3

Great Expectations

Most financial wealth aggregates future earnings that we can't directly sample. We have to look backward into the future. In practice we discount heavily for tiny fears of disaster and prize perceived safety. It gives economies a tremendous incentive to boost confidence—sometimes beyond the capacity to deliver.

Money symbolizes wealth at hand. However, most wealth isn't at hand, and we couldn't consume it now if we tried. It is a claim on future value. We can never measure future value. We can measure only past value, current trends, and expectations for the future.

Expectations can't be consistently right, because no one can predict the future. Expectations won't be consistently wrong, because markets part fools from their money. We scramble between error and error correction. It's called learning.

Learning rocks and rolls our wealth. Between 2003 and 2006, most Americans stopped saving out of income, because their houses and equities saved for them. In 2008 $10 trillion of their wealth—and $50 trillion worldwide—vaporized, without war, hellfire, or alien invasion. The adjustment was only on paper and electronic chits. Yet the material and psychic tolls have been enormous.

Given the dangers, wouldn't it be better to stop forming half-baked expectations and wait to invest until we know? No, it wouldn't. We can't know until we try. Besides, asset markets force us to choose. Whether we buy, sell, or pass, we implicitly compare the price to fair value and reveal something about our expectations. That revelation in turn influences others and helps shift the consensus view.

This chapter explores the transformation of expectations into asset value. I will start simply, assuming a constant rate of growth. I will then introduce various layers of risk and uncertainty and sketch the implications for pricing.

Remarkably, asset prices suggest we're cowards, while investment behavior suggests we're not. This puzzle has had the economics profession scratching its head for decades. The most plausible explanation is that asset prices respond more to fears of rare disasters and fears of others' fears than long-term investment does.

Discounting the Future

Imagine an asset that pays a dividend of 1 every future period, from now to eternity. While the sum of all future returns is infinite, no one will pay infinity for them. Let P denote the asset price today. If we pay it, we collect 1 next period plus a residual asset that pays 1 from the second period on. By symmetry, the price of the residual asset will be P in the next period, provided the market environment stays the same.

Hence the market implicitly values $P + 1$ next period as worth P today. The implicit interest rate r is given by the dividend ratio $1/P$. Usually we flip this around, regard r as given, and value the risk-free stream as $P = 1/r$.

Next imagine an asset whose dividends start at 1 and grow at a constant proportional rate g. By symmetry, the asset price must also grow at that rate. In equilibrium, the dividend ratio plus the capital gains rate must match the risk-free rate r. Hence, the dividend ratio must be $r - g$.

In practice this relation gets muddied by differential taxation on dividends and capital gains. Let's ignore this, or assume that r and g are given in post-tax terms. Let's also ignore inflation, or assume that dividends are measured in constant real prices.

Typically, r won't exceed g by more than a few percentage points. People aren't that impatient, and growth tends to be positive. Hence the price-to-dividend ratio $P = \dfrac{1}{r - g}$ will be a few dozen or more.

No wonder, then, that wealth greatly exceeds current returns. It also follows that wealth will be very sensitive to g, holding r fixed. A shift of half a percentage point may change asset value by a quarter, half, or more.

Indeed, if g consistently exceeds r and dividends are positive, price should be infinite. That's not a sustainable equilibrium. Instead of paying

out dividends, asset managers will reinvest them. Asset claimants will borrow against future wealth. To bring demand back in line with supply, interest rates must rise or forecast growth must fall. Now for the mysterious part: how do we forecast *g*? Ideally we would like to peer into the future and measure growth until the average settles down. Because of discounting, nearer years count for more than far. So let's try to make it easy on ourselves and peer only far enough to capture, say, 95% of the present value. How short a foresight will suffice?

Let's think about it. Every year we extract $1/P$ of asset value in dividends. After T years, residual value shrinks to $\left(1-1/P\right)^T \cong e^{-T/P}$. To reach $0.05 \cong e^{-3}$, T must be approximately $3P$.

Hence, we'll need to look ahead a century or so to capture 95% of value. Think how hard that is. It is hard even if we ignore the particularities of the asset and think only about the economy as a whole.

Imagine gathering the world's wisest seers in 1900 and asking them to forecast economic growth over the next century. Would they predict assembly-line manufacture, two world wars, highways clogged with cars and trucks, mass expansion of university education, computers on semiconductor chips, and the Internet? Would they predict the improvements in life expectancy and health, the impact of women's emancipation and retirement benefits on the workforce, and a population explosion that flattens out? Would they predict the retreat of global markets in favor of capital controls and central planning—and its rebound decades later?

Let us help them. Let's stuff a bottle with all that information, douse it with a charm potion that makes all who read believe, and smuggle it back in time. Our enlightened seers would still likely misestimate the impact on productivity and the rate of growth of wealth, unless our message explained that too.

To make forecasting easier, let us settle for capturing half of present value. That will chop our foresight needs down to a quarter-century or so. It will still be extremely difficult to predict the impact on economic growth.

Technological Progress

To better grasp change, science seeks to identify invariants—for instance, properties that stay constant in change. One wannabe invariant in economic growth is technological progress. In war or peace, by car or foot,

under capitalism or socialism, humanity seeks to innovate. Innovation helps produce more and better for less.

However, no natural or social law dictates the pace of innovation. For most of history it seems to have been slow. For the past two centuries it appears to be accelerating but we can't be sure the exception is the new rule. The uncertainty reflects an age-old struggle between know-how and resource depletion.

DeLong (2001: chap. 5) provides some summary statistics, drawing on various sources. From 1000 B.C. to 1800 A.D., for the world as a whole, GDP per capita is estimated to have grown to $250 from $160, as measured in year-2000 dollars. Over the same period, world population is estimated to have grown to 900 million from 50 million. Combining the two estimates, real GDP grew 31-fold in 2,800 years. That works out to 0.12% real GDP growth per year and less than 0.02% per capita per year. If GDP actually grew twice as fast, the average growth rate edges up to 0.14% per year.

Granted, we don't know the relevant resource constraints. It is harder to support the billionth person than the fifty millionth. Still, innovation was sluggish by modern standards and mostly absorbed by population growth. People lived and died with little sense of overall enrichment.

Growth accelerated in the Industrial Revolution. From 1800 to 1900, per capita GDP more than tripled to $850 while population nearly doubled to 1.63 billion. That works out to 1.2% per year per capita and 1.8% for real GDP.

Growth accelerated again from 1900 to 1950: 1.8% per year per capita and 2.6% for real GDP. The second half of the twentieth century saw even faster growth: 2.8% per year per capita and 4.7% for real GDP. See Figure 3.1.

It is tempting to extrapolate this to the skies. The information revolution provides a plausible mechanism for acceleration, namely the ease of information sharing and new learning. Even if growth merely stabilizes at late-twentieth-century rates, discount rates may have to rise substantially to keep us from feeding off future nirvana.

Heady optimism ten years ago—see Kurzweil (1998) for an imaginative depiction of the coming century—helped propel the dot-com bubble in asset markets. Perhaps it will come back in vogue. However, there are numerous grounds for caution:

- Recent and current growth may embed a one-time catch-up factor as know-how spreads to laggards.
- We are gorging on a subsurface bounty that preindustrial technology couldn't reach. We are rapidly depleting fuel reserves, mineral

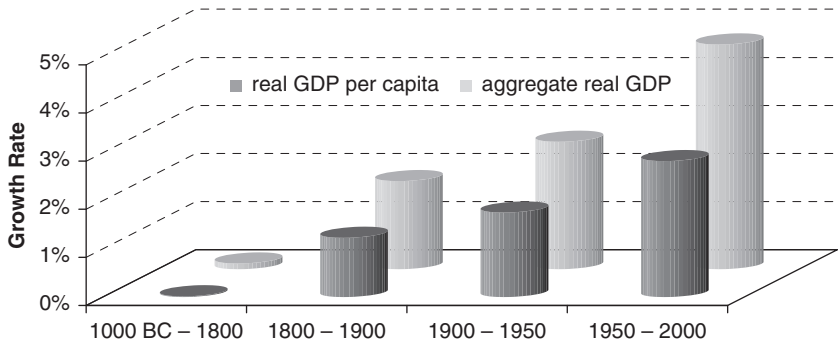

Figure 3.1
Average Annual Global Real GDP Growth

deposits, and underground aquifers accumulated over hundreds of millions of years. If scientists and engineers don't find cheap alternatives, standards of living could stagnate or even decline.

- Rapid growth tends to be socially destabilizing. While China and India are catching up to the developed world, most of Africa, the Middle East, and central Asia are not. Radical Islam is feeding on the backwardness it nourishes, and demographics are working in its favor. Meanwhile the developed West has hamstrung itself through entitlement pledges it cannot keep. In the struggle for spoils a lot of wealth will get spoiled.
- Human pressure on the environment might reach a tipping point, where growth is curbed either through disaster or preemptive regulation. In some ways it already has. We know neither the rate of escalation nor the costs of deferred action.

Looking Backward into the Future

Clearly, the available evidence on growth is open to widely diverging interpretation. Given the implications, why doesn't the market agonize about it more? The short answer is that it doesn't pay enough to care.

A longer answer distinguishes three causes: price offset, immediacy, and herding. The price offset stems from the positive correlation between average growth and the discount rate. Higher growth makes future goods and services more plentiful. The anticipated bounty makes us want to

consume more even today. With current goods just as scarce as before, the discount-rate premium on them rises.

Indeed, depending on the structure of consumer preferences, the equilibrium *r* may move more than the equilibrium *g*, so that rapid overall growth cuts the present value of long-term assets. Many economic models inadvertently exaggerate these effects. Still, the evidence for a substantial price offset seems strong.

Immediacy refers to the time needed to wait for vindication. Nobody will know tomorrow whether today's guesses about the long term are right. Hard evidence trickles in slowly. All the market will tell us is which guesses gain popularity.

Speculators seeking a marginal edge are likely better off studying popularity than principle. Will carbon cap-and-trade keep oceans from rising in 2030? Investors can hardly be bothered. Will carbon cap-and-trade make it through Congress? Now there's something to trade on. Blaming traders for fad ideas is like blaming music executives for fad music. They're not looking for soundness; they're looking for what will sell.

Investors who do want to bet on real growth are best off focusing on differentials between countries, industries, and specific companies. The narrower focus makes it easier to build and maintain an edge. The growth itself is less vulnerable to a price offset.

Herding stems from the inherent inscrutability of long-term growth. Most of us shade our views toward the consensus, figuring that others know something we don't. This makes the consensus even more inertial than the trickle of evidence would suggest. Growth estimates change slowly.

That's not wholly bad. Convictions that oscillate widely tend to paralyze. We do nothing, or waste a lot of effort undoing what we did before. Critics who fault the market for error largely miss the point. It's like criticizing a dog for singing off pitch. The marvel is it sings.

But we shouldn't idolize the market either. Weighting opinions by moneyed convictions doesn't make the average right. It is especially likely to err when the forecast is far-reaching and the evidence thin.

The market knows this and adjusts by using proxies. The closest proxy for the future growth we can't see is the growth we just saw. That doesn't mean the two will match, or even that they will run parallel. But there should be some relation. On that basis we can test our forecasts against the evidence and modify our hypotheses about the future.

Each small modification sculpts our view of the future. It chips away here and adds there. It corrects old mistakes and makes new ones. Once in

a while a great shock persuades us to toss out our old views and start over. Even then we look backward at some other history that seems more relevant. We're forever looking backward into the future.

Granted, we don't always look backward. We glance sideways; we scan the ground for clues; we peer into the sky. Piecing together the evidence as best we can, we close our eyes and imagine peering into the future. It is a wonderful proxy, except when it isn't.

One lesson for policymakers is not to abdicate their long-term responsibilities. No, the market won't punish them for it. Even when it recognizes what can't help but happen, it discounts heavily for not knowing when or how. But the future will punish a society for continually deferring what needs doing. When nobody saw it coming, it usually means nobody was looking.

Rates on Equities and Bonds

The risk and uncertainty of future growth shatter one discount rate into many. The less certain a future return, the less we'll pay for it unless its risk neutralizes other risks. As a first approximation, we can distinguish a risk-free rate for safe bonds and a risky rate for an economy-wide equity index. The difference is known as the risk premium.

Empirically, these rates are hard to measure. Actual bonds carry inflation, devaluation, and default risks, while equity returns are prone to long swings. Also, data are concentrated in the second half of the twentieth century, when a long market boom exceeded most expectations and so did inflation. This made bonds look richer and equities cheaper than they were likely intended to be.

Nevertheless, the evidence seems overwhelming that the risk-free rate is less than 3% while the risk premium exceeds 2%. In the late 1970s and 1980s, economists began calibrating their models to match this behavior. To their surprise, they couldn't. Indeed, standard models had trouble generating either a low risk-free rate or a high risk premium.

Over the past quarter-century, the rate puzzles have attracted more attention than any other controversy in finance theory. To this day there's no completely satisfying answer, or at least economists don't agree what it is (Mehra 2008). That already tells us something. If the ideal calculation of asset pricing baffles experts, we can hardly blame real asset markets for being erratic.

On balance, three answers resonate most with theorists. The first is that the risk premium reflects an aversion to occasional severe losses. The second is that people value future consumption for more than its direct thrills; the anticipation provides peace of mind or social stature. The third roots the risk premium in market uncertainty itself. The Appendix reviews the controversy and relates the answers to the puzzles.

If any of these explanations hold, discount rates on equities and bonds will depend critically on what we believe about the future. These beliefs are inherently wobbly, as new evidence continually rolls in and triggers reassessment. Hence, learning make asset valuations chronically unstable.

Granted, we could infer chronic instability just from the historical evidence. However, any specific experience can always be attributed to exceptional conditions or bad judgment. Theory reveals that markets upset our plans even when they act the way they're supposed to.

Because of this instability, long-dated bonds carry considerable mark-to-market risk even if payment is guaranteed. The obvious antidote is to trade long-dated bonds for short-dated bills. As Chapter 5 will show, bank regulators ignore this at society's peril.

The usefulness of short-dated bills in offsetting other kinds of risk can drive the risk-free rate well below the rate of time preference. In the aftermath of crises, when confidence has tanked, the real risk-free rate can be negative. Central banks' prime motive for targeting positive inflation rather than zero inflation is to discourage hoarding of risk-free cash and bills.

Yet if money is never allowed to be a safe haven, Mahserg's Law will favor other moneys. Hence central banks wobble between shoring up liquidity and taxing it. This wobble adds another layer of risk to asset valuation.

Regime Change

One of the biggest risks in markets is that the risks themselves vary. Markets can be calm for months or years on end, only to become extraordinary volatile and stay volatile for a while. Prices can trend upward for years, soar to new peaks, and then crash and slide. While a stable distribution of risks could in principle generate these shifts, the odds defy imagination. Instead we view one set of risk parameters—mean return, volatility, and so on—as giving way to another. This is called regime change.

Regime change can be needlessly confusing. For example, a classic random walk moves left or right one unit each period with probability ½. We

could redefine this as two completely stable trends, one moving left and the other right, with a 50% chance each period of a regime switch. But that's silly. Regime switching is best reserved for changes that can't be modeled more simply and have a large cumulative effect.

Many regime changes are rooted in real shifts in growth. As David and Wright (1999) explain, innovation comes in waves. Some major discovery or invention, like railroads or electricity or personal computers, captures popular imagination. Initial results usually disappoint, as other work practices need to change to make full use of the innovation. Eventually the infrastructure becomes more supportive, while people figure out new ways to tap the innovation. Productivity surges until the innovation becomes the new norm.

For example, while electric power was commercially available in the United States before 1900, it did not become a vital driver of production until electrical machinery and assembly-line production were invented. The main associated productivity boost occurred between 1919 and 1929 as factories reorganized. Peace and reengineering provided a bullish foundation for the Roaring Twenties.

The potential for regime change opens a Pandora's Box of interpretation. Once we allow risk parameters to shift we can never identify them precisely. Even the way we update our estimates is inherently fragile, as we shall see.

This fragility has immense significance for markets. If we knew the risks we were dealing with, asset prices would behave a lot less strangely than they do. They wouldn't bounce around so much or in such irregular ways. Markets wouldn't trade so frequently, or shake out so brutally.

Noisy growth and possible change in trend make for a potent combination. Sentiment swings between excess optimism and excess pessimism. Herding can aggravate the swings, as it encourages people to invest on momentum.

In other words, bad crises can start with things that are genuinely good. The good makes people feel better, which makes the real economy better and people feel better still. Eventually things become too good to stay true.

The Actuary Approach

Financiers handling other people's money tend to belittle regime change. The Canadian insurance industry offers a welcome exception. At one time,

it provisioned for losses on long-term equity investment as if they were independent deviations around a long-term mean. Thanks to work by Hardy (1999) and a responsive regulatory culture, it now takes regime switching into account.

Intuitively, extended runs of good years or bad years raise the odds of extreme outcomes. Like Moses's forecast of seven fat years followed by seven lean years, a regime-switching approach warns to lean against the current trend. It increases provisions in good years, reduces them in bad years, and penalizes products that aren't robust.

Figure 3.2 charts the impact of regime switching on index returns for the Toronto Stock Exchange (TSE), using parameter estimates from Hardy (1999). The horizontal axis represents the pretax percentage gain after five years from investing in TSE. Gross returns are spaced logarithmically to offer a clearer view. The vertical axis marks the probability density associated with each gain.

Compared to an ordinary lognormal density, the regime-switching density is squashed in the middle and fatter in the tails. It is also skewed downward. That's because bad news, while rarer than good news, is far more likely to repeat itself with regime switching than without.

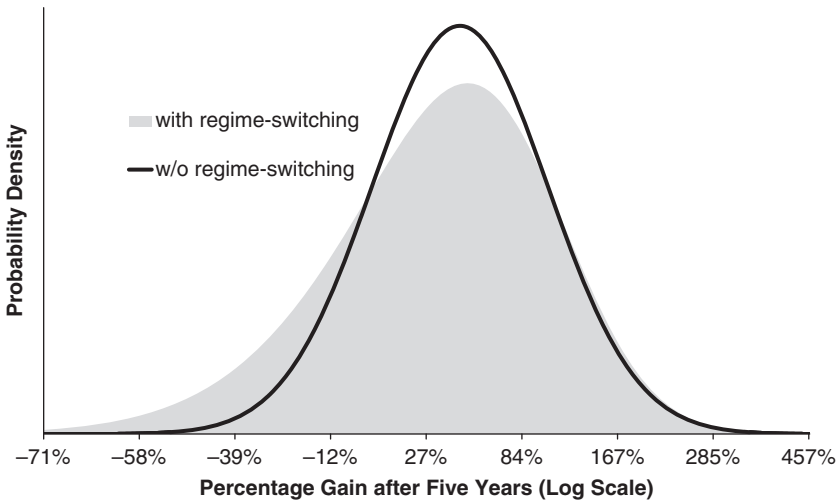

Figure 3.2
Estimated Risks of Five-Year TSE Investment

According to Hardy (*Wilmott* 2009), a strong actuary profession facilitated these reforms. Unlike most finance, where anyone who can say "yes, sir" and "nobody saw it coming" can legally sign off on risk, insurance risk requires certification by licensed actuaries. Actuaries must pass rigorous exams, pledge a fiduciary responsibility to the public, and answer to an independent professional board. Canadian actuaries were actively involved in discussions of the new methodology, in regulatory redesign, and in implementation.

Actuaries still answer to their employers, who expect them to help devise profitable products. Since the employers pay them, that loyalty normally carries higher weight. But the fiduciary responsibility matters too. It offers protection and authority when an actuary feels a risk is fudged.

Senior insurance executives wouldn't dare override an actuary's principled objections, unless an actuary board backed them up. In most banks or investment funds, by contrast, senior executives swat down risk managers at their discretion. It makes for a huge difference in risk culture.

The actuary approach discourages a cat-and-mouse game between regulators and risk takers. Instead, it trains intermediaries to high standards. It prizes respectful consultations.

For bang prevented per buck, few reforms would be more cost effective than extending the actuary approach to banks and investment companies. Granted, this can't be done overnight. Most financial risk managers need much better training in finance, economics, and statistics, to achieve at least master's-level proficiency in each. It will be even harder to change the cat-and-mouse culture.

"I love history," said Pandora. "The long fallow years, the sudden explosion of growth or conflict. No seer can foresee all of this.

"No market can either," said Prometheus. "Why should people expect otherwise?"

"Investments don't require getting the future right. They require welding a consensus to undertake them, and correcting big errors along the way. That's where asset markets shine. The tarnish comes after, when people look back and realize what they missed."

"I see. They blame markets for failures of social imagination. How human."

"I thought Osband conveyed that reasonably well. Are you satisfied now?"

"He writes loosely. This is bound to confuse."

"Getting lost in caveats is bound to confuse as well. Discount rates are huge drivers of asset prices. People need to realize how mysterious they are."

"That's not enough. Look how much effort equity analysts invest projecting revenue streams a decade or more ahead. Then they pull a discount factor out of a hat, with an impact that rivals the earnings projections. Saying it's a mystery won't help them do better."

"The Appendix provides more detail for those who want it."

"Well, I want it and don't get enough. He writes down the discounting equations as if they're easy to solve. Where does he recognize the dependence on hard-to-verify beliefs? Where does he acknowledge turbulence?"

"Prometheus, those are standard omissions for finance texts."

"His is supposed to be different. When he started talking about cumulants and the importance of small doubts, I thought he was getting warm. But he didn't follow through."

"You mean he hasn't yet followed through. Give him time."

"I'm not sure he's up to it. Tell him to start with the simplest case: debt that either pays in full or defaults completely."