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Probabilistic investing: or how to win the *Globe and Mail's* Stock Picking Contest (50% of the time)

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Abstract

For the past nine years the *Globe and Mail* (Canada's oldest national daily) newspaper has held an annual stock picking contest. In 2002, 2003, and then again in 2004, a finance professor won this contest. Motivated and inspired by the contest, this article shows that a rational player can increase the odds of winning an investment contest to a 50/50 chance by selecting a stock that (1) is highly volatile, and (2) negatively correlated with the other selections, or (3) exhibits a negative empirical beta. We conclude by arguing that picking stocks to win an investment game or contest is quite different from selecting securities for a personal investment portfolio.

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1. Introduction

For the past nine years, the *Globe and Mail* (Canada's oldest national daily) newspaper has held an annual stock picking contest entitled *My One and Only*. In this competition, which starts on January 1 of each year, a variety of financial commentators, money managers, and academics are asked to select one stock (from the universe of stocks trading above $1) of any public company quoted on the Toronto Stock Exchange (TSE). In addition to human participants, a completely random selection is added to the competition as well, usually

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chosen by a child or a mechanical toy. The performance of all entries are tracked daily on a popular web site and reported on quarterly in the printed version of the newspaper. The formal winner of the contest is the sole individual with the best performing stock at the end of the year, based on the last day of trading for the year. The final results of the contest are announced with much fanfare and publicity on the front page of the *Report on Business* section in the first week of the subsequent year. Aside from the extensive publicity (negative or positive) from being part of the game, the winner's only reward is a coffee mug, compliments of the *Globe and Mail*. There are no financial rewards or penalties for placing second, third, or dead last.

In 2002, 2003, and then again in 2004, a finance professor at one of Canada's leading business schools (and one of the authors of this article) won the contest by beating all other participants, as well as the TSE market index by a wide margin. And, although it is easy to dismiss such results as completely attributable to luck, the main thesis of this article is that there is, in fact, a well-developed theory behind optimal behavior in such a contest. A rational and cognizant player can substantially increase the odds of winning the investment contest by playing the game optimally. We will review this theory in detail and stress the practical insight that picking stocks to win an investment game is quite different from selecting securities for a personal investment portfolio.

In other words, motivated by this investment contest and the surrounding public interest, our article takes the opportunity to review the theory of probabilistic investment games and provide some anecdotal evidence as well as rigorous insights into the best way to win the *Globe and Mail's* stock picking contest. We show that a rational player can increase the odds of winning the investment contest (to a 50/50 chance) by selecting a stock that (1) is highly volatile, and (2) negatively correlated with the other selections, or (3) exhibits a negative empirical beta. And, although the first ingredient might be intuitively obvious, the second and third are not.

Our main practical objective, however, is to illustrate the critical difference between a rational and prudent strategy for building wealth versus the optimal strategy for picking stocks in these all-or-nothing contests. And, although there are many such investment games in existence (e.g., the *Wall Street Journal*'s quarterly analyst versus dartboard contest) the national stature and exposure of the *Globe and Mail* contest makes this an ideal case study. Therefore, individual investors who use these publicly advertised stock picks as the foundation or basis for their own investment portfolio might be taking-on excessive nonsystematic (i.e., diversifiable) risk that is sub-optimal for a utility maximizing investor. More on this will follow.

The actual paper is organized as follows. Section 2 provides an introduction to the theory behind investment contests and demonstrates that the strategy with the best odds of winning is somewhat counterintuitive. Namely, we demonstrate that one should pick securities with very high idiosyncratic (i.e., diversifiable) risk, but with zero or possibly negative beta, in the lingo of modern portfolio theory. This tactic is perfectly justified despite the widespread belief that there is no equilibrium compensation for bearing idiosyncratic risk in capital markets. Furthermore, we show that the a priori probability of winning such a contest under our suggested optimal strategy comes close to, but can never exceed, 50%. A technical appendix provides the necessary probability theory. Section 3 of the paper reviews the actual stock selections and choices of the contest participants over the first eight years of the contest. By examining betas and volatilities, we show that most of the winning stocks, or the stocks that had the highest probability of winning a priori, did, in fact, conform to the above selection criteria.

Aside from theoretical insights, the practical lesson from this paper's analysis is that picking stocks with the sole objective of winning a contest should not be viewed as a proxy for providing any guidance on building a well-diversified investment portfolio. Professional investment managers and individuals that manage their own portfolios must understand and acknowledge the inherent statistical illusions induced by such games. Indeed, one might go so far as to argue that the optimal strategies in both of these endeavors are orthogonal to each other. Ex post one might be tempted to ascribe talent to winners, and especially repeat winners, when, in fact, the odds strongly favor such an outcome by chance when the game is played optimally.

2. What does theory tell us about winning investment contests?

Modern investment theory, as originally developed by Markowitz and Sharpe (see the book by Elton and Gruber (1995) for a technical discussion of modern portfolio theory), argues that all stocks can be classified by a limited set of parameters, namely their expected return and covariance structure. And, although a priori it would seem that the optimal strategy for winning a contest is to locate the stock with the highest (best) expected return, this is not the case over short contest horizons. In fact, given the difficulty in estimating expected returns over very short periods of time, the key to winning such a contest (or at least maximizing the odds) is to *completely ignore* expected returns and focus exclusively on the covariance of the stock in question.

Traditional mean-variance framework underlies most of today's professional money management and is the springboard for our analysis. The technical appendix provides a detailed derivation of the probability of winning as a function of the expected return, standard deviation, and correlation structure. This analytic machinery can be used to demonstrate that for any reasonable expectation of investment returns, which is almost impossible to estimate over short contest horizons, the probability of winning is most sensitive to the covariance structure of the security. The optimal strategy is to pick a stock that is highly volatile and negatively correlated to the rest of the contestant's choices. This implicitly maximizes the odds of an extreme ranking. When done properly, the extreme ranking that is induced by this strategy will result in either winning the contest (50%) or achieving last place (50%). And, because there are no real financial rewards or penalties for participating in these games, a 50/50 chance is the best one can hope for. Recall that in contrast to optimal portfolio construction for individual investors, where the difference between third, fourth, or fifth place represents real dollars and cents in one's retirement portfolio or quarterly evaluation, there is little difference for those placing anything other than first, though it might be argued that some utility is derived from finishing in the top half of players, even if one doesn't finish first. And, although some might argue the harm caused by a last place or similar finish, these risk-averse contestants have the option of simply not participating. In the language of

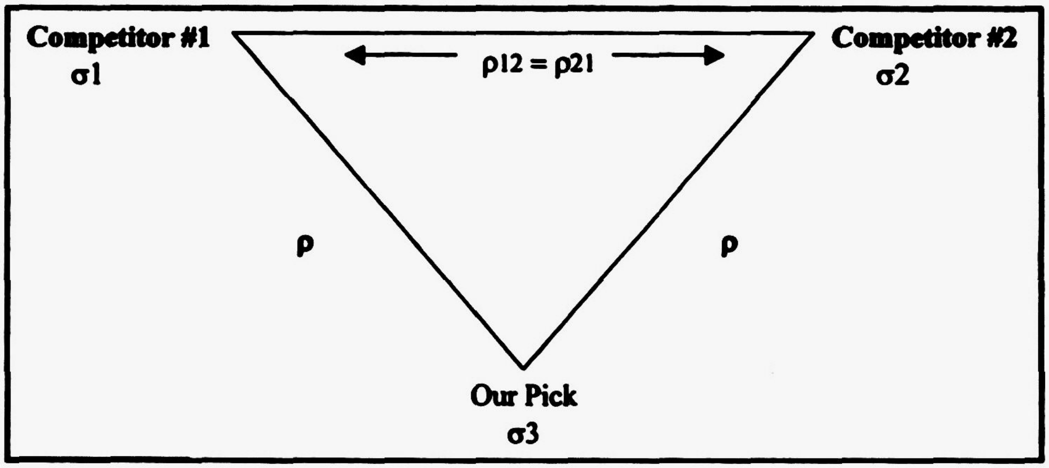

Fig. 1.

decision theory, the objective of the contest is to maximize a binary utility function that either takes on the value of one (winning) or zero (not winning). This is quite different from utility functions which balance risk (a.k.a. shortfall, standard deviation, or regret) and expected returns. Maximizing a smooth and differentiable utility function leads to a diversified portfolio of individual stocks, as originally shown by Markowitz and Sharpe. A binary objective function induces a strategy that maximizes the probability of beating a stochastic benchmark, independently of the magnitude of loss or disappointment. We refer the interested reader to the recent papers by Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997), as well as Busse (2001) or Goetsmann, Ingersoll, and Ross (2003), for a theoretical discussion and some empirical evidence on the impact of financial incentives on professional portfolio managers in a tournament-like environment. Indeed, it appears that similar game-theoretic behavior and strategies might be optimal in the money management business.

To understand the counterintuitive implications of this strategy and the impact of volatility and correlation on winning, we offer the following simple example. Assume we are asked to participate in a contest with only two other participants, each of whom has already selected their stock. We denote the standard deviation (or volatility) of our competitors' stocks by the symbols $\{\sigma_1, \sigma_2\}$ and their mutual correlation by the symbol $\{\rho_{12}\}$. Recall that volatility is a proxy for the range of possible values for the end-of-year investment returns, while correlation measures the extent to which the two move together. Correlation values range from $\{-1 \leq \rho \leq 1\}$. Volatility can be as low as zero, for a risk-free product and can goes as high as infinity, in theory.

We are now asked to join the contest, knowing our competitors' two picks, and must select a stock that is characterized by a standard deviation $\{\sigma_3\}$ and a correlation pair $\{\rho_{31}, \rho_{32}\}$. For the purpose of this example, we limit our search among the universe of correlation pairs that are equal. In other words, we assume that $\rho_{32} = \rho_{31}$. The same idea would apply under a more complicated search. Fig. 1 is a graphical illustration of the triangular relationship between our *yet-to-be-made* stock pick and our two competitors' picks. If, instead of two competitors, we had seven, then Fig. 1 would have a pyramid-like structure (in seven dimensions) displaying all the possible correlations. Although this might appear somewhat

Table 1
Probability of winning as a function of selected correlation and volatility our two opponents select equally volatile ($\sigma_1 = \sigma_2$) but uncorrelated ($\rho_{12} = 0$) stocks

Correlation	$\sigma_3 = 0.5$	$\sigma_3 = 1.0$	$\sigma_3 = 2.0$	$\sigma_3 = 5.0$	$\sigma_3 = 10.0$
$\rho = +0.7$	9.7%	13.4%	34.2%	44.8%	47.5%
$\rho = +0.5$	19.6%	24.9%	36.6%	45.1%	47.6%
$\rho = 0.0$	28.2%	33.3%	39.8%	45.6%	47.7%
$\rho = -0.5$	32.0%	36.6%	41.4%	45.9%	47.8%
$\rho = -0.7$	33.1%	37.5%	41.9%	46.1%	47.9%

abstract and removed from the process of stock picking (after all, where is the discussion of price-to-earning ratios, dividends or growth rates?), we believe this framework truly captures the essence of the competition.

With this model in hand, Table 1 provides a number of important insights into the optimal strategy for winning the contest, which differs markedly with best practices for portfolio construction. If we select a stock that is completely uncorrelated ($\rho = 0$) with our competitors' stock picks and all contestants have the same investment volatility ($\sigma = 1$), Table 1 illustrates that the probability that we win the contest is exactly one in three. This should be intuitive. There are three (2 + 1) stocks in the contest, they are all identical and symmetric, and, therefore, all have an equal chance of winning. The same *1/n* probability would apply for *n* symmetric securities as well. For those readers interested in a rigorous proof, we refer them to (Eq. 7) in the appendix that must be generalized to $\mathbf{R}^n$.

In contrast to the symmetric *1/n* result, when our competitors' correlations are zero ($\rho_{12} = 0$) and we select a stock that is twice as volatile as our competitors' ($\sigma = 2$), the probability of winning the contest goes from 33.3% to 39.8%. When our standard deviation is increased by a factor of 10 ($\sigma = 10$), the probability of winning then jumps to 47.7%. In fact, one can show that, as the standard deviation goes to infinity, the probability of winning converges to exactly 50%. This is true regardless of the number of stocks in the contest. For example, if there are eight stocks in the contest, the neutral symmetric probability of winning is one in eight, which is 12.5%. Increasing the volatility of the stock will rapidly drive our probability of winning to 50%, leaving the other 50% chance to be shared among our seven competitors. Note that we are focusing on total volatility, which is the sum of both systematic (nondiversifiable) and nonsystematic (diversifiable) risk.

If we decrease the correlation ($\rho \leq 0$) between our pick and our competitors' picks, the probability of winning increases to the same 50% upper limit, but at a much higher rate. Indeed, when the correlation between our selection and the two other picks is set to −70% ($\rho = -0.7$), the probability of winning increases to 37.5% (from 33.3%) when the volatilities are identical. Note that we have restricted the correlation parameters in Table 1 to the range (−0.7, +0.7) so as to maintain an appropriate covariance matrix that is positive semidefinite. We refer the interested reader to the appendix where this is explained in greater detail.

In the opposite volatility direction, if our stock pick is half as volatile as our two competitors' ($\sigma = 0.5$), the probability of winning the contest is greatly reduced. In fact, when our correlation to our competitors' is set to a positive 70% value, our probability of winning drops to a mere 9.7% compared to the equal chances under a completely symmetric

Table 2
Probability of winning as a function of selected correlation and volatility. Opponents select equally volatile ($\sigma_1 = \sigma_2$) but −25% correlated ($\rho_{12} = -0.25$) stocks

Correlation	$\sigma_3 = 0.5$	$\sigma_3 = 1.0$	$\sigma_3 = 2.0$	$\sigma_3 = 5.0$	$\sigma_3 = 10.0$
$\rho = +0.6$	6.28%	15.5%	33.6%	44.4%	47.3%
$\rho = 0.0$	25.0%	31.2%	38.4%	45.0%	47.4%
$\rho = -0.2$	27.2%	32.9%	39.3%	45.2%	47.5%

contest. In this case, that is, when we are 70% positively correlated to both our competitors', but half as volatile, the remaining 100% − 9.7% = 93.3% of winning is split evenly between the two opponents, for an equal 46.65% chance of winning. Thus, a poor choice of either correlation of volatility on our end not only harms our chances of winning, but also obviously greatly enhances our opponents' positions. Clearly, there is a substantial amount of game theoretical implication when this contest is played by rational investors, each fully cognizant of their opponents' rationality. Casual empiricism suggests, as evidenced by comments made to the reporter in justifying their stock picks, that other contestants were not implementing this type of strategy, at least early on in the life of the contest.

A full analysis of the relevant game theory is beyond the scope of this article, and we refer the interested and brave reader to a series of papers by Browne (1999, 2000) for more information about maximizing the probability of beating the return from a given portfolio of stocks within a game-theoretic context. Our point here is to emphasize the impact of volatility above all.

Table 2 provides information similar to Table 1, except that we assume the correlation between our opponents' stock picks is *negative* 25%, albeit with equal volatility. Once again our probability of winning the contest depends on our stock's volatility $\{\sigma_3\}$, as well as the correlation with the other two stocks.

The most pertinent observation is that the probability of winning when our opponents have selected anticorrelated stocks is reduced at all levels of volatility. For example, in contrast to Table 1, if we select zero correlation with our opponents' ($\rho = \rho_{31} = \rho_{32}$), and we have all picked stocks with equal volatility, our probability of winning is reduced from 33.3% in Table 1 to 31.2% in Table 2. This might not seem like much of a change, but as we increase the number of contestants, the relative gap will become larger and more noticeable. It is important to note that the relationship between winning and correlation does not appear to be universally monotonic, even though the probability of winning does increase with reduced correlation in both Table 1 and Table 2. At extreme levels of opponents' correlations, there might be a reduced benefit to selecting even more negatively correlated stocks.

One thing is true regardless of all the other parameters in the system: the greater our stock's volatility, the greater our chances are of winning. Once again, the intuition for this fact is as follows. When selecting an extremely volatile stock, there are two possible outcomes: either our stock earns a very high (extremely positive) return, or we earn a very low (i.e., extremely negative) return. The odds of either outcome are roughly 50/50. If we achieve a favorable return and our overall correlation with our opponents' is negative, they will likely experience a worse relative to the mean, and we win (50% chance). This is why both high volatility and negative correlation is important. The first factor places us in the required extremes, whereas the second factor places our opponents on the other side.

2.1. Unknown opponents, the connection to beta and diversifiable risk

One of the issues that arises when implementing such a strategy in practice is that we are unlikely to be told in advance the name (and, hence, the historical volatility and correlation) of our opponent's stock. However, if we assume they will be selected randomly from the available market, and we obviously have to compete against the market index as a whole, then we can focus on two hypothetical opponents. The first is the market itself, and the second is a stock with some unknown *beta* relative to the market.

Recall that modern portfolio theory dictates that diversifiable (i.e., idiosyncratic) investment risk is not worth bearing since it is not compensated in economic equilibrium. Under this theory, which has been questioned by a number of recent studies such as Goyal and Santa-Clara (2003), the only risk that matters is systematic, and the expected return from any security is linearly related to its beta. The greater the beta, which is the covariance of the security's return with the general market portfolio, scaled by the variance of the security, the greater is the expect return. Thus, investors who are interested in maximizing expected returns without any concern for risk would optimally select securities with the highest beta. The mathematical definition of beta is:

$$\beta_i = \frac{Cov(X_i, X_m)}{Var(X_m)} = \frac{\rho_{im}\sigma_i}{\sigma_m}. \tag{1}$$

From a mathematical point of view, the beta of the stock is a function of three ingredients, as discussed earlier in our analysis: the correlation with the market portfolio, the standard deviation of the stock in question, and the standard deviation of the market portfolio.

Now, as we argued above, the optimal strategy in a contest with a zero-one payoff function is to locate a security with a negative correlation $\{\rho_{im}\}$ to our competitors' (i.e., the market), and with as high a volatility $\{\sigma_i\}$ as possible. Thus, the optimal strategy is to pick very volatile and possibly *negative beta stocks*. This, once again, is in stark contrast to the objectives of any portfolio or wealth manager who is interested in maximizing expected returns subject to some reasonable constraints on risk.

The theory is unambiguous in recommending a very risky strategy to maximize the probability of winning the contest. Indeed, regardless of the actual (known or unknown) level of the drift (as long as it is within the plausible ranges of expected returns), the covariance matrix will play a dominant role in the outcome of the contest. We now move on to examine the mechanics and actual choices made by participants in the *Globe and Mail* contest during the first eight years of the contest.

3. Which stocks did contestants actually choose?

As we explained in the introduction, the contest operates in the following manner. In late December of each year, the investment editor of the *Report on Business* tabulates the performance of the previous year's contestants and asks the top four or five to participate in the coming year's event and select another stock. In addition, the editor picks four or five other contestants (at random) from a broad range of practitioners and academics in Canada. This assures a reasonable amount of turnover in the pool of contestants (unless one of them continues winning). Occasionally, contestants decide not to participate in the following year's contest and voluntarily withdraw, even though they earned a top berth in the previous year. Each contestant must select a stock among all securities traded on the Toronto Stock Exchange (TSE), valued at more than $1. To add an element of humor, the editors select a young child from the *Globe and Mail's* extended family and ask them to randomly toss a toy at the stock quote pages. This becomes yet another contestant.[1] In the first year of the contest (1997), there were a total of 8 participants; the list was expanded to 9 for the period 1998 through 2003, and last year the total came to 10. Another complication that has only recently been added is the option to 'cash in' at the end of each quarter. This option was used for the first time in 2004 by the winning contestant. From a theoretical perspective, this "option" further complicates the optimal strategy because one must now decide what security to select in addition to if-and-when to eventually cash in. However, note that this option will *not* reverse our main conclusion about the optimality of high volatility and/or negative beta strategies because it effectively shrinks the contest horizon.

Table 3 displays the selections made by all participants since the inception of the contest, as well as the standard deviation (volatility) and betas of the selected stock that we have computed using textbook methods. The stocks are listed in the order of their final ranking and return. Not surprisingly, the winning stocks *always* outperformed the S&P/TSX market by a very wide margin, even in years when the market as a whole dropped in value. In most years, the winning stock earned well in excess of 100% return.

The common and erroneous perception from a casual examination of these tables is that financial experts (or at least the participants in these contests) are able to select winning stocks that consistently beat the market and earn handsome returns. Indeed, quite a few of the winners have marketed their success in this contest as evidence of their stock-picking prowess. Some winners have added this achievement to their public biography and CVs. Yet, as we have argued in the previous section, perceptions vis-a-vis optimal contest strategies are removed from the harsh reality of picking a well-diversified portfolio of stocks that earns positive risk-adjusted returns in the long-run.

In the 1997 contest, the winning stock (CFL) had a volatility of only 18% and a beta close to one, which would appear to negate our theoretical claims that a highly volatility and/or negative beta security is required to win the contest. However, note that our model only provides *stochastic predictions* and there is always a chance that the coin comes up "tails." More importantly, the losing stock in the 1997 contest (GNU) actually had the highest volatility of 78.7%, which is consistent with our theory, namely that a high volatility stock provides the best odds of coming in first or last. If the stock does not win, it is quite likely to be the worst performer. The high volatility places the probable outcomes on the extreme of the distribution and, therefore, one of two possible events occur. In 1998, once again, the highest volatility stock did not win the contest, but its (ATY) beta was, in fact, negative. More importantly, the two losing stocks (BWR and

Table 3
Stocks selected by contest participants, their volatility and final return

	Stock pick	Ticker	% Return	Beta	Volatility
1997 Contestants					
Patrick McKeough	**Corporate Foods**	**CFL**	**81.5%**	**1.09**	**18.3%**
Irwin Michael	Canadian Occidental Petroleum	CXY	48.0%	N/A	N/A
Steven Misener	Eurogas	EUG	32.0%	−0.47	66.9%
David Bissett	Foremost Industries	FMO	30.0%	N/A	N/A
Robert Millham	Hummingbird Communications	HUM	16.5%	0.28	43.4%
Robert Boaz	Carmanah Resources	CKM	11.0%	0.77	35.4%
	S&P/TSX Index		**9.7%**	1.00	11.6%
Ron Meisels	Stampeder Exploration	SDX	5.3%	1.34	33.4%
Josef Schachter	Golden Rule Resources	GNU	−86.6%	1.06	78.7%
1998 Contestants					
Colleen Moorehead	**ATI Technologies**	**ATY**	**110.9%**	**−0.55**	**29.3%**
Patrick McKeogh	Nova Corp.	NCX	47.1%	−0.05	20.6%
David Bissett	Tecsyn International	TSN	16.7%	−0.78	53.2%
Nebby The Cat	Pet Valu	PVC	10.2%	0.66	23.6%
Steven Misener	Tembec	TBC	7.7%	0.71	38.9%
	S&P/TSX Index		**0.4%**	1.00	15.0%
Sebastian van Berkom	Hummingbird	HUM	−34.6%	−0.76	47.8%
Irwin Michael	Alliance Forest	ALP	−37.7%	0.01	39.2%
Benj Gallander	Breakwater	BWR	−76.8%	−1.80	86.9%
Ian Ihnatowycz	American Eco	ECX	−82.8%	1.36	57.4%
1999 Contestants					
Steven Misener	**BCE Emergis**	**IFM**	**459.6%**	**0.37**	**85.4%**
David Bissett	Axia Netmedia	AXX	249.1%	−0.61	84.6%
David Driscoll	Patheon	PTI	112.9%	0.21	48.5%
Patrick McKeough	Toronto-Dominion Bank	TD	47.4%	0.43	48.7%
	S&P/TSX Index		**26.0%**	1.00	28.8%
Suzann Pennington	Sobeys	SBY	18.8%	−0.29	18.5%
Duncan Stewart	Mortice Kern Systems	MKX	17.0%	0.05	60.2%
Hannah Willis	Economic Investment Trust	EVT	−4.2%	0.01	34.0%
Norman Raschkowan	RealFund (Riocan REIT)	RFNU	−8.0%	1.11	40.1%
Colleen Moorehead	Newbridge Networks	NN	−30.2%	N/A	N/A
2000 Contestants					
Clockwork Santa	**Denbury Resources**	**DNR**	**179.2%**	**−1.56**	**45.4%**
Patrick McKeough	CAE	CAE	146.5%	−0.11	23.6%
Derek Webb	BCE	BCE	34.8%	−0.04	37.7%
Moshe Milevsky	Investors Group	IGI	26.2%	−0.31	27.2%
Ian Joseph	TD Bank	TD	12.1%	−0.10	37.0%
	S&P/TSX Index		**9.9%**	1.00	15.7%
Steven Misener	Int. Forest	IFP.A	−1.3%	−0.44	53.5%
David Driscoll	Maax	MXA	−23.6%	0.01	17.9%
David Bissett	Glendale Int.	GIN	−70.2%	0.41	58.1%
Richard Croft	Bid.com Int.	BII	N/A	N/A	N/A
2001 Contestants					
Veronika Hirsch	**Gulf Canada Resources**	**GOU**	**61.6%**	**0.39**	**42.7%**
Steven Misener	Interpape Polymer Group	ITP	20.5%	0.59	95.1%
Moshe Milevsky	Industral-Alliance Life	IAG	14.8%	0.14	21.7%
Sharon Ranson	TD Bank	TD	−5.5%	−0.18	28.7%
Jane the orangutan	Thomson	TOC	−15.8%	0.35	37.6%
Patrick McKeough	BCE	BCE	−16.8%	0.04	19.3%
	S&P/TSX Index		**−18.0%**	1.00	21.9%

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Table 3
(*continued*)

	Stock pick	Ticker	% Return	Beta	Volatility
Andrew McCreath	MosaidTechnologies	MSD	−60.2%	1.29	110.8%
Ian Joseph	Nortel	NT	−75.3%	0.85	60.3%
Rohit Sehgal	Ensign Resource	ESI	−75.9%	1.08	45.1%
2002 Contestants					
Moshe Milevsky	**Ketch Energy**	**KCH**	**108.3%**	**0.63**	**69.0%**
Sharon Ranson	Royal Bank of Canada	RY	11.6%	0.01	20.0%
Steven Misener	E-L Financial Corp.	ELF	8.7%	0.60	28.9%
Ron Meisels	AUR Resources	AUR	−2.4%	0.68	43.5%
Veronika Hirsch	Magna Int'l	MG.A	−12.9%	0.23	21.8%
	S&P/TSX Index		**−14.1%**	1.00	21.2%
Buzz Lightyear	Quebecor Inc.	QBR	−26.6%	−0.71	49.9%
Philip Strathy	Labopharm Inc.	DDS	−67.4%	−0.56	69.1%
Fabrice Taylor	Slater Steel	SSI	−69.8%	−0.28	40.9%
Malvin Spooner	GT Group Telecom	GTG.B	−100.0%	−0.96	166.1%
2003 Contestants					
Moshe Milevsky	**Canadian Superior Energy**	SNG	**117.3%**	**−2.00**	**102.4%**
David Skarica	Eldorado Gold Corp.	ELD	95.7%	0.29	76.0%
Leslie Scorgie	WestJet Airlines	WJA	76.2%	2.37	57.7%
Veronika Hirsch	Aber Diamond Corp.	ABZ	52.9%	0.02	27.2%
	S&P/TSX Index		**29.7%**	1.00	13.9%
Madeleine Northfield	Manulife Financial	MFC	21.2%	0.29	26.8%
Sharon Ranson	Sun Life Financial	SLF	20.2%	0.18	25.1%
Janis Mackey Frayer	Bombardier Inc.	BBD.B	2.4%	−1.24	39.9%
Ron Meisels	Aecon Group Inc.	ARE	−4.2%	0.18	34.8%
Nick Majendle	Stelco Inc.	STE.A	−35.0%	0.99	47.4%
2004 Contestants					
Rachel Willis	Husky Injection Molding Systems	HKY	−6.42%	2.17	43.5%
Moshe Milevsky	**Forbes Medi-Tech Inc.**	**FMI**	**179%**	**0.81**	**97.1%**
David Skarica	Tan Range Exploration Corp.	TNX	−32.93%	0.57	53.8%
Lesley Scorgie	Westjet Airlines Ltd.	WJA	−36.78%	1.78	35.0%
Veronika Hirsch	GMP Capital Corp.	GMP	+25.57%	N/A	N/A
Marco Den Ouden	Peyto Energy Trust	PEY	86.45%	1.49	24.1%
Yola Edwards	QLT Inc.	QLT	−21.51%	−0.24	49.9%
Michael Smedley	TSX Group Inc.	X	28.02%	N/A	N/A
Vincent Delisle	Killam Properties Inc.	KMP	17.82%	−1.66	60.5%
Amanda Lang	Biovail Corp.	BVF	−29.09%	−1.25	69.7%

The betas and volatilities are based on 12 months of historical returns prior to the start of the contest. For example, for Gulf Canada Resources, which was selected for the 2001 year contest, the beta and volatility figures are calculated based on year 2000 returns. However, calculations for AXX and SBI (1999 contest) are based on 1999 returns, and calculations for IAG (2001 contest) are based on 2001 returns. These exceptions are due to the lack of a complete set of data for the prior years, likely because of demutualizations or IPOs. Additionally, where N/A is stated in the table, it is due to a lack of stock price data. In the 2004 contest, the 179% return achieved was based on the lock-in value at the end of the first quarter of 2004.

ECX) had the highest volatility of 86.9% and 57.4%, respectively. Once again, volatility placed the outcome in the extremes. We emphasize, from a methodological point of view, that our volatility and beta was estimated using 12 months of data before the contest. Thus, the volatility of BWR and ECX in 1997, on the eve of the 1998 contest, was 86.9% and 57.4%, respectively. In fact, despite coming in dead last, they were both rational choices and excellent candidates to win such a contest.

In 1999, the winning stock (IFM) earned an astounding 459% return over the 12 months and was estimated to have a volatility (in 1998) of 85.4%. This volatility was the highest among the stocks selected for the 1999 contest and, in fact, is precisely what theory would predict. The highest volatility (and low beta) stock placed first. In the year 2000, once again, theory was vindicated with DNR winning the contest and having a volatility much higher than the market, as well as the most negative beta among the stocks selected that year. Note that information about bid.com, the worst stock, was unavailable. This is likely because it ceased trading during the year; that is yet another example of high volatility leading to extreme outcomes. In the year 2002, once again, the highest volatilities were at the extremes; in the year 2003, the highest volatility and lowest (negative) beta stock placed first. Finally, in 2004, the highest volatility stock placed first again. As pointed out in the Introduction, the winning stocks in 2004 (FMI), 2003 (SNG), and 2002 (KCH) were selected by the same individual, using a variant of the theoretical strategy described in the previous section.[2]

In summary, consistent with our theoretical arguments, it seems that the most volatile and negatively correlated (or at least low beta) stocks were among the winning (or extreme losing) circle in any given year.

4. Conclusion and implications for portfolio management

Portfolio selection and wealth management is about good stock picking, as well as balancing risk and return. But, in the context of investment contests, these qualities have little bearing on the outcome. And though at first glance it might appear that maximizing the probability of winning may seem like a reasonable and innocuous investment strategy to apply in one's daily life, a deeper examination reveals its flaws. Interestingly, if the contest would require each contestant to select two stocks, and their returns were averaged, a large part of this perverse incentive would be eliminated.

The implications of our analysis go far beyond the strategies required to win a popular game. Anecdotal evidence suggests that individual investors observe and then mimic the selections made by so-called expert participants in such contests. In fact, although our sample is statistically small, we found that the average daily volume, on the Monday following the announcement in the newspaper, for the stocks selected by the previous year's winner was 5 to 10 times the normal amount. These effects are consistent with an extensive and growing branch of research in the field of behavioral finance (see Barber and Odean (2000) or Rashes (2001), which document persistent biases, mistakes, and consumer susceptibility to noisy signals). Therefore, it is extremely important that professional fund managers, as well as the press who are involved in promoting and participating in these contests, emphasize the hazards of mimicking these stock picks with one's own investment portfolio. In fact, this was precisely one of the rationales for writing the current paper.

5. Epilogue

After winning for three years in a row, the first author of this paper retired from the contest in early January 2005 and decided not to (publicly) select a stock for the 2005 competition. And, although the *Globe and Mail* declared this to be an unprecedented feat,[3] we find that, using the optimal strategy described in the paper, the chances of a *three-peat* performance are (1/2)^3 = 1/8. This is close to 92 times greater than a naïve (1/9)^3 = 1/729 analysis would suggest.

One of the reasons for the (voluntary) retirement from the contest was that an earlier draft of this paper was circulated and widely discussed in the *Globe and Mail* during the summer of 2004. It appears that a number of contestants for the 2005 version of the contest decided (or perhaps learned) to implement some of the probabilistic strategies advocated in this paper. Namely, many of the securities selected for the 2005 contest are quite volatile and trading close to the minimum $1 limit. Indeed, discussions with the reporter writing the story for the newspaper suggest that this was their intention as well.

Recall that the basic ideas developed in this paper were predicated on the *other* competitors being somewhat ignorant and behaving in a nondynamic manner. So, in fine academic tradition, we leave these more elaborate games for future research.

Notes

1. In fact, in the year 2000, the winner of the contest was a windup toy Santa who enviously picked the company Denbury Resources and earned a total return of 179% during the year.
2. Note that in the years 2000 and 2001 the author did *not* select a stock based on the strategy advocated in this paper (and did not win the contest in those years). In fact, the volatility numbers were not much higher than market averages during that period.
3. See "Milevsky Bows Out on Top," *Globe and Mail*, Report on Business (6 January 2005), by David Pyette.

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Appendix

In this appendix, we briefly summarize the analytics behind the *probability of winning* when there are a total of (2 + 1) competitors in the contest (two opponents plus ourselves). The computations can be generalized from three to *n* stocks by scaling-up the integral described below. We start by denoting the stock picks of our two competitors by the symbols S_1 (μ, σ_1, ρ_{12}) and S_2 (μ_2, σ_2, ρ_{21}), where each stock is assumed to obey a LogNormal distribution (a.k.a. geometric Brownian motion) and parameterized by an expected return (drift), standard deviation (volatility), and correlation ($\rho_{12} = \rho_{21}$) with the other security. These are standard assumptions in financial theory and underlie the foundations of the Capital Asset Pricing Model (CAPM). At this point, our model is obviously predicated on actually *knowing* our opponents' selections. In the body of the paper, we discuss what to do when this knowledge is unavailable. Also, when dealing with *n* securities instead of (2 + 1), each stock would be characterized by its relation to all other stocks via a covariance matrix.

We must now select a third stock, denoted by S_3 (μ_3, σ_3, ρ_{31}, ρ_{32}), with the highest probability of beating the stocks selected by our two opponents. If we let $\tilde{S}_i$, $i = 1,2,3$ denote the random price of each of these stocks at the end of the contest (i.e., year-end) and then define $X_i = \ln[\tilde{S}_i/S_i]$, $i = 1,2,3$ to be the continuously compounded return, our problem boils down to computing the following:

$$w: = \Pr[X_3 > \max[X_1, X_2]]. \tag{1}$$

The variable (stock's investment return) X_3 will win the contest *if and only if* it beats the maximum of the two investment returns generated by the competitors. Note that by computing and working with logarithms of the actual stock price, we are transformed from a LogNormal environment into a world of Normality. Of independent interest is the quantity $R^* = E[\max(X_1,X_2,X_3)]]$, which is the investment return earned by the winner of the contest. It is relatively easy to show that $R^* > \max[\mu_1,\mu_2,\mu_3]$.

A multivariate normal random variable is defined and characterized by its expected return and covariance matrix. Formally, let:

$$\mathbf{c}: = \begin{pmatrix} \sigma_1\sigma_1 & \rho_{12}\sigma_1\sigma_2 & \rho_{13}\sigma_1\sigma_3 \\ \rho_{21}\sigma_2\sigma_1 & \sigma_2\sigma_2 & \rho_{23}\sigma_2\sigma_3 \\ \rho_{31}\sigma_3\sigma_1 & \rho_{32}\sigma_3\sigma_2 & \sigma_3\sigma_3 \end{pmatrix}, \tag{2}$$

where $C[i, j]$ denotes the entry in the i'th row and j'th column of the covariance matrix. Note, of course, that $\{\rho_{23} = \rho_{32}, \rho_{13} = \rho_{31}, \rho_{21} = \rho_{12}\}$ and the distinct notation in Eq. (2) is used for cosmetic purposes only. We now define the inverse covariance matrix **IC**: = *inv*(**C**), and follow the same convention for the individual terms $IC[i, j]$. Also, we let $D: = |\mathbf{IC}|$, which is the determinant of the inverse of the covariance matrix. It is relatively straightforward to confirm this in our three-asset case

$$D = -({\sigma_1}^2{\sigma_2}^2{\sigma_3}^2({\rho_{23}}^2 + {\rho_{12}}^2 + {\rho_{13}}^2 - 2\rho_{12}\rho_{13}\rho_{23} - 1))^{-1}. \tag{3}$$

Recall that the need for a positive semidefinite covariance matrix **C** imposes the algebraic condition of $D > 0$ which then translates into an admissible range of correlation values for the set $\{\rho_{31},\rho_{32}\}$. For example, when the standard deviations are all arbitrarily set to $\sigma_i = 1$, $I = 1,2,3$, and the correlation between the competitors' stocks is set to $\rho_{12} = 0$, the determinant is $D = 1/(2\rho^2 - 1)$, from Eq. (3), and the positive semidefinite condition imposed on the selected correlation collapses to the region $\{-1/\sqrt{2} < \rho < 1\sqrt{2}\}$ when ρ: $= \rho_{31} = \rho_{32}$. Thus, caution is warranted when 'solving' for the best parameters that blindly maximize the probability of winning in Eq. (1), since they may inadvertently fall in a region that is unacceptable from a covariance matrix perspective. Finally, we define the function:

$$Q(x_1,x_2,x_3|\mu_1,\mu_2,\mu_2,\sigma_1,\sigma_2,\sigma_3,\rho_{12},\rho_{31},\rho_{32}) = \sum_{i=1}^{3}\sum_{j=1}^{3}(x_i-\mu_i)IC[i,j](x_j-\mu_j) \tag{4}$$

In Eq. (4) is the usual quadratic form that is the basis of the ubiquitous normal distribution. Thus, for example, when all three correlations $\{\rho_{ij}\}$ and expected return $\{\mu_i\}$ parameters are set equal to zero and all three standard deviations $\{\sigma\}$ are set equal to one, Eq. (4) collapses to: $Q(x_1,x_2,x_3) = x_1^2 + x_2^2 + x_3^2$.

With this notation in hand, the tri-variate probability density function (pdf) for the normal distribution can be written as:

$$f(x_1,x_2,x_3) = \frac{\sqrt{D}}{(2\pi)^{3/2}}\exp\left\{-\frac{1}{2}Q(x_1,x_2,x_3)\right\}, \tag{5}$$

where the function $Q(x_1,x_2,x_3)$ in the exponent suppresses the parameters for notational simplicity. The probability the random return $\{X_3\}$ will beat the better of the two random returns $\{X_1,X_2\}$ can be computed by integrating the pdf in Eq. (5) over the region in which $x_3 > \max[x_1,x_2]$, which can be expressed in integral form as:

$$w = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{\max[x_1,x_2]}^{\infty} f(x_1,x_2,x_3)dx_3dx_1dx_2. \tag{6}$$

Finally, using geometric arguments and visualizing the region of interest in $\mathbf{R}^3$, the probability of winning the contest, w, can be rewritten as:

$$w = \int_{-\infty}^{\infty}\int_{-\infty}^{x_2}\int_{x_2}^{\infty} f(x_1,x_2,x_3)dx_3dx_1dx_2 + \int_{-\infty}^{\infty}\int_{x_2}^{\infty}\int_{x_1}^{\infty} f(x_1,x_2,x_3)dx_3dx_1dx_2 \tag{7}$$

Eq. (7) is the basis of the calculations described in the body of the paper. It can be used in a number of interesting ways. First, assuming a predetermined set of parameters, estimated using historical performance data, for the opponents' selections $\{\mu_1,\mu_2,\sigma_1,\sigma_2,\rho_{12}\}$, we can solve for the optimum combination of $\{\mu_3,\sigma_3,\rho_{31},\rho_{32}\}$ which maximizes w in Eq. (7), taking into account the restriction imposed by $D > 0$ and possibly some (realistic) limits on μ_3. We can then search among the available securities in the market (TSX, contest) that exhibit statistical behavior closest to the optimum parameters. Alternatively, we can start by estimating the $\{\mu_3,\sigma_3,\rho_{31},\rho_{32}\}$ parameters for each and every available security in the market, and then 'plugging' each estimated set into Eq. (7) and then finally picking the stock (i.e., parameter set) with the highest integral value (i.e., the probability of winning.) Of course, in a contest with more than (2 + 1) participants, the bounds of integration, as well as the precise integrand in Eq. (7) will have to be modified accordingly. In practice, for those who are interested in implementing this procedure in higher dimensions, we recommend using a symbolic computational language such as Maple [see Monagan, Geddes, Labahan, and Vorkoetter (1996) for a description of the software used to evaluate Eq. (7)].

Note that in the actual paper we have assumed the mean return parameters $\{\mu_1,\mu_2,\mu_3\}$ are all set to zero, thus our methodology remains agnostic about the ability to estimate the expected return for any given security over the short length of the contest. However, we stress that *even* if we were to arbitrarily plug-in a *reasonable* value for $\{\mu\}$ into Eq. (7), the volatility and correlation structure would have a much greater influence on the probability of winning.

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