Black Swans, Beta, Risk, and Return

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Beta has been a controversial measure of risk ever since it was proposed almost half a century ago, and we do not pretend to settle with this article what decades of research has not. We do, however, take advantage of the recent trend of investing in countries and industries through index funds and exchange-traded funds (ETFs), as well as a renewed interest on the impact of black swans, and explore the merits of beta in that context. Ultimately, we ask two questions: 1) Is beta a good measure of risk? And, 2) is beta a valuable tool for portfolio selection? Our evidence, spanning over 47 countries, 57 industries, and four decades finds beta to be useful in both dimensions. More precisely, when negative black swans hit the market, high-beta portfolios fall substantially more than low-beta portfolios; furthermore, a strategy that reacts to black swans by selecting portfolios on the basis of beta clearly outperforms a passive investment in the world market.

■"*The empirical record may indicate that markets are more complex than posited by the simple CAPM. But it seems highly unlikely that expected returns are unrelated to the risks of doing badly in bad times. In this broader sense, announcement of the death of beta appears to be highly premature*." Sharpe (2007).

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The debate on the empirical merits of the capital asset pricing model (CAPM) and its embedded measure of risk, beta, has been raging on for decades. In fact, the CAPM is arguably the model most widely and hotly debated in empirical finance literature. Whoever wants to defend or attack this model with evidence would find plenty to choose from.

Our goal in this article is far from attempting to settle this debate. Rather, we aim to evaluate beta both as a measure of risk and as a tool for portfolio selection in light of two rather-recent developments: The trend of investing in diversified portfolios of countries and industries through low-cost index funds and exchange-traded funds (ETFs), and a renewed interest on the impact of black swans on the performance of investors' portfolios.

In this context, we ultimately explore two issues. First, we ask whether beta is a good measure of risk, particularly when the latter is thought of as exposure to large market declines. More precisely, we explore whether high-beta portfolios of countries and industries fall more than low-beta portfolios when negative black swans hit the market. Second, we ask whether beta is a valuable tool for portfolio selection. More precisely, we explore whether a strategy that reacts to positive and negative black swans by investing in portfolios selected on the basis of beta outperforms a passive investment in the world market portfolio.

Our evidence, spanning over 47 countries, 57 industries, and four decades finds beta to be useful on both dimensions. We find that in the months in which negative black swans hit the market, high-beta portfolios of countries fall on average 350 basis points (bps) more than low-beta portfolios; in the case of industries, high-beta portfolios fall 610bps more than low-beta portfolios. Therefore, we find beta to be a useful

measure of risk in the sense of properly capturing exposure to the downside, and particularly to large and unexpected market declines.

We then test an investable strategy that reacts to negative black swans by investing in high-beta portfolios, and to positive blacks swans by investing in low-beta portfolios. We find that this beta-based strategy outperforms a passive investment in the world market by 430bps a year in the case of countries, and by 200bps a year in the case industries. In both cases, the beta-based strategy outperforms the passive investment in terms of returns and does not underperform in terms of risk-adjusted returns. Therefore, we find beta to be a valuable tool for portfolio selection.

As mentioned above, we do not pretend to settle the debate on the empirical merits of the CAPM and beta with this article. Yet from the perspective we look at it, we do find beta to be useful both as a measure of risk and as a tool for portfolio selection. To be sure, we view our conclusions about the usefulness of beta as being more relevant from a portfolio management perspective than from a corporate finance point of view.

The rest of the article is organized as follows. Section I discusses in more detail the issue at stake; Section II discusses our data and methodology; Section III discusses our main results; and Section IV provides an assessment. An appendix with tables and figures concludes the article.

I. The Issue at Stake

Few would dispute that the CAPM, originally proposed by Sharpe (1964), Lintner (1965), and Mossin (1966) is one of the cornerstones of modern financial theory.[1] Even fewer would dispute that the model is far from uncontroversial. In fact, a debate on its merits has been raging on for almost half a century, accumulating loads of research both supporting and rejecting the usefulness of beta.

We do not attempt here to review the enormous literature on the CAPM. Recent surveys by Levy (2010) and Subrahmanyam (2009) provide a thorough review and assessment of the main empirical contributions assessing the ability of beta to explain the cross-section of stock returns. For our purposes it suffices to say, as suggested before, that whoever wants to defend or attack the CAPM with evidence would find plenty to choose from.

For our purposes it is also relevant to highlight that a vast amount of research on the CAPM consists of methodological refinements of the approaches followed in previous research. These methodological battles, often resulting in contradictory results even when analyzing the same data, have certainly not helped to get practitioners interested in the debate. Because our aim is both to contribute to the academic literature and to influence practice, we follow here a very simple and intuitive approach. We have no new sophisticated econometric technique or methodological breakthrough to offer; rather, we hope to offer an approach appealing to both academics and practitioners out of our belief that it is essential to involve both in this debate.

A distinctive characteristic of our approach is the context on which we evaluate beta. We do not focus on individual stocks; rather, we focus on diversified indices of countries and industries. Furthermore, we do not just fall back on finance theory and assert that beta is a proper measure of risk; rather, we explore whether beta is a good measure of exposure to large and unexpected market declines. Finally, we do not test whether there is a positive and significant relationship between beta and returns; rather, we devise an investable strategy that uses beta as the single tool for portfolio selection, and compare its performance to a passive investment.

Much of the research on the CAPM focuses on forming portfolios of individual stocks. We take a somewhat different approach, focusing here on portfolios of countries and industries instead. We do this to account for the rather-recent possibility to invest in widely-diversified portfolios of countries and industries through low-cost index funds and ETFs. Although the portfolios we build and evaluate would have been very costly to assemble during most of our sample period, they are both feasible and cheap to build nowadays. Hence, we believe our results are relevant from a forward-looking perspective.

Furthermore, we seek to bring black swans into our analysis. Interest in these large and unexpected swings in asset values has been revived after the publication of Taleb's (2007) book, *The Black Swan*; see, for example, Estrada (2008, 2009a, 2009b). To be sure, we are not the first to explore the merits of beta in the presence of large market fluctuations; both Chan and Lakonishok (1993) and Grundy and Malkiel (1996) also do so, and conclude that beta properly captures the downside potential of portfolios during periods in which markets fall substantially. Our results confirm and expand their findings.

The context on which we analyze the usefulness of beta, then, consists of diversified country and industry indices as well as a special focus on black swans. Within this framework, we first evaluate the usefulness of beta as a measure of risk by assessing the impact of black swans on portfolios of countries and industries sorted by beta. We then evaluate the usefulness of beta as a tool for portfolio selection by assessing a strategy that reacts to black swans by investing in portfolios of countries and industries selected on the basis of beta. As mentioned above, and explored in detail below, we find beta to be useful on both counts.

[1] Credit for the CAPM is often also given to Treynor (1961) and Black (1972).

Table I. Black Swans

This exhibit shows all the black swans considered, ordered chronologically. A black swan is defined as a monthly return in the world market higher than or equal to 5% in absolute value. The world market is the MSCI index of developed markets between January 1970 and December 1987, and the MSCI index of both developed and emerging markets between January 1988 and December 2009. For countries, all 99 black swans are relevant; for industries, only the 38 black swans after (and including) February 1998 are relevant. All returns in dollars and in %.

Date	Return	Date	Return	Date	Return	Date	Return
Nov/73	–12.9	May/84	–7.4	Dec/91	7.4	Nov/01	6.1
Jul/74	–5.8	Aug/84	10.1	Mar/93	5.7	Jun/02	–6.1
Aug/74	–9.5	Jan/85	5.6	Nov/93	–5.2	Jul/02	–8.4
Sep/74	–9.2	May/85	5.2	Dec/93	5.4	Sep/02	–11.0
Oct/74	9.7	Oct/85	5.4	Jan/94	6.6	Oct/02	7.4
Jan/75	14.7	Nov/85	5.6	Nov/96	5.3	Nov/02	5.5
Feb/75	9.0	Feb/86	9.0	May/97	6.0	Apr/03	8.9
Jul/75	–5.4	Mar/86	9.8	Jun/97	5.1	May/03	5.8
Oct/75	7.0	Aug/86	8.8	Aug/97	–7.0	Oct/03	6.1
Jan/76	9.0	Jan/87	11.8	Sep/97	5.3	Dec/03	6.3
Dec/76	7.6	Mar/87	6.2	Oct/97	–6.0	Nov/04	5.5
Jul/78	7.3	Apr/87	5.9	Feb/98	6.8	Sep/07	5.4
Oct/79	–7.3	Aug/87	5.9	Aug/98	–14.0	Jan/08	–8.2
Jan/80	6.1	Oct/87	–17.0	Oct/98	9.1	Apr/08	5.7
Mar/80	–10.6	Feb/88	5.8	Nov/98	6.1	Jun/08	–8.2
Apr/80	6.7	Aug/88	–5.5	Oct/99	5.1	Sep/08	–12.5
May/80	5.1	Oct/88	6.6	Dec/99	8.3	Oct/08	–19.8
Sep/81	–7.4	Jul/89	11.3	Jan/00	–5.4	Nov/08	–6.5
Feb/82	–6.0	May/90	10.4	Sep/00	–5.5	Feb/09	–9.7
Apr/82	5.0	Aug/90	–9.4	Nov/00	–6.2	Mar/09	8.3
Aug/82	7.4	Sep/90	–10.4	Feb/01	–8.4	Apr/09	11.9
Oct/82	7.0	Oct/90	9.2	Mar/01	–6.7	May/09	10.1
Nov/82	5.4	Feb/91	9.4	Apr/01	7.3	Jul/09	8.8
Apr/83	7.2	Jun/91	–6.1	Sep/01	–9.1		

II. Data and Methodology

In this section, we first describe our data, define a black swan from an empirical perspective, and briefly discuss the black swans we consider. We then describe the methodology we use to assess the usefulness of beta as a measure of risk and as a tool for portfolio selection, focusing here on the main aspects and leaving some details for the next section.

A. Data and Black Swans

Our sample consists of the entire MSCI database of countries and industries. We consider monthly returns on 47 countries (23 developed and 24 emerging) and 57 industries (based on companies from both developed and emerging markets) over the whole sample period available for each. Although not all series start at the same time, in all cases the data goes through December 2009. Exhibit A1 in the appendix shows all the countries and industries in our sample, the month in which the return data begins for each of them, and some summary statistics. All monthly returns are in dollars and account for both capital gains and dividends.

Our benchmark portfolio, used both to determine the black swans we consider and to play the role of the passive investment when evaluating our beta-based strategy, is the MSCI world (equity) market index. Due to data availability, between January 1970 and December 1987 we use a world market portfolio consisting only of developed markets; from that point on, between January 1988 and December 2009, we use a world market portfolio consisting of both developed and emerging markets. As is the case with the rest of our data, the returns of the world market portfolio are in dollars and account for both capital gains and dividends.

The first step in our inquiry is to identify the relevant black swans. Taleb (2007) defines a black swan as an event with three attributes: 1) It is an outlier, lying outside the realm of regular expectations because nothing in the past can convincingly point to its occurrence; 2) it carries an extreme impact; and 3) despite being an outlier, plausible explanations for its occurrence can be found after the fact, thus giving it the appearance that it can be explainable and predictable. In short, a black swan has three characteristics: rarity, extreme impact, and retrospective predictability.

This definition is illustrative but not operational. We therefore arbitrarily define a black swan as a monthly return in the world market higher than or equal to 5% in absolute value. Because we need to compute betas and we do so with a minimum of 36 months, we look for black swans only during the January 1973 to December 2009 period; that is, excluding the first three years of data. Given our definition, we find a total of 99 black swans, all of which are reported on Table I. All these black swans are relevant for our analysis across countries, but given that the sample period for industries is shorter than that for countries, only those black swans after (and including) February 1998 are relevant for our analysis across industries.[2]

In the case of countries, of the 99 black swans we identify, 63 are positive (monthly returns higher than or equal to 5%) and 36 are negative (monthly returns lower than or equal to –5%). Positive and negative black swans average 7.3% and –8.6%. A runs test cannot reject the null hypothesis of randomness (at a 5% confidence level, the test statistic of -0.62 is within the critical values of ±1.96), indicating that a positive or negative black swan has no information useful to determine the sign of the next black swan.

In the case of industries, due to their shorter history, only 38 of the 99 black swans are relevant, 21 of which are positive (averaging 7.2%) and 17 negative (averaging –9.1%). Again, a runs test indicates that black swans are unpredictable in sign (at at 5% confidence level, the test statistic of -1.59 is within the critical values of ±1.96), with the occurrence of one carrying no information about the sign of the next.

The black swans in the sample are dependent on our definition for these events. It may be argued that black swans are very rare events, and that observing as many as we do in our sample is not consistent with such definition. The point is well taken. Our focus is on outliers or large market fluctuations, which many investors nowadays refer to as black swans. Importantly, there is no operational or quantitative definition of a black swan, which makes all definitions rather arbitrary; ours is no exception.

It may be argued that a monthly fluctuation of |5%| in the world market is not large enough to qualify as a black swan. When choosing |5%| as the minimum monthly return to define a black swan, we attempted to strike a balance between two things: On the one hand, we did not want to end up with a sample with so many black swans that they could hardly be thought of as large and unexpected; on the other hand, we wanted to end up with a sample with enough black swans so that we could have many events to average across. To illustrate, if we had defined blacks swans as monthly returns in the world market of at least |10%|, we would have had only 15 events (8 negative and 7 positive) between January 1973 and December 2009, relevant for countries; and only 6 events (4 negative and 2 positive) between January 1998 and December 2009, relevant for industries.

B. Methodology

In order to determine whether beta is a useful measure of risk, we assess the impact of negative black swans on diversified portfolios of countries and industries sorted by beta. More precisely, we explore whether high-beta portfolios fall more than low-beta portfolios when the market declines substantially, as theory would lead us to expect.[3]

In a nutshell, our procedure is as follows. Every time a negative black swan hits the market we estimate betas for each country in our sample on the basis of the 60 months previous to, but not including, the black swan month.[4] We then rank all countries by those betas; split them into four portfolios, one containing the high-beta countries, another containing the low-beta countries, and two portfolios in between; and calculate the return of each portfolio for the black swan month as an equally-weighted average of the returns of the countries in each portfolio during that month.[5] This yields one return for each of the four portfolios for each negative black swan, and we finally average the returns of each portfolio across all negative black swans. This yields

[2] The return data for industries starts in January 1995, but again we exclude the first three years to allow for the estimation of betas. Thus, for industries, we look for black swans during the January 1998 to December 2009 period and we find the first on February 1998.

[3] Some may argue that exploring this issue is pointless because theory does lead to expect a positive relationship between beta and returns. Needless to say, Fama and French (1992) and a vast literature both before and after them report evidence inconsistent with this expectation. In other words, what theory may lead us to expect may or may not be what the data shows, and in the case of beta, there is a huge amount of evidence of both sides of the fence. Hence, we want to explore with our data, focus, and methodology whether there is in fact a positive relationship between beta and returns.

[4] When the data does not allow for the estimation of 60-month betas, we estimate them with as many months as possible but never with less than 36 months. All betas are estimated relative to the world market portfolio.

[5] Whenever possible we allocate the same number of countries to each of the four portfolios. When this is not possible, we allocate the same number of countries to the riskiest and the least risky portfolios, and the rest of the countries to the two portfolios in the middle, always trying to keep the four portfolios as similar as possible in terms of the number of countries in each.

the average decline for the riskiest (high-beta) portfolio, the least risky (low-beta) portfolio, and the two portfolios in between.

For reasons to be discussed below, we repeat this whole procedure also for positive black swans. And we finally repeat it again, for both negative and positive black swans, for our sample of industries. At the end of this first step we are able to assess whether beta is a good measure of risk when the latter is thought of as exposure to the downside during turbulent periods. Throughout this analysis, our focus is on economic (rather than statistical) significance.

In our second step, we assess whether beta is a valuable tool for portfolio selection. To this purpose we devise an investable strategy based on beta that also accounts for the well-known pattern of mean reversion; that is, the tendency of equity markets to revert to their long-term mean, as documented by Siegel (2008) and many others. In the presence of mean reversion we would expect markets to eventually rise after negative black swans and fall after positive black swans. In fact, we would expect high-beta portfolios to rise more than low-beta portfolios after negative black swans; and low-beta portfolios to decline less than high-beta portfolios after positive black swans.

This reasoning leads us to the following simple strategy (which we describe only for countries because it is similar for industries): After negative black swans, invest in a portfolio of high-beta countries, thus obtaining exposure to the countries expected to rise the most; after positive black swans, invest in a portfolio of low-beta countries, thus obtaining exposure to the countries expected to fall the least; and between black swans, simply hold whatever portfolio was formed after the last black swan.

In order to implement this strategy, right after each black swan we estimate betas for all countries; rank all countries by those betas; split them into four portfolios, one containing the high-beta countries, another the low-beta countries, and two portfolios in between; and invest in the portfolio of high-beta countries or low-beta countries depending on the sign of the black swan just observed.[6] The benchmark against which we compare this strategy is a passive (buy-and-hold) investment in the world market portfolio.

Note that when consecutive black swans are of different sign, we switch from a high-beta portfolio to a low-beta portfolio, or the other way around. Also, note that even if consecutive black swans are of the same sign we may still rebalance our portfolio. This is the case simply because betas change over time, and which are the countries with the highest and lowest betas may change between black swans. In other words, we make sure that we are properly exposed to the riskiest or least risky countries after each black swan.

Everything we just described for countries we then repeat for industries. At the end of this second step we will be able to assess the merits of our strategy relative to a passive investment in the world market, and, therefore, whether beta is a valuable tool for portfolio selection. As in our first step, our focus is on economic (rather than statistical) significance.

III. Evidence

In this section we first assess the merits of beta as a measure of risk and then as a tool for portfolio selection, in both cases focusing on countries. Subsequently, as a robustness test, we evaluate beta on both counts by focusing on industries.

A. Beta As a Measure of Risk – Countries

The first step in our inquiry is to ask whether beta is a good measure of risk, particularly when the latter is thought of as exposure to large and unexpected market declines. Chan and Lakonishok (1993) suggest that extensive conversations with money managers indicate that their main concern is downside risk. Furthermore, Grundy and Malkiel (1996) suggest that most investors think of risk as the possibility of losing money in a declining market. Our question is, precisely, whether beta is a proper measure of risk in this context.

Following the methodology outlined in Section II, we explore the performance of country portfolios sorted by beta when negative black swans hit the market. Because we estimate betas on the basis of the 36-to-60 months previous to, but not including, the black swan months, we are able to determine the impact of large market declines on *existing* portfolios of high-beta and low-beta countries.

As mentioned in Section I, during the relevant sample period there are 36 negative black swans as measured by monthly declines in the world market portfolio, averaging an 8.6% fall. Our question, then, is whether high-beta portfolios fell, on average across all 36 events, more than low-beta portfolios; our results are summarized in Panel A of Table II.

Across all 36 negative black swans, high-beta portfolios (P1) and low-beta portfolios (P4) have average betas of 1.50 and 0.54. P2 and P3, the two portfolios in between, have average betas of 1.10 and 0.88. The decline in average betas from P1 to P4 is of course by construction; that is, right before each black swan countries were ranked by beta, the 25% with highest betas were assigned to P1, the 25% with

[6] As before, whenever possible we allocate the same number of countries to each portfolio. When this is not possible, we allocate the same number of countries to the riskiest and the least-risky portfolios, and the rest of the countries to the two portfolios in the middle, always trying to keep the four portfolios as similar as possible in terms of the number of countries in each. Also as before, we estimate betas relative to the world market portfolio and with as many months as possible, but never with less than 36 months or more than 60 months. The only difference with respect to what we do in our first step is that in this second step we estimate all betas as of the end of (that is, including) the black swan month.

Table II. Beta and Risk – Countries

This exhibit shows, in panel A, the average beta and average decline of the four country portfolios considered across 36 negative black swans; and in panel B, the average beta and average rise of those portfolios across 63 positive black swans. P1 and P4 denote the portfolios of high-beta and low-beta countries, and P2 and P3 two portfolios in between. The world market and the black swans considered are those described on Table I.

Panel A. Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.50	1.10	0.88	0.54	
Return	–8.6%	–10.6%	–9.2%	–8.2%	–7.1%	–3.5%
Panel B. Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.42	1.05	0.86	0.53	
Return	7.3%	9.8%	7.1%	7.1%	5.4%	4.4%

the next-highest betas to P2, and so forth.

In terms of returns, and again averaging across all 36 events, the relationship between beta and return is strictly negative and monotonic. On average, high-beta portfolios fell by 10.6% and low-beta portfolios by 7.1%, in both cases relative to a decline of 8.6% for the world market. In other words, on average, high-beta portfolios fell 200bps more than the market, and low-beta portfolios fell 150bps less than the market. The 350bps monthly spread between P1 and P4 is, needless to say, substantial from an economic point of view.[7] As theory would lead us to expect, then, beta appears to properly capture the risk that concerns money managers and investors in general; that is, exposure to large and unexpected market declines.

Panel B of Table II shows the performance of high-beta and low-beta portfolios when 63 positive black swans, with an average rise of 7.3%, hit the market. On average across all 63 events, high-beta portfolios rose by 9.8% (250bps more than the market) and low-beta portfolios by 5.4% (190bps less than the market). The 440bps spread between P1 and P4 is, as was the case for negative black swans, substantial from an economic point of view.[8]

Importantly for the strategy we evaluate below, note that Table II shows that when negative black swans hit the market, high-beta portfolios fall the most; that is, their prices are those punished most severely. On the other hand, when positive black swans hit the market, low-beta portfolios rise the least; that is, their price run-ups are the least excessive. We will get back to these two facts below.

B. Beta As a Tool for Portfolio Selection – Countries

The second step in our inquiry is to ask whether beta is a valuable tool for portfolio selection by following the methodology outlined in Section II. We kick-off the horse race by investing $100 in our strategy and in the world market portfolio (the passive benchmark) after the first relevant black swan hits the market, on November 1973. More precisely, at the very beginning of December 1973, we estimate betas for all countries, rank countries by those betas, and split them into four portfolios.[9] Given that November 1973 is a negative black swan, and that in the presence of mean reversion we would expect stocks to eventually rebound from this large decline, we invest $100 in the portfolio of high-beta countries (and at the same time another $100 in the world market portfolio), thus obtaining exposure to the countries expected to rebound the most.

We hold this (high-beta) portfolio until the next black swan hits the market (July 1974), and then at the very beginning of August 1974 we again estimate betas, rank countries by those betas, and split them into four portfolios. Given that August 1974 is another negative black swan, we position our accumulated funds in the high-beta portfolio again.[10] We keep repeating this process until the end of our sample period (December 2009), at which point we evaluate the performance of our strategy and that of the passive benchmark. The results of this evaluation are summarized in Table III and in Exhibits A2 and A3 in the appendix.

[7] Interestingly, during October 2008 (our largest negative black swan, when the world market dropped 19.8%), the high-beta portfolio fell by 30.8% and the low-beta portfolio by 19.7%, for a very substantial spread of 1,110bps.

[8] Although the table shows P2 and P3 as rising by the same amount when the results are rounded to one decimal, P2's average rise of 7.14% is actually slightly higher than P3's average rise of 7.10%.

[9] Importantly, note that all our portfolios are built solely on the basis of information that would have been available to investors at the time of construction; therefore, ours is an investable strategy.

[10] The first time we position our funds in a low-beta portfolio is after the October 1974 positive black swan, and we do so, as discussed before, in order to gain exposure to the countries expected to fall the least.

Table III. Beta and Performance – Countries

This exhibit summarizes the performance of our strategy (Strategy) and that of the passive investment in the world market portfolio (World) over the 433 months between December 1973 and December 2009. For both series of monthly dollar returns panel A shows the arithmetic mean return (AM), geometric mean return (GM), standard deviation (SD), beta with respect to the world market (Beta), semideviation for a benchmark of 0% (SSD), minimum (Min) and maximum (Max) return, and coefficients of standardized skewness (SSkw) and standardized kurtosis (SKrt). Panel B shows the annualized standard deviation (ASD) and annualized geometric mean return (AGM); the terminal value (TV) at the end of December 2009 of $100 invested at the beginning of December 1973; the terminal value of $100 invested at AGM after any hypothetical period of 10 (TV10), 20 (TV20), and 30 (TV30) years; and risk-adjusted returns based on SD (RAR1=AM/SD) and SSD (RAR2=AM/SSD).

Panel A. Performane Measures

	AM	GM	SD	Beta	SSD	Min	Max	SSkw	SKrt
World	0.9%	0.8%	4.4%	1.00	2.9%	–19.8%	14.7%	–4.9	8.2
Strategy	1.3%	1.1%	5.5%	0.96	3.6%	–31.2%	21.7%	–8.2	22.8

Panel B. Performance Measures (Continued)

	ASD	AGM	TV	TV10	TV20	TV30	RAR1	RAR2
World	15.2%	10.1%	$3,210	$262	$684	$1,788	0.21	0.31
Strategy	19.2%	14.4%	$12,834	$384	$1,474	$5,661	0.23	0.35

Panel A shows that over the evaluation period of 433 months, our strategy delivered a higher arithmetic and geometric mean return than the passive investment, and it did so with somewhat higher risk, regardless of whether the latter is measured by the standard deviation, the semideviation, the minimum return, or the fatness of the tails as measured by the coefficient of standardized kurtosis.[11] As shown in Panel B, the annualized volatility of our strategy was 4 percentage points higher than that of the passive investment (19.2% versus 15.2%).

Panel B also shows that our strategy delivered an annualized return of 14.4%, outperforming the 10.1% annualized return of the passive investment by a very substantial 430bps a year. The $100 invested in our strategy at the beginning of December 1973 would have turned into $12,834 by December 2009, almost exactly four times as much as the $3,210 we would have obtained from the passive investment.[12] There is something to be said about a strategy that outperforms a passive investment by such a substantial margin.

Finally, Panel B suggests that our strategy also outperformed the passive investment in terms of risk-adjusted returns, regardless of whether risk is measured by volatility or downside volatility. If risk is measured by the standard deviation, the 0.23 risk-adjusted return of our strategy outpaced (by 13%) the 0.21 of the passive investment; if risk is measured by the semideviation instead, the 0.35 risk-adjusted return of our strategy also outpaced (by 12.2%) the 0.31 of the passive investment. That being said, a test for a difference in Sharpe ratios does not reject the equality of risk-adjusted returns, at least when risk is measured by volatility.[13]

A few remarks are in order. First, as discussed before, note that our strategy seeks to be exposed to high-beta countries when the market is expected to rise (after negative black swans), and to low-beta countries when the market is expected to fall (after positive black swans). Note that, at the same time, our strategy tends to buy the countries whose prices have fallen the most or risen the least. This is the case because we form our portfolios *after* observing black swans. Table II shows that the portfolios that fall the most during negative black swans are those with high beta; these are precisely the portfolios we buy after negative black swans in order to profit the most from the expected recovery. Similarly, Table II shows that the portfolios that rise the least during positive black swans are those with low beta; and these are precisely the portfolios we buy after positive black swans in order to minimize the impact of the expected downturn. Thus, our strategy tends to buy relatively cheap assets in the sense that their prices have fallen the most or risen the least.

It is important to note that we *tend to* buy the countries whose prices have fallen the most or risen the least, although we do not necessarily do that in every case. In order to do that, instead of focusing on beta we would have to focus

[11] The semideviation measures volatility below, but not above, any chosen benchmark. All semideviations in this article are calculated for a benchmark of 0% and therefore measure volatility below that benchmark. For a practical introduction to the semideviation, see Estrada (2006).

[12] Panel B also shows the terminal value of $100 invested at the annualized returns (AGM) shown in this panel after any hypothetical investment period of 10, 20, and 30 years.

[13] This conclusion follows from the Jobson-Korkie-Memmel test; see Memmel (2003).

Table IV. Beta and Risk – Industries

This exhibit shows, in panel A, the average beta and average decline of the four industry portfolios considered across 17 negative black swans; and in panel B, the average beta and average rise of those portfolios across 21 positive black swans. P1 and P4 denote the portfolios of high-beta and low-beta industries, and P2 and P3 two portfolios in between. The world market and the black swans considered are those described on Table I.

Panel A. Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.49	1.03	0.81	0.42	
Return	–9.1%	–11.4%	–9.4%	–8.6%	–5.3%	–6.1%
Panel B. Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.48	1.04	0.83	0.47	
Return	7.2%	9.4%	7.8%	6.3%	4.0%	5.4%

on returns. However, our goal in this article is to evaluate beta as a tool for portfolio selection, and, therefore, we base our strategy solely on this magnitude. That being said, Table II shows that high-beta countries *tend to be* (though not necessarily are in every case) those whose prices fall the most during negative black swans; and low-beta countries *tend to be* (but again not necessarily are in every case) those whose prices rise the least during positive black swans.

Secondly, as discussed earlier, our strategy buys low-beta stocks after positive black swans in order to minimize the impact of a market that is expected to decline. Arguably, in these circumstances we could enhance the returns of our strategy (and most likely lower its volatility) by parking our accumulated funds in cash or bonds rather than investing them in a low-beta portfolio. Yet again, because of our focus in on beta, we decided to implement the latter.

Thirdly, the figures on Table III do not account for the transaction costs of our strategy or those of the passive investment. Although typically ignored, a passive investment would still incur in the annual cost of the relevant index fund or ETF (the world market portfolio is currently investable through at least two ETFs whose annual expense ratio is around 30-35bps). Our strategy, which rebalances the portfolio after each black swan, would have incurred in higher transaction costs, but nothing even remotely close to the 430bps annual outperformance over the passive investment.

Finally, although we do not test formally for mean reversion, our results imply that it is present in the data. We do not explore this issue further simply because it is not one of our goals in this article. That being said, our beta-based strategy is expected to outperform the passive investment only in the presence of mean reversion, not in the presence of random walks. We take no preliminary view on whether either process is present in the data; we simply run a horse race between our strategy and a passive investment, find that our strategy outperforms, and highlight that our results imply the presence of mean reverting returns.

C. Robustness Test – Industries

The results discussed so far support beta both as a measure of risk and as a tool for portfolio selection. However, as is usually the case with empirical studies, one might wonder whether the results would have been more or less supportive if we had defined black swans, or estimated betas, or formed portfolios in a different way. Rather than replicating all of our work for countries after defining black swans differently, or estimating betas over a longer or shorter period of time, or forming portfolios using another criterion, we chose to repeat all of our work for countries on an entirely different dataset. Here is where the 57 industries mentioned in Section II come in.

As a robustness test, everything we run for countries we re-run for industries. As mentioned in Section II, there are 17 negative black swans during the relevant (January 1998 to December 2009) period, averaging –9.1%. Panel A of Table IV summarizes the results of our new inquiry about the usefulness of beta as a measure of risk. As the exhibit shows, across all 17 events, high-beta portfolios (P1) and low-beta portfolios (P4) have average betas of 1.49 and 0.42. P2 and P3, the two portfolios in between, have average betas of 1.10 and 0.81.

In terms of returns, averaging across all 17 events, the relationship between beta and return is again strictly negative and monotonic. On average, high-beta portfolios fell by 11.4% and low-beta portfolios by 5.3%, in both cases relative to a decline of 9.1% for the world market. In other words, on average, high-beta portfolios fell 230bps more than the market, and low-beta portfolios fell 380bps less than the market. The 610bps monthly spread between P1 and P4 is obviously substantial from an economic point of view. Thus,

Table V. Beta and Performance – Industries

This exhibit summarizes the performance of our strategy (Strategy) and that of the passive investment in the world market portfolio (World) over the 142 months between March 1998 and December 2009. For both series of monthly dollar returns panel A shows the arithmetic mean return (AM), geometric mean return (GM), standard deviation (SD), beta with respect to the world market (Beta), semideviation for a benchmark of 0% (SSD), minimum (Min) and maximum (Max) return, and coefficients of standardized skewness (SSkw) and standardized kurtosis (SKrt). Panel B shows the annualized standard deviation (ASD) and annualized geometric mean return (AGM); the terminal value (TV) at the end of December 2009 of $100 invested at the beginning of March 1998; the terminal value of $100 invested at AGM after any hypothetical period of 10 (TV10), 20 (TV20), and 30 (TV30) years; and risk-adjusted returns based on SD (RAR1=AM/SD) and SSD (RAR2=AM/SSD).

Panel A. Performance Measures

	AM	GM	SD	Beta	SSD	Min	Max	SSkw	SKrt
World	0.4%	0.3%	4.9%	1.00	3.6%	–19.8%	11.9%	–4.2	4.4
Strategy	0.6%	0.5%	5.1%	0.90	3.8%	–25.1%	12.3%	–6.7	13.5

Panel B. Performance Measures (Cont.)

	ASD	AGM	TV	TV10	TV20	TV30	RAR1	RAR2
World	17.0%	3.8%	$155	$145	$209	$303	0.09	0.12
Strategy	17.7%	5.8%	$195	$176	$309	$542	0.12	0.16

these results for industries strengthen the previous ones for countries and reinforce the fact that beta is a good measure of exposure to large and unexpected market declines.

Panel B of Table IV summarizes the performance of high-beta and low-beta portfolios when 21 positive black swans, averaging 7.2%, hit the market. On average across all 21 events, high-beta portfolios rose by 9.4% (220bps more than the market) and low-beta portfolios by 4.0% (320bps less than the market). The 540bps spread between P1 and P4 is again substantial from an economic point of view.

Finally, Table IV shows that when negative black swans hit the market, high-beta portfolios fall the most; and when positive black swans hit the market, low-beta portfolios rise the least. As was the case for countries, then, the beta-based strategy we evaluate immediately below benefits from buying assets whose prices have fallen the most or risen the least.

The investable strategy, identical to that implemented before for countries but now applied to industries, again reacts to negative black swans by investing in high-beta portfolios, and to positive black swans by investing in low-beta portfolios. The benchmark against which we compare the performance of this strategy is again a passive investment in the world market portfolio. Table V and Exhibit A4 in the appendix summarize the results of our new inquiry about the usefulness of beta as a tool for portfolio selection.

As was the case for countries, Panel A shows that our strategy delivered a higher arithmetic and geometric mean return than the passive investment, and it did so with somewhat higher risk regardless of whether the latter is measured by the standard deviation, the semideviation, the minimum return, or the fatness of the tails as measured by the coefficient of standardized kurtosis. Importantly, as Panel B shows, our strategy had an annualized volatility less than one percentage point higher than the passive investment (17.7% versus 17.0%).

Panel B also shows that our strategy delivered an annualized return of 5.8%, outperforming the 3.8% return delivered by the passive investment by 200bps a year. Thus, $100 invested in our strategy at the beginning of March 1998 would have turned into $195 by December 2009, over 25% more than the $155 we would have obtained from the passive investment.

Finally, Panel B suggests that our strategy also outperformed the passive investment in terms of risk-adjusted returns, regardless of whether risk is measured by volatility or downside volatility. If risk is measured by the standard deviation, the 0.12 risk-adjusted return of our strategy outpaced (by 35.4%) the 0.09 of the passive investment; if risk is measured by the semideviation instead, the 0.16 risk-adjusted return of our strategy also outpaced (by 32.6%) the 0.12 of the passive investment.[14] Thus, these results for industries again strengthen the previous ones for countries and reinforce the fact that beta is a valuable tool for portfolio selection.

IV. An Assessment

The debate on the usefulness of beta as a measure of risk, and on the CAPM as an appropriate model to estimate required returns, has been raging on for decades. No single

[14] That being said, as before, the difference in risk-adjusted returns is not significant, at least when risk is measured by volatility, according to the Jobson-Korkie-Memmel test.

paper can be expected to settle this controversy and ours is no exception. Reasonable people must ultimately balance the empirical arguments in favor of and against beta, and our paper may be viewed as adding a straw that tilts a little, in favor of beta, the scale that weighs the evidence on this contentious issue.

A distinctive characteristic of our approach is the context on which we evaluate beta. We do not focus on individual stocks but on diversified portfolios of countries and industries. We do not start from the presumption that beta is a proper measure of risk but explore whether it properly captures exposure to the downside. And we do not test whether beta and returns are significantly related but devise a beta-based strategy and ask whether it outperforms a passive investment.

Our evidence spans over 47 countries, 57 industries, and four decades and supports the usefulness of beta both as a measure of risk and as a tool for portfolio selection. High-beta portfolios do fall substantially more than low-beta portfolios when the market is hit by negative black swans. The difference ranges from 350bps (for countries) to 610bps (for industries) a month, clearly substantial from an economic point of view.

Furthermore, an investable strategy that reacts to negative black swans by investing in high-beta portfolios, and to positive black swans by investing in low-beta portfolios, does outperform a passive investment in the world market. The difference in returns ranges from 200bps (for industries) to 430bps (for countries) a year, again substantial from an economic point of view.

From the perspective we look at it, beta does seem to be a good measure of risk, at least in the sense of properly capturing the exposure to large and unexpected market declines that concerns portfolio managers and investors at large. And it does seem to be a valuable tool for portfolio selection, at least in the sense of selecting the portfolios expected to rise the most (after negative black swans) and decline the least (after positive black swans), thus exposing investors to a strategy very likely to outperform a passive investment.

All in all, our evidence supports beta both as a measure of risk and as a tool for portfolio selection. From a portfolio management perspective, then, we think it may be too early to discard this very controversial magnitude. In fact, from where we stand, beta does look alive and well.■

Appendix

Exhibit A1. Summary Statistics

This exhibit shows, for the series of monthly returns, the arithmetic mean (AM), geometric mean (GM), and standard deviation (SD) of all the countries and industries in the sample, all calculated between the beginning (Start) and the end (Dec/2009) of each series' sample period. All country and industry benchmarks are MSCI indices. Returns are in dollars and account for capital gains and dividends. All figures in %.

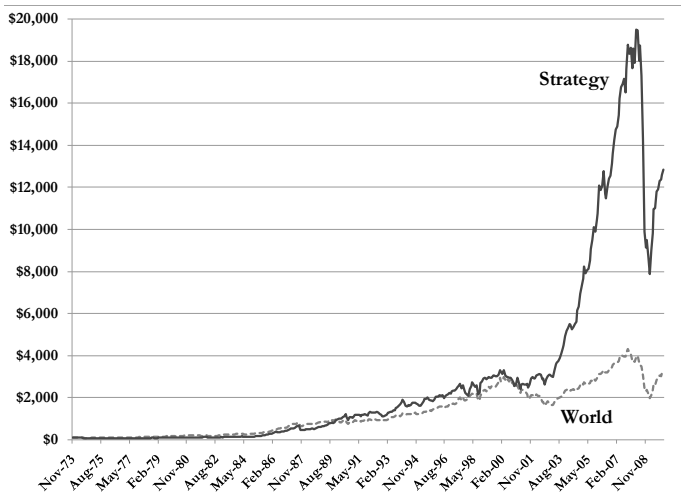
Country	AM	GM	SD	Start	Industry	AM	GM	SD	Start
Developed					Aerospace and Defense	1.0	0.8	5.9	Jan/95
Australia	1.0	0.8	7.0	Jan/70	Air Freight and Logistics	0.8	0.6	5.6	Jan/95
Austria	1.0	0.8	6.6	Jan/70	Airlines	0.4	0.2	6.5	Jan/95
Belgium	1.1	0.9	6.0	Jan/70	Auto Components	0.5	0.3	6.0	Jan/95
Canada	1.0	0.8	5.8	Jan/70	Automobiles	0.7	0.5	6.2	Jan/95
Denmark	1.2	1.0	5.6	Jan/70	Beverages	0.8	0.7	4.5	Jan/95
Finland	1.2	0.8	9.4	Jan/88	Biotechnology	0.9	0.6	8.2	Jan/95
France	1.1	0.9	6.5	Jan/70	Building Products	0.4	0.2	6.1	Jan/95
Germany	1.0	0.8	6.3	Jan/70	Chemicals	0.8	0.7	5.4	Jan/95
Greece	1.3	0.8	10.5	Jan/88	Commercial Banks	0.7	0.5	6.2	Jan/95
Hong Kong	1.7	1.2	10.4	Jan/70	Commercial Services and Supplies	0.3	0.2	4.7	Jan/95
Ireland	0.5	0.3	6.4	Jan/88	Communications Equipment	0.9	0.4	9.7	Jan/95
Italy	0.8	0.5	7.3	Jan/70	Computers and Peripherals	1.1	0.8	8.1	Jan/95
Japan	1.0	0.8	6.3	Jan/70	Construction and Engineering	0.5	0.3	6.4	Jan/95
Netherlands	1.2	1.0	5.6	Jan/70	Construction Materials	0.7	0.5	6.4	Jan/95
New Zealand	0.7	0.4	6.8	Jan/88	Containers and Packaging	0.2	0.0	6.0	Jan/95
Norway	1.3	0.9	7.9	Jan/70	Distributors	0.0	?0.3	8.3	Jan/95
Portugal	0.6	0.4	6.6	Jan/88	Diversified Financial Services	0.6	0.3	7.4	Jan/95
Singapore	1.3	0.9	8.5	Jan/70	Diversified Telecommunication Sces.	0.5	0.4	5.6	Jan/95
Spain	1.1	0.8	6.6	Jan/70	Electric Utilities	0.8	0.7	3.6	Jan/95
Sweden	1.3	1.1	7.0	Jan/70	Electronic Equipment and Instruments	0.4	0.1	7.9	Jan/95
Switzerland	1.1	0.9	5.4	Jan/70	Electronic Equipment Manufacturers	0.8	0.5	6.6	Jan/95
UK	1.0	0.8	6.5	Jan/70	Energy Equipment and Services	1.3	0.9	9.3	Jan/95
USA	0.9	0.8	4.5	Jan/70	Food Products	0.8	0.7	3.8	Jan/95

(*Continued*)

Exhibit A1. Summary Statistics (*Continued*)

Country	AM	GM	SD	Start	Industry	AM	GM	SD	Start
Emerging					Food/Staples Retailers	0.6	0.5	3.7	Jan/95
Argentina	2.5	1.3	16.1	Jan/88	Gas Utilities	0.8	0.8	4.2	Jan/95
Brazil	2.9	1.7	15.4	Jan/88	Health Care Equipment and Support	0.9	0.8	4.4	Jan/95
Chile	1.8	1.5	7.2	Jan/88	Health Care Providers and Services	0.7	0.5	6.0	Jan/95
China	0.6	0.0	11.0	Jan/93	Hotels, Restaurants and Leisure	0.7	0.5	5.1	Jan/95
Colombia	1.8	1.3	9.6	Jan/93	Household Durables	0.2	0.0	6.9	Jan/95
Czech Rep.	1.6	1.2	8.7	Jan/95	Household Products	1.0	0.9	4.7	Jan/95
Egypt	2.0	1.5	9.8	Jan/95	Industrial Conglomerates	0.7	0.5	6.3	Jan/95
Hungary	1.9	1.3	11.0	Jan/95	Information Technology Services	0.3	0.0	7.7	Jan/95
India	1.3	0.9	9.1	Jan/93	Insurance	0.6	0.4	6.1	Jan/95
Indonesia	2.0	0.9	15.1	Jan/88	Internet and Catalogue Retail	1.1	0.6	9.6	Jan/95
Israel	0.9	0.7	7.2	Jan/93	Internet Software and Services	1.7	0.2	16.4	Jan/95
Jordan	0.5	0.4	5.4	Jan/88	Leisure Equipment and Products	0.3	0.1	5.1	Jan/95
Korea	1.2	0.6	11.4	Jan/88	Machinery	0.6	0.4	6.2	Jan/95
Malaysia	1.0	0.7	8.6	Jan/88	Marine	0.6	0.4	7.3	Jan/95
Mexico	2.1	1.7	9.4	Jan/88	Media	0.5	0.3	5.9	Jan/95
Morocco	1.2	1.1	5.7	Jan/95	Metals and Mining	1.1	0.8	7.7	Jan/95
Peru	2.0	1.5	9.7	Jan/93	Multi-Utilities	0.5	0.3	6.1	Jan/95
Philippines	1.0	0.5	9.4	Jan/88	Multiline Retailers	0.8	0.6	6.0	Jan/95
Poland	2.2	1.3	14.7	Jan/93	Office Electronics	0.6	0.4	6.7	Jan/95
Russia	2.7	1.3	17.0	Jan/95	Oil, Gas and Consumable Fuels	1.2	1.0	5.5	Jan/95
South Africa	1.3	1.0	8.1	Jan/93	Paper and Forestry Products	0.3	0.0	7.2	Jan/95
Taiwan	1.1	0.5	10.9	Jan/88	Personal Products	1.1	1.0	5.9	Jan/95
Thailand	1.2	0.6	11.4	Jan/88	Pharmaceuticals	0.9	0.8	4.2	Jan/95
Turkey	2.4	1.0	17.2	Jan/88	Road and Rail	0.5	0.4	4.3	Jan/95
World					Road and Rail	1.4	1.0	8.6	Jan/95
World Market	0.9	0.8	4.4	Jan/70	Specialty Retail	0.7	0.5	6.1	Jan/95
					Textiles, Apparel and Luxury Goods	0.8	0.6	6.2	Jan/95
					Tobacco	1.4	1.2	6.4	Jan/95
					Trading Companies and Distributors	0.5	0.3	7.2	Jan/95
					Transportation Infrastructure	0.8	0.7	5.7	Jan/95
					Water Utilities	1.3	1.2	5.1	Jan/95
					Wireless Telecommunication Services	1.1	0.9	6.8	Jan/95

Exhibit A2. Beta and Performance – Countries



(*Continued*)

Exhibit A3. Beta and Performance – Countries - Log Scale

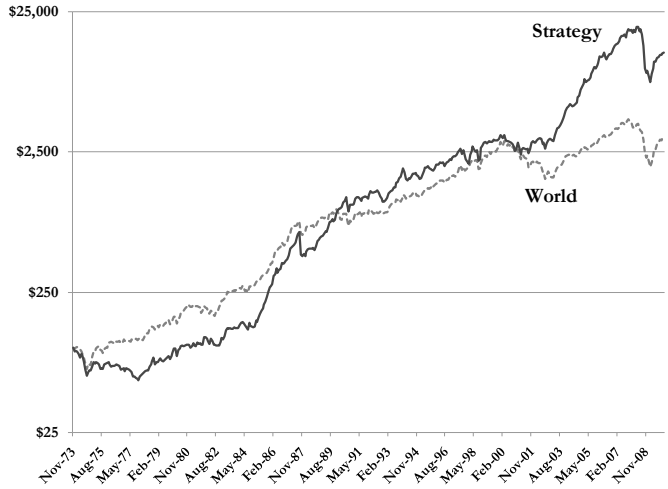
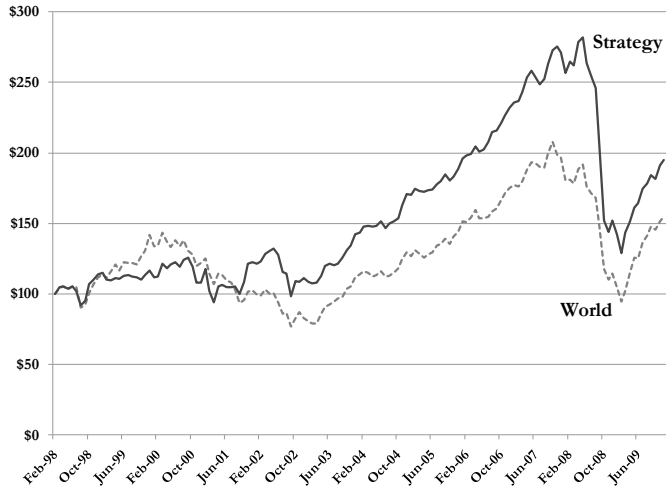


Exhibit A4. Beta and Performance – Industries



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