Interfaces with Other Disciplines

Two-stage financial risk tolerance assessment using data envelopment analysis

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ABSTRACT

Typical questionnaires administered by financial advisors to assess financial risk tolerance mostly contain stereotypes of people, have seemingly unscientific scoring approaches and often treat risk as a one-dimensional concept. In this work, a mathematical tool was developed to assess *relative* risk tolerance using Data Envelopment Analysis (DEA). At its core, it is a novel questionnaire that characterizes risk by its four distinct elements: propensity, attitude, capacity, and knowledge. Over 180 individuals were surveyed and their responses were analyzed using the Slacks-based measure type of DEA efficiency model. Results show that the multidimensionality of risk must be considered for complete assessment of risk tolerance. This approach also provides insight into the relationship between risk, its elements and other variables. Specifically, the perception of risk varies by gender as men are generally less risk averse than women. In fact, risk attitude and knowledge scores are consistently lower for women, while there is no statistical difference in their risk capacity and propensity compared to men. The tool can also serve as a "risk calculator" for an appropriate and defensible method to meet legal compliance requirements, known as the "Know Your Client" rule, that exist for Canadian financial institutions and their advisors.

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1. Introduction

In Canada, the securities industry is regulated by provincial and territorial securities commissions and self-regulatory organizations (SROs). In Ontario, the province where this study takes place, the Ontario Securities Commission collaborates with two major SROs: the Investment Dealers Association of Canada and the Mutual Fund Dealers Association of Canada. Each SRO enforces an equivalent "Know Your Client" (KYC) rule[1] (that most developed countries also have) which mandates that all 17,000 Canadian certified financial planners, investment dealers and wealth management advisors consider a client's personal circumstances, financial status, investment objectives and risk tolerance when determining whether or not an investment opportunity is suitable for such client. Of these factors, financial risk tolerance is the most challenging to assess because no formal metrics exist. Intuitively, "knowing a client" involves the establishment of a relationship between a financial advisor and an investor through personal interviews. However, due to time constraints, advisors increasingly deal with clients through the telephone and/or E-mails. Moreover, while the Internet allows the financial services industry to offer investment services over the World Wide Web, it introduces a paradoxical challenge: how do financial institutions comply with the KYC rule and fiduciary investment standards if investors do not interact with advisors?

Current practice involves administering risk tolerance assessment questionnaires in person (especially for high net worth individuals) or over the Internet. These questionnaires help create a risk "profile" from which an appropriate investment portfolio can be recommended. However, the value of these risk profiles is debatable since questionnaires vary across institutions and do not provide a consistent profile of the same client who may consequently receive different advice from advisors depending on which test is used. This inconsistency – attributed to biases and stereotypes, invalid questions, a disregard for psychometrics,

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[1] The Investment Dealer's Association's Regulation 1300.1 (d) states that "Each [financial advisor], when recommending to a customer the purchase, sale, exchange or holding of any security, shall use due diligence to ensure that the recommendation is suitable for such customer based on factors including the customer's financial situation, investment knowledge, investment objectives and risk tolerance" (IDA, 2007). The Mutual Fund Dealers Association's Rule No. 2.2.1 requires that "Each [financial advisor] shall use due diligence: (a) to learn the essential facts relative to each client and to each order or account accepted; (b) to ensure that the acceptance of any order for any account is within the bounds of good business practice; (c) to ensure that each order accepted or recommendation made for any account of a client is suitable for the client and in keeping with the client's investment objectives; and (d) to ensure that, notwithstanding the provisions of paragraph (c), where a transaction proposed by a client is not suitable for the client and in keeping with the client's investment objectives, the Member has so advised the client before execution thereof" (MFDA, 2007).

incorrect mathematical approaches and the treatment of risk as a one-dimensional concept – may potentially expose an investor to unnecessary risk.

Although financial risk tolerance has been studied extensively, there is a lack of consensus on its definition: the words "profile", "attitude", "capacity" and "tolerance" are often used interchangeably. In theory, risk tolerance is a multidimensional concept consisting of four key elements – *propensity, attitude, capacity, and knowledge* – which all must be individually assessed, and then combined to obtain a *complete* risk profile. To date, the reliability and validity of so-called risk assessment questionnaires have suffered without a universally-accepted definition of risk tolerance, resulting in misguided assessments that are either incomplete (when different elements are collated) or incorrect (when one element, such as capacity, is treated synonymously with tolerance). Moreover, advisors are inevitably influenced by demographic stereotypes, many of which are embedded in these questionnaires. Research on age, gender, income, etc., and their relationship to risk tolerance has yielded inconclusive results, giving rise to a need for better understanding of client demography and risk tolerance.

Most questionnaires are in multiple-choice form with the same scoring motif: each possible answer to every question is assigned a score. Upon completion of a questionnaire, a final risk score is generated by summing the scores of the selected answers for all the questions and then interpreted by the advisor (Bank of Montreal, 2007; Canadian Imperial Bank of Commerce, 2007; Royal Bank of Canada, 2007; Scotiabank, 2007; Toronto Dominion Bank, 2007). For example, a lower score may indicate a risk averse investor whereas a higher score might indicate a risk seeking investor. However, summation without weights inappropriately treats collected data equally when the relationships across questions (from which demographic and psychological variables are obtained) are unclear.

Addressing this mathematical simplicity, Ardehali, Paradi, and Asmild (2005) first used a nonparametric linear programming technique called Data Envelopment Analysis (DEA) to compute "risk tolerance scores" from data collected using a questionnaire created by a commercial firm, ProQuest (now FinaMetrica Pty Ltd.). DEA treated each response to each psychological question as one dimension of risk tolerance without prior knowledge of the relationship between the questions. The results were encouraging, but suggested that DEA would be an even more effective tool for obtaining a single risk tolerance index when accompanied by a questionnaire specifically designed for analysis with DEA, as ProQuest's was not. The ideal questionnaire would thus have responses to questions that are easily manipulated (scored) for pre-selected variables, each representing one dimension of risk tolerance and thereby taking advantage of DEA's mathematical strength.

The purpose of our research was to create a new survey tool supported with DEA to assess the *relative* risk tolerance of a group of investors: i.e. to create a questionnaire that characterizes risk by the four distinct elements mentioned. DEA generates risk tolerance "scores" between 0 and 1 for each client, where the most aggressive investors are given a score of 1, while all other clients are scored as fractions of the riskiest investors. In effect, this is the first step towards developing a risk "calculator" software package for financial advisors or Web-based securities sales systems to use in everyday assessments which may offer solid information on risk tolerance while satisfying the KYC rule.

The rest of the paper is organized as follows: Section 2 provides a literature survey on risk and risk tolerance; Section 3 reviews relevant DEA theory and outlines the methodology of this work; Section 4 discusses the results obtained from DEA; and Section 5 summarizes the key findings and concludes with future research recommendations.

2. Risk tolerance

2.1. Assessment with questionnaires

The financial services industry administers questionnaires to assess a client's risk tolerance for two main reasons. First, while interviews provide a thorough assessment, advisors lack the time required to build a significant relationship with their client and prefer to use questionnaires when client portfolios are small. Second, assessment by interview can be unreliable because it is qualitative and generally unstructured with conclusions drawn from cognitive biases (Roszkowski & Grable, 2005). Hence, a quantitative instrument, such as a questionnaire, allows for a more standardized and repeatable assessment, as well as a translation of observations into numerical values. However, questionnaires vary across different financial institutions; Yook and Everett (2003) examined six "investor risk tolerance" questionnaires and reported that these did not provide a consistent picture of the same client who consequently received six different recommendations. This again motivates the need for a reliable measure of risk tolerance.

2.2. Demography of risk

Research on the demography of risk has yielded results which have either led to conflicting conclusions or have challenged intuition. Inconsistencies can be attributed to the lack of consensus on the definition of risk tolerance and choice of experimental methodology. Most studies use census data collected by the Survey of Consumer Finances through which risk tolerance is elicited from one question with four possible answers.[2] Despite its simplicity, the response is treated as a score of risk tolerance and correlated with demographic variables using various statistical methods. To the best of our knowledge, Ardehali et al.'s work (2005) is the only example of applying an operations research (OR) approach with a questionnaire to assess financial risk tolerance. In fact, in the field of investment banking, OR is more commonly used for portfolio optimization (e.g. Canakoglu and Ozekici (2010), Fabozzi, Huang, and Zhou (2009), Rios and Sahinidis (2010), Xidonas, Mavrotas, Zopounidis, and Psarras (2011), and Yu, Takahashi, Inoue, and Wang (2010)).

Table 2.1 summarizes the effect of some demographic variables on risk tolerance.

2.2.1. Age

Some researchers have shown that financial risk tolerance decreases with age because older individuals have less time to recover from any losses incurred from investments (e.g. Ahmad, Safwan, Ali, and Tasbasum (2011), Bajtelsmit and Bernasek (1996), Hallahan, Faff, and McKenzie (2004), Palsson (1996), Riley and Chow (1992), and Sung and Hanna (1996)), while others have argued that it increases with age (e.g. Grable and Lytton (1998) and Wang and Hanna (1997)) since younger individuals are likely to have limited financial resources to endure short term losses.

2.2.2. Gender

Most, if not all, studies have shown that women are less risk tolerant than men to degrees varying with situational context (e.g. Ahmad et al. (2011), Bajtelsmit and Bernasek (1996), Palsson

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[2] Which of the statements comes closest to the amount of financial risk that you and your (spouse/partner) are willing to take when you save or make investments?

1. Take substantial financial risks expecting to earn substantial returns.
2. Take above average financial risks expecting to earn above average returns.
3. Take average financial risks expecting to earn average returns; or
4. Not willing to take any financial risks.