

Hari P. Krishnan & Ash Bennington

MARKET TREMORS

Quantifying Structural Risks in Modern Financial Markets



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1

Introduction

People who count their chickens before they are hatched act very wisely because chickens run about so absurdly that it's impossible to count them accurately.

—Oscar Wilde

As we look out across the spectrum of global markets in the middle of 2021, there are no visible signs of overt distress. In fact, we see the opposite: many markets appear “Zombified”—saddled with astronomical levels of public and private debt as yields remain pinned to the zero bound. Meanwhile, many veteran investors are bewildered by asset prices that no longer seem linked to traditional valuation metrics, such as price to book value. On a recurring basis, the high priests of finance try to justify the most recent rally on financial news networks to a growing legion of benumbed investors.

Against this surreal but seemingly benign financial backdrop, the authors of this book find themselves wrestling with several thorny questions: Are there circumstances where market volatility is persistently low, while a rising danger lurks beneath the surface? Can we identify structurally weak asset classes where a small price shock will spiral into a major sell off? If so, how can we defend against price meltdowns and liquidations before they actually occur?

As we will discover in the chapters that follow, the answer is a qualified “Yes!” There are many important situations where we can improve upon standard risk estimates, based on our knowledge of the major players in a given market and how they are likely to act. In service of that goal, this book is intended for readers who wish to understand and profit from situations

where risk is rising in the financial network while credit spreads and realized volatility remain low.

To begin this journey, it is worth reflecting upon how the availability of credit affects asset prices over time. It is widely understood that leverage and volatility tend to move in opposite directions in the later stages of the credit cycle. Leverage is high, yet equity prices are grinding up and credit spreads are stable or declining. Credit is cheap and can be readily deployed into the equity and corporate bond markets. This means that investors have the firepower to “buy the dips”, which dampens downside volatility until the cycle breaks.

Historically, the US credit cycle tended to last six to eight years, measured from peak to peak. We could say with some degree of certainty where we were in the cycle. Asset booms and busts were somewhat predictable, as they corresponded to peaks and troughs in the quantity of credit available. Since 2008, however, this template has been altered by Central Banks, who now seem to equate economic stability with low asset price volatility. The expansionary phase of the current credit cycle has become extremely long in the tooth, given the ever increasing presence of the Fed.

While credit expansion usually has a stabilizing impact on asset prices, even that stability has a limit. If a large enough price shock occurs, leveraged agents will be forced to liquidate their positions as they get hit by margin calls and breach their risk limits. In recent years, banks and prime brokers have become increasingly risk averse, partly as a function of regulations enacted after the Global Financial Crisis. Brokerage houses set tighter position limits for their clients than before. This has important implications. An initial wave of selling can easily cause a cascade of forced liquidations, as other investors have to cut their positions after plunging through their loss limits. Within a Zombified market, prices can fall very rapidly, at least in the short term. Notably, the COVID-19 induced sell off in February and March 2020 started from a recent high in the S&P 500 and a very low volatility base.

“Zombification” of Modern Markets

In the past decade, the tendency for volatility and leverage to move in opposite directions has become even more extreme—as leverage rises, volatility declines in markets awash in liquidity. (Note that this stylized fact did not rigidly apply to global equity markets in 2020, but was largely the case in the previous decade.) Before the Global Financial Crisis, the Fed’s balance sheet was just under \$900 billion; at the time of this writing, in early 2021, it has

ballooned to over \$8 trillion. The quantity of corporate debt is now larger than ever, suggesting greater default risk—and yet the volatility of most asset classes has been persistently low.

This low level of volatility may seem puzzling since leverage *is* risk, in a certain sense. By definition, without the existence of leverage, there could be no defaults, with no need for margin calls. To repeat, we now find ourselves in an environment of structurally low volatility across asset classes, bloated balance sheets and negative yields. Bank deposits provide what is essentially a 0% return to savers, forcing investors to consider other riskier investments in the search for yield. Long positioning in risky strategies has become over-extended because of the lack of suitable investment alternatives. This “volatility paradox”, where market fragility is high, but overall volatility is low, has become a stubborn feature of modern markets. Historically, the volatility paradox has been restricted to the later stages of a real economic cycle, where it creates a toxic blend of plentiful credit and investor complacency.

As an example, we can think about some of the forces at play in a simplified version of a housing bubble. Within the bubble, homeowners often borrow an increasing amount of money per dollar of equity, causing aggregate loan-to-value (LTV) ratios to rise. This type of borrowing is a function of market sentiment: investors and lenders are both convinced that prices will continue to go up, so they borrow and lend more. This is based on the dangerous assumption that higher housing prices in the future will push LTV ratios back down to more reasonable levels. Everyone seems to make solvency assumptions based on extrapolations from recent historical returns—and seem dangerously unaware of the risks inherent in the broader debt cycle.

We can think of this problem a bit more mechanistically. Easy credit generally increases the aggregate demand for assets. As a consequence, a fresh supply of new money enters the market and bids up asset prices, as investors fear missing out on the rally. This liquidity, partially provided by late entrants to the market, dampens downside volatility. As the rally continues, it becomes possible to borrow even more, given the rising value of the underlying collateral. It is worth observing that we live in a world where lending has become increasingly collateralized. The process becomes an archetypal, positive feedback loop.

A model describing precisely this phenomenon has been developed by Thurner (2012) and others. Minsky (2021) was one of the earliest academics to identify the problem. The volatility paradox arises as a function of the feedback between prices, risk appetite and access to credit. While “average” returns are compressed into a relatively narrow range, extreme event risk

grows ever larger. With enough leverage in the system, even a moderate-sized sell off can wash a large number of over-leveraged investors out of the market. Ultimately, the sell off can cause a nasty chain of further selling—and a potential crash.

The Challenge to Investors

No cycle lasts forever, even a distorted one, and this cycle will need to end at some point as well. But until the end of this cycle arrives, the volatility paradox can persist for a surprisingly long time. If pressures on balance sheets are high enough, the risk is that the cycle will end in a spectacular collapse. This brings us to an important point. Market Zombification presents a serious challenge to active managers. Intermittent mega-spikes in the VIX and other volatility indices increasingly occur from a low volatility base—often without much warning. This forces investors to make a difficult choice: if they stay out of the market, they collect no return; however, if they buy and hold equities or risky bonds, they may collect a small premium, but have to accept the risk of a large and sudden drawdown in return.

Taking on an over-extended market by selling futures against it is a dangerous alternative. Frothy markets have a tendency to become even frothier in the near term. Moreover, the timing of a market reversal is nearly impossible to predict in advance, which is why shorting bubbles can lead to catastrophic losses. Finally, buying insurance through the options market might seem to be a theoretically sound idea and actually is, given enough skill and over a long enough horizon. However, options strategies that decay over time require immense patience from investors in an environment when many other investors are piling on risk and Central Banks are standing guard. While it is true that active managers can blend long and short volatility strategies in their portfolios, the core problem remains an intractable one.

An Analogy with Waiting Times

At some point, the credit cycle will turn, dragging equities and other risky assets into a bear market. Prices may drop quickly without recovering. If yields normalize somewhat, bonds may also sell off. This will be doubly toxic if we see a wave of defaults, as institutions are no longer able to finance their debt. Institutions that target a fixed return without too much regard for risk (think pensions and insurance companies) will take large losses in

this scenario. It may turn out that options-based hedging is the only truly diversifying strategy left to investors if the stock and bond bubbles burst simultaneously.

The trouble is that we don't know *when* the cycle will turn. Many observers with a bearish disposition argue that every passing day makes the risk of an imminent liquidation more likely. This may well be true, but a simple analogy shows the dangers in this assumption. Imagine that you are waiting for a friend. If someone issued a guarantee that your friend would be no more than an hour late, the odds that he or she will arrive in the next 5 min would increase rapidly over time. After 55 min, the probability of arrival in the next 5 would be 100%. However, this doesn't correspond with experience. The longer you are kept waiting, the *less* likely that your friend will be coming anytime soon. Something material may have happened, which has qualitatively changed the distribution of arrival times.

Qualitative Features of Zombification

In this new era of increased systemic risk, it appears that the economic cycle has been damaged—perhaps permanently. As we have suggested above, the price action we see across markets reflects this new reality. Equity sell offs, such as the events we observed in February 2010 and December of 2018, now occur spontaneously and often materialize out of nowhere during periods of low volatility. While these sell offs are quick to arise, they also seem to be quickly forgotten by the financial media and even market participants.

Historically, this was not always the case. The VIX and other implied volatility indicators tended to decay quite slowly after a spike. The market at large had a longer memory. Slow decay was reflected in the various econometric models that were developed by practitioners and academics alike. In the current market, however, “melt ups” are almost as violent as the melt-downs and V-shaped recoveries are increasingly common. Volatility tends to collapse quickly as investors jump back into “risk-on” mode, in an attempt to recover profits and make up for lost time in the markets.

Viewed through a wider lens, equities and fixed income have both been trending upward for an unusually long time. As of this writing, the S&P 500 has increased by a factor of 5X since 2009, while US bond prices have enjoyed nearly 30 years of steady positive performance. Credit markets have been underpinned by several rounds of Central Bank monetary easing in each of the major economies. Since corporate credit and equity are linked, Central

Banks have effectively acted as a backstop on the S&P 500 and other large-cap equity indices. In the meantime, US government bonds have received a nearly continuous bid from institutions. In the post-2008 regime, where loans are increasingly collateralized, the demand for sovereign debt has been remarkably high (Fig. 1.1).

Moreover, the zero interest rate policies implemented by Central Banks have incentivized excessive risk-taking in other areas. Rather than maintaining their strategic asset allocation weightings and simply accepting the lower forward returns that the current environment offers, investors have piled in *en masse* into riskier corporate bonds, illiquid assets and various short volatility strategies. Consequently, excess demand has reduced the amount of compensation they now receive for bearing risk. For example, many pensions with an annual return target of 6% to 7% have simply ramped up the credit and liquidity risk exposure in their portfolios, with something of a cavalier attitude toward extreme event risk.

Many observers, including the authors of this book, do not believe that these dynamics are sustainable indefinitely. In general, Central Banks can control either their domestic yield curves or their currency valuations, but not both at the same time. Lowering benchmark interest rates can encourage banks to increase their balance sheets, assuming that sentiment is not too bad. However, that increased velocity tends to come at a cost. Easy money policies have historically tended to weaken currency values, sometimes to disastrous effect.

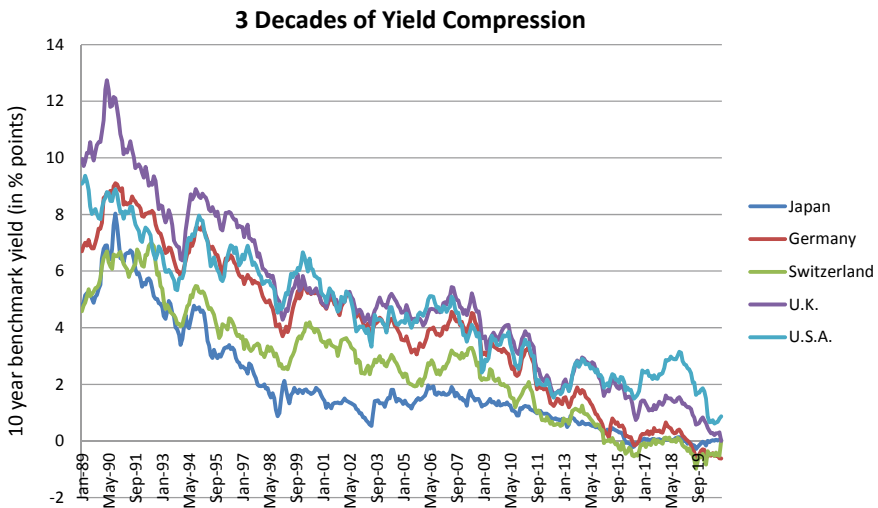


Fig. 1.1 30 year secular bear market for government yields (Source Bloomberg)

Under the current regime, it has taken a great deal of Central Bank coordination to maintain a reasonable level of stability across the major currency pairs. In the meantime, alternative forms of exchange with a fixed supply, such as gold and Bitcoin, have rallied. The Central Banks have collectively walked a tightrope in their activities. We would argue that synchronized easing is an inherently unstable process, as the financial system is highly non-linear and sentiment driven. The fault lines for a major dislocation in currency or bond markets are now in place.

The Dilemma for Institutional Investors

Artificially low yield curves have forced many investors into areas that may not provide adequate compensation for risk. We might, for example, consider the case of a hypothetical European pension fund that is currently underfunded. In this example, using historical yields as our reference point, the situation has become dire. For the sake of simplicity, assume that the pension fund needs an average forward return of 4% on an annualized basis to meet its expected future liabilities. Current government bond yields fall well short of that threshold, as Fig. 1.1 clearly indicates.

One potential investing strategy would be to substitute Euroland debt with US Treasury bonds. After all, US bonds offer a modestly positive return over time. A 1.5% return might be a drag on a 4% return target—but something is better than nothing, right? Unfortunately, the added yield from US Treasuries introduces currency risk for European investors. Any attempt to hedge dollars back to Euros will cancel out the yield in US Treasuries. It follows that the pension fund in question needs to be an implicit currency speculator in order to get some yield from this strategy.

The other, far riskier alternative is to buy lower-quality credits, moving further down the capital structure in the process. This requires an invocation of the so-called Fed put, which is now the stuff of legend. The theory goes that Central Banks will bail out anything and everything that might be large enough to cause collateral damage to the economy. Following this line of thought, Central Banks have become an across-the-board backstop for virtually all risky assets.

If this theory were correct, it would be perfectly logical to buy the highest yielding loans possible. In the authors' view, however, this smacks of overconfidence. It is impossible to say with certainty what the Fed and other Central Banks might do if push comes to shove in the credit markets. The magnitude of QE required to calm things down may be met with political resistance

among a host of other factors. What we do know is that many large buy side investors have been forced to take on enormous levels of risk in an effort to generate high single digits returns, when comparable returns could have been easily achieved with government bonds 20 years ago.

Given that investors crave yield, corporations have been happy to supply it. Figure 1.2 tracks the quantity of US corporate debt issuance over the past 25 years.

If we drill down a bit, we can see that companies that barely qualify as investment grade have been particularly active in their debt issuance (Fig. 1.3).

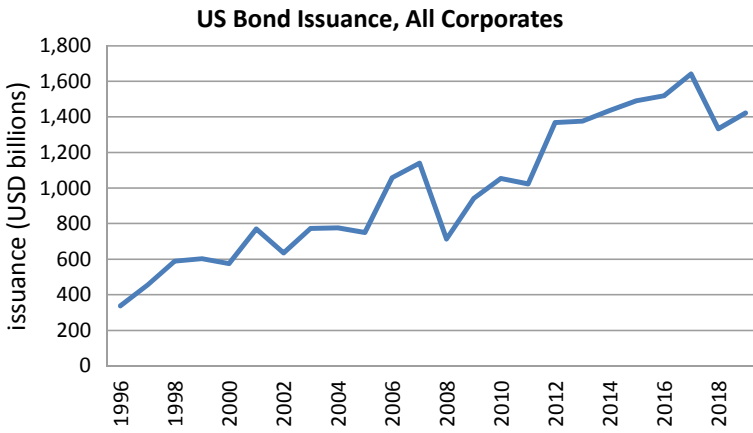


Fig. 1.2 Historical time series of US corporate bond issuance (Source SIFMA)

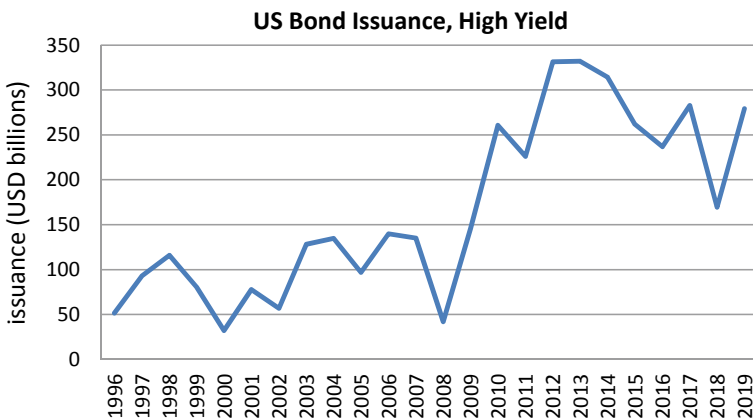


Fig. 1.3 Historical time series of US high yield debt issuance

The indiscriminate search for yield has offered enormous benefits to companies that are large enough to securitize their debt. Corporate treasury departments have been able to issue new bonds with low coupons, reducing the burden of servicing their debt. Persistently low yields have led to narrowing credit spreads, as investors are willing to accept a large amount of risk per unit of incremental return. This, in turn, has allowed corporate treasuries to issue new bonds with low coupons. The large overhang of debt and leverage in capital markets has had destabilizing effects on the financial network.

External and Network Risks

We now need to define a few key terms that will be helpful in our characterization of modern markets. Concisely, moderate *exogenous* shocks can drive increasingly large *endogenous* liquidations and squeezes. At the risk of stating the obvious, endogenous risks come from within the financial system, emerging from the complex interaction of agents who form the network. By contrast, exogenous risks affect prices from the outside and can arise from a wide variety of sources, such as geopolitical events and changes in technology.

There are gray areas in this coarse decomposition. Corporate earnings, for example, have both an exogenous and endogenous component. On the one hand, corporate earnings constitute news flow that affects prices once they are released (exogenous); on the other, companies are part of a global financial network, and their earnings are a function of transactions within the network (endogenous).

Endogenous network risks largely arise from a combination of factors: complex counterparty exposures, excessive leverage and overly concentrated exposure to certain asset classes or strategies. Counterparty risk played a major role in the Great Financial Crisis. It was impossible to untangle the network enough to know how much exposure to the mortgage markets a given bank faced. This caused the short-term financing markets to seize up, as the major banks doubted the solvency of each other. These markets are the lifeblood of the financial system. Leverage and over-exposure are loosely connected: when credit in the system is excessive, it eventually gets directed toward unproductive areas. This is the source of the various speculative bubbles we have seen over time. However, positioning risk can play a role even when Central Banks are not particularly dovish, e.g., when investors sell their core positions to chase returns in another asset class.

We can represent the financial system visually as a large graph. It consists of circles, or “nodes” of variable size and lines between nodes. The lines can also have variable width, based on the connection strength between two nodes. Figure 1.4 provides a stylized view of the global financial network.

Nodes are agents in the system, such as governments, banks, companies and households. When two agents transact with each other, they are joined by a line. Banks are the largest nodes, based on the size of their balance sheet and the sheer number of connections with corporations, individuals and other financial institutions. Banks are similar to major airport hubs, as a disproportionately large number of financial transactions are directed through them. Market makers, including those in the algorithmic trading space, are also large nodes, based on the percentage of order flow they service.

Conceptually, a financial network can become dangerous if the web of connections becomes too complex and convoluted or certain nodes increase beyond a reasonable size. For example, if the global banking system has become too interconnected, a shock to any part of the system may propagate throughout it and cause damage to large swathes of the network. This offers a more precise description of the source of defaults and large-scale price

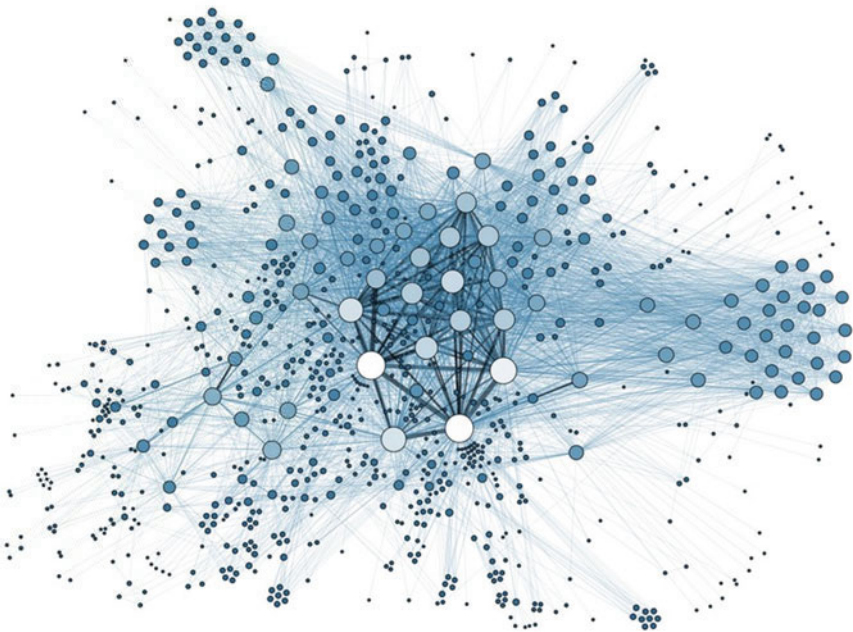


Fig. 1.4 Slightly cartoonish representation of the global financial network (Courtesy <https://www.interaction-design.org>)

moves observed during the Global Financial Crisis than the tangled web one above. Naturally, Central Banks are going to be larger than the typical household, so the real question is whether a node or related collection of nodes is acting out of proportion to its usual size. Bloated nodes can destabilize the financial network, increasing the odds of an extreme price move, as we will see in the sections below.

Vulnerability Not Predictability

This book is decidedly not a treatise on market timing: instead, we are largely concerned with *market vulnerability*. Over time horizons longer than just a few seconds, it is nearly impossible to know for certain when a sharp sell off is going to occur. Even when looking across the very short time scales of high frequency trading, price action has a large component of randomness. To frame the argument more generally, a limit order book provides an incomplete and imperfect overview of where prices are likely to go from one moment to the next. The implication is that timing is always going to be elusive. As time horizons increase, the problem rapidly becomes more intractable. On longer time scales, randomness plays an ever-larger role, and the range of potential outcomes increases.

What we can do, however, is identify market configurations that are dangerous from a structural standpoint. These are the “market tremors” that give this book its title. Markets are constantly exposed to random shocks of varying sizes that are inherently unpredictable and essentially beyond categorization. Even if we were able to create a comprehensive list of externalities that influence corporate earnings or economic growth, for example, other market participants might already have done the same analysis. Many of the external factors that drive price action are already baked into the market at any given point in time.

Given this understanding of the uncertainty in markets, what options remain for investors to pursue? To pose the question more specifically, if attempting to build a comprehensive and predictive economic model is a fool’s errand, where might we more profitably focus our attention?

A wiser course of action, in the authors’ view, is to accept that random shocks occur as a matter of course in markets—and to focus instead on *regime identification*. In the simplest terms, what we are looking for are the repeatable pre-conditions for a major liquidation or a spike in volatility. Specifically, we want to know in advance when a shock of moderate size is likely to have an unusually large market impact. Under these circumstances, realized volatility

might be low, but disequilibrium lurks beneath the surface. To a certain extent, these vulnerable market setups can be identified since they tend to follow predictable patterns. This is a major theme which we will expand upon at length in this book.

When the interbank lending market breaks down, as it did during the Global Financial Crisis in 2008, two things generally happen. First, highly liquid assets that can be easily posted as collateral, such as Treasuries, rally hard; currencies required for global settlement—especially the US dollar—also rally, because dollars are needed to close positions. Second, strategies that expose market participants to equity or credit risk are liquidated. The notion of diversifying across multiple risk premia capture strategies becomes secondary.

To put the general thesis into more practical terms, the two high-risk setups we will examine in this book are the following:

First, when the amount of leverage in the system is unsustainably high. When leverage rises, the price of risk assets inflates. This can lead to an Everything Bubble, such as the one we have largely experienced for the past decade, where the prices of stocks and bonds have both risen dramatically. When leverage is high enough, even a moderate change in market conditions will force certain agents to either liquidate their positions or to hedge them aggressively. This offers a rough explanation for the extremely sharp, short-lived sell offs we have seen in the past several years.

Second, when certain market participants are overly exposed to a specific asset or class of assets. When this occurs, too much of the available supply of cash and credit has been deployed into a segment of a market, which causes an asset bubble to form there. These asset bubbles can easily burst after the last marginal buyers come in during the late stages of an exhausted market.

One manifestation of over-concentration is the “pain trade”. This phrase has gained a great deal of currency over the years. The pain trade is the one that will force the largest number of speculators out of the market in one go. In rising markets, there are actually two possible pain trades. If there is a large amount of tactical short interest, the pain trade can be a “melt up” where equity indices power through recent highs. Shorts have to cover their positions to avoid outsized losses. Otherwise, it tends to be a reversal, as momentum traders who have increased positions during the rally get flushed out. In bear markets, the pain trade oscillates quite rapidly between a rebound and a collapse. Shorts pile into down trends, but have tight risk controls. This can increase the degree of short-term mean reversion. Prices move sharply down; however, given a mild positive shock, momentum traders have to buy