Three Essays in Financial Economics

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to my family and my wife

Message to UPF

So Long, and Thanks for All the Fish.
– The message left by the dolphins when they departed Planet Earth just before it was demolished to make way for a hyperspatial express route, as described in The Hitchhiker's Guide to the Galaxy.

Acknowledgment

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Raša Karapandža, Barcelona, March 2009

Abstract

This thesis consists of three essays. The first essay, titled PROMISING FAILURE: Political and Company Rhetoric as a Determinant of Success establishes a negative relationship between the number of promises made by politicians and companies and their consequent performance. I show that firms that make sparing use of the future tense in their annual reports significantly outperform those that use it more. Similarly, in all of the U.S. presidential elections from 1960 through 2004, the candidate who made less use of the future tense during the televised debates won the popular vote. I show that the frequency of using future-tense sentences is strongly correlated with the frequency of making promises and that the latter can be modeled within a game-theoretic framework.

Keywords: *market efficiency, pricing anomalies, cheap talk*

The second essay, Valuing Mortgage Insurance Contracts in Emerging Market Economies, deals with application of real options for pricing of mortgage insurance contracts. We develop a new option-based method for the valuation of mortgage insurance contracts in closed form in an economy where agents are risk neutral. While the proposed valuation method is general and can be used in any market, it may be particularly useful in emerging market economies where other existing methods may be either inappropriate or are too difficult to implement because of the lack of a relevant data. It is the first paper to develop an option-pricing framework for pricing MI contracts in closed form. As a result, comparative static results can be obtained analytically instead of numerically, as is typically the case in the related literature. This is the first paper that quantifies the effects of legal inefficiency on the pricing of MI contracts and demonstrates that these effects can be quite significant and should be taken into account when pricing MI contracts.

Keywords: *mortgage insurance, default rate, prepayment rate, black-scholes formula*

The third essay is titled Consequences of increased longevity for wealth, fertility and population growth. We present, solve and numerically simulate a simple model that describes the consequences of increased longevity for fertility rates, population growth and the distribution of wealth in developed societies. We look at the consequences of the repeated use of life extension techniques and show that they represent a novel commodity whose introduction will profoundly influence key aspects of the economy and society in general. In particular, we uncover two phases within our simplified model, labeled as mortal and immortal.

Keywords: *wealth distribution, population growth, longevity*

Resum

Aquesta tesi consisteix de tres captols. El primer captol, titulat "PROMETENT FRACÀS: Retòrica Poltica i Empresatial com a Determinant de l'Èxit" estableix una relació negativa entre el número de promeses fetes per polítics i empreses i el seu consecutiu rendiment. Mostro que les empreses que fan poc ùs del temps futur en els seus informes annuals superen significativament aquelles que l'utilitzen més. De la mateixa manera, en totes les eleccions presidencials dels E.U.A. des del 1960 fins el 2004, el candidat que va fer un menor ús del futur durant els debats televisats va guanyar el vot popular. Mostro que la freqüència en que s'usa el futur a les frases està fortament correlacionat amb la freqüència de fer promeses i que aquesta última pot ser modelada en un marc de teoria de jocs.

Paraules clau: *eficiència de mercat, anomalies de preus, cheap talk*

El segon capítol, "Valorant Contractes d'Assegurança de la Hipoteca en Economies de Mercat Emergents, tracta de l'aplicació d'opcions reals per a posar preus a contractes d'assegurança de la hipoteca. Deselvolupem un nou mètode basat en opcions per a l'avaluació de contractes d'assegurança de la hipoteca en forma tancada en una economia en la qual els agents són neutrals

al risc. Mentre el mètode d'avaluació proposat és general i pot ser usat en qualsevol mercat, pot ser particularment útil en economies de mercat emergentsen les quals altres mètodes existents poden ser inapropiats o són massa difcils d'implementar degut a la manca de dades relevants. És el primer article que desenvolupa un marc de preu d'opcions per a posar preus a contractes d'assegurança de la hipoteca en forma tancada. D'aquesta manera podem obtenir resultats d'estàtiques comparatives de forma analítica en comptes de forma numèrica, com sol ser el cas en literatura relacionada. Aquest és el primer article que quantifica els efectes de la ineficiècia legal en el preu dels contractes d'assegurança de la hipoteca i demostra que aquest efectes poden ser significants i s'haurien de tenir en consideració alhora de posar preu en aquest tipus de contractes.

Paraules clau: *assegurança d'hipoteca, quota de morositat, quota de prepagament, fòrmula black-scholes.*

El tercer capítol es titula "Conseqüències de l'increment de la longevitat en la riquesa, fertilitat i el creixament de la poblaciò". Presentem, solucionem i simulem numèricament un model simple que descriu les conseqüències del creixement de la longetivitat per a la taxa de fertilitat, el creixement de la població i la distribució de riquesa en societats desevolupades. Veiem les conseqüències de l'ús repetit de tècniques d'extensió de la vida i mostrem que representen una nova matèria prima, la introducció de la qual influenciarà en gran mesura aspectes claus de l'economia i la societat en general. En particular, desvelem dues fases en el nostre model simplificat, que anomenem "mortal" i "immortal".

Paraules clau: *distribució de riquesa, creixement poblacional, longevitat*

Contents

Foreword

The first out of three essays that constitute this thesis is titled PROMISING FAILURE: Political and Company Rhetoric as a Determinant of Success. Whats a promise worth? At the start of Shakespeares Loves Labours Lost, four men swear to forgo all worldly pleasures and, in particular, sex. A group of French ladies quickly helps them to reconsider. One by one, the men break their promises. The tension between their oaths and the temptations offered by a group of attractive young women is responsible for much of the entertainment, and it allows us to gain insight into each mans character. That solemn oaths are not good predictors of future behavior has been noted throughout the ages by writers and philosophers alike. Jean-Jacques Rousseau argued that those who make promises keep few of them: He who is slowest in making a promise is most faithful in keeping it. In this paper, I ask if Shakespeares and Rousseaus instincts are true and whether we should trust those who make commitments for the future. In particular, I examine if the extensive use of promises about ones future actions predicts poor performance and/or failure. I explore this issue in two distinct areas: corporate financial success and the popular vote in U.S. presidential elections. By studying the language structure used in corporate reports, I show that the frequency of the verbs will, shall, and going to represents a good proxy for a frequency of promises in these reports. Therefore, I will interchangeably use the terms future tense and promises. It turns out that companies that use future tense less frequently in their reports systematically outperform companies that use future tense more often. This relationship is not restricted to financial markets; a similar pattern exists in the context of political rhetoric. The U.S. presidential candidates who consistently make more statements about the future tend to lose the subsequent popular vote. To the best of my knowledge, this is the first study connecting game-theoretic models of talk with a feature of real everyday language.

The second essay, Valuing Mortgage Insurance Contracts in Emerging Market Economies, deals with application of real options for pricing of mortgage insurance contracts. This essay was co-authored with Ashok Bardhan and Branko Uroševic and published in a slightly different form in *Journal of Real Estate Finance and Economics*, Volume 32, Issue 1, 2006. We develop a new option-based method for the valuation of mortgage insurance contracts in closed form in an economy where agents are risk neutral. While the proposed valuation method is general and can be used in any market, it may be particularly useful in emerging market economies where other existing methods may be either inappropriate or are too difficult to implement because of the lack of a relevant data. The main contributions of this essay are the following. It is the first paper to develop an option-pricing framework for pricing mortgage insurance contracts in closed form. As a result, the method can be readily implemented in various market settings. Also, comparative static results can be obtained analytically instead of numerically, as is typically the case in the related literature. It is also the first paper that quantifies the effects of legal inefficiency on the pricing of mortgage insurance contracts and demonstrates that these effects can be quite significant. In particular, in markets where legal inefficiencies are typically quite large, they have to be taken into account when pricing mortgage insurance contracts. Current crisis showed that banks suffer of a dramatic exposure to risk that comes from illiquidity of real estate markets. Repossession of a real estate by the bank does not necessarily mean that bank will be able to sell the real estate under reasonable conditions. The model presented in this essay can readily measure that risk.

The third essay is titled Consequences of increased longevity for wealth, fertility and population growth. This essay was co-authored with Antun Balaž and Aleksandar Bogojević and in a slightly different form published in *Physica A*, Volume 387, Issues 2-3, 2008. Constant lifespan is often taken as one of the assumptions in creating and analyzing economic models. In this essay we challenge this assumption by arguing that todays bio-medical research is uncovering the reasons why organisms live as long as they do. Through modern genetic engineering, the applications of this research are converging on the point of finding practical ways to extend life substantially (and possibly repeatedly) beyond current life expectancy. The uncovering of the so-called secret of life was one of the crowning achievements of the second half of the past century. The discovery of the structure of DNA by Crick and Watson, and the later successful translation of the DNA code into the language of proteins, fueled the continuing revolution in molecular biology and biotechnology. This revolution is now making it possible to tackle rationally the complementary question of why we die. For the first time we look at death from a fact-based scientific perspective. The picture that is emerging is quite unexpected. In our model we remove the paradigm of mortality. If there is even a slight chance that this paradigm gets brought down to its knees with scientific advances a great change will happen in the way how societies function. Therefore it is important to try to anticipate these changes. Successful modeling of these phenomena is not only of practical, but also of heuristic value. In the model I introduce a new and extremely sought-after commodity, allowing for the extension of life. In this essay I presents and solve a simple model dealing with the consequences of just such a novel commodity. I study the implications of possible long-term extensions of life for society and its economy. I model the dynamics of social and economic indicators of a society and investigate how the introduction of life extension will influence fertility rates, population growth and the distribution of wealth. The results presented here include conclusions that the population explosion is not a necessary consequence of the introduction of the life extension commodity, and I uncovers two phases within this simplified model, labeled as mortal and immortal that are endogenously generated by the model.

Chapter 1

PROMISING FAILURE:Political and Company Rhetoric as a Determinant of Success

1.1 Introduction

Whats a promise worth? At the start of Shakespeares Loves Labours Lost, four men swear to forgo all worldly pleasures and, in particular, sex. A group of French ladies quickly helps them to reconsider. One by one, the men break their promises. The tension between their oaths and the temptations offered by a group of attractive young women is responsible for much of the entertainment, and it allows us to gain insight into each mans character. That solemn oaths are not good predictors of future behavior has been noted throughout the ages by writers and philosophers alike. Jean-Jacques Rousseau argued that those who make promises keep few of them: *"He who is slowest in making a promise is most faithful in keeping it."*

In this paper, I ask if Shakespeares and Rousseaus instincts are true and whether we should trust those who make commitments for the future. In particular, I examine if the extensive use of promises about ones future actions predicts poor performance and/or failure. I explore this issue in two distinct areas: corporate financial success and the popular vote in U.S. presidential elections. By studying the language structure used in corporate reports, I show that the frequency of the verbs *will*, *shall*, and *going to* represents a good proxy for a frequency of promises in these reports. Therefore, I will interchangeably use the terms future tense and promises. It turns out that companies that use future tense less frequently in their reports systematically outperform companies that use future tense more often. This relationship is not restricted to financial markets; a similar pattern exists in the context of political rhetoric. The U.S. presidential candidates who consistently make more statements about the future tend to lose the subsequent popular vote. Both of these findings are consistent with theoretical predictions on the existence of equilibrium with inflated talk in the model of Kartik, Ottaviani, and Squintani (2007) (hereafter KOS), which is built on a classic "cheap talk" game (Crawford and Sobel 1982). To the best of my knowledge, this is the first study connecting game-theoretic models of talk with a feature of real everyday language.

The finance literature has recognized that quantitative data in corporate reports may be important for pricing (Fama and French 1993; Chan, Jegadeesh, and Lakonishok 1996; Sloan 1996; Franzoni and Marin 2006). The impact of language use on performance and price formation in financial markets has been studied previously. Tetlock, Saar-Tsechansky, and Macskassy (2007) showed that a fraction of negative words in company-specific news stories forecasts low earnings. Moreover, company earnings briefly under react to the information embedded in negative words. Similarly, Tetlock (2007) studied how the proportion of negative words in popular news columns on the stock market is incorporated into aggregate market valuation. The work of Antweiler and Frank (2004) is similar in spirit. The authors constructed an algorithm to assign a "bullish", "neutral", or "bearish" rating to more then 1.5 million messages posted at the Yahoo! Finance website about various companies and found that these messages not only help predict market volatility but also have a statistically significant effect on stock returns. These studies analyze the wording of messages about companies, or about stocks in general. In this paper, I show that companies that use the future tense (the words *will*, *shall*, and *going to*) in their annual reports less frequently outperform companies that use such words more frequently. The excess returns persist after controlling for such well-documented risk and anomaly factors as momentum, book to market, and size. The studied sample consists of 53,260 annual 10K reports of 9,767 companies for a period from 1993 to 2006. The size of the effect is large: 2% to 6% per year. This phenomenon is summarized in Figure 1.1a.

The influence of televised debates on the outcome of the U.S. presidential elections is generally recognized in the field of political science (Hellweg, Pfau, and Brydon 1992; Benoit and Wells 1996). Personality psychologists and political psychologists have tried to identify key words that mark a candidates personality (Simonton 1986, 1988, 2001; Kowert 1996; Rubenzer, Faschingbauer, and Ones 2000). Others extract information about candidates achievements by analyzing their speeches (Winter and Stewart 1977; McClelland 1985; Winter 1987). The level of optimism in the candidates speeches has also been proposed as a predictor of election outcome (Zullow et al. 1988). Even the level of complexity of a candidates grammatical constructs has been hypothesized to be a possible predictor of election success (Slatcher et al. 2006).

This paper continues and extends earlier work on the content analysis of political speeches. Namely, I document that, in every U.S. presidential contest from 1960 through 2004, the candidate who spoke more in the future tense during the presidential debates subsequently lost. These results are summarized in Figure 1.1b. The predictive power of future-tense usage also holds for the margin of defeat for the losing candidate: there is a negative correlation between the percentage of popular votes received by U.S. presidential candidates and the proportion of future-tense sentences they used in the debates.

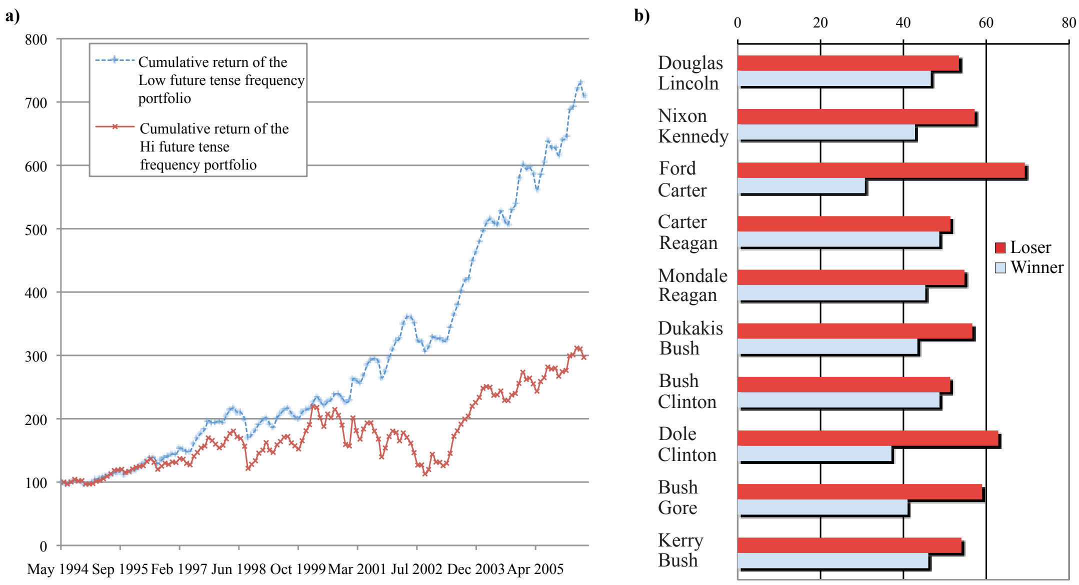

Figure 1.1: a) Cumulative returns of two portfolios. The lower performance portfolio is the equally weighted portfolio of the 10% of sample companies with the highest future-tense frequency in their reports; the higher performance portfolio is the equally weighted portfolio of the 10% of sample companies with the lowest future-tense frequency in their reports. The difference in performance cannot be explained away by standard risk factors. b) Candidates proportion of all promises made during the debates. Winners (resp. losers) correspond to candidates with the majority (resp. minority) of popular votes.

This relationship persists after controlling for the effects of incumbency, economic growth in the year prior to the elections, Gallup poll predictions, and aspects of a candidates physical appearance such as height and baldness. A number of parametric and nonparametric tests show that the winners of the popular vote used the future tense less frequently in their debates than did the losers. If we recognize that the frequency of future tense or promises is relevant as a predictor of performance, what accounts for it? Could this effect be modeled in a game-theoretic framework? In the baseline CS model, the informed Sender sends a message (e.g., the company publishes a report), in the form of a number that belongs to a closed interval, to a Receiver (e.g., an investor) with misaligned preferences about the state of the world. In the financial literature this message/number is usually an estimate of a price, return, or some balance-sheet item (Morgan and Stocken 2003). I take a similar approach by interpreting the frequency of future tense or promises as the message. Therefore, the more promises a company makes in its annul report, the higher is the message that its trying to send investors. After receiving the message, the Receiver in the CS model takes an action (e.g., the investor buys the company stock). This action could depend on the message, which in the original CS model affects the payoffs only indirectly. The Receiver is rational and aware of her conflict of interest with the Sender, so she takes an equilibrium action that is unbiased. Therefore, in a fully separating CS equilibrium, the senders message will fully reveal his private information. In the context of my empirical findings, the implication of the model is that no false message in a corporate report could deceive an investor and hence no company could be mispriced if the CS model depicts reality. However, this is not quite what I find empirically.

My empirical findings are closer to the predictions of the KOS model that extends CS as follows: communication may be to a pool of receivers (rather than to a single receiver); some of the receivers may be naive; and misreporting might be costly to the receiver. In the KOS model it turns out that the sender (companys management, in our case) induces a belief in naive receivers such that the average population (investors) response is in fact the “bliss point”, which is higher than the true state of nature. Moreover under broad conditions there exists a separating equilibrium in which the meaning of the message is inflated-that is, higher than the true state. These results stand even though sophisticated receivers correctly infer the state of the world in equilibrium and even when there is a conflict of interest. As applied to the corporate report results, this implies that some companies might be overpriced owing to the inflated talk of their management.

But how can we explain why some companies are more overpriced than others? Differences in the level of mispricing could be driven by the fact that-in the KOS equilibrium-as misreporting costs shrink, the degree of language inflation rises (Chen, Kartik, and Sobel 2008). If applied directly to the results here, this would imply that companies that sparingly use future tense have a lower cost of misrepresenting the facts than companies that use the future tense more liberally in their reports to investors. It turns out that this prediction of the model is confirmed by data. In my sample, the companies that less frequently use future-tense sentences in their reports tend to have significantly older CEOs and management with significantly longer tenure than do companies that use such sentences more often in their reports. Since both the age and tenure of executives are inversely related to their cost of being fired (e.g., for misrepresenting facts) (Bellante, and Green 2004; Becker 1993), this implies that management in companies that sparingly use the future tense faces a higher cost of misrepresenting facts than does management in companies that use the future tense more often.

The same model could be used to explain inflated talk in the U.S. presidential debates. However, the explanation may be even simpler. It could be that the number of promises is related to the expected election outcome. Talk is cheaper for politicians who expect to be defeated because they will not have to back up their words with actions. This is consistent with the KOS model, where the magnitude of misreporting costs reduces the equilibrium level of language inflation; hence candidates that expect to lose an election will make more promises.

In order to test further whether frequency of future-tense usage matters, I design a simple controlled experiment and show that subjects significantly favor offers involving less future-tense wording in advertisements. This finding confirms the influence of future-tense frequency or promises on choice. These results are also consistent with KOS model, wherein some agents are rational and others are credulous, and it demonstrates that the proposed language quantification might be applied to yet another walk of life that is of interest to economists. This chapter is organized as follows.

- Section 1.2 describes a new pricing anomaly: Companies that sparingly use the future tense systematically outperform those that make more promises.
- Section 1.3 demonstrates that, in all of the U.S. presidential elections from 1960 through 2004, the candidate who made less use of the future tense during the debates won the popular vote.
- Section 1.4 argues that frequency of the future tense or promises is a language feature that can be modeled in game-theoretic framework. I also show that the described empirical findings can be explained by the signaling game of Kartik, Ottaviani, and Squintani (2006).
- Section 1.5 describes findings from a controlled experiment that further supports the hypothesis that frequency of the future tense is an important feature of language usage and that the described phenomenon pertain to various fields of interest to economists.
- Section 1.6 concludes.

1.2 Corporate Rhetoric and Performance

In this section I look at the frequency of future-tense usage in 10K corporate reports and its relation to the companies performance. I demonstrate that companies that make fewer promises systematically outperform those that make more promises. I also show, in the framework of conventional empirical asset pricing models, that the number of promises in companies annual reports does affect returns. In other words, the number of promises appears to reflect risks that investors care about but are missing in the standard empirical models. The U.S. federal securities laws require publicly traded companies to disclose information on an ongoing basis in the form of SEC filings. The domestic issuers (other than small business issuers) must submit annual reports on a Form 10K. The annual report on this form provides a comprehensive overview of the companys business and financial condition and includes audited financial statements. Laws that govern the filing of these reports do not require companies to reveal their future plans or their estimates of future events; companies need only to disclose relevant information that shaped the preceding fiscal year[1]. Nevertheless, companies do tend to talk about the future in their reports. To get an idea of how widespread the use of future tense is in company reports, note that in my sample (which consists of 53,476 annual 10K reports of 10,139 companies for the period 1993-2006) there were more than 15 million instances of the future tense being used in some way. On average, more than 20% of all sentences in a given report were written in some form of the future tense, with a median exceeding 12%. The searching algorithm I used counted occurrences of the verbs *will*, *shall*, or *going to*, since the future tense in English is always constructed with one of these auxiliary verbs. As a measure of the number of sentences I counted occurrences of the punctuation marks “. ”, “! ”, and “? ”. Out of the 15,923,185 future-tense auxiliary verbs I found, about 70% were *shall*, 29% were *will*, and less then 1% were *going to*. In financial reporting, *shall* is often used to express explicit obligation rather than intention, as in

[1] http://www.sec.gov/answers/form10k.htm

the case of legal requirements (e.g., *"The Board shall meet every Thursday"*). In 300 randomly chosen sentences that contained *shall*, the word was used in this "legal" context 294 times but was used only 6 times to express a promise. On the other hand, in 300 randomly chosen sentences that contained *will*, the word was used to express some kind of a promise 282 times; on 17 occasions *will* was used in a sentence that posed a question (and once *will* was actually a name). Moreover, in 60 out of 60 randomly chosen sentences that expressed a promise[2], the word *will* was used. For these reasons and for the sake of robustness, in all further analysis I use more then one measure of promises: the number of occurrences of *will*, denoted by *Nwill*; the number of *will* plus the number of *going to*, denoted by *Nwillgoing*; and the number of *will* plus the number of *going to* plus the number of *shall*, denoted by *Nfuture*.

To illustrate my hypothesized relationship between future-tense frequency and financial performance, let us first consider the following investment strategy. Every year, on the 1st of July reinvest your money in the equally weighted portfolio consisting of the 10% of sample companies with the lowest *Nwill* in reports that were submitted to the SEC from July of year $t-1$ until June of year t. If you had started with \$100 in the year 1994 and followed the described strategy until the year 2006, you would end up with \$708. In contrast, if you had instead invested in the 10% of sample companies with the highest future-tense frequency then you would end up with only \$298 (see Figure refchartsa). The $T-$test, with variance estimated using a GARCH(1,1) model, strongly supports the hypothesis ($p-$value< 0.0000) that, after 12 years, the returns on these two portfolios are different. Other parametric and nonparametric tests yield the same results. Choosing July as the portfolio formation date ensures that the accounting information for the preceding fiscal year is

[2]I select random paragraphs from randomly selected reports and read them until a first promise is reached. This might sound like a task that leaves the reader much freedom in judging whether some sentence is a promise or not, but the task is actually fairly simple: it turns out that companies make many promises and that they are easy to detect. Here, for example, is a typical sentence from the 2006 10-K report of Microsoft Corporation that contains promises: "Microsoft Windows Vista will include advances in security, digital media, user interfaces, and other areas that will enhance the user and developer experience."

available to the market (cf. Fama and French 1993). As suggested by Figure 1.2, this is a natural choice because by then most financial information is already available on the SECs website.

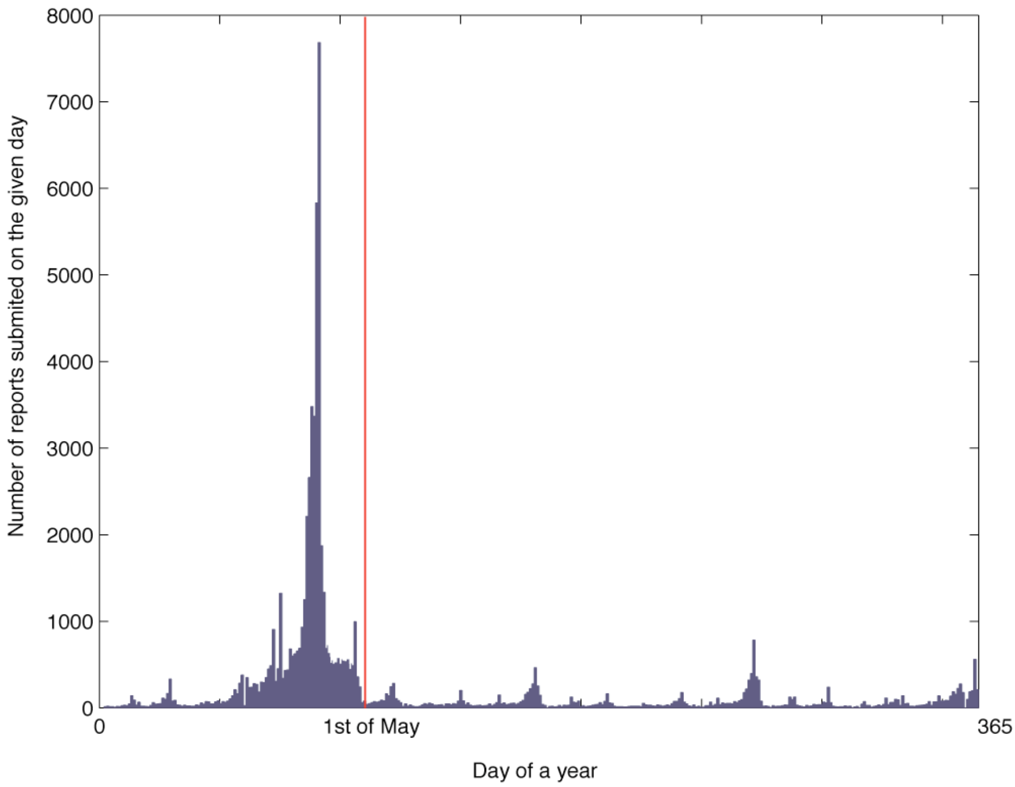

Figure 1.2: Frequency of report submissions for a given day of a year. The red line denotes the 1st of May. Sorting of portfolios is done in July, which ensures that information from the reports is available to the market.

However, the described methodology could be misleading. At least since the 1970s (Merton 1973a, 1973b), asset pricing has recognized that factors or sources of priced risk beyond movements in the market portfolio might be needed to explain why some average returns are higher than others. Among the factor models, the Fama-French model (Fama and French 1993, 1996) is one of the most popular and now guides much empirical research in the field (Cochrane 2005). Actually, the dominant model is one that includes three Fama-French factors in addition to the momentum factor (Jegadeesh and Titman 1993). To test whether the difference in returns between our two portfolios could be explained by different factor loadings, I run the standard time-series regressions of portfolio returns on different factors.

I create monthly portfolio return series by equally weighting the returns of the companies for the period from July of year t to June of year $t+1$ that have the lowest *Nwill*, *Nwillgoing*, and *Nfuture* in reports that were received by the SEC in the period from July of year $t-1$ to June of year t. Again, choosing July of year t as the portfolio formation date ensures that the accounting information for the fiscal year ending in year $t-1$ is available to the market (Fama and French 1993). Similarly, I observe a time series of returns of portfolios consisting of companies that frequently use the future tense. I take financial data from the CRSP database; the link between company identifiers in the SEC database and identifiers in CRSP is taken from the CRSP-COMPUSTAT merged WRDS database. For the sake of robustness I observe returns of portfolios made of the 10% of companies with the highest or lowest *Nwill*, *Nwillgoing*, and *Nfuture* in their reports. The portfolios are equally weighted, as suggested by Fama and French (2008). Also, I report results for three different specifications:

$$\begin{aligned}
r_{it} - r_{ft} &= \alpha + \beta_1\, EXM_t + \epsilon_t \\
r_{it} - r_{ft} &= \alpha + \beta_1\, EXM_t + \beta_2\, HML_t + \beta_3\, SMB_t + \epsilon_t \\
r_{it} - r_{ft} &= \alpha + \beta_1\, EXM_t + \beta_2\, HML_t + \beta_3\, SMB_t + \beta_4\, UMD_t + \epsilon_t
\end{aligned}$$

where $r_i - r_f$ is a portfolio excess return, EXM, HML and SMB are three Fama-French factors, and UMD is the momentum factor. The first specification is equivalent to testing against the CAPM, the second one is equivalent to testing against the Fama-French three-factor model, and the third one is equivalent to testing the hypothesis against the "Fama-French plus momentum" model. These models predict that alpha should be 0. A positive and significant alpha implies that a given portfolio systematically outperforms what theory predicts; a negative and significant alpha implies that the portfolio systematically underperforms.

It turns out that the intercepts for all portfolios made of companies with the lowest *Nwill*, *Nwillgoing*, and *Nfuture* and across all model specifications are positive and significant. The alphas for portfolios made of companies that use the highest number of *Nwill*, *Nwillgoing*, and *Nfuture* are not always significant, but whenever they are significant they are negative. The results are summarized in Table I. The presented results are not changed qualitatively if I remove from the sample all observations that have *Nwill*, *Nwillgoing*, and *Nfuture* more than five standard deviations away from their corresponding means.

TABLE I

Average Abnormal Returns for Portfolios Formed Using Sorts on Different Measures of Future-Tense Frequency in Corporate Reports: July 1994 to June 2006

This table reports the intercepts (alphas) and their corresponding *p*-values from monthly time-series regressions of *Hi* and *Low* portfolio excess returns on the CAPM, the three Fama–French factors, and the "Fama–French plus momentum" model. The *Hi* portfolio consists of the 10% of companies with the highest *Nwill, Nwillgoing,* and *Nfuture*; the *Low* portfolio consists of the 10% of companies with the lowest frequency of *Nwill, Nwillgoing,* and *Nfuture*. The searching algorithm I used counted occurrences of the verbs *will*, *shall*, or *going to* in 10K reports. *Nwill* denotes the number of occurrences of the verb *will* in a 10K report. Similarly, *Nwillgoing* denotes the number of verbs *will* plus the number of verbs *going to*. And *Nfuture* denotes the number of *will* plus the number of *going to* plus the number of *shall*.

In all of the regression involving the *Hi* portfolio, the intercept is positive and significant. In regressions involving *Low* portfolio, all significant intercepts are negative. This implies that companies that are sparing in their use of the future tense systematically outperform those that use future tense the most.

Average equally weighted monthly returns in percents	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	-0.15	0.68	-0.32	0.31	-0.10	0.46
Nwillgoing	-0.15	0.66	-0.03	0.29	0.09	0.44
Nfuture	0.05	0.60	-0.22	0.25	0.11	0.41
p-values for average equally weighted returns	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	0.074934	0.001581	0.078699	0.042359	0.055146	0.001996
Nwillgoing	0.062802	0.002156	0.057149	0.057409	0.578195	0.003311
Nfuture	0.842999	0.004663	0.255363	0.090949	0.428898	0.005001

For further robustness checks I split my time series in two samples: from 1994 to 2000 and from 2000 to 2006. It turns out that the same phenomenon is robust in both subsamples; see Table II and Table III.

TABLE II

Average Abnormal Returns for Portfolios Formed Using Sorts on Different Measures of Future-Tense Frequency in Corporate Reports: July 1994 to June 2000

This table is the same as Table I except that the period covered ranges from July 1994 to June 2000. It reports the intercepts (alphas) and their corresponding *p*-values from monthly time-series regressions of *Hi* and *Low* portfolio excess returns on the CAPM, the three Fama–French factors, and the "Fama–French plus momentum" model. The *Hi* portfolio consists of the 10% of companies with the highest *Nwill, Nwillgoing,* and *Nfuture*; the *Low* portfolio consists of the 10% of companies with the lowest frequency of *Nwill, Nwillgoing,* and *Nfuture*. The searching algorithm I used counted occurrences of the verbs *will*, *shall*, or *going to* in 10K reports. *Nwill* denotes the number of occurrences of the verb *will* in a 10K report. Similarly, *Nwillgoing* denotes the number of verbs *will* plus the number of verbs *going to*. And *Nfuture* denotes the number of *will* plus the number of *going to* plus the number of *shall*.

In all of the regression involving the *Hi* portfolio, the intercept is positive and significant. In regressions involving *Low* portfolio, all significant intercepts are negative. This implies that companies that are sparing in their use of the future tense systematically outperform those that use future tense the most.

Average equally weighted monthly returns in percents	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	-0.06	0.33	0.02	0.27	0.03	0.32
Nwillgoing	-0.10	0.28	-0.11	0.26	0.02	0.26
Nfuture	-0.08	0.29	0.12	0.11	-0.11	0.28
p-values for average equally weighted returns	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	0.078336	0.035789	0.734253	0.012499	0.863821	0.03752
Nwillgoing	0.134278	0.043432	0.634781	0.047343	0.690139	0.05431
Nfuture	0.229087	0.078532	0.555066	0.611203	0.615731	0.06238

TABLE III

Average Abnormal Returns for Portfolios Formed Using Sorts on Different Measures of Future-Tense Frequency in Corporate Reports: July 2000 to June 2006

This table is the same as Tables I and II except that the period covered ranges from July 2000 to June 2006. This table reports the intercepts (alphas) and their corresponding *p*-values from monthly time-series regressions of *Hi* and *Low* portfolio excess returns on the CAPM, the three Fama–French factors, and the "Fama–French plus momentum" model. The *Hi* portfolio consists of the 10% of companies with the highest *Nwill, Nwillgoing,* and *Nfuture*; the *Low* portfolio consists of the 10% of companies with the lowest frequency of *Nwill, Nwillgoing,* and *Nfuture*. The searching algorithm I used counted occurrences of the verbs *will*, *shall*, or *going to* in 10K reports. *Nwill* denotes the number of occurrences of the verb *will* in a 10K report. Similarly, *Nwillgoing* denotes the number of verbs *will* plus the number of verbs *going to*. And *Nfuture* denotes the number of *will* plus the number of *going to* plus the number of *shall*.

In all of the regression involving the *Hi* portfolio, the intercept is positive and significant. In regressions involving *Low* portfolio, all significant intercepts are negative. This implies that companies that are sparing in their use of the future tense systematically outperform those that use future tense the most.

Average equally weighted monthly returns in percents	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	-0.57	1.39	0.07	0.59	-0.08	0.59
Nwillgoing	-0.55	1.38	-0.06	0.58	0.07	0.58
Nfuture	-0.08	1.36	-0.18	0.65	-0.25	0.65
p-values for average equally weighted returns	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	0.207316	0.000009	0.855142	0.012499	0.765871	0.004754
Nwillgoing	0.220093	0.000014	0.871387	0.018143	0.790049	0.007459
Nfuture	0.023875	0.000006	0.555066	0.006112	0.212736	0.002037

In Fama and French (2008) the authors show that, when using time-series Fama-French regressions, it is important to check whether phenomenon is driven by the returns of very small companies ("microcaps"). From a practical perspective, if the extreme returns associated with an anomalous variable are unique to microcaps then such returns are probably not generally realizable owing to high trading costs. From a general economic perspective, it is important to know whether anomalous patterns of returns are market wide or are instead limited to illiquid stock representing a small portion of market. Microcap companies are not required to file with the SEC and so most likely do not even occur in my sample, but to be on the safe side I follow Fama and French (2008) and remove them: I define a cutoff point for a company to be considered a microcap as the 20th percentile of end-of-June market capitalization of NYSE stocks. It turns out that the anomaly discussed here survives the tests suggested by Fama and French (2008) and is present in both small and large companies. Results are summarized in Table IV.

TABLE IV

Average Abnormal Returns for Portfolios Formed Using Sorts on Different Measures of Future-Tense Frequency in Corporate Reports of Companies Excluding Microcap Companies: July 1994 to June 2006

This table is the same as Table I except that, as in Fama and French (2008), all microcap companies have been removed from the sample. These numbers show that my results are not driven by microcap companies. For the definition of microcap companies I follow Fama and French (2008): I define a cutoff point for a company to be considered a microcap as the 20th percentile of end-of-June market capitalization of NYSE stocks.

This table reports the intercepts (alphas) and their corresponding *p*-values from monthly time-series regressions of *Hi* and *Low* portfolio excess returns on the CAPM, the three Fama–French factors, and the "Fama–French plus momentum" model. The *Hi* portfolio consists of the 10% of companies with the highest *Nwill, Nwillgoing,* and *Nfuture*; the *Low* portfolio consists of the 10% of companies with the lowest frequency of *Nwill, Nwillgoing,* and *Nfuture*. The searching algorithm I used counted occurrences of the verbs *will*, *shall*, or *going to* in 10K reports. *Nwill* denotes the number of occurrences of the verb *will* in a 10K report. Similarly, *Nwillgoing* denotes the number of verbs *will* plus the number of verbs *going to*. And *Nfuture* denotes the number of *will* plus the number of *going to* plus the number of *shall*.

In all of the regression involving the *Hi* portfolio, the intercept is positive and significant. In regressions involving *Low* portfolio, all significant intercepts are negative. This implies that companies that are sparing in their use of the future tense systematically outperform those that use future tense the most.

Average equally weighted monthly returns in percents	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	0.01	0.64	-0.23	0.21	-0.11	0.34
Nwillgoing	0.01	0.62	-0.23	0.19	0.12	0.33
Nfuture	0.16	0.55	-0.15	0.14	0.14	0.26

p-values for average equally weighted returns	CAPM		Fama–French		Fama–French and Momentum	
	Hi	Low	Hi	Low	Hi	Low
Nwill	0.987930	0.001667	0.209424	0.050681	0.378540	0.010435
Nwillgoing	0.987335	0.002165	0.215954	0.144151	0.367156	0.011785
Nfuture	0.478872	0.007482	0.377103	0.305382	0.278073	0.046749

Observe that, as expected, alphas of portfolios formed by *Nfuture* sorts are in general slightly smaller than alphas of portfolios sorted by the number of *Nwill* and *Nwillgoing*. This finding is consistent with our hypothesis that sentences containing shall introduce some noise because that word is often used more to express a formal obligation than a promise. All this together suggests that companies using the future tense sparingly in their annual reports systematically outperform those that make more promises.

1.3 Political Rhetoric and Performance

How do we assess a politicians chances of becoming president? Many authors have argued that some measure of past economic performance should be taken into account[3]. Others argue that economic stability is the key factor[4]. Stigler (1973) concluded that fluctuation in unemployment is a key predictor of electoral success. Federal government spending per capita has also been used by some authors (Pelzman 1992). Even the number of U.S. military personnel killed has been used as a predictor of electoral outcomes (Hibbs 2000). In general, the success of these modeling exercises has been modest. This point is demonstrated by one of the best-known models of aggregate presidential voting, that of Fair (1978). Since 1978, Fair has updated his original model six times while trying to solve earlier problems that led to an inability to predict electoral outcomes (Fair 1982, 1988, 1990, 1996, 1998, 2006). His latest iteration[5] includes a set of three economic variables: the average growth rate of real per capita GDP in the first three quarters of the election year; the absolute value of the GDP deflator annual growth rate during the first 15 quarters of the administration; and the number of "good news" quarters during the term in which the annual growth rate of real GDP per capita exceeded 3.2%. Even models that use Gallup polls (see Beck 2000 for a review) are not too successful. The forecasting of the 2000 presidential election could serve as a lesson, since none of the authors of the 2000 American Political Science Association meeting forecast a Bush victory and many predicted victory for Al Gore by a comfortable margin (Lockerbie 2004).

Here I look at the frequency of future-tense usage by presidential candidates during televised debates and its relation to their performance in elections. I use popular vote after each debate as a measure of success and use the number

[3]The seminal contribution is by Kramer (1971). For a review of older contemporaneous literature see Peltzman (1990), and for a review of more recent contributions see Hibbs (2000).

[4]See for example Cameron (1978), Quinn and Woolley (1998), or Rodrik (1999).

[5]Fair 2006, http://fairmodel.econ.yale.edu

of verbs will, shall, and going to as a measure of future-tense usage. It turns out that, in all the U.S. presidential debates from 1960 through 2004[6], the candidate who made less use of the future tense won the popular vote, whether he was an incumbent or a challenger. Note that Al Gore failed to become president but actually won the popular vote, consistent with our prediction. Also, in the 2004 U.S. election, John Kerry said will or going to 176 times while George W. Bush did so 150 times.

The paired $t-$test of the null hypothesis - that the mean of the difference between the average number of future-tense constructs used by the winner and the loser is greater than 0, versus the alternative hypothesis that this difference is smaller than 0 - yields a $p-$value of 0.0019. The nonparametric Wilcoxon signed rank test gives a $p-$value of 0.0117. The one-sided sign test gives a $p-$value of 0.0039 and the two-sided version gives a $p-$value of 0.0078. All these tests suggest that the popular-vote winners use the future tense less than do the losers. In order to further explore the relationship between future-tense usage in the debates and the popular vote, I first investigate the following specification:

$$win_i = \alpha + b\ future_i + c\ incumbent_i + \sum_{j=1}^{8} d_{j,i}\ t\_dummy_{j,i} + u_i$$

Here i indexes candidates and j indexes elections. The dependent variable win_i takes a value of 1 if the candidate won the popular vote and 0 otherwise. The variable $future_i$ represents the percentage of total future-tense sentences used in a debate by both candidates. For instance, if candidate A used 10 future-tense sentences and candidate B used 30, then $future_A = 25\%$ and $future_B = 75\%$. The $incumbent_i$ is a dummy variable that takes a value of 1 if the candidate was an incumbent and 0 if he was a challenger. I include

[6] The transcripts were obtained from the website of the Commission on Presidential Debates (www.debates.org).

this variable since incumbents can use fewer future-tense words simply because they can talk about their deeds in the previous term. I include the full set of time dummies t_dummy_i, where the omitted category is the last debate. Here u_i represents the error term, and the number of observations is 18.

In a regression with robust standard errors (White 1980) I obtain $b = -0.046$ with a $p-$value of 0.007. All other coefficients are not significant. The $R^2 = 72\%$. Of these 72%, 13 percentage points can be attributed to the future-tense variable, while the remaining 58 percentage points can be attributed to all other variables. The negative and significant b tells us that there is a negative relationship between the probability of winning the popular vote and a candidates use of the future tense.

As a further check on the robustness of this relationship, I examine the following specification:

$$\begin{aligned} win_i &= \alpha + b\ future_i + c\ incumbent_i + \sum_{j=1}^{8} d_i\ time_i \\ &+ e\ incumbent_i \times gdpgrowth_{t-1} + f\ polls_i + g\ height_i + h\ bald_i + u_i \end{aligned}$$

The variables are unchanged from the previous specification, but now several have been added. One such is $incumbent_i \times gdpgrowth_{t-1}$, a variable that takes the value of real GDP per capita growth rate in the year prior to the election if the candidate is an incumbent and takes the value 0 if the candidate was a challenger. The variable $polls_i$ represents results of Gallup polls prior to elections for candidate i. I also add the variable $height_i$ (the candidates height) and the dummy variable $bald_i$, which takes a value of 1 if the candidate was bald and 0 otherwise. I include these two variables to control for the common myths that taller, nonbald candidates have a greater chance to win the popular vote. (Results do not change qualitatively if the baldness dummy is replaced by a dummy variable that takes a value of 1 for the candidate with more hair and 0 for the one with less hair.) In a regression with robust standard errors, I obtain $b = -0.071$ with $p-$value of 0.022. No other coefficients are significant.

Again, negative and significant b tells us that there is a negative relationship between the probability of winning the popular vote and future-tense usage.

Because the dependent variable is binary, a probit or logit model might be more appropriate than the linear probability model described so far. Since in every debate the eventual winner made less use of future tense than the loser, both probit and logit regressions should tell us that the future-tense variable predicts the outcome perfectly.

To exploit still unused variation, I also examine a setup with a different dependent variable: $\%\ votes_i$, which represents the percentage of votes won in elections by a given candidate. This variable by its nature is bounded-for example, a candidate cannot win more than 100% of the votes-so to overcome this I apply the standard logit transformation (McDowell 2001) of the variable such that:

$$\%\ votes\_transformed = log\left(\frac{\frac{\%\ votes}{100}}{1-\frac{\%\ votes}{100}}\right)$$

The specification is then:

$$\%\ votes\_transformed = \alpha + b\ future_i + c\ incumbent_i + \sum_{j=1}^{8} d_i\ time_i$$
$$+e\ incumbent_i \times gdpgrowth_{t-1} + f\ polls_i + u_i$$

As before, the variable $future_i$ represents the percentage of total future-tense sentences used in a debate by both candidates. The other variables are all as defined previously. In the regression with robust standard errors I obtain $b = -0.0036$ with a $p-$value of 0.049. The only other coefficient that is significant is the one for $polls_i$: with a $p-$value of less than 0.000; the $R^2 = 94\%$.

Constructing a different measure of the future-tense frequency (e.g., normalizing by number of sentences or using a raw count) does not qualitatively change any of the results presented here. In all of the mentioned and unmentioned specifications that I have run, the coefficient of the future-tense variable was negative and significant. I conclude that there is a negative relationship between the level of future-tense usage by a candidate during a debate and his subsequent performance in the election. Results from all regressions are summarized in Table V.

TABLE V

Summary of All Regressions

There is a negative correlation between the percentage of popular votes received by U.S. presidential candidates and the proportion of future-tense sentences that they used in the debates. This relationship persists in the linear probability model as well as in logit and probit models. The effect is robust to controlling for incumbency, economic growth in the year prior to elections, Gallup polls, and aspects of candidates' physical appearance (e.g., height and baldness). Parametric and nonparametric tests show that winners of the popular vote use less future tense in their debate talks than do losers. The sample consists of 18 U.S. presidential candidates; the elections covered are from 1960 (when the first U.S. presidential debate was televised) through 2004.

Model	Significant variables	Regression description	Decription of variables
$win_i = a + b \cdot future_i$	$b = -0.044$ p-value < 0.000	Linear regression with robust standard errors (White 1980). $R^2 = 65\%$	• i - Indexes candidates. • j - Indexes elections. • win_i - Takes a value of 1 if the candidate won election and 0 if he lost. • $\%\text{votes\_transformed} = \log\left(\frac{\frac{\%\text{votes}}{100}}{1-\frac{\%\text{votes}}{100}}\right)$ • $future_i$ - The percentage of total future tense sentences used in a debate by both candidates; e.g., if candidate A used 10 future-tense sentences and candidate B used 30, then $future_A = 25\%$ and $future_B = 75\%$. • $incumbent_i$ - Takes the value of 1 if the candidate was an incumbent and 0 if he was a challenger. • t_dummy_i - Time dummies, where the omitted category is the last debate. • $incumbent_i \times gdpgrowth_{t-1}$ - Takes the value of a real GDP per capita growth rate in a year prior to the election if the candidate was an incumbent and 0 if the candidate was a challenger. • $polls_i$ - The results of Gallup polls prior to elections . • $height_i$ - Height of the candidate $bald_i$ -Takes a value of 1 if the candidate was bald and 0 otherwise. • u_i - The error term.
$\%\text{votes\_transformed} = a + b \cdot future_i$	$b = -0.0087$ p-value < 0.036	Linear regression with robust standard errors (White 1980). $R^2 = 15\%$	
$win_i = a + b \cdot future_i + c \cdot incumbent_i + \sum_{j=1}^{8} d_{j,i} \cdot t\_dummy_{j,i} + u_i$	$b = -0.046$ p-value < 0.007	Linear regression with robust standard errors (White 1980). $R^2 = 72\%$	
$win_i = a + b \cdot future_i + c \cdot incumbent_i + \sum_{j=1}^{8} d_{j,i} \cdot t\_dummy_{j,i} \ldots$ $+ e \cdot incumbent_i \times gdpgrowth_{t-1} + f \cdot polls_i + g \cdot height_i + h \cdot bald_i + u_i$	$b = -0.071$ p-value < 0.022	Linear regression with robust standard errors (White 1980). $R^2 = 84\%$	
$\%\text{votes\_transformed} = a + b \cdot future_i + c \cdot incumbent_i + \sum_{j=1}^{8} d_{j,i} \cdot t\_dummy_{j,i}$ $+ e \cdot incumbent_i \times gdpgrowth_{t-1} + f \cdot polls_i + u_i$	$b = -0.0036$ p-value < 0.049 $f = 0.0264$ p-value < 0.000	Linear regression with robust standard errors (White 1980). $R^2 = 94\%$	

1.4 Future-Tense Frequency in a Game-Theoretic Framework

The goal of this section is to show that frequency of the future tense or promises is a measure that can be mapped into a game-theoretic framework.

Many economic, political, legal, and everyday activities involve one or more self-interested parties using communication to persuade uncommitted decision makers to take certain actions. Examples include travel agencies that publish advertisements, candidates that confront each others views in debates, and companies that issue corporate reports. Even flirting in bars could fit this description. From the theoretical perspective, direct communication has been well studied and can be classified into two approaches (Kartik 2008). The first approach was initiated by Grossman (1981) and Milgrom (1981) and assumes that information is verifiable and that agents cannot lie. Crawford and Sobel (1982) initiated the second approach, which assumes that agents can lie arbitrarily without cost; this is usually referred to as games of "cheap talk".

That both politicians and companies misrepresent information is common knowledge, so formal references are hardly necessary for this claim. However, here are two anecdotal examples: (i) "Read my lips: No new taxes"-spoken by presidential candidate George H. W. Bush at the 1988 Republican National Convention as he accepted the nomination; and (ii) "Microsoft Windows Vista will include advances in security, digital media, user interfaces, and other areas that will enhance the user and developer experience"-sentence from a 10K report that Microsoft submitted to the SEC. In fact, once he became president, Bush raised taxes (to help reduce the national budget deficit). And Windows Vista appeared on the market several years later then first scheduled yet still underperformed its predecessor, Windows XP[7]. For these reasons, models that cannot accommodate such misrepresentation are not appropriate.

[7]http://www.tomshardware.com/reviews/xp-vs-vista,1531.html

On the other hand, talk is not completely cheap. As noted by Kartik (2008), these are two extremes between which the true state generally lies: individuals often misrepresent information but bear some cost in doing so. Therefore, and because with almost no modifications it explains my empirical findings, I choose the model of Kartik, Ottaviani, and Squintani (2006) as a theoretical framework for further study. The KOS model builds on that of Crawford and Sobel (1982) and is a general model of communication between an informed sender and one or more uninformed agents. As discussed in Section 1.1, the main departure of KOS from CS is that the message affects the senders payoff directly.

In KOS the authors propose two possible sources of these costs. First, the sender may suffer a direct disutility from misreporting. Such costs could arise, for example, if there are penalties for detected misreporting or if, as suggested by experimental findings, people have an intrinsic aversion to lying (Gneezy 2005; Sanchez-Pages and Vorsatz 2006; Hurkens and Kartik 2008;). Second, the direct dependence of the senders utility can stem from the receivers being at least partially nonstrategic. As a consequence of this extension, Kartik, Ottaviani, and Squintani (2006) show that-in such a setting and under some broad conditions-there exists a separating equilibrium that features inflated communication: the message sent by sender has a meaning that is higher than the true state. The intuition behind these results is best illustrated by the following paragraph:

Suppose first that the Sender has lying costs that are increasing and convex in the magnitude of the lie. An inflated communication separating equilibrium exists, because even though the Sender can induce the sophisticated receiver to take a more favorable action by deviating to a higher message, this gain can be exactly offset by the marginal increase in the lying cost when the equilibrium message is already sufficiently inflated. On the other hand, suppose instead that there are no lying costs but that some receivers are wholly credulous, simply believing the literal message they receive. In the separating equilibrium, for any given state the message is so inflated that the credulous receivers are deceived to take an action that is even higher than the one that is ideal for the sender. Sophisticated receivers decode the message and take their preferred action, which is lower than the Senders ideal action. Thus, by deviating to a higher (lower) message, the sender gains trough the induced response from sophisticated (credulous) receivers, but is hurt by the undesirable response from credulous (sophisticated) receivers. By exactly offsetting these gains and losses a separating equilibrium is sustained. (Kartik, Ottaviani, and Squintani 2006, p. 96)

If I interpret the number of future-tense sentences in a report as a KOS-type message, then these results can be used to explain the pricing anomaly that I have detected. The more promises a company makes in their report, the higher is the message it is trying to send investors. From KOS it follows directly that companies that make more promises will be overpriced compared to those that make fewer promises. The heterogeneity of mispricing among companies can be explained by the fact that management has heterogeneous costs of misrepresenting because, in the KOS model, if misreporting costs shrink then in equilibrium language inflation grows (Kartik 2005). Indeed, it turns out that the sample companies that make the least use of future tense in their reports have significantly older CEOs and management (on average about 4 years) with significantly longer tenure (about 3.5 years) than their counterparts in companies that make the most use of future tense in their reports. The paired $t-$test of the null hypothesis - that the mean of the difference between the average age of CEOs and management of companies that promise the least and those that promise the most is larger than 0, versus the alternative hypothesis that this difference is smaller than 0 - yielded a $p-$value of 0.003. The nonparametric Wilcoxon signed rank test gives a $p-$value of 0.023. The same qualitative results are obtained for the average difference in tenure.

The intuition behind this relationship is that, as a manager works in a company and develops company-specific human capital, her salary increases (Becker 1993). Therefore, if laid off this manager stands to lose more than a manager who has been with the company for a shorter period of time. The relationship between age and costs of misrepresenting results from the risk aversion that accompanies age (Bellante, and Green 2004). Older managers are more risk averse; hence they prefer the smaller payoff for telling the truth and keeping their job (with probability p) to the higher payoff for misrepresenting and being fired (with probability $1 - p$).

In a similar way, frequency of the future tense or promises could be defined as a "message" in other models where communication has previously been abstracted to a one-dimensional utterance.

1.4.1 Yet Another Game-Theoretical Model

Goal of this section is not to create a general theory of debates, persuasion or advertising or to creat yet another game-theoretical model. The only purpose of this section is to demonstrate that the phenomenon described in previous sections can be expected as an outcome of a rational or quasi rational behavior. Or in other words that there is a rationale to claim that previously described empirical findings are really driven by the same phenomenon. Morover the goal of this section is to show that the future tense frequency is indeed a feature of everyday language that can be modeled in a wide class of game-theoretical models.

Consider e.g. the problem that some imaginary Miss Jones is facing when choosing a vacation. She has narrowed her choice to two options: *Sp* resort and *Pl* resort. The *Sp* resort is oriented toward sporty people with lot of sport facilities, trainers etc, while the *Pl* one is geared toward the pleasure with a lot of live performances, bars, food ... Miss Jones can be either quite indecisive (uninformed type)so that she does not really know what she wants, or she could be of type that she knows exactly what she wants (informed type). When approaching Miss Jones resorts' agents want to attract her. Since they had a lot of customers before Miss Jones they estimate how prone to sports/pleasure she is. Every resort has a different methodology when evaluating their customers so their estimation is asymmetric, but also noisy since it is very difficult to estimate such abstract things. When giving an offer agents make some promises about the sport and pleasure activities that Miss Jones will be able to choose from in their resorts. Promises range from the sporty ones, that are really easy and cheap for the *Sp* resort and expensive to organize for the the *Pl* resort, to the pleasurable ones that are cheap for the *Pl* and expensive for the *Sp* resort. After presenting their promises about the vacation Miss Jones needs to announce which activities she would like to do with a goal to minimize the distance between this announced activities and the one that suite her best. If some agent does not include in his offer the activities that Miss Jones announced he will not be the chosen one. If both of them in their offer include the activities that Miss Jones is asking for, Miss Jones will buy her package from one of the agents with the same probability. If Miss Jones is of informed type, she will announce exactly those activities that she wants. If on the other hand she is not sure which activities to choose she will try to infer that from the promises made by the agents that are experienced in evaluation of someone's preferences. Of coarse taking in to the account that agents are biased, and that agent *Sp* beside wanting to be the chosen one wants Miss Jones to include more sporty activities while the agent of the *Pl* resort wants her to include more pleasurable activities.

Let us be a little more formal. The game has three stages and there are three players: the agent *Sp*, the agent *Pl* and the buyer, in our case Miss Jones. There is a state space $S = [0, 1]$ with, we denote by s_i the i-th state.Every state of nature has a corresponding actual best activity[8] for Miss Jones, let us denote it by $o_i \in [0, 1]$. If Miss Jones is of the informed type she observes o_i, if she is of uninformed type she does not observe o_i. Both agents receive a signal about the orientation of the Miss Jone, about how sporty/pleasurable she is. Agent *Sp* receives a signal σ_i^{Sp}, and agent *Pl* receives the signal σ_i^{Pl}. These signals are intervals that are $\subseteq [0, 1]$ and such that $o_i \subseteq \sigma_i^{Sp} \bigcap \sigma_i^{Pl}$. Agents do not observe wether Miss Jones observes the set o_i.

*Stage*1: Nature performs a sequence of independent experiments in which it chooses a state in S, o_i and the composition of the sets of signals such that $\sigma_i^{Sp} \supseteq o_i$ and $\sigma_i^{Pl} \supseteq o_i$, and all possible intervals in $[0, 1]$ that satisfy this condition are drawn equally likely. So, by definition $o_i \in \sigma_i^{Sp} \bigcap \sigma_i^{Pl}$.

*Stage*2: The agents observe the realization of the signals in their respective sets implied by the true state s^*. The agent *Sp* observes the set σ_i^{Sp} similarly the agent *Pl* observes the signal σ_i^{Pl}. The agent *Sp* chooses and announces the set of promises $P^{Sp} \subseteq [0, 1]$. At the same time the agent *Pl* chooses and

[8]We could allow to Miss Jones to chose more then one activity and to have more then one activity that suits her best, this would not influence qualitatively our results.

announces the set $P^{Pl} \supseteq [0,1]$.

*Stage*3: Miss Jones observes P^{Sp}, P^{Pl}, maybe o_i and makes her announcement $o \in [0,1]$. The true state is then revealed and the players receive their payoff. The agent $Sp's$ expected payoffs are given by:

$$\begin{array}{rl} 0 & \text{if} \quad O \notin P^{Sp} \\ \frac{1}{2}(1-O) & \text{if} \quad O \in P^{Sp} \wedge O \in P^{Pl} = O \\ (1-O) & \text{if} \quad O \in P^{Sp} \wedge O \notin P^{Pl} \end{array}$$

First zero payoff is to cover the case if Miss Jones wants to enjoy some activity that agent Sp does not offer. In that case Miss Jones will not choose the offer of the agent Sp. Second payoff is weighted by $\frac{1}{2}$ since if both agents include in their offer the activity that Miss Jones is asking for that each agent will be chosen with the probability $\frac{1}{2}$. The third case is the case when the agent Sp offers what Miss Jones is asking for, but agent Pl fails to make that offer. Similarly, expected payoffs of the agent Pl are given by:

$$\begin{array}{rl} 0 & \text{if} \quad O \notin P^{Sp} \\ \frac{1}{2}O & \text{if} \quad O \in P^{Sp} \wedge O \in P^{Pl} = O \\ O & \text{if} \quad O \in P^{Sp} \wedge O \notin P^{Pl} \end{array}$$

Miss Jones receives:

$$-(O - o_i)^2$$

The Equilibrium

Since Nature's choice of the true state is unaffected by the actions of any player, the agent Sp will seek to minimize O. Lets assume that there are enough informed buyers so that agents will always make sure that $o_i \in P^{Sp}$ to avoid zero payoff. Similarly, agent Pl will seek to maximize O and in order to avoid the 0 payoff he will have to make sure that $o_i \in P^{Pl}$. On the other hand if Miss Jones is of informed type she will have an easy task, she will just announce what she really wants, or in other words, she will set $O = o_i$. If she is of uninformed type her task can be understood in the following way. Miss Jones is aware that both agents are biased, that Sp agent wants her to choose the sporty activities and Pl the one that are more pleasurable. On the other hand agents in order not to receive 0 payoffs from the informed buyers will always announce at least the truth. In other words agent Sp always sets $P^{Sp} \supseteq \sigma^{Sp}$ and agent Pl always promises $P^{Pl} \supseteq \sigma^{Pl}$. Then the problem of Miss Jones can be understood as:

$$\min_{O} \int_0^1 (O - o_i)^2 \mu(s_i, P^{Sp} \bigcap P^{Pl}) ds_i$$

Where $\mu(s, P^{Sp} \bigcap P^{Pl})$ is a probability that the realized state is s when agents Sp and Pl announce P^{Sp} and P^{Pl}, respectively. it would be more formally correct to write $\mu(s, P^{Sp}, P^{Pl})$ but Miss Jones knows that agents will tell at least the truth in order not to receive zero payoff.

The first conclusion that we can draw is that there is no equilibrium in which both agents tell only the truth. In other words there is no equilibrium in which agent Sp always sets $P^{Sp} = \sigma^{Sp}$ and agent Pl always promises $P^{Pl} = \sigma^{Pl}$. Suppose, for contradiction, that the equilibrium strategy is to always tell the whole truth and nothing but the truth. So let us assume that agent Sp receives signal $\sigma^{Sp} = (a, b)$. He knows that there is a non zero probability that agent Pl received the signal $\sigma^{Pl} = (a - \delta, b)$. Since the uninformed Miss Jones will infer about the true state from the $P^{Sp} \bigcap P^{Pl}$, agent Sp would obviously be better off by announcing $(0, b)$ instead of (a, b), since Miss Jones minimizes $\sum_i (O - o_i)^2 \mu(s_i, P^{Sp} \bigcap P^{Pl})$. To see that better observe that if agent Sp announces (a, b), $P^{Sp} \bigcap P^{Pl} = (a, b)$ on the other hand if he announces $(0, b)$ the $P^{Sp} \bigcap P^{Pl} = (a - \delta, b)$. Therefore the agent Sp will be strictly better off by announcing the $(0, b)$.

The second conclusion that we can draw is that equilibrium strategy profile for the agents will be given by:

$$\begin{array}{lll} \text{agent } Sp & \text{given the signal } \sigma^{Sp} = (a, b) & \text{anounces } P^{Sp} = (0, b) \\ \text{agent } Pl & \text{given the signal } \sigma^{Pl} = (c, d) & \text{anounces } P^{Pl} = (c, 1) \end{array}$$

Later we will refer to this strategy as a *promising* strategy. To show that this is really the case assume that agent Sp receives the signal (a, b), and agent Pl receives the signal (c, d). Agent Sp does not know what is the signal that agent Pl received, but he knows that he will announce at least the truth. Moreover he knows that agent Pl will never make a promise such that $(c - \epsilon, d)$ since by doing this he would decrease his expected payoff. On the other hand he might offer $(c, d + \xi)$. In any case agent Sp knows that when making an offer agent Pl will offer an interval that begins with c. Now, he does not have information about the value of c but he knows that it could be any number $\in [0, 1]$.Note that this number could also be $< a$. Since there is a non zero probability that agent Pl received a signal $\sigma^{Pl} = (0, d)$ strategy that will give the highest expected payoff to agent Sp is to announce $P^{Sp} = (0, b)$. Since the structure of the problem facing the player Sp is identical to the one just described, exactly the same argumentation can be used to show that it is optimal for the agent Pl to play the *promising* strategy.

Relationship between Yet Another Game-Theoretical Model and the Empirical Findings

Important conclusion that we can get from this model can be obtained by observing some special cases. First, let us assume that agents Sp, and Pl receive the signals $\left(\frac{1}{2}-\delta,\frac{1}{2}+\delta\right)$ and $\left(\frac{1}{2}-\xi,\frac{1}{2}+\xi\right)$, respectively. Where $\delta<\xi$. In this case agents will then set $P^{Sp}=\left(0,\frac{1}{2}+\delta\right)$ and $P^{Pl}=\left(\frac{1}{2}-\xi,1\right)$. Obviously, $\left(0,\frac{1}{2}+\delta\right)<\left(\frac{1}{2}-\xi,1\right)$. Interpretation of this result could be that given that agents have the same expectation about the preferences of the Miss Jones, the one that has more noise in his information will make more promises. It is even more interesting to observe the case where agents Sp, and Pl receive the signals $(\eta-\delta,\eta+\delta)$ and $(\xi-\delta,\xi+\delta)$, respectively. Where $\eta<\xi$. In this case agents will then set $P^{Sp}=(0,\eta+\delta)$ and $P^{Pl}=(\xi-\delta,1)$. Obviously, $(0,\eta+\delta)<(\xi-\delta,1)$. This result is even more interesting, since it implies that one that thinks that will have lower expected payoff will promise more.

These results can be applied, in a straightforward way, on the case of US presidential debates/elections. But can this model explain the pricing anomaly in our example with companies? To explain pricing anomaly model needs to be extended a little bit. If we assume that instead of agents selling the vacation to Miss Jones we have two companies trying to convince analyst/ what is the right approach regarding some issue important for functioning of the company. Now, in companies' reports, many of these topics are discussed, and company wants to convince analyst that in each of these cases analyst announces as the proper strategy the one "closer" to that company. But since reports are huge, analyst will enter only some of these "persuasion" games and will not discuss all aspects of the business that actually matters, but companies do not know which games analyst will play, and if they do not discuss the game that analyst finds important they get penalized. And this is where the pricing anomaly comes from. Since analyst will not assess all relevant topics his estimate of the success of the company will not be proper. And it will underprice the companies that in aggregate[9] promise less. It is easiest to see this if we consider the example of two companies identical in every aspect including the games that are played by analyst except one game that analyst does not observe. These two companies will receive the same grade by analyst. But if the game that was not played deals with the characteristic that is important for the future performance of a company the company that has promised less in this game will be underpriced. And since everything else is the same, company that made less promises in this game that was not played is the one that made less promises in total and that is the underpriced company.

[9]Here we consider the aggregate of all promises in in reports which are parts of different games.

1.5 The Influence of Future-Tense Frequency on Advertising Campaigns: Experimental Approach

Here I provide further evidence in favor of the hypothesis that "future-tense count" represents an important measure.

In a controlled experiment I split native English-speaking students in two groups: control and treated. In both groups, subjects choose between two vacation packages, one offered by agency A and the other by agency B. Each vacation package is presented by a single-paragraph advertisement. Advertisements were taken from the website of a real travel agency. For details see section 1.7.

The only difference between the control and treated group is that for the latter group some parts of agency Bs advertisement are rewritten using the future tense. So agency As advertisement for both groups and agency Bs advertisement for the control group were written in the past tense.

First, after reading the advertisements, subjects are asked to answer which vacation package they would buy and which advertisement they find more credible. Second, the advertisements are taken away and then subjects are asked which advertisement contains more future-tense sentences.

Results clearly show that subjects in the treated group chose the agency Bs package significantly less often than did the control group. Subjects in the treated group also considered agency Bs advertisement to be significantly less credible than did subjects in the control group. Finally, approximately 74% of subjects in the treated group were able to remember correctly which advertisement contained more future-tense sentences. See Figure 1.3 and Tables VI - VIII.

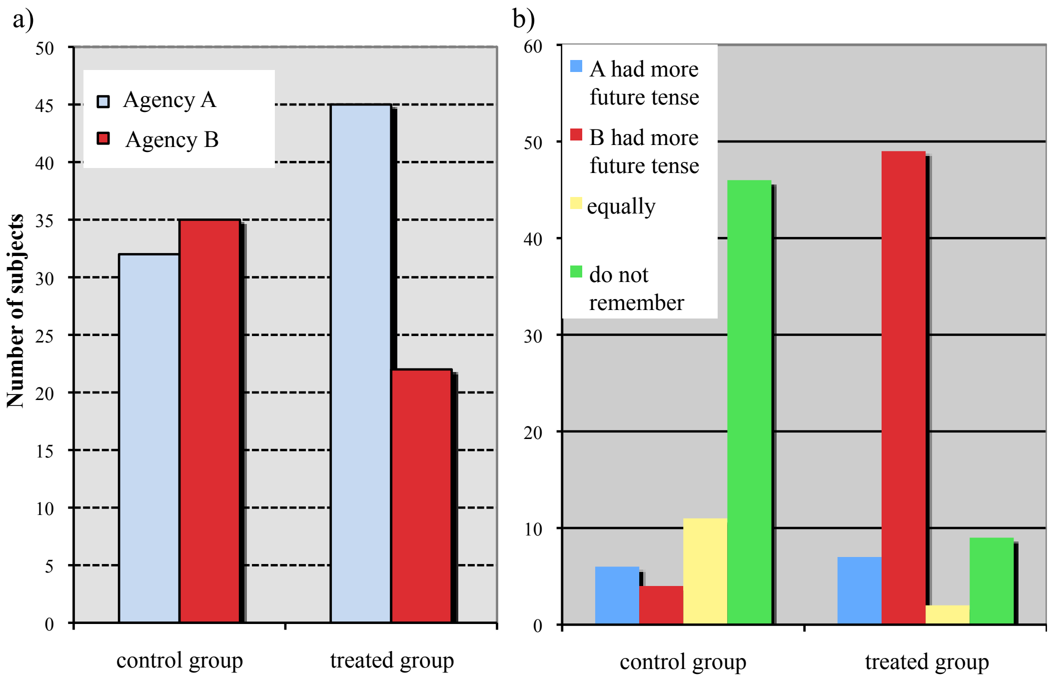

Figure 1.3: a) Testing the negative relationship between future tense usage and performance in an experimental environment. Results of the choice experiment showing the quantity of students in each group choosing one of two possible vacation offers. Each vacation package is presented by a single-paragraph advertisement. For the "treated" group, some parts of agency Bs advertisement were written using the future tense. A contingency table ?2 statistical test strongly rejects the null hypothesis that the probabilities for each outcome are independent of the treatment ($p-$value $= 0.023$). The Fisher exact test gives qualitatively similar results ($p-$value $= 0.018$). b) After returning the advertisements to the experimenters, subjects were asked to recall which advertisement contained more of the future tense. The only advertising text that contained any future tense was agency Bs offer to subjects in the treated group, and indeed 74% of those subjects gave the correct answer.

TABLE VI

Experimental Results: Effect of Advertising That Contains Future Tense

This table reports the results of an experiment. Native English-speaking students were split into a control group and a treated group. In both groups subjects chose between two vacation packages, one offered by agency A and the other package by agency B. Each vacation package is described by a single-paragraph advertisement. For the treated group, some parts of agency B's advertisement are written using the future tense. Subjects are asked *which vacation package they would buy?* The numbers in this table show the quantity of students in each group that have chosen one of three possible answers. The results of a contingency table χ^2 statistical test strongly rejects the null hypothesis that the probabilities for each outcome are independent of the treatment (p-value < 0.023). The Fisher exact test gives qualitatively similar results (p-value < 0.018).

	A	B
Control Group	32	35
Treated Group	45	22

TABLE VII

Experimental Results: Credibility of Advertising That Contains Future Tense

This table reports the results of an experiment. Native English speaking students are split in two groups control and treated one. In both groups subjects choose between two vacation packages, one package is offered by agency A and the other package is offered by agency B. Vacation packages are presented by a one paragraph advertisement each. The only difference between the control and treated group is that in the case of the treated group some parts of the advertisement of agency B are written using the future tense. The subjects are asked to answer **which advertisement they find more credible**. The numbers in this table show the quantity of students in each group that have chosen one of three possible answers. The results of a contingency table χ^2 statistical test strongly rejects the null hypothesis that the probabilities for each outcome are independent of the treatment $p-value < 0.083$. The Fisher Exact gives the qualitatively same results ($p-value < 0.060$).

	A	B
Control Group	32	33
Treated Group	43	24

TABLE VIII

Experimental Results: Recall of Future Tense in Advertising

This table reports the results of an experiment. Native English-speaking students were split into a control group and a treated group. In both groups subjects chose between two vacation packages, one offered by agency A and the other package by agency B. Each vacation package is described by a single-paragraph advertisement. For the treated group, some parts of agency B's advertisement are written using the future tense. Subjects are asked *which advertisement contained more future tense.* The numbers in this table show the quantity of students in each group that have chosen one of three possible answers.

	A	B	Equally	Do not remember
Control Group	6	4	11	46
Treated Group	7	49	2	9

1.6 Conclusion

Those who promise much achieve little. This paper shows that this is true in both politics and business. By examining the rhetoric of presidential debates, and the language of corporate reports, I demonstrate that firms which do poorly inflate their claims about the future. The same is true of contenders for the US presidency. I argue that the phenomenon can be explained in a simple game-theoretic setup in which talk is not entirely cheap.

Are managers aware of the promises they make in an annual report? A typical "Safe-Harbor Statement" indicates that they are:

> Safe-Harbor Statement: Under the Private Securities Litigation Reform Act of 1995. This press release may contain forward-looking information within the meaning of Section 21E of the Securities Exchange Act of 1934, as amended (the "Exchange Act"), including all statements that are not statements of historical fact regarding the intent, belief or current expectations of the Company, its directors or its officers with respect to, among other things: (i) the Companys financing plans; (ii) trends affecting the Companys financial condition or results of operations; (iii) the Companys growth strategy and operating strategy; and (iv) the declaration and payment of dividends. The words "may," "would," "will," "expect," "estimate," "anticipate," "believe," "intend," and similar expressions and variations thereof are intended to identify forward-looking statements. Investors are cautioned that any such forward-looking statements are not guarantees of future performance and involve risks and uncertainties, many of which are beyond the Companys ability to control, and that actual results may differ materially from those projected in the forward-looking statements as a result of various factors.

On the other hand, candidates and their staff recognize the importance of debates and try to control every aspect of the event (Schroeder 2001), from the sitting position of the spouses to the color of the banner hanging behind the podiums. Candidates spend weeks preparing themselves and making every attempt to prevent spontaneity. Even Reagans famous "There you go again"[10] was planned beforehand, as was vice-presidential candidate Lloyd Bentsens "Youre no Jack Kennedy." [11]

Can the lack of spontaneity of the U.S. presidential candidates and an awareness of the finding presented here-that promising much goes hand in hand with achieving little-result in a change of a language used in U.S. presidential debates? Can the awareness of these findings, coupled with the fact that every word is carefully chosen in corporate reports (as indicated by "Safe-Harbor Statements") lead to a different corporate rhetoric? If we believe in the predictions of the model of Kartik, Ottaviani, and Squintani (2006), then the inflated talk described here is optimal. Nevertheless, it is reasonable to assume that awareness of the phenomenon identified here could reduce the number of credulous investors and increase the costs of misrepresenting, thereby reducing the inflation of talk in equilibrium.

Future research might investigate whether the same effect can be found in other settings, as suggested by my experimental findings. For example, it would be interesting to know whether the use of future tense influences the success of advertising campaigns. Similarly, it could be that successful closing statements in jury trials do not refer to the future as extensively as do less successful ones. Finally, future research will be able to investigate if

[10]In this debate, when Carter accused Reagan of planning to cut Medicare, Reagan (who had previously complained that Carter was misrepresenting his stands on a number of issues) responded with the now-famous line: "There you go again."

[11]Statement made by Bentsen to Republican vice-presidential candidate Senator J. Danforth Quayle during the 1988 vice-presidential debate. Jack Kennedy was, of course, John F. Kennedy. Since then, the words "No Jack Kennedy" have become a part of the political lexicon as a way to insult a politician or other individual who thinks too highly of himself. The full quote is as follows: "Senator, I served with Jack Kennedy, I knew Jack Kennedy, Jack Kennedy was a friend of mine. Senator, you are no Jack Kennedy."

the findings from this study have resulted in a change in language in company reports and U.S. presidential debates.

1.7 Appendix

1.7.1 Text Presented to the *Control* Group

You have decided to spend a vacation in the Punta Cana (Caribbean). After few days of looking for a perfect vacation package you are still not able to make a decision which vacation package to choose. You have narrowed your choice to two alternatives: Alternative offered by agency A and one offered by agency B. Prices of the packages are same and both offerings are all inclusive for 7 days including transport.

This is what Agency A says about the package in their advertisement.

Along one of the most magnificent beaches of this Caribbean island with turquoise blue waters stretching to the horizon, Sunscape The Beach has offered to its guests a glorious setting for this spectacular full service resort. Guests of this brand new resort have enjoyed a “lazy river” swimming pool that meanders from the lobby down to the beach and is complete with waterfalls, a swim-up bar and themed restaurants and venues throughout. Nine 3-story buildings has provided intimacy and privacy yet easy access to all of the a la carte restaurants, lounges & bars, Spa & Fitness Center & the various sports, entertainment and activities facilities to the guests. Visitors have enjoyed outstanding scenery, tranquility and hospitality. Sunscape The Beach has been the perfect escape for many.

This is what Agency B says about the package in their advertisement.

We have a secret. Secrets Excellence Punta Cana that is. Secrets Excellence Punta Cana is a glorious full service resort. Our guests have considered the hotel as a perfect romantic getaway. Secrets is located far from crowds where our guests have been enjoying forest of seven thousand palm trees on a remote stretch of Punta Canas Caribbean beach. Our guests have peaceful but not dull vacation. Secrets Excellence guests have enjoyed different sport activities, live stage shows featuring Latin American dance and music, and a casino. Secrets Excellence has been providing to its guests the playground with two giant pools including swim-up bars and poolside meals under palapas. The world-class spa and fitness center have been giving to our guests an opportunity to keep up their workout schedules and pamper their bodies. Our customers have valued dining in seven different restaurants with cuisines from around the world, or enjoying a seaside candlelight dinner.

Please answer following questions:

1. Would you purchase vacation package from agency A or B?
   (a) A
   (b) B
   (c) Indifferent
2. Which advertisement do you find more credible A or B?
   (a) A
   (b) B
   (c) Equally

1.7.2 Text Presented to the *Treated* Group

You have decided to spend a vacation in the Punta Cana (Caribbean). After few days of looking for a perfect vacation package you are still not able to make a decision which vacation package to choose. You have narrowed your choice to two alternatives: Alternative offered by agency A and one offered by agency B. Prices of the packages are same and both offerings are all inclusive for 7 days including transport.

This is what Agency A says about the package in their advertisement.

Along one of the most magnificent beaches of this Caribbean island with turquoise blue waters stretching to the horizon, Sunscape The Beach has offered to its guests a glorious setting for this spectacular full service resort. Guests of this brand new resort have enjoyed a “lazy river” swimming pool that meanders from the lobby down to the beach and is complete with waterfalls, a swim-up bar and themed restaurants and venues throughout. Nine 3-story buildings has provided intimacy and privacy yet easy access to all of the a la carte restaurants, lounges & bars, Spa & Fitness Center & the various sports, entertainment and activities facilities to the guests. Visitors have enjoyed outstanding scenery, tranquility and hospitality. Sunscape The Beach has been the perfect escape for many.

This is what Agency B says about the package in their advertisement.

We have a secret. Secrets Excellence Punta Cana that is. Secrets Excellence Punta Cana is a glorious full service resort. Our guests will consider the hotel as a perfect romantic getaway. Secrets is located far from crowds where our guests will enjoy forest of seven thousand palm trees on a remote stretch of

Punta Canas Caribbean beach. Our guests will have peaceful but not dull vacation. Secrets Excellence guests will enjoy different sport activities, live stage shows featuring Latin American dance and music, and a casino. We will provide to our guests the playground with two giant pools including swim-up bars and poolside meals under palapas. The world-class spa and fitness center will give our guests an opportunity to keep up their workout schedules and pamper their body. Our customers will value dining in seven different restaurants with cuisines from around the world, or they will enjoy a seaside candlelight dinner.

Please answer following questions:

1. Would you purchase vacation package from agency A or B?
   (a) A
   (b) B
   (c) Indifferent
2. Which advertisement do you find more credible A or B?
   (a) A
   (b) B
   (c) Equally

   After answering to the first two questions, text with advertisements together with answers to first two questions is taken away form subjects and they are asked to answer one more question.
3. Which advertisement uses more future tense in its text?
   (a) A
   (b) B

(c) Approximately equal

(d) Don't remember

Chapter 2

Valuing Mortgage Insurance Contracts in Emerging Market Economies

2.1 Introduction

In the United States and other developed countries, mortgage insurance plays an important role in the functioning of the housing finance market since it reduces the risk exposure of lenders and facilitates the creation of secondary mortgage markets[1]. The need for similar risk-sharing mechanisms exists in emerging markets as well. In fact, in addition to unclear property rights and inefficient legal systems (Aruñada 2003), the absence of secondary mortgage markets has been identified as one of the key reasons for the relatively low level of development of the housing finance market in emerging markets[2].

In order to have a viable mortgage insurance (MI) scheme, it is necessary

[1]For a review of the mortgage insurance industry in the United States, see Canner and Passmore (1994), among others.

[2]See, for example, Jaffee and Renaud (1995), Jaffee and Renaud (1997), and Hardt and Lichtenberger (2001).

to know how to properly price MI contracts. The pricing of such contracts is a rather challenging task even when data are available (i.e., in developed countries). The task is all the more challenging in case of emerging markets, where, in the case of borrower default, the process of the repossession of loan collateral can last several years, and where data on housing and mortgage markets are either unavailable or of poor quality.

In this paper, we develop a new option pricing method that allows us to explicitly price MI contracts in closed form in an economy where agents are risk neutral. Importantly, the method is general enough so that it can be readily implemented in a variety of market settings, including emerging markets. The closest to our model is the actuarial pricing method proposed in Dennis et al. (1997) (DKY). We build upon it, significantly extending it in the process. Like DKY, we price an MI contract as the actuarially fair value of the contract, adjusted by the gross profit margin necessary for the operation of the mortgage insurance company. The actuarially fair value is determined as the sum of the present values of the expected loss for each year of the mortgage life. In turn, the expected loss, for any given year of the life of a mortgage, is equal to the expected loss in the case when the default occurs during that year (we refer to this as the severity of loss), weighted by the exogenously determined probability that the loss will occur during that year. Our model shares these features with DKY (and any other actuarial pricing model).

On the other hand, in our model the severity of loss is determined in a completely different fashion from DKY. In their model, the severity of loss is, simply, a constant fraction of the loan balance. In contrast, we take into account both the fact that the realized loss for the insurer in case of the borrowers default can be represented as a portfolio of put options on the borrowers collateral, as well as the fact that additional losses may occur from a delay in the repossession of the collateral by the lender, i.e., as a result of legal inefficiency. Assuming that agents in the economy are risk neutral, that the collateral value follows a geometric Brownian motion process and that a risk-free asset in the economy exists and has a constant return, we represent the severity of loss as a portfolio of standard Black-Scholes put option prices (Black and Scholes 1973). Identical results for the severity of loss are obtained if the assumption of risk neutrality of agents is relaxed and insurance contracts are assumed to be traded on the market.

Our paper contributes to the literature on MI pricing in the following ways:

- It is the first paper to develop an option-pricing framework for pricing MI contracts in closed form. As a result, the method can be readily implemented in various market settings. Also, comparative static results can be obtained analytically instead of numerically, as is typically the case in the related literature.
- It is the first paper that quantifies the effects of legal inefficiency on the pricing of MI contracts and demonstrates that these effects can be quite significant. In particular, in emerging markets where legal inefficiencies are typically quite large, they have to be taken into account when pricing MI contracts.
- We calibrate the model in case of Serbia, an emerging market that has recently initiated the creation of a government-backed mortgage insurance scheme and where the pricing of MI contracts presents challenges typical of many other emerging markets.

2.2 Literature Review

The related literature is extensive. Clauretie and Jameson (1990), Jackson and Kaserman (1980), and Swan (1982) review early literature on mortgage default insurance and the determinants of foreclosure. Kau et al. (1992, 1993, 1995), and Kau and Keenan (1995, 1999), among many others, develop backward pricing models in which mortgage insurance prices are obtained numerically as a by-product of the pricing of mortgages. In this literature there are typically two state variables: the interest rate and the collateral value process. Furthermore, prepayments and defaults are typically determined endogenously within the model. Despite their certain theoretical appeal, there are reasons why such models are a less-than-perfect choice for pricing MI contracts. On the one hand, the implementation of these models requires rather complex numerical procedures since no closed form expressions exist.

On the other hand, this complexity may not be warranted from the point of view of fitting the model to the data. Indeed, while it is far from clear how people really make decisions on default or prepayment [see Ambrose et al. (2001)], the existing empirical evidence (Deng et al. 2000) is inconsistent with the feature inherent in models with endogenous prepayment/default decisions, namely, that people always choose to default or prepay strategically.

In contrast to these models, in our model there is only one state variable, namely the collateral value. Not including the interest rate as a state variable is consistent with the empirical findings reported in Hendershott and Van Order (1987), Section 3 (and the literature cited therein), who provide evidence that mortgage insurance premiums are not very sensitive to interest rate volatility. In addition, the unconditional probabilities of default in our model are given exogenously, rather than determined endogenously. DKY and Schwartz and Torous (1992), among others, also model the unconditional probability of default exogenously.

Our model is well defined for arbitrary exogenously specified probabilities of default. One way of estimating these probabilities is by using actuarial mortgage default and prepayment experience or their proxies, if the appropriate data is unavailable (see Section 2.6.1 for more details). It is important to note that actuarial (historical) distributions, by construction, contain both strategic and non-strategic prepayment and default decisions by borrowers. Moreover, as long as past prepayment and default experience is a decent predictor of future prepayment and default experience (a reasonable assumption in stable economies), such an approach is guaranteed to work, i.e., on average, modeled unconditional probabilities of default would coincide with the observed ones[3].

[3]For more sophisticated models of empirical estimation of hazard rates see Schwartz and Torous (1992)

2.3 The Model for Pricing Mortgage Insurance Contracts

We consider an economy in which there is a risky asset whose price at time t is given by $V(t)$ (we refer to this asset as the collateral) as well as a risk-free asset with a constant continuously compounded annual return r.

There are three types of agents in the economy: the lender, the borrower, and the insurer. At time $t = 0$, i.e., at origination, the lender issues a $T-$year mortgage, secured by the collateral, for the amount of $B(0) = L_V V_0$. Here, L_V is the initial loan-to-value ratio and $V(0) = V_0$ is the initial value of the collateral. We assume that the mortgage loan has a fixed interest rate $c > r$ and that installments y are paid annually. With no prepayment or default prior to time t, the loan balance at time $0 \leqslant t \leqslant T$ is given by the following expression (equal to the value of an ordinary annuity with an annual payment equal to y and the discount rate equal to the contract rate c):

$$B(t) = \frac{y}{c}\left(1 - \frac{1}{(1+c)^{T-t}}\right) \tag{2.1}$$

At origination, also, the insurer writes a mortgage insurance contract that promises to compensate the lender in the case of the borrowers default. According to a typical MI contract [4], if a default occurs at time t, the insurer has to pay the lender the amount:

$$Loss(t) = max\left(0, min\left(B(t-1) - V(t), L_R B(t-1)\right)\right) \tag{2.2}$$

Mortgage insurance payoff diagram is presented in Figure 2.1.

Quantity L_R in equation 2.2 is called the loss ratio. This expression implies

[4] See, e.g., Kau et al. (1995), equation 19.

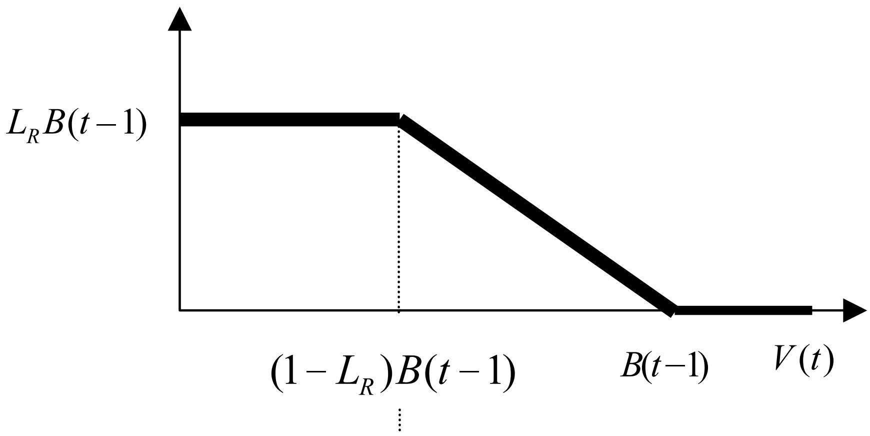

Figure 2.1: Mortgage insurance payoff as a function of the collateral value at the time of default $V(t)$.

that if the collateral value is greater than the remaining loan balance, after the collateral is sold and the lender compensated from the proceeds, the lender sustains no loss and, therefore, the loss to the insurer is zero. On the other hand, if the collateral value is not sufficient for a full repayment of the loan balance, the maximum loss to the insurer is equal to $LRB(t-1)$. Note that in equation 2.2 we assume, implicitly, that the repossession of the collateral by the lender happens instantaneously at the time of the default; we relax this assumption later (see Section 2.5).

In the literature, it is standard to model the value of the collateral as follows:

$$\begin{aligned} \frac{dV(t)}{V(t)} &= (\mu - s)\,dt + \sigma dz(t) \\ V(0) &= V_0 \end{aligned} \tag{2.3}$$

Here, the expected return on the collateral is equal to μ parameter s is the so-called maintenance yield while $\mu - s$ is the expected appreciation of the collateral value[5]. Parameters μ, s, and σ are assumed to be known scalar quantities and the stochastic process $z(t)$ is a Standard Brownian Motion. As a result, $V(t)$ is a Geometric Brownian Motion and, thus, its conditional distributions are log-normal. Calculating the severity of loss (see the next section) involves taking the unconditional expectation $E[\cdot]$ of the equation 2.2, and, in general, depends on the expected return μ. In order to avoid possible ambiguity related to market incompleteness, we assume, from now on, that the agents in the economy are risk neutral. In that case, pricing kernel is unique and $\mu = r$. (Note that identical results for the severity of loss given by equation 2.4 can be obtained without assuming the risk-neutrality of the agents but, instead, assuming that MI contracts are traded. In that case, equation 2.4 would involve the expectation with respect to the risk neutral probability measure (Hull 1999).

Finally, we assume that the unconditional probability of borrower default at time $t \in \mathbb{T} \equiv [1, 2, ..., T]$ is exogenously determined and set equal to $P_d(t)$, where $P_d(t)$ is a function that maps the set of integers $\mathbb{T}$ into the set of positive real numbers such that $0 < P_d(t) < 1$ for all $t \in \mathbb{T}$, and $\sum_{t=1}^{T} P_d(t) = 1$. Now we are ready to state the main results of the paper.

[5] see the discussion in Kau et al. (1995) after equation 1, for a justification of equation 2.3

2.4 The main results

Using the equations 2.2 and 2.3, the present value of the severity of loss, i.e., the expected loss to the insurer conditional on default happening at time $t \in T$ and discounted back to the present time, is given by the following expression:

$$\begin{aligned} CL(t) &\equiv e^{-rt}E\left[Loss(t)\right] \\ &= e^{-rt}E\left[max\left(K_1 - V(t), 0\right)\right] - e^{-rt}E\left[max\left(K_2 - V(t), 0\right)\right] \\ K_1 &= B(t-1), K_2 = (1 - L_R)B(t-1) \end{aligned} \tag{2.4}$$

The second equality in equation 2.4 stems from the following identity, valid for all realizations of the collateral value $V(t)$:

$$\begin{aligned} &max\left(0, min\left(B(t-1) - V(t), L_R B(t-1)\right)\right) \\ &\equiv max\left(K_1 - V(t), 0\right) - max\left(K_2 - V(t), 0\right) \end{aligned}$$

Equation 2.4 implies that the present value of the severity of loss, given a default at time $t \in \mathbb{T}$, can be represented as the value of a portfolio of two put options: a long position in a European put option with a strike price K_1 and a short position in a European put option with a strike price K_2, both with the time to maturity equal to the time to default t. The underlying asset for both of these options is the collateral value. Given the assumptions of the previous section, the expectation in equation 2.4 can be represented, for all $t \in \mathbb{T}$, using the standard pricing results for European put options with constant dividend yields (e.g. Hull 1999):

$$
\begin{aligned}
CL\left(t\right) &\equiv Put\left(K_1,t\right)-Put\left(K_2,t\right)\\
Put\left(K_i,t\right) &= K_ie^{-rt}N\left(-d_2\left(K_i\right)\right)-V_0e^{-st}N\left(-d_1\left(K_i\right)\right),\ i=1,2 \qquad (2.5)\\
d_1\left(K_i\right) &= \frac{ln\left(\frac{V_0}{K_i}\right)+\left(r-s+\frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}, d_2\left(K_i\right)=d_1\left(K_i\right)-\sigma\sqrt{t},\ i=1,2
\end{aligned}
$$

Since, by assumption, the unconditional probability of defaulting at time $t\in\mathbb{T}$ does not depend on the value of the collateral and is equal to $P_d(t)$ the actuarially fair price (AFP) of the MI contract is given by the following expression:

$$AFP=\sum_{t=1}^{T}P_d\left(t\right)CL\left(t\right) \qquad (2.6)$$

Equation 2.6 is the present value of the accumulated expected loss. Note that this expression is valid for an arbitrary set of exogenous probabilities of default. Setting the value of the collateral to zero and selecting the probabilities of default as in DKY. Equation 2.6 implies DKY, equation 4. Thus, the results of DKY are subsumed in our model as a special case.

2.5 The cost of legal inefficiency

The time to repossession of the collateral in the case of the borrowers default is a measure of the inefficiency of the legal system. Thus far we have implicitly assumed that, at the moment when default is declared, the transfer from the borrower to the lender and/or sale of the collateral is instantaneous. In practice, of course, this is never the case. The average time required for the repossession of the collateral in case of a borrowers default varies from country to country and, within the United States, from state to state. For example, in Spain the average time to repossession is around 3 years, while in Denmark, on the other hand, it is only 6 months.

Suppose, as before, that the loan balance at the time of default $t \in \mathbb{T}$ is equal to $B(t-1)$. If a default occurs, the lender starts up the repossession procedure. Suppose, for simplicity, that the time to repossession is constant and equal to t (the case of a time-varying or stochastic time to repossession can be analyzed similarly, but the formulas are more complicated). During that time, the lender faces the opportunity cost of lending the amount $B(t-1)$ to another borrower (at the interest equal to c). Normally, the insurer has to compensate the lender for the losses thus accumulated (if any). In our case, for the loss incurred at time $t \in \mathbb{T}$ the insurer would have to pay to the lender, at time $t+\tau$, the amount equal to:

$$\begin{aligned} Loss\,(t+\tau) &= max\left(K_1^l - V\,(t+\tau)\,,0\right) - max\left(K_2^l - V\,(t+\tau)\,,0\right) \\ K_1^l &\equiv (1+c)^\tau B\,(t-1)\,,\ K_2^l = (1-L_R)\,(1+c)^\tau B\,(t-1) \end{aligned} \quad (2.7)$$

Notice that equation 2.7 coincides with equation 2.2 if there is no delay in repossession, i.e., if $\tau = 0$. On the other hand, this loss is partially offset by gains that the insurer obtains by postponing the payment of the claim for the period of time t. Such gain is equal to (we assume that the insurer can invest in the risk-free asset only):

$$Gain\,(t+\tau) = e^{r\tau} \cdot Loss\,(t) \tag{2.8}$$

where the expression for $Loss\,(t)$ is given by equation 2.2. Both equations 2.7 and 2.8 are expressed in terms of money at the point in time $t+\tau$, i.e., at the moment in time when the court proceedings end.

The net loss from legal inefficiency is obtained by subtracting expression 2.8 from expression 2.7. If a default occurred at time $t \in \mathbb{T}$ the present value of the expected net (additional) loss resulting from legal inefficiency is given by the following expression:

$$\begin{aligned} LCL\,(t) &= e^{-r(t+\tau)}E\left[Loss\,(t+\tau)\right] - e^{-r(t+\tau)}E\left[Gain\,(t+\tau)\right] \\ &= \left[Put\left(K_1^l, t+\tau\right) - Put\left(K_2^l, t+\tau\right)\right] - \left[Put\,(K_1, t) - Put\,(K_2, t)\right] \end{aligned} \tag{2.9}$$

The present value of the net expected loss is zero if $\tau = 0$, i.e., if there is no delay in repossession of the collateral. Note, also, that the expression in the second bracket in expression 2.9 coincides with expression 2.5. Since the present value of the expected loss when there is legal inefficiency is equal to the present value of the expected loss when there is no inefficiency, expression 2.5, plus the net present value of the legal inefficiency loss, expression 2.9, it is equal to:

$$CL\,(t) = Put\left(K_1^l, t+\tau\right) - Put\left(K_2^l, t+\tau\right) \tag{2.10}$$

Substituting expression 2.10 into expression 2.6 we obtain the expression for the actuarially fair value of a MI contract when the cost of legal inefficiency is taken into the account. Finally, assuming that the gross profit margin that the insurer requires is equal to q and that the premium is collected upfront (see DKY for other ways of charging the premium), the MI premium is given by the expression: $Pm = (1 + q)\, AFP$.

2.6 Comparative Statics and Model Calibration

The actuarially fair price given by expressions 2.6 and 2.10 is a linear combination of Black and Scholes European put option prices with a constant dividend yield. Therefore, we can use the standard results on option "Greeks" to analyze the comparative statics for variables of interest (e.g. Hull 1999, Chapter 13). As a result, the comparative statics results are, in contrast to most of the previous literature, available analytically. One can easily convince oneself that the MI premium Pm increases, *ceteris paribus*, with an increase in volatility of the collateral, the probability of default, the mortgage contract rate (or, equivalently, mortgage installment payments), or the time delay in the repossession of the collateral. While the first three properties are quite intuitive, let us explain why the last one holds. First of all, an increase in τ increases the time to maturity, which makes both options in expression 2.10 more valuable. On the other hand, since a put option is always monotonically increasing in the strike price and the strike price of the first option is higher than the strike price of the second option and monotonically increasing in τ the difference between the two put options monotonically increases in τ, *ceteris paribus*. Along the same lines, one can show that an increase in the risk-free rate lowers the MI premium, *ceteris paribus*.

In this discussion we did not explicitly consider the unconditional probabilities of default, see equation 2.6. In fact, the comparative static results are robust with respect to reasonable assumptions about these probabilities. For example, since expression 2.10 increases in the value of the mortgage contract rate, the MI premium increases in the contract rate as long as the probabilities of default are not sharply decreasing in the contract rate (such a decrease would be both counterfactual as well as counterintuitive). Other cases can be treated similarly.

2.6.1 Calibrating the Model to the Serbian Market

In countries where mortgage markets have a long tradition, model calibration may be complex but is still relatively straightforward in principle. In case of Serbia, as well as in many other transitioning and developing countries, the lack of almost any relevant data, particularly those related to mortgage default and prepayment experience, makes this process a true challenge, much more of an art than a science.

Recently, a government-backed mortgage insurance company was created in Serbia (the Serbian Housing Corporation or SHC) with the aim of helping reduce excess lender risk exposure and facilitate the creation of a secondary mortgage market. There are significant dangers related to this measure. Namely, in an economy with an already large public sector, creation of a government-sponsored instead of a private mortgage insurance scheme looks like a step in the wrong direction. In addition, there are potentially large moral hazard problems related to cherry-picking of risks, as well as risks of political meddling in the loan selection process, in setting of the insurance rates and in management of the reserves. In order to at least partially protect the public against these risks, the law governing SHC operations explicitly defines several of the parameters that insured mortgages have to satisfy. In particular, the law sets the loss ratio to $L_R = 75\%$. This ensures that lenders share some of the risk with the insurer and, thus, reduces the potential moral hazard problem. In addition, the maximum loan-to-value ratio is set at $LTV = 70\%$, the duration of the mortgage contract is set at $T = 20$ years, while the allowed gross profit margin is set at $g = 10\%$. The law also requires the SHC to invest all proceeds from paid-in premiums into risk-free securities only. This rate is currently around $r = 5\%$. The typical contract rate of mortgages currently insured by the SHC is $c = 9\%$. The average size of the insured property is $V_0 = 50,000$ euros. Finally, while the initial optimistic scenarios put the expected time to repossession t at around 6 months (as in Denmark), we think it would be more realistic to expect a t of around 3 years (as in Spain).

In order to estimate the volatility of the collateral process given by expression 2.3, we use the only available source of data on residential real estate prices in Serbia. This data is provided by "KROV", a magazine published by the Association of Real Estate Agents of Serbia. Their recently upgraded dataset contains monthly data on the aggregate real estate transaction prices from 2000 to 2004 (we gratefully acknowledge their help in getting us the updated data). Based on that data, we estimate the historic annual volatility to be around $\sigma = 15\%$. Maintenance yield is set at $s = 1\%$, half the typical U.S. number (Kau et al. 1995). The rational for this choice is that in Serbia, as in many other emerging markets, properties are less maintained than in the developed world.

By far the most challenging (and the most arbitrary) task is the estimation of the unconditional probabilities of default. This is so because no relevant mortgage default and prepayment history for Serbia exists. Thus, we have to resort to the comparables method. Following DKY, for each $t \in \mathbb{T}$ we introduce the probabilities of defaulting and prepaying at time t, given that no prepayment or default occurred prior to that time. We denote these conditional probabilities by d_t and p_t, respectively. The probability of staying current, i.e., neither prepaying nor defaulting at time t, conditional on being current up to that date, is denoted as $\pi_t = 1 - d_t - c_t, t \in \mathbb{T}$. The unconditional probability of defaulting at time $t \in \mathbb{T}$ is given by the following expression:

$$P_d\left(t\right) = \pi_1 \pi_2 ... \pi_{t-1} d_t \tag{2.11}$$

To derive this expression, note that probability of defaulting at time $t \in \mathbb{T}$ is equal to the probability of defaulting at time $t \in \mathbb{T}$ conditional on not defaulting or prepaying at times up to t (which we denoted by d_t) times the unconditional probability of not defaulting or prepaying at times up to time t. In turn, the unconditional probability of not defaulting or prepaying at times up to time t is a product of a probability of not prepaying or defaulting at time $t-1$ conditional on not prepaying or defaulting at times up to time $t-1$

(we denoted this probability by π_{t-1}), times the unconditional probability of not prepaying or defaulting at times up to $t-1$. Continuing the recursive argument proves that expression 2.11 holds without loss of generality.

As our benchmark, we use the actuarial experience of the Federal Housing Administration (FHA) mortgage insurance scheme as reported in DKY[6] and adjust the scale of the default and prepayment curves to 20 years (instead of 30 years, as is the case in the U.S.). Next, we assume that the prepayment and default probabilities in Serbia are similar to the findings on Low Income - High Credit risk customers in the U.S. reported by Deng and Gabriel (2002). They find that the default probabilities for such customers are 3 times higher than the average FHA experience, while the prepayment probabilities are 5 times lower than the FHA average. The unconditional probabilities of default, $P_d(t)$, estimated for the case of Serbia, are presented in Figure 2.2.

For the base case values of the parameters, the MI premium is estimated to be 6.99% of the initial loan value. The importance of legal system inefficiency is illustrated in Figure 2.3. Note that if the average time to repossession of the collateral is decreased (increased) from the base case premium changes significantly. Clearly, models of the pricing of MI contracts in emerging markets cannot afford to ignore the cost of legal inefficiency (Figure 2.3).

[6]Their data is based on a study by Price Waterhouse (1997).

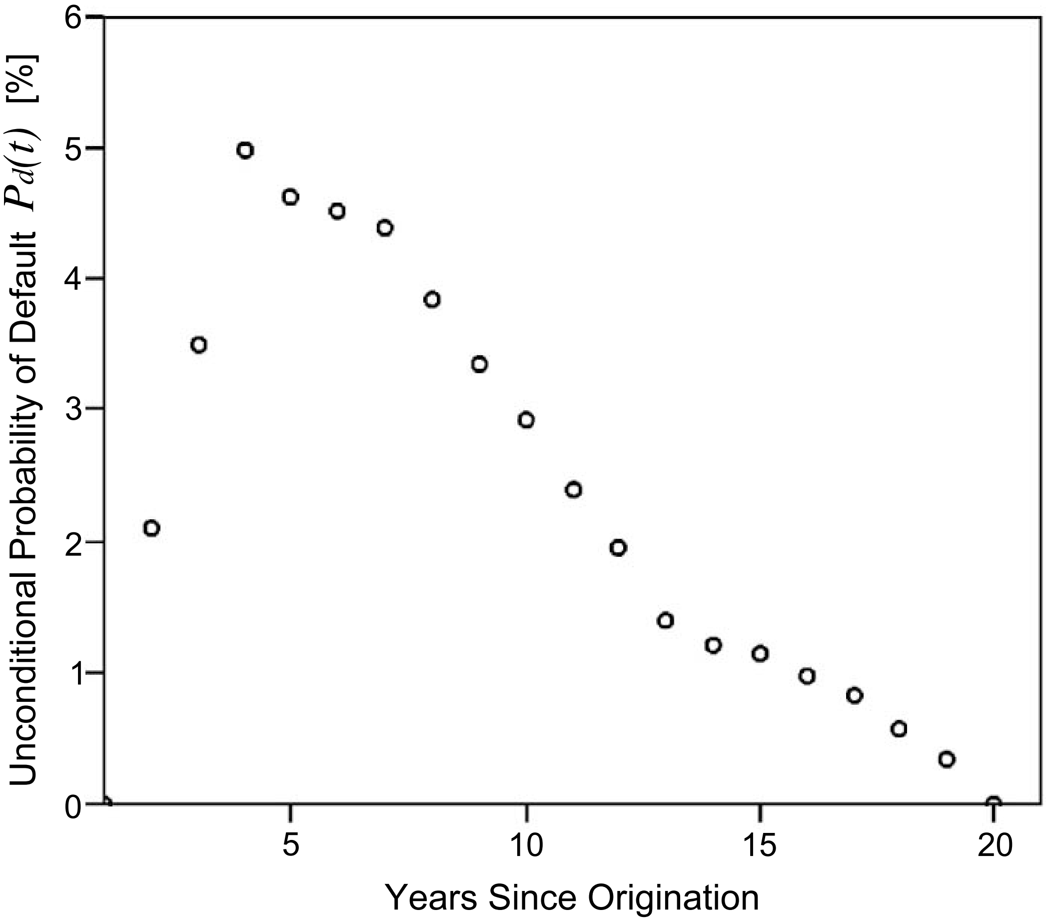

Figure 2.2: Unconditional probabilities of default estimated for a typical mortgage in Serbia, as a function of the number of years since origination.

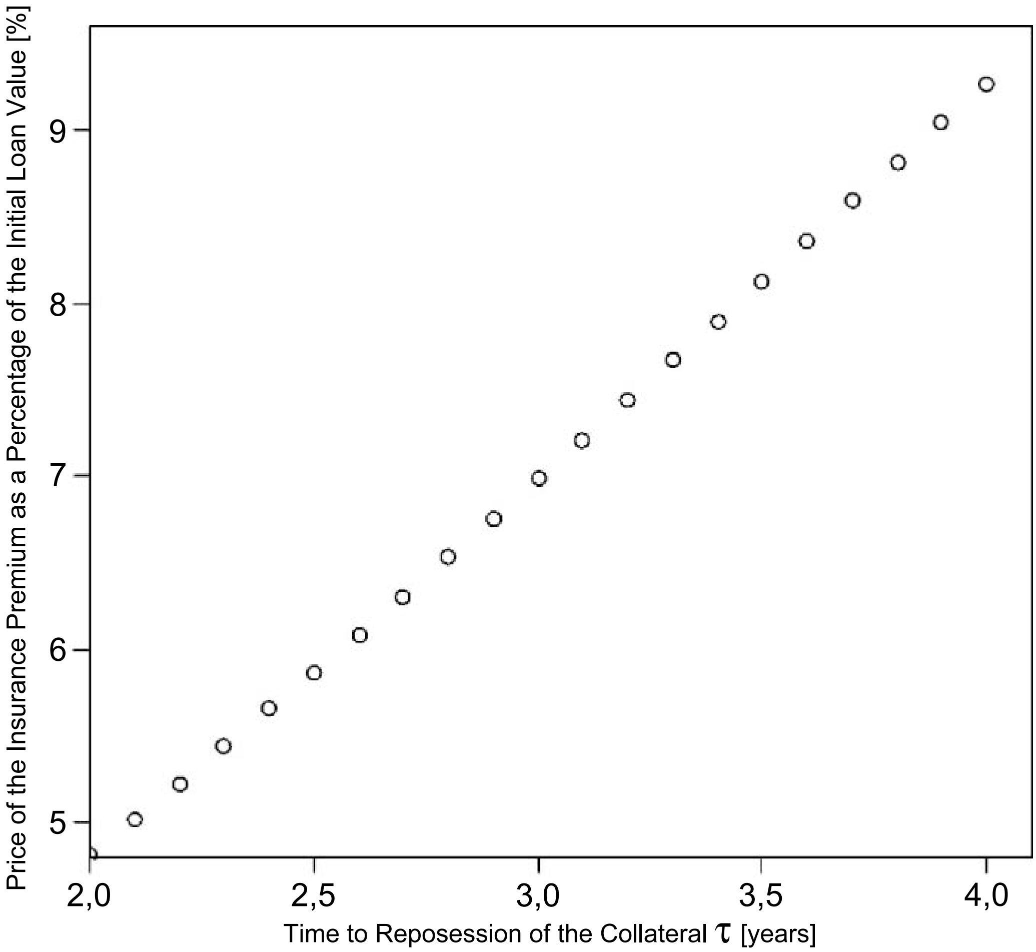

Figure 2.3: Inuence of delay τ in repossession of the collateral on the price of MI contract in Serbia.

2.7 Conclusion

In this paper, we develop a new option-based model for the pricing of mortgage insurance contracts in closed form. Our method extends the actuarial pricing approach of DKY by taking into consideration both the stochastic nature of the collateral as well as additional costs to the insurer stemming from a delay in repossession of the collateral in the case of borrower default. To the best of our knowledge, no paper prior to this one has attempted to quantify the effects of legal inefficiency on the pricing of MI contracts. The proposed valuation method is general and can be used in any market. However, it may be particularly useful in emerging markets where other methods currently in existence may be either inappropriate or are too difficult to implement because of the lack of relevant data. We calibrate the model to price a typical Serbian government-backed mortgage insurance contract and show that one of the key factors affecting the affordability of MI in Serbia is precisely the cost of legal inefficiency. Similar conclusion would hold, no doubt, in most emerging markets or any other country where it can often take several years for the repossession of the collateral to take place. For this reason, one of the key factors that would contribute to the success of a mortgage insurance scheme in such markets is, therefore, a comprehensive legal reform that would shorten the time delay in repossession of the collateral in case of borrower default.

Chapter 3

Consequences of increased longevity on wealth, fertility, and population growth

3.1 Introduction

Constant lifespan is often taken as one of the assumptions in creating and analyzing econophysical and sociophysical models. Today's bio-medical research is, however, uncovering the reasons why organisms live as long as they do. Through modern genetic engineering, the applications of this research are converging on the point of finding practical ways to extend life substantially (and possibly repeatedly) beyond current life expectancy.

The uncovering of the so called "secret of life" was one of the crowning achievements of the second half of the past century. The discovery of the structure of DNA by Crick and Watson (1953), and the later successful translation of the DNA code into the language of proteins, fueled the continuing revolution in molecular biology and bio-technology. This revolution is now making it possible to tackle rationally the complementary question of why we die. For the first time we have the option of looking at death from a fact-based (The Human Mortality Database) scientific perspective. The picture that is emerging is quite unexpected (Azbel 2002). We are getting farther from the concept of "natural death" as an immutable and inevitable end of life (Penna 1995; Penna, Racco, and Sousa 2001; Oeppen, and Vaupel 2002; Arking, et al. 2004).

Physical models played a crucial role in the discoveries that marked the birth of molecular biology (Judson 1979). Similarly, the well-developed machinery for understanding the behavior of complex systems is today being positioned to help understand the mechanisms of death and the extension of life (Rauch, Sayama, Bar-Yam 2002; Coe, Mao, and Cates 2002; Masa, Cebrat, and Stauffer 2006; de Oliveira, et al. 1999). Another avenue of research is to try to understand the social and economic implications of the prolongation of human lifespan. In principle, there are two quite distinct paths that one may choose to take (Ball 2006): economics or econophysics. In this chapter we approach these problems from a point in between these two not so distinct frameworak. Using this language we show that it is possible to model and predict some of the far-reaching social and economic consequences of the successful extension of human lifespan that have, up to now, been disregarded both by economists (Blanchard, and Fischer 2001; Barro, and Sala-i-Martin 2002) and physicists (Arthur 1994; Chakrabarti, Chakraborti, and Chatterjee 2006; Mantegna, and Stanley 1995).

The fact that we all must die has been one of the central points shaping all human societies. Substantial modification or even the removal of this mortality paradigm will necessarily bring about great change in how societies function. It is important to try to anticipate these changes. Successful modeling of these phenomena is not only of practical, but of heuristic value. Many important discoveries, particularly in physics, have followed from analyzing the consequences of modifying key paradigms. The introduction of a new and extremely sought-after commodity, allowing for the extension of life, would bring about a great change in economy and society in general.

In this paper we present and solve a simple model dealing with the consequences of just such a novel commodity. We study the implications of possible long-term extensions of life on society and its economy. We model the dynamics of social and economic indicators of a society and investigate how the introduction of life extension will influence fertility rates, population growth and the distribution of wealth. For this purpose we propose and analytically solve a simple model. The presented model, when life extension is absent, is related to earlier investigations (Coelho, et al. 2005; Santos, et al. 2007), the main new feature being the introduction of overall economic and population growth. The presented results include conclusions that the population explosion is not a necessary consequence of introduction of life extension commodity, and that it is even possible to have sustainable economic growth in a population of stable size.

3.2 Basic model

Our model tracks through the generations the number and individual wealth of all of the descendants of a specific individual at generation $t = 0$ having wealth m. We begin by first treating the simpler case of no life extension. Within our model, the life span of each individual consists of three phases: formative years (parents invest in the individual); adult years (individual inherits some initial money, marries, the pair earns some final amount of money, has children); old age (individual lives off his pension and ultimately dies). As a result of these assumptions, dependency ratios are fixed within our basic model, and are constant throughout the population. We track the adult phase of each individual which starts at t and lasts until $t + 1$. We assume that individuals inheriting m money choose spouses having the same amount of money, i.e. that the pair starts off with $2m$ initial capital. While this may appear to be a natural assumption it is not obvious if it holds empirically. For example, Dragulescu and Yakovenko (2003) have studied the related phenomena of the earnings of spouses and have shown the earnings to be essentially uncorrelated. It would be interesting to investigate the correlation of inherited wealth of spouses. Within the model presented here we stay with the above simplifying assumption. We further assume that society is numerous enough so that everyone can find a mate. During their working life the pair increase their wealth by a factor γ, a fixed constant for the whole society satisfying $\gamma > 1$. This money is spent on their children and the pair's pensions:

$$2\gamma m = kC + km' + 2P(m) \ . \qquad (3.1)$$

In the above equation k is the number of children, C the investment in each child, m' the inheritance of each child. The pension is assumed to be proportional to initial wealth, i.e. $P(m) = \alpha\, m$. The number of children k is assumed to take on the maximal possible value consistent with the rule $m' \geq m$. This is a crucial assumption strongly affecting the model's predictions. It implies that parents have children only if they can assure them equal or better financial start-up compared to what they had. The number of children thus follows from a simple economic criterion. As a consequence, the model leads to a positive relation between fertility and wealth. For this reason, it is obviously not applicable to poor societies. In those societies the choice of the number of children is more strongly related to survival (procreation) and less to expectations of their future wealth. Our ultimate goal is to analyze the effects of life extension on society. For this reason we focus on developed societies in which economic choices play a dominant role, societies having the necessary financial means to purchase life extension. Although many other things influence fertility (e.g. religion, level of education, system of beliefs), the criterion chosen is that of a simplified model seeking to capture the dominant aspect of the relation between fertility and wealth in developed societies.

We will keep track of $m(t)$ and $n(t)$ (money inherited by the descendants at generation t and the number of those descendants). Note that the total number of people in the society at time t is simply $N(t) \propto n(t)/2^t$.

It is easy to see that for non-trivial dynamics we need to further have $\gamma \geq \alpha + 1/2 + C/2m$, since smaller values of γ lead to $k = 0$ for all values of m. By introducing the critical value $m_* = C/(2\gamma - 2\alpha - 1)$, as well as auxiliary quantities $K_1 = \left[\frac{2m(\gamma-\alpha)}{C+m}\right]$ and $M_1 = \frac{2m(\gamma-\alpha)}{K_1} - C$, we can write the solution of the above dynamics as

$$
\begin{aligned}
k &= \theta(m - m_*)\, K_1 \ , \\
m' &= \theta(m - m_*)\, M_1 \ .
\end{aligned}
$$

Square brackets denote the integer part of an expression. The step function $\theta(x)$ used here equals unity for $x \geq 0$, and vanishes for $x < 0$.

The above equations make it possible to investigate the dynamical evolution of wealth distributions from given initial conditions. Wealth distributions have been extensively studied in the literature. The field began with the power law distribution of Pareto (1897). Recent investigations show that, while Pareto's

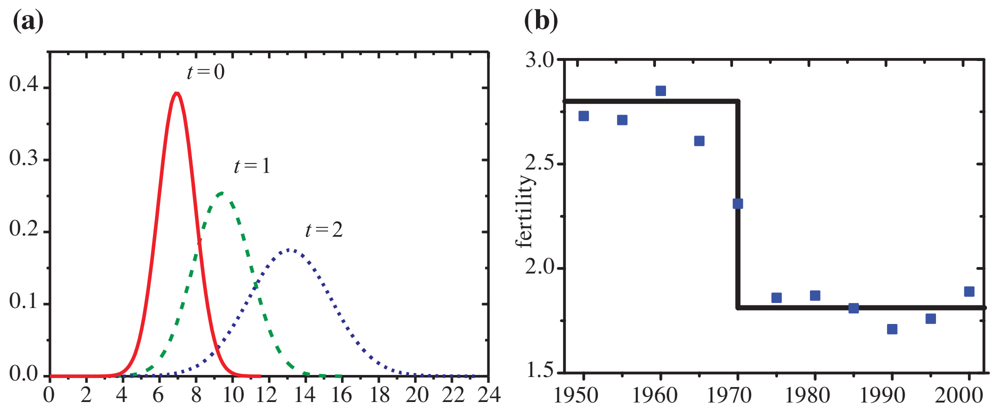

Figure 3.1: (a) Numerical simulations of the time evolution of wealth distributions for the case of no life extension. The plot corresponds to $\gamma = 2$, $\alpha = 0$, $C = 2$, and an initial Gaussian wealth distribution. (b) Comparison of the time dependance of the fertility rate for France (UN Statistics Division - Common Database) with the predictions of the model without life extension when $\gamma - \alpha$ decreases slowly (adiabatically) bellow the critical half-integer value.

law gives a good fit at higher incomes, it does not agree well with observed data at middle and low incomes (Fuentes, Kuperman, and Iglesias 2006; Aoyama, Souma, and Fujiwara 2003; Dragulescu, and Yakovenko 2000; Dragulescu, and Yakovenko 2001; Dragulescu, and Yakovenko 2001; Chakraborti, and Chakrabart 2000) which best fit to lognormal or Gibbs distributions. The two regimes follow (Fuentes, Kuperman, and Iglesias 2006; Silva, and Yakovenko 2005) from the fact that in low and middle income ranges the accumulation of wealth is additive, while in the high-income range wealth grows multiplicatively. Simplified models (Trigaux 2005; Das, and Yarlagadda 2005; Iglesias, et al. 2003; Iglesias, et al. 2004) have linked Gaussian wealth distributions with egalitarian societies. Our model without life extension agrees well with this phenomenology. The dynamics of the model is such that it preserves Gaussian shaped wealth distributions, as shown in Fig. 3.1a.

In contradistinction to this, Sala-i-Martin has shown (Sala-i-Martin 2006) that highly segregated societies exhibit bi-modal wealth distributions. In the next section, we will show that the introduction of life extension in our model can lead to societal segregation, which then results in the appearance of just such bi-modal distributions.

Within the framework of our model it is also possible to analyze fertility rates of a given society. The fertility rate f is the average of $k(m)$ over the whole population. If the wealth distribution is such that most of the population have wealth $m \gg C$ then the above solution gives $f \lesssim [2(\gamma - \alpha)]$. Due to the integer part operation, the fertility can depend strongly on small changes in economic growth γ or of social expenditures α. If γ and α change slowly with time, then $\dot{\gamma}$ and $\dot{\alpha}$ can be neglected it the equations of motion and we uncover the same relation between fertility, economic growth and social expenditure. As a result, even the smallest decrease of $\gamma - \alpha$ bellow half integer values leads to a decrease of fertility by one unit. This is illustrated in Fig. 3.1b. The data points correspond to measured fertility rates in France. Similar abrupt decreases of fertility have been observed for many other developed countries (UN Statistics Division - Common Database). Thus, an increase in social expenditures greater than the increase in economic growth results in a step-down in fertility rate. The sharp decline of fertility rates in developed countries has been most often accredited to increased participation of women in the work market. The study of the relation between fertility and wealth within the presented simplified model may offer new insight into this important phenomenology.

It is important to note that the simplifying assumptions made in this paper make the presented toy model (and its generalization to include life extension) analytically solvable. Future models will need to be made more realistic. To do this it will be necessarily to relax some of the assumptions of the current model. In particular they will have to treat the effects of overlapping generations. Unlike in our mean-field model, a more realistic model will have to have agents with different growth factors, different life spans, richer or poorer spouses, etc. We intend to study the effects of the relaxation of these assumptions in a future publication. These more realistic models will have more phenomenological input parameters and will necessitate a purely numerical treatment. We hope that the present analytically solvable model will serve as a useful zeroth-order approximation to these future models.

3.3 Model with recursive life extension

We now generalize the model to include life extension. The extension of life for one individual and one time step (equal to the natural length of the adult period) costs E. We assume that any individual having enough money to pay for this life extension will do so, no matter what. Therefore, for $\gamma m \geq E$ we now have:

$$2\gamma m = 2E + kC + km' + 2m' \ . \tag{3.2}$$

On the right hand side the first term pays for life extension for the pair, the second and third terms are the investment and inheritance of each child, while the last term represents the "inheritance" of the original pair with which they begin their new life cycle. Note that we have assumed that both parents inherit the same money as do each of their children. After life extension individuals are assumed to be working able, i.e. there is no pension term in this case. Note that for $\gamma m < E$ we have the same dynamics as before, i.e. as given in Eq. (3.1), with $P(m) = \alpha m$. Note that the introduction of life extension decreases dependency ratios - in the extended life periods the population is of good health and is assumed to be in the economically productive phase. Recursive application of life extension drives the dependency ratio to zero.

We introduce $m_1 = E/\gamma$ and $m_2 = E/(\gamma - 1)$. The life extension phase is for $m \geq m_1$. The solution of the model depends on the relation between critical values m_* and m_1. In terms of $K_2 = \left[\frac{2m\gamma - 2E - 2m}{C+m}\right]$ and $M_2 = \frac{2m\gamma - 2E - K_2 C}{K_2 + 2}$, the solution for $m_* < m_1$ is given by:

$$\begin{aligned} k &= \{\theta(m - m_*) - \theta(m - m_1)\} K_1 + \theta(m - m_2) K_2 \ , \\ m' &= \{\theta(m - m_*) - \theta(m - m_1)\} M_1 + \theta(m - m_2) M_2 \ . \end{aligned}$$

Similarly, the solution for $m_* \geq m_1$ equals:

$$\begin{aligned} k &= \theta(m - \max\{m_2, m_*\}) K_2 \ , \\ m' &= \theta(m - m_1) M_2 \ . \end{aligned}$$

Note that for all values of m the function $\theta(m - m_1)$ measures if life was extended in the current generation.

From the above solutions it follows that, in the life extension phase, $k \neq 0$ is possible only for the case $\gamma > 3/2$, and $m \geq (C + 2E)/(2\gamma - 3)$. We also see that $m' \geq m$ everywhere except for $m \in [m_1, m_2)$. It follows that individuals with $m \geq m_2$ are immortal – they extend their lives and later they (and their children if they have any) have more money then in the previous life cycle. Note that the potential segregation between mortals and immortals can lead to serious political tensions and instabilities in a society. We next tackle the issue of segregation.

Fig. 3.2 illustrates the obtained solutions for the time dependence of the number of children k and wealth m for a society with $\gamma = 3/2$, $\alpha = 1/2$, $C = 1$. Fig. 3.2a and 3.2b correspond to the case of no life extension. The part of the population with $m < 1$ has no children and dies off, those with $m \geq 1$ have one child. That child is financially better off than its parents, i.e. m' is above the dashed $m' = m$ line. After t generations we have $m(t) \sim 2^t$, while the population decreases as $N(t) \sim 2^{-t}$. Fig. 3.2c and 3.2d correspond to the same society as before but with life extension costing $E = 3$. The population now consists of two groups that never mix – mortals and immortals. Immortals have $m \geq 6$. The number of mortals roughly decreases as 2^{-t} while their individual wealth oscillates in the interval $[1, 6)$. In fact, numerical simulations show that the majority of this population oscillates in a narrow interval of wealth around $m = 2$. For $k = 0$ (immortals without children) we have $m' = 3m/2 - 3$, so that their wealth grows asymptotically as $(3/2)^t$. For $k > 0$ the condition $m' \geq m$ is not met, i.e. for the case considered immortals can have no children. From Eq.(3.2) it follows that immortals can procreate only if economic growth is such that $\gamma > 3/2$.

Even this single example shows how the introduction of life extension severely affects both population growth and wealth distribution of the whole society, not just of the newly created class of immortals. The key effect of life ex-

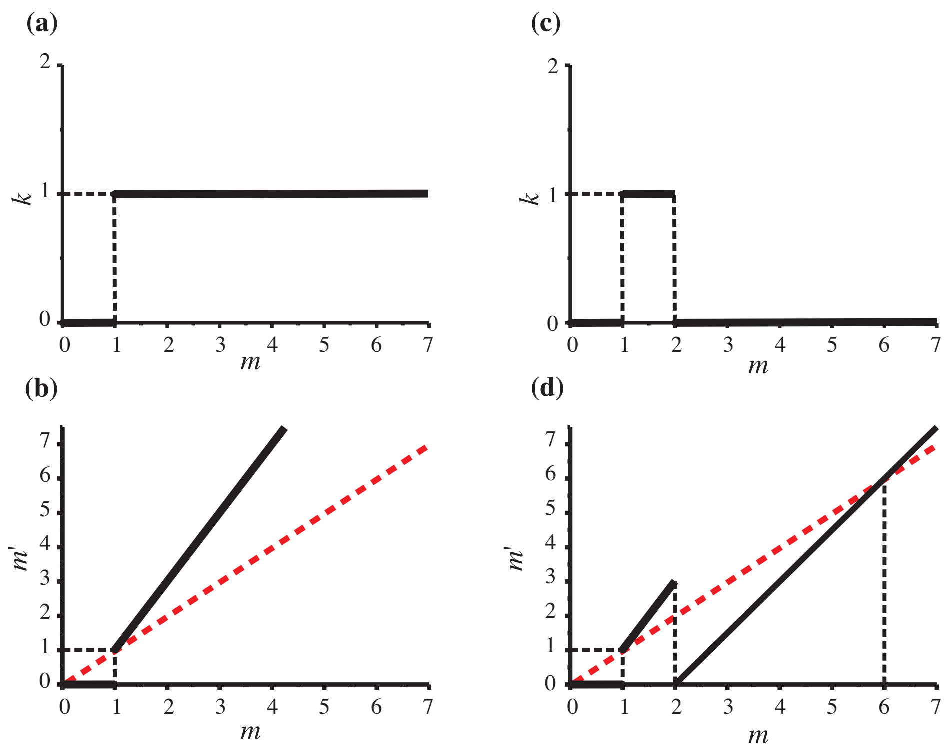

Figure 3.2: Solutions of the model for $\gamma = 3/2$, $\alpha = 1/2$, $C = 1$. Plots (a) and (b) correspond to no life extension, plots (c) and (d) to life extension with $E = 3$. The dashed lines in (b) and (d) correspond to $m' = m$. Note that the introduction of life extension has decreased fertility.

tension on mortals is that for some of them life span is increased – some do cross into the life extension phase $m \geq 2$, however, their wealth then decreases (solid curve bellow the dashed $m' = m$ line) and ultimately makes further life extension impossible.

Fig. 3.3 illustrates the time dependence of wealth for two different sets of parameters. The interval $[m_1, m_2)$ represents a barrier through which a mortal must "tunnel" in a single generation in order to become immortal. The only way that the descendants of mortals can become immortal is if $m = m_1 - 0+$

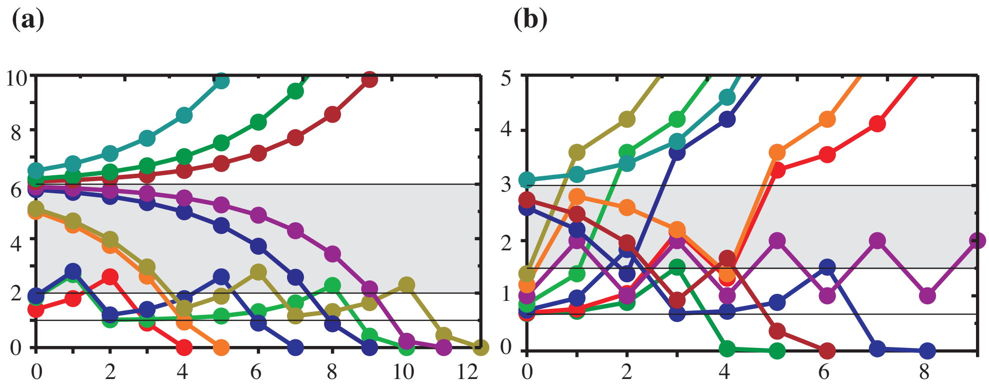

Figure 3.3: Time evolution of individual wealth: (a) An example of a society where tunneling is not possible and mortals and immortals remain segregated ($\gamma = 3/2$, $\alpha = 1/2$, $C = 1$, $E = 3$); (b) An example with tunneling ($\gamma = 2$, $\alpha = 0$, $C = 2$, $E = 3$). Shaded regions denote corresponding $[m_1, m_2)$ intervals. Horizontal lines beneath them denote the critical value $m = m_*$.

leads to $m' \geq m_2$. To get this we must have:

$$\begin{aligned} m_* &< m_1 \; , & (3.3) \\ \frac{2m_1(\gamma-\alpha)}{C+m_2} &\geq \left[\frac{2m_1(\gamma-\alpha)}{C+m_1}\right] \; . & (3.4) \end{aligned}$$

Equivalently, these inequalities may be written as:

$$\frac{2\frac{E}{C}(\gamma-\alpha)}{\gamma+\frac{E}{C}\frac{\gamma}{\gamma-1}} \geq \left[\frac{2\frac{E}{C}(\gamma-\alpha)}{\gamma+\frac{E}{C}}\right] \geq 1 \; . \tag{3.5}$$

These inequalities specify a series of isolated islands within the (γ, E/C) plane in which it is possible to tunnel from mortality into immortality. These islands are indexed by integer n. For the simplest case $\alpha = 0$ they are the areas between curves $\frac{E}{C} = \frac{(n+1)\gamma}{2(\gamma-\alpha)-n-1}$ and $\frac{E}{C} = \frac{n\gamma(\gamma-1)}{2(\gamma-\alpha)(\gamma-1)-n\gamma}$. The critical points $\gamma_n = (1+\sqrt{1+2n(n+1)})/2$ denote the start of the n-th island. It follows that mortals and immortals necessarily form segregated populations if γ is smaller than the golden mean $\gamma_1 = (1+\sqrt{5})/2$.

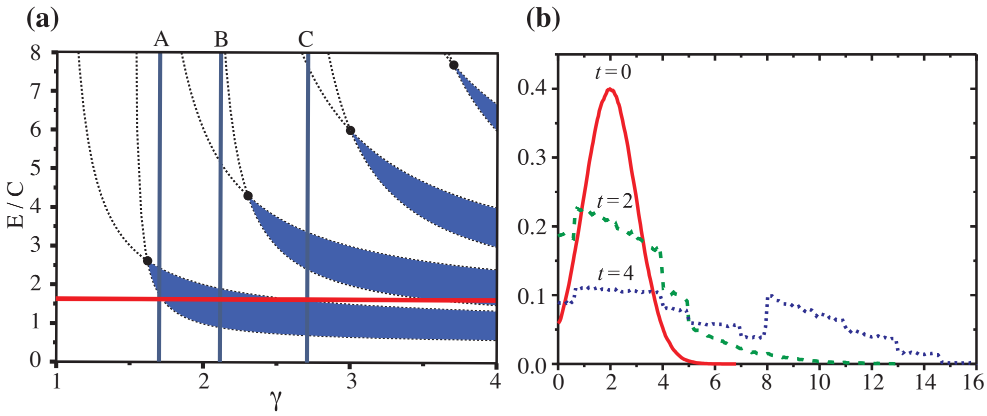

Figure 3.4: (a) Phase diagram showing the isolated islands in the model's parameter space where it is possible to tunnel from mortality into immortality in the case $\alpha = 0$. The vertical lines denote γ values for: UK, Sweden, Australia (A); US, France, Italy, Canada, India (B); Spain, Greece, Romania (C). For $E/C = 1.5$ all the above countries lie on the first island. (b) Time evolution of wealth distributions for the case of life extension with tunneling ($\gamma = 2$, $\alpha = 0$, $C = 2$, $E = 3$). In this case the introduction of life extension leads to the emergence of a bi-modal distribution of wealth.

Fig. 3.4a shows the first few islands in which tunneling is allowed for the case $\alpha = 0$ (similar graphs follow for other values of α). The vertical lines in Fig. 3.4a denote γ values for: UK, Sweden, Australia (A); US, France, Italy, Canada, India (B); Spain, Greece, Romania (C). These have been calculated using data for adjusted annual growth of these countries from 1960 to 2000 and assuming that one generation in our model corresponds to 30 years (Barro, and Sala-i-Martin 2002). For $E/C = 1.5$ all the above countries lie on the first island in the above phase diagram. The much higher growths of China and Singapore are also consistent with tunneling between mortals and immortals for the same value of E/C since they lie on the second island. Fig. 3.4b shows that life extension profoundly influences the distribution of wealth. For the society with $\gamma = 2$, $\alpha = 0$, $C = 2$, and $E = 3$, tunneling takes an initial Gaussian wealth distribution into a bi-modal one. Wealth distributions of this type are very similar to those of existing highly segregated societies in which life expectancies at birth differ significantly between the rich and the poor (Sala-i-Martin 2006). This is an indication that the presented model, although substantially simplified, captures key aspects of realistic processes.

Similar changes may be found when looking at fertility rates of mortals and immortals, as well as the overall size of the population. In contradistinction to what one might naively expect, the introduction of life extension does not speed up population growth. In fact, for realistic values of γ the size of the population generally stabilizes. This gives us interesting examples of societies with sustained economic growth but without a spiraling population explosion. It is not difficult to see that this is a consequence of the dynamical equilibrium between two phases in the model. In fact, this uncovered non-trivial behavior within a simplified model is the essence of how economics can contribute to our understanding of economy and society in general. Namely, like effective models in physics (e.g. the Ising model) are of value not because they encode the detailed phenomenology, but because they capture key qualitative relations between dynamical quantities like the one above, providing insight needed for deeper understanding of the underlying phenomenology.

So far we have looked at life extension from the consumer's perspective. We now briefly look at the profits of the pharmaceutical companies selling the life extension product. Each individual purchase of life extension increases the profit of the life extension companies by E. We assume here that all the R&D expenses of developing the product have already been covered and that the actual cost of manufacturing the product is negligible. Summing the purchases over the whole society we get the time dependence of the total profit. An example of this is illustrated in Fig. 3.5 for a society with $\gamma = 2$, $\alpha = 0$, and $C = 2$. From the figure we see that the maximal profit determines that $E/C \approx 1.5$. Note that this is also the horizontal line in the phase diagram in Fig. 3.4a. We see, therefore, that the economic requirement of maximizing profit of pharmaceutical companies is consistent with the political requirement of easing social tension through de-segregating mortals and immortals, i.e. through allowing tunneling into immortality.

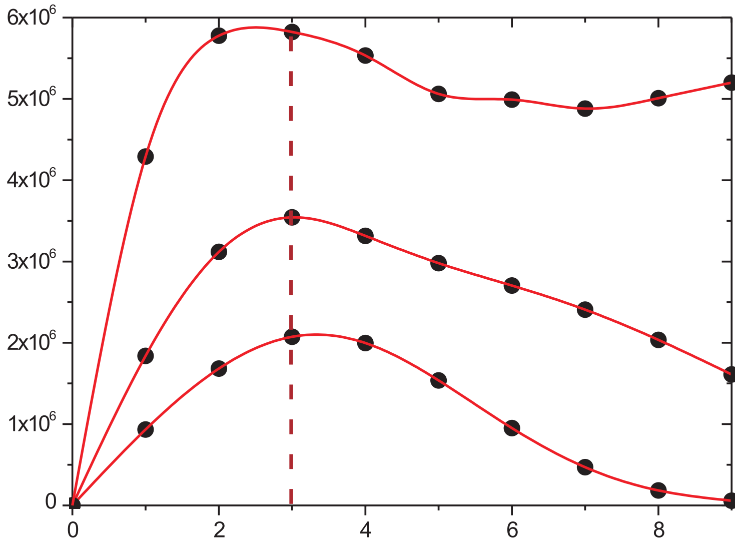

Figure 3.5: Profit of pharmaceutical companies as a function of the unit price E. The society shown has $\gamma = 2$, $\alpha = 0$, $C = 2$. The initial wealth distribution was a Gaussian centered at $m = 2$ with width $\sigma = 1$. The $t = 1, 2, 4$ time slices are shown from bottom to top. The maximal profit for the producers of life extension is for $E \approx 3$, i.e. for $E/C \approx 1.5$.

3.4 Concluding remarks

We have presented and solved a simplified model that analyzes the consequences of (repeatable) life extension on fertility, population growth and wealth distribution. When life extension is absent the model correctly reproduces observed time dependence of wealth distributions, and abrupt declines in fertility rates. We have analyzed in detail the introduction of life extension to the model and have found it to be a novel commodity which profoundly influences key aspects of society. Of particular interest is the emergence of two distinct phases: societies in which mortals and immortals are segregated, and societies in which economic factors allow descendants of mortals to "tunnel" into immortality.

The analysis of simplified models such as ours is but a first step in a process that could ultimately help in forming important future policies, e.g. those to do with the pricing of pharmaceutical and medical products and services, wider health-care and insurance policies, etc. As is well known, these issues can have profound effects on the stability of societies and their economic growth, and have for this reason attracted much attention. An important recent example is the decision of the Brazilian government to bypass the copyright on US-produced AIDS drugs[1] in order to be able to treat significant part of the AIDS-infected population, and to avoid political instability that may arise from this problem. Models such as ours have the possibility of leading to rationally thought-out policies, allowing society to make critical choices acceptable to its members. However, in order to do this they necessarily need to be followed up by the development and analysis of a series of richer models incorporating more realistic assumptions. We have already commented on some directions in which this process of model building needs to go when we discussed the assumptions within our basic model without life extension. The introduction of life extension will further affect matters such as dependency ratios, or the effects of overlapping generations. The issue of work-leisure tradeoffs can also play an important role in the dynamics of a society with life extension. On the

[1]http://news.bbc.co.uk/2/hi/americas/6626073.stm

other hand, the very introduction of life extension could greatly influence our attitudes towards work and leisure in prolonged life spans. Also, the decisions based on risk assessment will necessarily undergo a qualitative change when made from longer time perspective offered by repeated life extension. Social and economic strategies will also change accordingly.

In the presented model the economic growth, parental investment, and price of life extension were all externally determined. More realistic models should include the boot-strap influence of population growth and wealth distribution on these parameters. We plan to pursue this generalization in a future publication. Another interesting extension of the model would be to consider the interaction and co-existence of two parts of society having different parental investments.

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