-term capital gains tax rate will induce the firm to choose the long-term project instead of the short-term project. t_L^* is the greatest value of the tax-rate on long-term capital gains at which the firm will undertake the long-term project in this setting. Equation (13) states that this critical tax-rate on long-term capital gains, t_L^*, is that rate which would equalize the after-tax

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[19]Of course, an across-the-board capital gains tax cut will lower the cost of capital, and may perhaps transform a long-term project which was previously a negative NPV project into a positive NPV project. Thus, such a tax cut would cause the firm to undertake more such long-term projects, and is therefore favored by those who argue that the cost of capital in the U.S. is somehow too high. However, this raises a question as to the "right" level of the cost of capital. Rather than enter into such a discussion, here we define myopia as a situation in which long-term projects and short-term projects compete with each other for scarce capital, and long-term projects which have a higher NPV at the prevailing discounting rate are rejected in favor of lower NPV short-term projects.

and the long-term project increases. Finally, for any given level of the other parameters, the myopia problem is more severe as the proportion of short-term trading γ is larger. Thus, the economic impact of a reduction in the long-term capital gains tax rate will be significant only in situations where there are a range of technologies available in the same industry, with the difference in value generated by the two technologies falling within a certain window (i.e., not too large or too small), with significant differences in the pace of the resolution of information asymmetry between the short-term and long-term technology, and a significant amount of short-term trading by stock holders.

A natural question that now arises is whether a long-term capital gains tax cut, aimed at combatting corporate myopia, may in fact create a bias toward *inefficient* long-term projects if the assumption that long-term projects are intrinsically more valuable than short-term projects is incorrect. The next proposition demonstrates that, even in this case, no distortions are generated by a cut in long-term capital gains tax rates.

Proposition 4. (Absence of Distortions) Let $\gamma > \gamma^*$, and let the long-term capital gains tax rate be reduced to t_L^* (as specified under proposition 3) in order to cure corporate myopia. Assume now that the magnitude of project cash flows from good short-term projects available [illegible]ms changes to C'_{GS}, while the magnitude of cash flows from good long-term as well as those from [illegible] projects remain unchanged, such that:

$$C'_{GS} - I_S > C_{GL} - I_L > C_B - I_B \tag{14}$$

(i.e., the short-term projects available to good firms now have greater net present values than the long-term projects available). Firms will then undertake short-term projects in equilibrium.

Proposition 4 demonstrates an important advantage of a long-term capital gains tax cut over alternative ways of correcting myopic corporate behavior that provide incentives to behave in the "right" manner at the firm level (for instance, tax credits for longer term projects). A long-term capital gains tax-than (1). This is demonstrated in proposition 5.

Proposition 5. (Tax Credit for Long-Term Projects). Let $\gamma > \gamma^*$, and let the relationship between the net present values of the long-term and the short-term project be such that (14) is satisfied. Then, providing a tax-credit s^* leads to inefficient investment in the long-term project for parameter values satisfying:

$$\gamma\,[\delta_{GL} V_L(g) + (1-\delta_{GL}) V_L(b) - I_L(1-s^*)] + (1-\gamma)(C_{GL} - I_L(1-s^*)) > \gamma\,[\delta_{GS} V'_S(g) + (1-\delta_{GS}) V'_S(b) - I_S] + (1-\gamma)(C'_{GS} - I_S). \tag{16}$$

where $V'_S(g)$ and $V'_S(b)$ represent the time 1 market values of a short-term project satisfying (14), conditional on a good signal or a bad signal respectively.

While proposition 5 assumes a particular implementation of a long-term project tax credit, the intuition behind this result carries through for alternative implementations.[20] The idea here is that, unlike a differential capital gains tax cut, a long-term project tax credit rewards firms explicitly for undertaking long-term projects, and can therefore lead to investment distortions in situations where it is the short-term project which is intrinsically more valuable. (However, if the short-term project is so much better than the long-term project that the inequality (16) is reversed, then the firm would not inefficiently undertake the long-term project despite the incentive provided by the tax-credit to do so.)

Of course, the cost to the government from any cut in the capital-gains tax rate in order to "cure" corporate myopia is the potential loss in tax revenues. Proposition 6 studies the effect of a differential capital-gains tax cut on government tax revenues.

[20] Another way to provide such a direct incentive to firms undertaking long-term projects would be for the government to lower the capital gains tax for investors in such firms (so that they pay a rate lower than t_S regardless of the duration of their equity holding in the firm). It can be shown that this will also lead to inefficient investment in the long-term project in situations where assumption (1) is violated, and it is in fact the short-term project that is intrinsically more valuable.

might occur, for instance, because investors may try to confine their liquidity related sales of shares (as much as possible) to shares held for a period long enough to qualify for the favorable tax treatment. In this section, we will briefly examine how our results are modified if we allow for γ to fall as the long term capital gains tax rate t_L is reduced below the short term rate, t_S.

Proposition 7. Denote by γ_0 the value of γ for $t_L = t_S$ (with $\gamma_0 > \gamma^*$). Assume now that γ falls from this level γ_0 with any decline in t_L, so that $\gamma_\tau < 0$ (where $\tau \equiv t_S - t_L$), for all $\tau > 0$. The cut in the long-term capital gains tax rate required to eliminate corporate myopia will now be smaller than in the case where γ remains constant at γ_0 (i.e., if we denote by $\hat{t}_L$ the level to which the long-term capital gains rate has to be reduced to eliminate corporate myopia under the assumption that γ falls with t_L, then $\hat{t}_L > t_L^*$).

If the extent of short-term trading falls with the difference in long-term and short-term capital gains tax rates, there are now *two* ways in which such a long-term capital gains tax cut affects the firm's project choice. As before, the reduction in the long-term rate increases the magnitude of the advantage to the firm from undertaking the long-term project rather than the short-term project (arising from the higher after-tax value of the time 2 cash flow from the long-term project) relative to the disadvantage of doing so (arising from the greater after-tax expected loss due to the greater short-term mispricing of the firm's shares if the firm undertakes the long-term rather than the short-term project). If, in addition, the proportion of short-term trading falls with a long-term capital gain tax cut, then the number of shareholders who care about the short-term mispricing of the firm's equity also falls, so that only a smaller cut in the long-term capital gains tax rate is required (compared to the case where γ remains constant) to induce the firm to undertake the long-term project.

It should be noted all the results we derived earlier under the assumption of a constant γ go through even when γ is allowed to be a function of the difference between short-term and long-term capital gains tax rates (though the specifics of various functions and parametric restrictions will of course be altered). Thus, proposition 2, which demonstrates that an across-the-board tax cut will not eliminate projects are long-term (an example is perhaps the aircraft industry) but in industries where there are a wide variety of competing technologies available, with the resolution of uncertainty in the development of some (ultimately better) technologies occurring at a slower rate than in others. Thus, a targeted cut in the long-term capital gains tax rates for investors holding equity in firms in such industries will be useful in minimizing the effects of corporate myopia. Second, our analysis demonstrates that even in a situation with asymmetric information, firms where most investors hold equity for extended periods will not be motivated to make myopic corporate investment decisions. Thus, firm managers may be justified in trying to increase the proportion of share-holding by long-term investors ("relationship investing") in their firm (since long-term investors are less concerned with short-run mispricing of the firm's equity, and therefore would not exert pressure on firm management to favor short-term projects). Third, our model demonstrated that a long-term capital gains tax cut is not an unduly sensitive policy instrument, in the sense that it does not create a bias toward inefficient long-term projects in those cases where it is in fact short-term projects that are more valuable. Thus, at the very least, such a tax-cut does not do harm even when it is not particularly beneficial. Finally, our model demonstrates that implementing such a tax-cut may not necessarily be a significant revenue loser for the government: in fact, it may even enhance tax revenue in many situations where it is successful in lengthening corporate planning horizons.

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1 (we denote this equilibrium probability by $\pi(S)$), and the long-term project (L) with probability 0 (denote this probability by $\pi(L)$). Consistent with this equilibrium strategy, outsiders infer that any firm choosing a long-term project is of type G with probability 0 (denote the probability of the firm being of type G inferred by outsiders in response to observing a project choice of L by $\mu(L)$, and a project choice of S by $\mu(S)$). We refer to the pair (π, μ) consisting of the equilibrium strategy profile π and the equilibrium belief system μ as the equilibrium "assessment" (in general, all such pairs of strategy profiles and belief systems will be referred to as "assessments"). Now, to demonstrate that the consistency condition is satisfied, we only need to demonstrate that there is a sequence $(\pi_n, \mu_n)_{n=1}^{\infty}$ of assessments that converges to (π, μ) in Euclidean space, and has the properties that each strategy profile π_n is completely mixed, and that each belief system μ_n is derived from π_n using Bayes' Rule. This is demonstrated by considering the sequence of strategies $\pi_n(L) = 1/n$, $\pi_n(S) = 1 - 1/n$, for n = 1, 2, 3..... Then, using Bayes' Rule, $\mu_n(L) = (1/n)\theta_L / \{(1/n)\theta_L + (1/n)(1 - \theta_L)\} = \theta_L$, which yields $J_{GS} > J_{GL}$ and $J_{BS} > J_{BL}$ (using (4) to (7)), so that this sequence of assessments converges trivially to (π, μ). Since it is obvious that this equilibrium assessment (π, μ) is also sequentially rational (given that there is only one sub-game here), it constitutes a sequential equilibrium.

The proof that the equilibrium for the case where $\gamma \leq \gamma^*$, given [illegible]) $= 0$, $\mu(S) = 0\}$, also satisfies the consistency condition and is therefore a sequential equilibrium is analogous (the sequence of assessments supporting the equilibrium is now given by $\pi_n(S) = 1/n$, $\pi_n(L) = 1 - 1/n$, for n = 1, 2, 3, ...).

We now demonstrate that the above equilibrium satisfies the Cho-Kreps refinement. To accomplish this, we only need to demonstrate that there is no out-of-equilibrium move that either type of firm can make which *simultaneously* satisfies the following two conditions (Cho (1987)): (i) If player I (the firm) is of type G, and if his making the move convinces player II (outside investors) that he is of type G, he will be better off; (ii) If player I (the firm) is of type B, then irrespective of what player II (outside

$$\frac{dt_L^*}{d\gamma} = - \frac{(1-t_S)[\{\delta_{GS}V_S(g) + (1-\delta_{GS})V_S(b)-I_S\} - \{\delta_{GL}V_L(g) + (1 - \delta_{GL}V_L(b)-I_L\}]}{\{(C_{GL}-I_L)-(C_{GS}-I_S)\}(1-\gamma)^2}. \tag{A3}$$

$(1 - t_S) > 0$, and the denominator of (A3) is positive (since, by (1), the long term project has a larger net present value than the short-term project). Therefore, (A3) will be negative if and only if

$$\{\delta_{GS}V_S(g) + (1-\delta_{GS})V_S(b) - I_S\} - \{\delta_{GL}V_L(g) + (1-\delta_{GL})V_L(b)-I_L\} > 0. \tag{A4}$$

(A4) can be shown to hold using (12), and the fact that $\gamma^* < 1$ (recall that $\gamma > \gamma^*$ in this case, and $0 \leq \gamma \leq 1$), proving that $dt_L^*/d\gamma < 0$.

Proof of proposition 4. For the short-term project to be undertaken in this case, J'_{GS} should be greater than J_{GL} (we denote all values related to the short-term project under the new assumption (14) with a prime attached to the original notation, to indicate that we are using the altered values for the cash flows from short term projects). In other words, we need the inequality (A5) to hold:

$$\begin{aligned}\gamma(1-t_S)[\delta_{GS}\ V'_S(g) + (1-\delta_{GS})\,V'_S(b) - I_S] + (1-\gamma)(1-t_L^*)(C'_{GS} - I_S) > \\ \gamma(1-t_S)[\delta_{GL}V_L(g) + (1-\delta_{GL})V_L(b) - I_L] + (1-\gamma)(1-t_L^*)(C_{GL} - I_L).\end{aligned} \tag{A5}$$

Now, the first term on the left hand side of the inequality (A5) is greater than the first term on the right hand side, since

$$\{\delta_{GS}V'_S(g) + (1-\delta_{GS})V'_S(b) - I_S\} > \{\delta_{GL}V_L(g) + (1-\delta_{GL})V_L(b)-I_L\}. \tag{A6}$$

((A6) can be shown to hold using (A4), and the fact that, given (14) $V'_S(g) > V_S(g)$ and $V'_S(b) > V_S(b)$). The second term on the left hand side of (A5) is greater than the second term on the right hand side, using the assumption (14). Therefore the inequality (A5) holds, so that firms undertake short term projects in equilibrium.

Proof of Proposition 5. For $\gamma > \gamma^*$, the tax revenue collected by the government when $t_L = t_S$ (so that the short-term project is implemented) is given by $t_S\{\theta_S (C_{GS} - I_S) + (1 - \theta_S)(C_{BS} - I_B)\}$; on the other