AGI and the EMH: markets are not expecting aligned *or* unaligned AI in the next 30 years

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In this post, we point out that short AI timelines would cause *real interest rates* to be high, and would do so under expectations of either unaligned or aligned AI. However, 30- to 50-year real interest rates are low. We argue that this suggests one of two possibilities:

1. **Long(er) timelines.** Financial markets are often highly effective information aggregators (the "efficient market hypothesis"), and therefore real interest rates accurately reflect that transformative AI is unlikely to be developed in the next 30-50 years.
2. **Market inefficiency.** Markets are radically underestimating how soon advanced AI technology will be developed, and real interest rates are therefore too low. There is thus an opportunity for philanthropists to borrow while real rates are low to cheaply do good today; and/or an opportunity for anyone to earn excess returns by betting that real rates will rise.

In the rest of this post we flesh out this argument.

1. Both intuitively and under every mainstream economic model, the "explosive growth" caused by *aligned* AI would cause high real interest rates.
2. Both intuitively and under every mainstream economic model, the existential risk caused by *unaligned* AI would cause high real interest rates.
3. We show that in the historical data, indeed, real interest rates have been correlated with future growth.
4. Plugging the Cotra probabilities for AI timelines into the baseline workhorse model of economic growth implies substantially higher real interest rates today.
5. In particular, we argue that markets are decisively rejecting the shortest possible timelines of 0-10 years.
6. We argue that the efficient market hypothesis (EMH) is a reasonable prior, and therefore one reasonable interpretation of low real rates is that since markets are simply *not* forecasting short timelines, neither should we be forecasting short timelines.
7. Alternatively, if you believe that financial markets are wrong, then you have the opportunity to (1) borrow cheaply today and use that money to e.g. fund AI safety work; and/or (2) earn alpha by betting that real rates will rise.

An order-of-magnitude estimate is that, if markets are getting this wrong, then there is easily $1 trillion lying on the table in the US treasury bond market alone – setting aside the enormous implications for every other asset class.

Interpretation. We view our argument as the best existing *outside view* evidence on AI timelines – but also as only *one* model among a mixture of models that you should consider when thinking about AI timelines. The logic here is a simple implication of a few basic concepts in orthodox economic theory and some supporting empirical evidence, which is important because the unprecedented nature of transformative AI makes "reference class"-based outside views difficult to construct. This outside view approach contrasts with, and complements, an inside view approach, which attempts to build a detailed structural model of the world to forecast timelines (e.g. Cotra 2020; see also Nostalgebraist 2022).

Outline. If you want a short version of the argument, sections I and II (700 words) are the heart of the post. Additionally, the section titles are themselves summaries, and we use text formatting to highlight key ideas.

I. Long-term real rates would be high if the market was pricing advanced AI

Real interest rates reflect, among other things:
1. Time discounting, which includes the probability of death
2. Expectations of future economic growth

This claim is compactly summarized in the "Ramsey rule" (and the only math that we will introduce in this post), a version of the "Euler equation" that in one form or another lies at the heart of *every* theory and model of dynamic macroeconomics:

$$r = \rho + \sigma g$$

where:
- r is the real interest rate over a given time horizon
- ρ is time discounting over that horizon
- σ is a (positive) preference parameter reflecting how much someone cares about smoothing consumption over time
- g is the growth rate

(Internalizing the meaning of these Greek letters is wholly not necessary.)

While more elaborate macroeconomic theories vary this equation in interesting and important ways, it is common to all of these theories that the real interest rate is higher when either (1) the time discount rate is high or (2) future growth is expected to be high.

We now provide some intuition for these claims.

Time discounting and mortality risk. Time discounting refers to how much people discount the future relative to the present, which captures both (i) *intrinsic* preference for the present relative to the future and (ii) the probability of death.

The intuition for why the probability of death raises the real rate is the following. Suppose we expect with high probability that humanity will go extinct next year. Then there is no reason to save today: no one will be around to use the savings. This pushes up the real interest rate, since there is less money available for lending.

Economic growth. To understand why higher economic growth raises the real interest rate, the intuition is similar. If we expect to be wildly rich next year, then there is also no reason to save today: we are going to be tremendously rich, so we might as well use our money today while we're still comparatively poor.

(For the formal math of the Euler equation, Baker, Delong, and Krugman 2005 is a useful reference. The core intuition is that either mortality risk or the prospect of utopian abundance reduces the supply of savings, due to *consumption smoothing* logic, which pushes up real interest rates.)

Transformative AI and real rates. Transformative AI would either raise the risk of extinction (if unaligned), or raise economic growth rates (if aligned).

Therefore, based on the economic logic above, the prospect of transformative AI – unaligned or aligned – will result in high real interest rates. This is the key claim of this post.

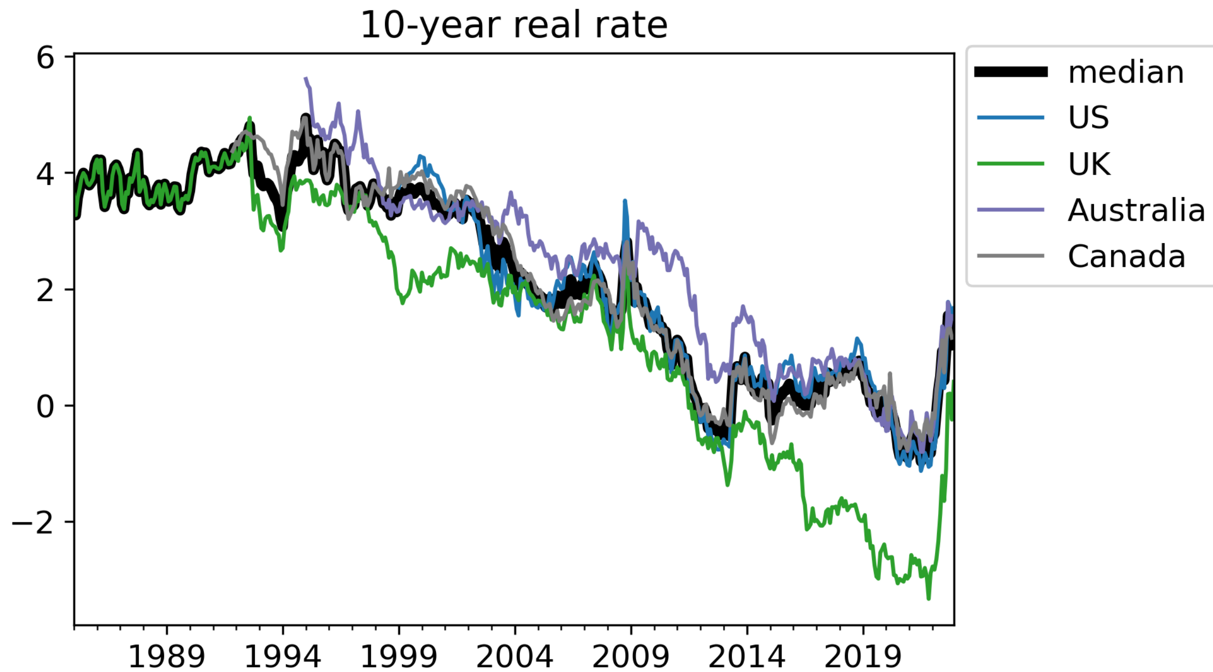
As an example in the aligned case, Davidson (2021) usefully defines AI-induced "explosive growth" as an increase in growth rates to at least 30% annually. Under a baseline calibration where $\sigma=1$ and $\rho=0.01$, and importantly assuming growth rates are known with certainty, the Euler equation implies that moving from 2% growth to 30% growth would raise real rates from 3% to 31%!

For comparison, real rates in the data we discuss below have never gone above 5%.

(In using terms like "transformative AI" or "advanced AI", we refer to the cluster of concepts discussed in Yudkowsky 2008, Bostrom 2014, Cotra 2020, Carlsmith 2021, Davidson 2021, Karnofsky 2022, and related literature: AI technology that precipitates a transition comparable to the agricultural or industrial revolutions.)

II. But: long-term real rates are low

The US 30-year real interest rate ended 2022 at 1.6%. Over the full year it averaged 0.7%, and as recently as March was below zero. Looking at a shorter time horizon, the US 10-year real interest rate is 1.6%, and similarly was below *negative* one percent as recently as March.



(Data sources used here are explained in section V.)

The UK in autumn 2021 sold a *50*-year real bond with a -2.4% rate at the time. Real rates on analogous bonds in other developed countries in recent years have been similarly low/negative for the longest horizons available. Austria has a *100*-year nominal bond – being nominal should make its rate higher due to expected inflation – with yields less than 3%.

Thus the conclusion previewed above: financial markets, as evidenced by real interest rates, are not expecting a high probability of either AI-induced growth acceleration or elevated existential risk, on *at least* a 30-50 year time horizon.

III. Uncertainty, takeoff speeds, inequality, and stocks

In this section we briefly consider some potentially important complications.

Uncertainty. The Euler equation and the intuition described above assumed *certainty* about AI timelines, but taking into account uncertainty does not change the core logic. With uncertainty about the future economic growth rate, then the real interest rate reflects the *expected* future economic growth rate, where importantly the expectation is taken over the risk-neutral measure: in brief, probabilities of different states are reweighted by their marginal utility. We return to this in our quantitative model below.

Takeoff speeds. Nothing in the logic above relating growth to real rates depends on slow vs. fast takeoff speed; the argument can be reread under either assumption and nothing changes. Likewise, when considering the case of aligned AI, rates should be elevated whether economic growth starts to rise more rapidly *before* advanced AI is developed or only does so afterwards. What matters is that GDP – or really, consumption – *ends up* high within the time horizon under consideration. As long as future consumption will be high within the time horizon, then there is less motive to save today ("consumption smoothing"), pushing up the real rate.

Inequality. The logic above assumed that the development of transformative AI affects everyone equally. This is a reasonable assumption in the case of unaligned AI, where it is thought that all of humanity will be evaporated. However, when considering *aligned* AI, it may be thought that only some will benefit, and therefore real interest rates will not move much: if only an elite Silicon Valley minority is expected to have utopian wealth next year, then everyone else may very well still choose to save today.

It is indeed the case that inequality in expected gains from transformative AI would *dampen* the impact on real rates, but this argument should not be overrated. First, asset prices can be crudely thought of as reflecting a *wealth-weighted average* across investors. Even if only an elite minority becomes fabulously wealthy, it is *their* desire for consumption smoothing which will end up dominating the determination of the real rate. Second, *truly* transformative AI leading to 30%+ economy-wide growth ("Moore's law for everything") would not be possible without having economy-wide benefits.

Stocks. One naive objection to the argument here would be the claim that real interest rates sound like an odd, arbitrary asset price to consider; certainly stock prices are the asset price that receive the most media attention.

In appendix 1, we explain that the level of the real interest rate affects *every* asset price: stocks for instance reflect the *present discounted value* of future dividends; and real interest rates *determine the discount rate used to discount* those future dividends. Thus, if real interest rates are 'wrong', *every* asset price is wrong. If real interest rates are wrong, *a lot* of money is on the table, a point to which we return in section X.

We also argue that stock prices in particular are not a useful indicator of market expectations of AI timelines. Above all, high stock prices of chipmakers or companies like Alphabet (parent of DeepMind) could only reflect expectations for *aligned* AI and could not be informative of the risk of *unaligned* AI. Additionally, as we explain further in the appendix, aligned AI could even *lower* equity prices, by pushing up discount rates.

IV. Historical data on interest rates supports the theory: preliminaries

In section I, we gave theoretical *intuition* for why higher expected growth or higher existential risk would result in higher interest rates: expectations for such high growth or mortality risk would lead people to want to save less and borrow more today. In this section and the next two, we showcase some simple empirical evidence that the predicted relationships hold in the available data.

Measuring real rates. To compare historical real interest rates to historical growth, we need to measure real interest rates.

Most bonds historically have been *nominal*, where the yield is not adjusted for changes in inflation. Therefore, the vast majority of research studying real interest rates starts with *nominal* interest rates, attempts to construct an estimate of expected inflation using some statistical model, and then subtracts this estimate of expected inflation from the nominal rate to get an *estimated* real interest rate. However, constructing measures of inflation expectations is extremely difficult, and as a result most papers in this literature are not very informative.

Additionally, most bonds historically have had some risk of default. Adjusting for this default premium is also extremely difficult, which in particular complicates analysis of long-run interest rate trends.

The difficulty in measuring real rates is one of the main causes, in our view, of Tyler Cowen's Third Law: "all propositions about real interest rates are wrong". Throughout this piece, we are badly violating this (Gödelian) Third Law. In appendix 2, we expand on our argument that the source of Tyler's Third Law is measurement issues in the extant literature, together with some separate, frequent conceptual errors.

Our approach. We take a more direct approach.

Real rates. For our primary analysis, we instead use market real interest rates from *inflation-linked bonds*. Because we use interest rates *directly* from inflation-linked bonds – instead of constructing shoddy estimates of inflation expectations to use with nominal interest rates – this approach avoids the measurement issue just discussed (and, we argue, allows us to escape Cowen's Third Law).

To our knowledge, prior literature has not used real rates from inflation-linked bonds only because these bonds are comparatively new. Using inflation-linked bonds confines our sample to the last ~20 years in the US, the last ~30 in the UK/Australia/Canada. Before that, inflation-linked bonds didn't exist. Other countries have data for even fewer years and less liquid bond markets.

(The yields on inflation-linked bonds are not perfect measures of real rates, because of risk premia, liquidity issues, and some subtle issues with the way these securities are structured. You can build a model and attempt to strip out these issues; here, we will just use the raw rates. If you prefer to think of these empirics as "are *inflation-linked bond yields* predictive of future real growth" rather than "are *real rates* predictive of future real growth", that interpretation is still sufficient for the logic of this post.)

Nominal rates. Because there are only 20 or 30 years of data on *real* interest rates from inflation-linked bonds, we supplement our data by also considering unadjusted *nominal* interest rates. Nominal interest rates reflect real interest rates plus inflation expectations, so it is not appropriate to compare nominal interest rates to *real* GDP growth.

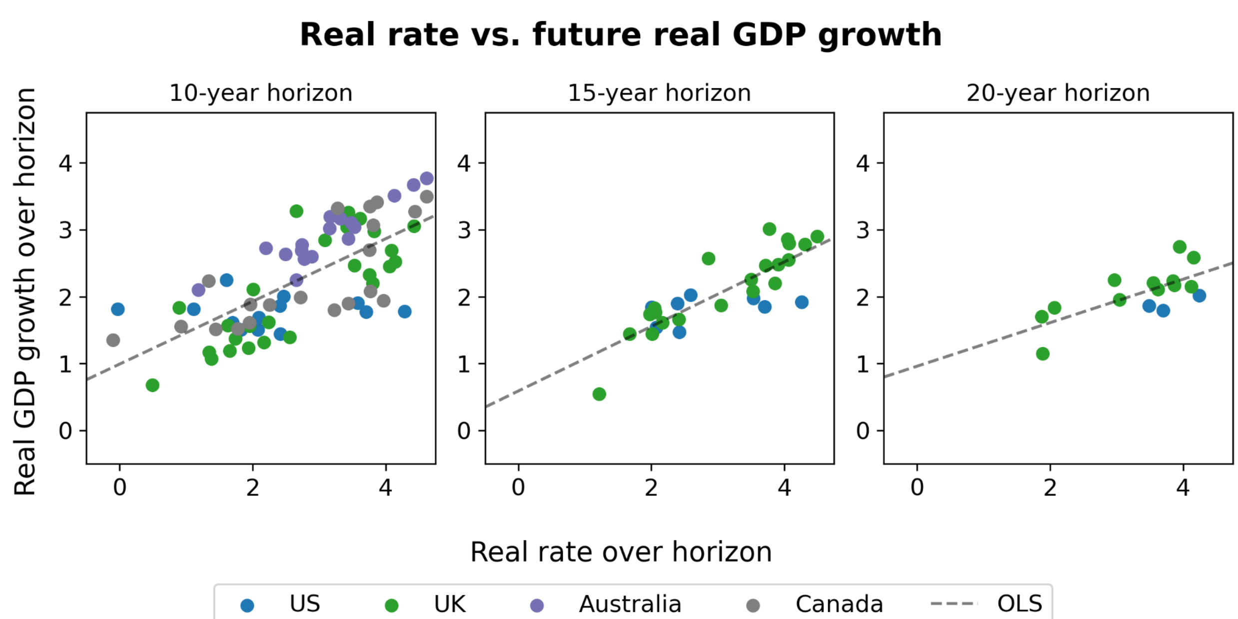
Instead, analogously to comparing *real* interest rates to *real* GDP growth, we compare *nominal* interest rates to *nominal* GDP growth. The latter is not an ideal comparison under economic theory – and inflation variability could swamp real growth variability – but we argue that this approach is simple and transparent.

Looking at nominal rates allows us to have a very large sample of countries for many decades: we use OECD data on nominal rates available for up to 70 years across 39 countries.

V. Historical data on interest rates supports the theory: graphs

The goal of this section is to show that real interest rates have correlated with future real economic growth, and secondarily, that nominal interest rates have correlated with future nominal economic growth. We also briefly discuss the state of empirical evidence on the correlation between real rates and existential risk.

Real rates vs. real growth. A first cut at the data suggests that, indeed, higher real rates today predict higher real growth in the future:



To see how to read these graphs, take the left-most graph ("10-year horizon") for example. The x-axis shows the level of the real interest rate, as reflected on 10-year inflation linked bonds. The y-axis shows average real GDP growth over the *following* 10 years.

The middle and right hand graphs show the same, at the 15-year and 20-year horizons. The scatter plot shows all available data for the US (since 1999), the UK (since 1985), Australia (since 1995), and Canada (since 1991). (Data for Australia and Canada is only available at the 10-year horizon, and comes from Augur Labs.)

Eyeballing the figure, there appears to be a strong relationship between real interest rates today and future economic growth over the next 10-20 years.

To our knowledge, this simple stylized fact is novel.

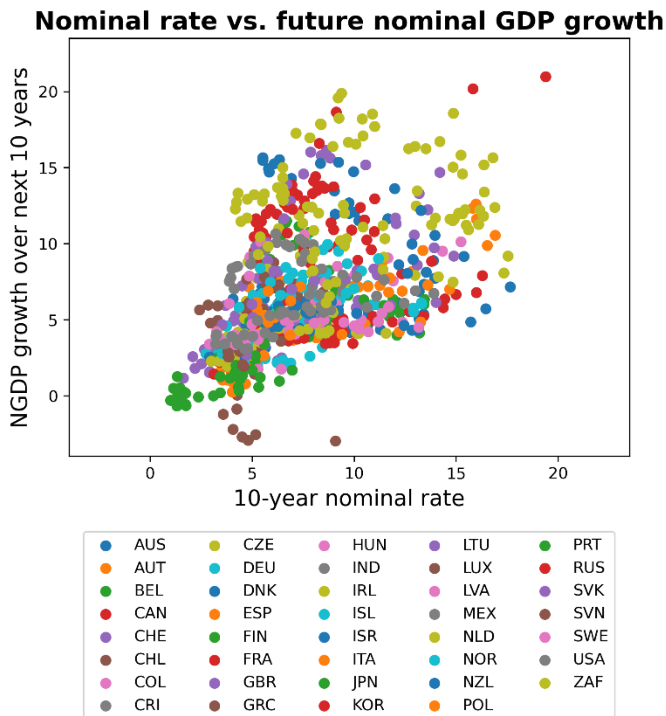
Caveats. "Eyeballing it" is not a formal econometric method; but, this is a blog post not a journal article (TIABPNAJA). We do not perform any formal statistical tests here, but we do want to acknowledge some important statistical points and other caveats.

First, the data points in the scatter plot are not statistically independent: real rates and growth are both persistent variables; the data points contain overlapping periods; and growth rates in these four countries are correlated. These issues are evident even from eyeballing the time series. Second, of course this relationship is not causally identified: we do not have exogenous variation in real growth rates. (If you have ideas for identifying the causal effect of higher real growth expectations on real rates, we would love to discuss with you.)

Relatedly, many other things are changing in the world which are likely to affect real rates. Population growth is slowing, retirement is lengthening, the population is aging. But under AI-driven "explosive" growth – again say 30%+ annual growth, following the excellent analysis of Davidson (2021) – then, we might reasonably expect that this massive of an increase in the growth rate would drown out the impact of any other factors.

Nominal rates vs. nominal growth. Turning now to evidence from nominal interest rates, recall that the usefulness of this exercise is that while there only exists 20 or 30 years of data on *real* interest rates for two countries, there is much more data on *nominal* interest rates.

We simply take all available data on 10-year nominal rates from the set of 39 OECD countries since 1954. The following scatterplot compares the 10-year nominal interest versus nominal GDP growth over the succeeding ten years by country:



Again, there is a strong positive – if certainly not perfect – relationship. (For example, the outlier brown dots at the bottom of the graph are Greece, whose high interest rates despite negative NGDP growth reflect high default risk during an economic depression.)

The same set of nontrivial caveats apply to this analysis as above.

We consider this data from nominal rates to be significantly weaker evidence than the evidence from real rates, but corroboration nonetheless.

Backing out market-implied timelines. Taking the univariate pooled OLS results from the real rate data *far* too seriously, the fact that the 10-year real rate in the US ended 2022 at 1.6% would predict average annual real GDP growth of 2.6% over the next 10 years in the US; the analogous interest rate of -0.2% in the UK would predict 0.7% annual growth over the next 10 years in the UK. Such growth rates, clearly, are not compatible with the arrival of transformative aligned AI within this horizon.

VI. Empirical evidence on real rates and mortality risk

We have argued that in the theory, real rates should be higher in the face of high economic growth or high mortality risk; empirically, so far, we have only shown a relationship between real rates and growth, but not between real rates and mortality.

Showing that real rates accurately reflect changes in existential risk is very difficult, because there is no word-of-god measurement of how existential risk has evolved over time.

We would be very interested in pursuing new empirical research examining "asset pricing under existential risk". In appendix 3, we perform a scorched-earth literature review and find essentially zero existing empirical evidence on real rates and *existential* risks.

Disaster risk. In particular, the extant literature does not study existential risks but instead "merely" *disaster risks*, under which real assets are devastated but humanity is not exterminated. Disaster risks do *not* necessarily raise real rates – indeed, such risks are thought to *lower* real rates due to precautionary savings. That notwithstanding, some highlights of the appendix review include a small set of papers finding that individuals with a higher perceived risk of nuclear conflict during the Cold War saved less, as well as a paper noting that equities which were headquartered in cities more likely to be targeted by Soviet missiles did worse during the Cuban missile crisis (see also). Our assessment is that these and the other available papers on *disaster* risks discussed in the appendix have severe limitations for the purposes here.

Individual mortality risk. We judge that the best evidence on this topic comes instead from examining the relationship between *individual mortality risk* and *savings/investment* behavior. The logic we provided was that if humanity will be extinct next year, then there is no reason to save, pushing up the real rate. Similar logic says that at the *individual* level, a higher risk of death for any reason should lead to lower savings and less investment in human capital. Examples of lower savings at the *individual* level need not raise interest rates at the *economy-wide* level, but do provide evidence for the *mechanism* whereby extinction risk should lead to lower saving and thus higher interest rates.

One example comes from Malawi, where the provision of a new AIDS therapy caused a significant increase in life expectancy. Using spatial and temporal variation in where and when these therapeutics were rolled out, it was found that increased life expectancy results in more savings and more human capital investment in the form of education spending. Another experiment in Malawi provided information to correct pessimistic priors about life expectancy, and found that higher life expectancy directly caused more investment in agriculture and livestock.

A third example comes from testing for Huntington's disease, a disease which causes a meaningful drop in life expectancy to around 60 years. Using variation in when people are diagnosed with Huntington's, it has been found that those who learn they carry the gene for Huntington's earlier are 30 percentage points less likely to finish college, which is a significant fall in their human capital investment.

Studying the effect on savings and real rates from increased life expectancy *at the population level* is potentially intractable, but would be interesting to consider further. Again, in our assessment, the best empirical evidence available right now comes from the research on individual "existential" risks and suggests that real rates should increase with existential risk.

VII. Plugging the Cotra probabilities into a simple quantitative model of real interest rates predicts very high rates

Section VI used historical data to go from *the current real rate* to a very crude *market-implied forecast* of growth rates; in this section, we instead use a model to go from *existing forecasts* of AI timelines to *timeline-implied real rates.* We aim to show that under short AI timelines, real interest rates would be unrealistically elevated.

This is a useful exercise for three reasons. First, the historical data is only able to speak to growth forecasts, and therefore only able to provide a forecast under the possibly incorrect assumption of *aligned* AI. Second, the empirical forecast assumes a *linear* relationship between the real rate and growth, which may not be reasonable for a massive change caused by transformative AI. Third and quite important, the historical data cannot transparently tell us anything about uncertainty and the market's beliefs about the full probability *distribution* of AI timelines.

We use the canonical (and nonlinear) version of the Euler equation – the model discussed in section I – but now allow for *uncertainty* on both how soon transformative AI will be developed and whether or not it will be aligned. The model takes as its key inputs (1) a probability of transformative AI each year, and (2) a probability that such technology is aligned.

The model is a simple application of the stochastic Euler equation under an isoelastic utility function. We use the following as a baseline, before considering alternative probabilities:

- We use smoothed **Cotra (2022) probabilities for transformative AI** over the next 30 years: a 2% yearly chance until 2030, a 3% yearly chance through 2036, and a 4% yearly chance through 2052.
- We use the **FTX Future Fund's median estimate of 15% for the probability that AI is *un*aligned** conditional on the development of transformative AI.
- With the arrival of *aligned* AI, we use the **Davidson (2020) assumption of 30% annual economic growth**; with the arrival of unaligned AI, we assume human extinction. In the absence of the development of transformative AI, we assume a steady 1.8% growth rate.
- We calibrate the pure rate of subjective time preference to 0.01 and the consumption smoothing parameter (i.e. inverse of the elasticity of intertemporal substitution) as 1, following the economic literature.

Thus, to summarize: by default, GDP grows at 1.8% per year. Every year, there is some probability (based on Cotra) that transformative AI is developed. If it is developed, there is a 15% probability the world ends, and an 85% chance GDP growth jumps to 30% per year.

We have built a spreadsheet here that allows you to tinker with the numbers yourself, such as adjusting the growth rate under aligned AI, to see what your timelines and probability of alignment would imply for the real interest rate. (It also contains the full Euler equation formula generating the results, for those who want the mathematical details.) We first estimate real rates under the baseline calibration above, before considering variations in the critical inputs.

Baseline results. The model predicts that under *zero* probability of transformative AI, the real rate at any horizon would be 2.8%. In comparison, under the baseline calibration just described based on Cotra timelines, the real rate at a 30-year horizon would be pushed up to 5.9% – roughly three percentage points higher.

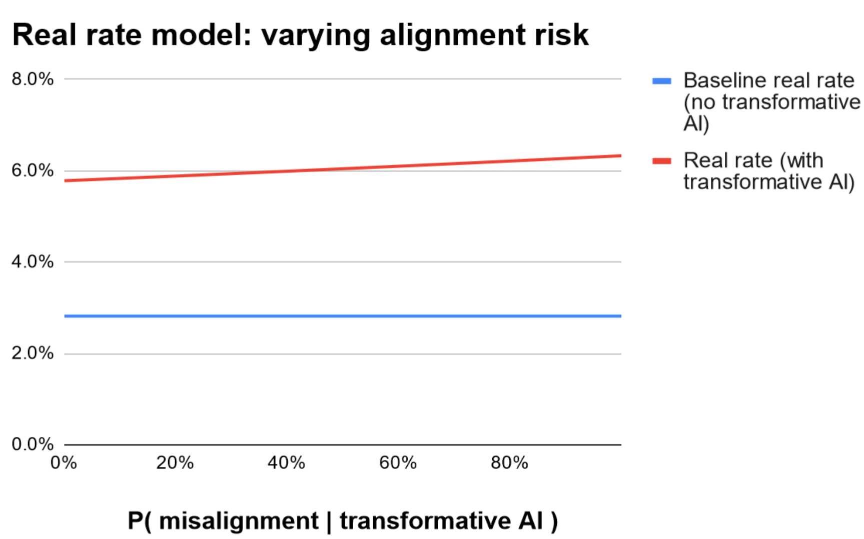
For comparison, the 30-year real rate in the US is currently 1.6%.

While the simple Euler equation somewhat overpredicts the level of the real interest rate even under zero probability of transformative AI – the 2.8% in the model versus the 1.6% in the data – this overprediction is explainable by the radical simplicity of the model that we use and is a known issue in the literature. Adding other factors (e.g. precautionary savings) to the model would lower the level. Changing the level does not change its *directional* predictions, which help quantitatively explain the fall in real rates over the past ~30 years.

Therefore, what is most informative is the three percentage point *difference* between the real rate under Cotra timelines (5.9%) versus under no prospect of transformative AI (2.8%): Cotra timelines imply real interest rates substantially higher than their current levels.

Now, from this baseline estimate, we can also consider varying the key inputs.

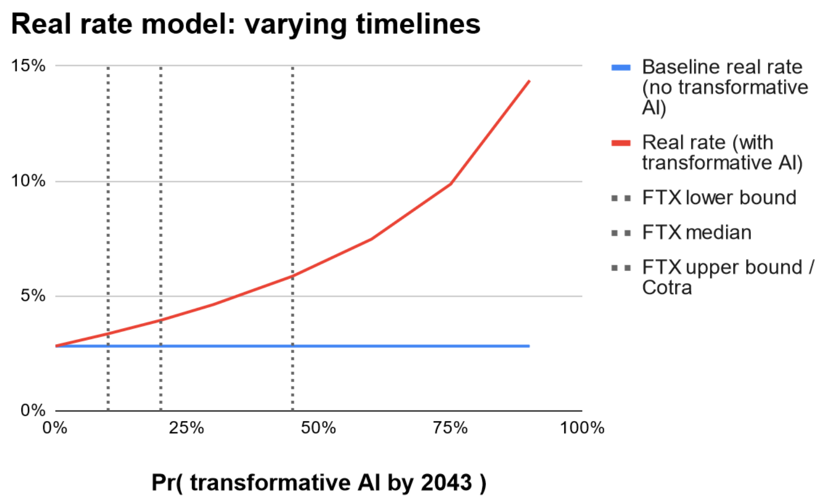
Varying assumptions on P(misaligned|AGI). First consider changing the assumption that advanced AI is 15% likely to be unaligned (conditional on the development of AGI). Varying this parameter does not have a large impact: moving from 0% to 100% probability of misalignment raises the model's predicted real rate from 5.8% only to 6.3%.



Varying assumptions on timelines. Second, consider making timelines shorter or longer. In particular, consider varying the *probability of development by 2043*, which we use as a benchmark per the FTX Future Fund.

We scale the Cotra timelines up and down to vary the probability of development by 2043. (Specifically: we target a specific *cumulative* probability of development by 2043; and, following Cotra, if the *annual* probability up until 2030 is x, then it is $1.5x$ in the subsequent seven years up through 2036, and it is $2x$ in the remaining years of the 30-year window.)

As the next figure shows and as one might expect, shorter AI timelines have a very large impact on the model's estimate for the real rate.



- The original baseline parameterization from Cotra corresponds to the FTX Future Fund "upper threshold" of a 45% chance of development by 2043, which generated the 3 percentage point increase in the 30-year real rate discussed above.
- The Future Fund's median of a 20% probability by 2043 generates a 1.1 percentage point increase in the 30-year real rate.
- The Future Fund's "lower threshold" of a 10% probability by 2043 generates a 0.5 percentage point increase in the real rate.

These results strongly suggest that any timeline shorter than or equal to the Cotra timeline is *not* being expected by financial markets.

VIII. Markets are decisively rejecting the shortest possible timelines

While it is not possible to back out *exact* numbers for the market's implicit forecast for AI timelines, it is reasonable to say that the market is *decisively* rejecting – i.e., putting very low probability on – the development of transformative AI in the *very* near term, say within the next ten years.

Consider the following examples of extremely short timelines:

1. Five year timelines: With a 50% probability of transformative AI by 2027, and the same yearly probability thereafter, the model predicts 13.0pp higher 30-year real rates today!
2. Ten year timelines: With a 50% probability of transformative AI by 2032, and the same yearly probability thereafter, the model predicts 6.5pp higher 30-year real rates today.

Real rate movements of these magnitudes are wildly counterfactual. As previously noted, real rates in the data used above have never gone above even 5%.

Stagnation. As a robustness check, in the configurable spreadsheet we allow you to place some yearly probability on the economy stagnating and growing at 0% per year from thereon. Even with a 20% chance of stagnation by 2053 (higher than realistic), under Cotra timelines, the model generates a 2.1% increase in 30-year rates.

Recent market movements. Real rates have increased around two percentage points since the start of 2022, with the 30-year real rate moving from -0.4% to 1.6%, approximately the pre-covid level. This is a large enough move to merit discussion. While this rise in long-term real rates could reflect changing market expectations for timelines, it seems much more plausible that high inflation, the Russia-Ukraine war, and monetary policy tightening have together worked to drive up short-term real rates and the risk premium on long-term real rates.

IX. Financial markets are the most powerful information aggregators produced by the universe (so far)

Should we update on the fact that markets are not expecting very short timelines?

Probably!

As a prior, we think that market efficiency is reasonable. We do not try to provide a full defense of the efficient markets hypothesis (EMH) in this piece given that it has been debated ad nauseum elsewhere, but here is a scaffolding of what such an argument would look like.

Loosely, the EMH says that the current price of any security incorporates all public information about it, and as such, you should not expect to systematically make money by trading securities.

This is simply a no-arbitrage condition, and certainly no more radical than supply and demand: if something is over- or under-priced, you'll take action based on that belief until you no longer believe it. In other words, you'll buy and sell it until you think the price is right. Otherwise, there would be an unexploited opportunity for profit that was being left on the table, and there are no free lunches when the market is in equilibrium.

As a corollary, the current price of a security should be the best available risk-adjusted predictor of its future price. Notice we didn't say that the price is equal to the "correct" fundamental value. In fact, the current price is almost certainly wrong. What we did say is that it is the best guess, i.e. no one knows if it should be higher or lower.

Testing this hypothesis is difficult, in the same way that testing any equilibrium condition is difficult. Not only is the equilibrium always changing, there is also a joint hypothesis problem which Fama (1970) outlined: comparing actual asset prices to "correct" theoretical asset prices means you are simultaneously testing whatever asset pricing model you choose, alongside the EMH.

In this sense, it makes no sense to talk about "testing" the EMH. Rather, the question is how quickly prices converge to the limit of market efficiency. In other words, how fast is information diffusion? Our position is that for most things, this is pretty fast!

Here are a few heuristics that support our position:

1. For our purposes, the earlier evidence on the link between real rates and growth is a highly relevant example of market efficiency.
2. There are notable examples of markets seeming to be eerily good at forecasting hard-to-anticipate events:
    a. In the wake of the Challenger explosion, despite no definitive public information being released, the market seems to have identified which firm was responsible.
    b. Economist Armen Alchian observed that the stock price of lithium producers spiked 461% following the public announcement of the first hydrogen bomb tests in 1954, while the prices of producers of other radioactive metals were flat. He circulated a paper within RAND, where he was working, identifying lithium as the material used in the tests, before the paper was suppressed by leadership who were apparently aware that indeed lithium was used. The market was prescient even though *zero* public information was released about lithium's usage.

Remember: if real interest rates are wrong, *all* financial assets are mispriced. If real interest rates "should" rise three percentage points or more, that is easily hundreds of billions of dollars worth of revaluations. It is unlikely that sharp market participants are leaving billions of dollars on the table.

X. If markets are not efficient, you could be earning alpha and philanthropists could be borrowing

While our prior in favor of efficiency is fairly strong, the market could be currently failing to anticipate transformative AI, due to various limits to arbitrage.

However, if you do believe the market is currently wrong about the probability of short timelines, then we now argue there are two courses of action you should consider taking:

1. Bet on real rates rising ("get rich or die trying")
2. Borrow today, including in order to fund philanthropy ("impatient philanthropy")

1. Bet on real rates rising ("get rich or die trying")

Under the logic argued above, if you genuinely believe that AI timelines are short, then you should consider putting your money where your mouth is: bet that real rates will rise when the market updates, and potentially earn a lot of money if markets correct. Shorting (or going underweight) government debt is the simplest way of expressing this view.

Indeed, AI safety researcher Paul Christiano has written publicly that he is (or was) short 30-year government bonds.

If short timelines are your true belief in your heart of hearts, and not merely a belief in a belief, then you should seriously consider how much money you could earn here and what you could do with those resources.

Implementing the trade. For retail investors, betting against treasuries via ETFs is perhaps simplest. Such trades can be done easily with retail brokers, like Schwab.

(i) For example, one could simply short the LTPZ ETF, which holds long-term real US government debt (effective duration: 20 years).

(ii) Alternatively, if you would prefer to avoid engaging in shorting yourself, there are ETFs which will do the shorting for you, with nominal bonds: TBF is an ETF which is short 20+ year treasuries (duration: 18 years); TBT is the same, but levered 2x; and TTT is the same, but levered 3x. There are a number of other similar options. Because these ETFs do the shorting for you, all you need to do is purchase shares of the ETFs.

Back of the envelope estimate. A rough estimate of how much money is on the table, just from shorting the US treasury bond market *alone*, suggests there is easily $1 trillion in value at stake from betting that rates will rise.

- In response to a 1 percentage point rise in interest rates, the price of a bond falls in percentage terms by its "*duration*", to a first-order approximation.
- The average value-weighted duration of (privately-held) US treasuries is approximately 4 years.
- So, to a first-order approximation, if rates rise by 3 percentage points, then the value of treasuries will fall by 12% (that is, 3*4).
- The market cap of (privately-held) treasuries is approximately $17 trillion.
- Thus, if rates rise by 3 percentage points, then the total value of treasuries can be expected to fall by $2.04 trillion (that is, 12%*17 trillion).

- Slightly more than half (55%) of the interest rate sensitivity of the treasury market comes from bonds with maturity beyond 10 years. Assuming that the 3 percentage point rise occurs only at this horizon, and rounding down, we arrive at the $1 trillion estimate.

Alternatively, returning to the LTPZ ETF with its duration of 20 years, a 3 percentage point rise in rates would cause its value to fall by 60%. Using the 3x levered TTT with duration of 18 years, a 3 percentage point rise in rates would imply a mouth-watering cumulative return of 162%.

While fully fleshing out the trade analysis is beyond the scope of this post, this illustration gives an idea of how large the possibilities are.

The alternative to this order-of-magnitude estimate would be to build a complete bond pricing model to estimate more precisely the expected returns of shorting treasuries. This would need to take into account e.g. the convexity of price changes with interest rate movements, the varied maturities of outstanding bonds, and the different varieties of instruments issued by the Treasury. Further refinements would include trading derivatives (e.g. interest rate futures) instead of shorting bonds directly, for capital efficiency, and using leverage to increase expected returns.

Additionally, the analysis could be extended beyond the US government debt market, again since changes to real interest rates would plausibly impact the price of every asset: stocks, commodities, real estate, *everything*.

(If you would be interested in fully scoping out possible trades, we would be interested in talking.)

Trade risk and foom risk. We want to be clear that – unless you are risk neutral, or can borrow without penalty at the risk-free rate, or believe in short timelines with 100% probability – then such a bet would not be a free lunch: this is not an "arbitrage" in the technical sense of a risk-free profit. One risk is that the market moves in the other direction in the short term, before correcting, and that you are unable to roll over your position for liquidity reasons.

The other risk that could motivate not making this bet is the risk that the market – for some unspecified reason – never has a chance to correct, because (1) transformative AI ends up *unaligned* and (2) humanity's conversion into paperclips occurs *overnight*. This would prevent the market from ever "waking up".

However, to be clear, expecting this specific scenario requires both:

1. Buying into specific stories about how takeoff will occur: specifically, Yudkowskian foom-type scenarios with fast takeoff.
2. Having a lot of skepticism about the optimization forces pushing financial markets towards informational efficiency.

You should be sure that your beliefs are actually congruent with these requirements, if you want to refuse to bet that real rates will rise. Additionally, we will see that the second suggestion in this section ("impatient philanthropy") is not affected by the possibility of foom scenarios.

2. Borrow today, including in order to fund philanthropy ("impatient philanthropy")

If prevailing interest rates are lower than your subjective discount rate – which is the case if you think markets are underestimating prospects for transformative AI – then simple cost-benefit analysis says you should save less or even borrow today.

An illustrative example. As an extreme example to illustrate this argument, imagine that you think that there is a 50% chance that humanity will be extinct next year, and otherwise with certainty you will have the same income next year as you do this year. Suppose the market real interest rate is 0%. That means that if you borrow $10 today, then in expectation you only need to pay $5 off, since 50% of the time you expect to be dead.

It is only if the market real rate is 100% – so that your $10 loan requires paying back $20 next year, or exactly $10 in expectation – that you are indifferent about borrowing. If the market real rate is less than 100%, then you want to borrow. If interest rates are "too low" from your perspective, then on the margin this should encourage you to borrow, or at least save less.

Note that this logic is not affected by whether or not the market will "correct" and real rates will rise before everyone dies, unlike the logic above for trading.

Borrowing to fund philanthropy today. While you may want to borrow today simply to fund wild parties, a natural alternative is: borrow today, locking in "too low" interest rates, in order to fund philanthropy today. For example: to fund AI safety work.

We can call this strategy "impatient philanthropy", in analogy to the concept of "patient philanthropy".

This is not a call for philanthropists to radically rethink their cost-benefit analyses. Instead, we merely point out: ensure that your financial planning properly accounts for any difference between *your* discount rate and *the market real rate at which you can borrow*. You should not be using the market real rate to do your financial planning. If you have a higher effective discount rate due to your AI timelines, that could imply that you should be borrowing today to fund philanthropic work.

Relationship to impatient philanthropy. The logic here has a similar flavor to Phil Trammell's "patient philanthropy" argument (Trammell 2021) – but with a sign flipped. Longtermist philanthropists with a zero discount rate, who live in a world with a positive real interest rate, should be willing to save all of their resources for a long time to earn that interest, rather than spending those resources today on philanthropic projects. Short-timeliners have a higher discount rate than the market, and therefore should be *im*patient philanthropists.

(The point here is not an exact analog to Trammell 2021, because the paper there considers strategic game theoretic considerations and also takes the real rate as exogenous; here, the considerations are not strategic and the endogeneity of the real rate is the critical point.)

XI. Conclusion: outside views vs. inside views & future work

We do not claim to have special technical insight into forecasting the likely timeline for the development of transformative artificial intelligence: we do not present an inside view on AI timelines.

However, we do think that market efficiency provides a powerful *outside view* for forecasting AI timelines and for making financial decisions. Based on prevailing real interest rates, the market seems to be strongly rejecting timelines of less than ten years, and does not seem to be placing particularly high odds on the development of transformative AI even 30-50 years from now.

We argue that market efficiency is a reasonable benchmark, and consequently, this forecast serves as a useful prior for AI timelines. If markets are wrong, on the other hand, then there is an enormous amount of money on the table from betting that real interest rates will rise. In either case, this market-based approach offers a useful framework: either for forecasting timelines, or for asset allocation.

Opportunities for future work. We could have put 1000 more hours into the empirical side or the model, but, TIABPNAJA. Future work we would be interested in collaborating on or seeing includes:

1. More careful empirical analyses of the relationship between real rates and growth. In particular, (1) analysis of data samples with larger variation in growth rates (e.g. with the Industrial Revolution, China or the East Asian Tigers), where a credible measure of *real* interest rates can be used; and (2) *causally identified* estimates of the relationship between real rates and growth, rather than correlations. Measuring historical real rates is the key challenge, and the main reason why we have not tried to address these here.
2. Any empirical analysis of how real rates vary with changing existential risk. Measuring changes in existential risk is the key challenge.
3. Alternative quantitative models on the relationship between real interest rates and growth/x-risk with alternative preference specifications, incomplete markets, or disaster risk.
4. Tests of market forecasting ability at longer time horizons for any outcome of significance; and comparisons of market efficiency at shorter versus longer time horizons.
5. Creation of sufficiently-liquid genuine *market* instruments for directly measuring outcomes we care about like long-horizon GDP growth: e.g. GDP swaps, GDP-linked

bonds, or binary GDP prediction markets. (We emphasize *market* instruments to distinguish from forecasting platforms like Metaculus or play-money sites like Manifold Markets where the forceful logic of financial market efficiency simply does not hold.)

6. An analysis of the most capital-efficient way to bet on short AI timelines and the possible expected returns ("the greatest trade of all time").
7. Analysis of the informational content of infinitely-lived assets: e.g. the discount rates embedded in land prices and rental contracts. There is an existing literature related to this topic: [1], [2], [3], [4], [5], [6], [7].
   - This literature estimates *risky, nominal* discount rates embedded in rental contracts out as far as 1000 years, and finds surprisingly low estimates – certainly less than 10%. This is potentially extremely useful information, though this literature is not without caveats. Among many other things, we cannot have the presumption of informational efficiency in land/rental markets, unlike financial markets, due to severe frictions in these markets (e.g. inability to short sell).

Thanks especially to Leopold Aschenbrenner, Nathan Barnard, Jackson Barkstrom, Joel Becker, Daniele Caratelli, James Chartouni, Tamay Besiroglu, Joel Flynn, James Howe, Chris Hyland, Stephen Malina, Peter McLaughlin, Jackson Mejia, Laura Nicolae, Sam Lazarus, Elliot Lehrer, Jett Pettus, Pradyumna Prasad, Tejas Subramaniam, Karthik Tadepalli, Phil Trammell, and participants at ETGP 2022 for very useful conversations on this topic and/or feedback on drafts.

Update 1. To try to group/summarize our replies to some common critiques:

1. 'Traders are not thinking about AGI, the inferential distance is too large'; or 'a short can only profit if other people take the short position too'

(a) *Anyone* who thinks they have an edge in markets thinks they've noticed something which requires such a large inferential distance that no one else has seen it.

- *Any* trade requires that the market price eventually converges to the 'correct' price
- ⇒ <u>This argument proves too much – it's a general argument against *ever* betting that the market will correct an incorrect price</u>!
  - Those who are arguing against need to be a clearer argument about why this situation is fundamentally different from any other
  - Sovereign bond markets are easily some of the most liquid and well-functioning markets ever to exist

(b) Many financial market participants ARE thinking about these issues.

- Asset manager Cathie Wood has AGI timelines of 6-12 years and is betting the house on that ("AGI could accelerate growth in GDP to 30-50% per year")
- Masayoshi Son raised $100 billion for Softbank's Vision Fund on the basis that superintelligence will arrive by 2047

The prospect of AGI is not a Thielian secret.

(c) Do make sure to read section X on “Trade risk and foom risk”, where we acknowledge that if you are both (i) extremely skeptical of market efficiency, and (ii) think foom is the likely takeoff scenario, then trading seems less like a good idea.

2. Stocks versus bonds

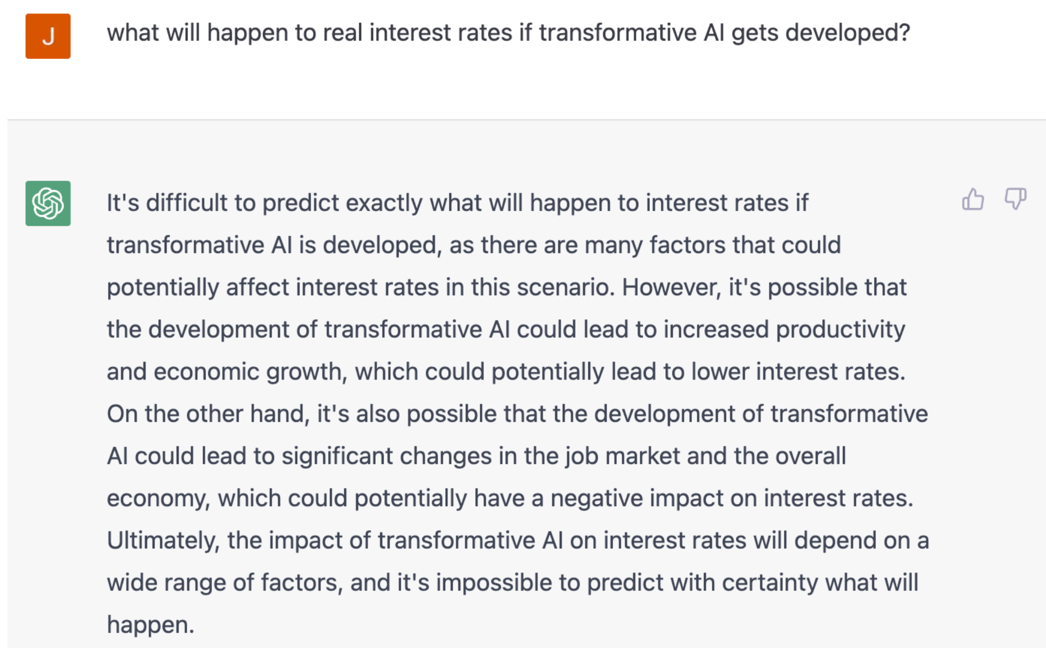
- Again we refer to detailed discussion in appendix 1 on stocks:
  - (1) Stocks cannot capture the risk of unaligned AI
  - (2) Developers of TAI might not actually profit much
  - (3) The developers of TAI might not be publicly traded or even exist yet
  - (4) The development of TAI *could* even lower stock prices!
- To be clear, though: the economic logic suggests stocks are bad for *forecasting* timelines (due to the four reasons mentioned in that post)
- BUT stocks still *could* be good ways to *earn money* betting on short timelines (if the four sources of noise mentioned in that post don’t turn out to hold)

3. Other empirical evidence on real rates

- Again we refer to detailed discussion in appendix 2 and the important discussion of econometric caveats in section V (“Caveats”)
- We emphasize that we would *love* to have more/better empirical evidence with respect to asset pricing under existential risk (appendix 3)
- The challenge with using the historical data (e.g. the Bank of England brought up in the comments) is – as discussed in section IV and in the appendix – that these data are infected with (1) poor estimates of expected inflation and (2) poor estimates of credit risk
  - For example, in the Schmelzing paper that has been cited: certain claimed spikes in the risk-free rate, e.g. during the Napoleonic war, look *far* more like a spike in default risk
  - Or the ex ante real interest rate in World War II in his data is negative, which seems unlikely

Postscript

OpenAI's ChatGPT model on what will happen to real rates if transformative AI is developed: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what will happen to real interest rates if transformative AI gets developed?

It's difficult to predict exactly what will happen to interest rates if transformative AI is developed, as there are many factors that could potentially affect interest rates in this scenario. However, it's possible that the development of transformative AI could lead to increased productivity and economic growth, which could potentially lead to lower interest rates. On the other hand, it's also possible that the development of transformative AI could lead to significant changes in the job market and the overall economy, which could potentially have a negative impact on interest rates. Ultimately, the impact of transformative AI on interest rates will depend on a wide range of factors, and it's impossible to predict with certainty what will happen.

🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔🤔

Some framings you can use to interpret this post:

1. "This blog post takes Fama seriously" [a la Mankiw-Romer-Weil]
2. "The market-clearing price does not hate you nor does it love you" [a la Yudkowsky]
3. "Existential risk and asset pricing" [a la Aschenbrenner 2020, Trammell 2021]
4. "Get rich or hopefully don't die trying" [a la 50 Cent]
5. "You *can* short the apocalypse." [contra Peter Thiel, cf Alex Tabarrok]
6. "Tired: market monetarism. Inspired: *market longtermism*." [a la Scott Sumner]
7. "This is not *not* financial advice." [a la the standard disclaimer]

Appendix 1. Against using stock prices to forecast AI timelines

One naive objection would be the claim that real interest rates sound like an odd, arbitrary asset price to consider. Certainly, real interest rates are not frequently featured in newspaper headlines – if any interest rates are quoted, it is typically *nominal* interest rates – and stock prices receive by far the most popular attention.

The importance of real rates. However, even if real interest rates are not often discussed, real interest rates affect *every* asset price. This is because asset prices always reflect some *discounted* value of future cash flows: for example, the price of Alphabet stock reflects the present *discounted* value of future Alphabet dividend payments. These future dividend payments are discounted using a discount rate *which is determined by the prevailing real interest rate*. Thus the claim that real interest rates affect every asset price.

As a result, if real interest rates are 'wrong', *every* asset price is wrong. If real interest rates are wrong, *a lot* of money is on the table.

Stocks are hard to interpret. It may nonetheless be tempting to look at *stock* prices to attempt to interpret how the market is thinking about AI timelines (e.g. Ajeya Cotra; Matthew Barnett; /r/ssc). It may be tempting to consider the high market capitalization of Alphabet as reflecting market expectations for large profits generated by DeepMind's advancing capabilities, or TSMC's market cap as reflecting market expectations for the chipmaker to profit from AI progress.

However, extracting AI-related expectations from stock prices is a very challenging exercise – to the point that we believe it is simply futile – for four reasons.

(1) First, and most importantly, these companies will only have the possibility of high profits if transformative AI is *aligned*; under unaligned AI, the value of stocks along with everything else is converted to zero.
(2) Second, it is not obvious that even in the aligned case that these companies will earn high profits. For instance, OpenAI has committed to a capped profit model, and others may sign on to a similar 'Windfall Clause'. Beyond corporate altruism, it seems extremely plausible that if a private company develops truly transformative AI technology then the state will (attempt to) nationalize and expropriate it to distribute the benefits more broadly, preventing profits.
(3) Third, stock valuations are extremely idiosyncratic: which stock should we be looking at? And critically, even if we take a basket of tech companies and average over them, then this only includes *public* companies. If the market expects transformative AI in 12 months, but only because it will be developed by OpenAI – a company which is not traded publicly – then this will not show up in any equity index.
(4) Fourth, and quite importantly, *it is not obvious whether expectations of transformative AI would raise or lower stock prices*. This is because, as described in the previous subsection,

stock prices reflect the present-discounted value of future profits; and advanced AI may raise those future profits, but – as the central thesis of this piece argues – advanced AI would *also* raise the interest rate used to discount those profits. The net effect on stock prices is not immediately obvious.

   a. (In math, briefly: if the price P is the value of future profits D discounted at rate r, i.e. $P = D/r$, then transformative AI may raise future profits D but it could raise the discount rate r by even more.)
   b. (Higher growth causes lower average stock prices if the intertemporal elasticity of substitution is greater than one, rather than less than one. This parameter is subject to significant debate; see the linked slides for useful discussion. John Cochrane offers additional intuition here and argues that the empirically-relevant case is the one where higher growth causes lower equity prices: expectations for transformative AI would *lower* equity prices.)

If you want to use market prices to predict AI timelines, using equities is not a great way to do it.

In contrast, real interest rates do not suffer from these problems.

Appendix 2. Explaining Tyler Cowen's Third Law

Throughout the body of the main post, we are badly violating Tyler Cowen's Third Law: "all propositions about real interest rates are wrong".

The origin of this (self-referential) idea is that there are many conflicting claims about real interest rates. One way to see this point is this thread from Jo Michell listing seventy different theories for the determination of real and nominal interest rates.

We do think Tyler's Third Law is right – economists do not have a sufficiently good understanding of real interest rates – and we speculate that there are three reasons for this poor understanding.

1. Real vs. nominal interest rates. A basic problem is that many casual observers simply conflate *nominal* interest rates and *real* interest rates, failing to distinguish them. This muddies many discussions about "interest rates", since nominal and real rates are driven by different factors.

2. Adjusting for inflation and default risk. Another extremely important part of the problem, discussed at length in section IV of the main post, is that there did not exist a market-based measure of *risk-free, real* interest rates until the last 2-3 decades, with the advent of inflation-linked bonds and inflation swaps.

Most analyses instead use *nominal* rates – where in contrast there are centuries of data – and try to construct a measure of expected inflation in order to estimate real interest rates via the Fisher equation (e.g. Lunsford and West 2019). Crucially, the crude attempts to measure expected inflation create extensive distortions in these analyses.

Even more problematically, much of the historical data on nominal interest rates comes from bonds that were not just nominal but also were *risky* (e.g. Schmelzing 2020): historical sovereigns had high risk of default. Adjusting for default risk is extremely difficult, just like adjusting for inflation expectations, and also creates severe distortions in analyses.

3. Drivers of short-term real rates are different from those for long-term rates. Finally, another important issue in discourse around real interest rates is that the time horizon really matters.

In particular: our best understanding of the macroeconomy predicts that real rates should have very different drivers in the short run versus in the long run.

(a) Short-run real rates have different drivers than long-run real rates because in the short run, prices and wages and contracts are nominally sticky, so *monetary policy* affects the real rate in the short run.

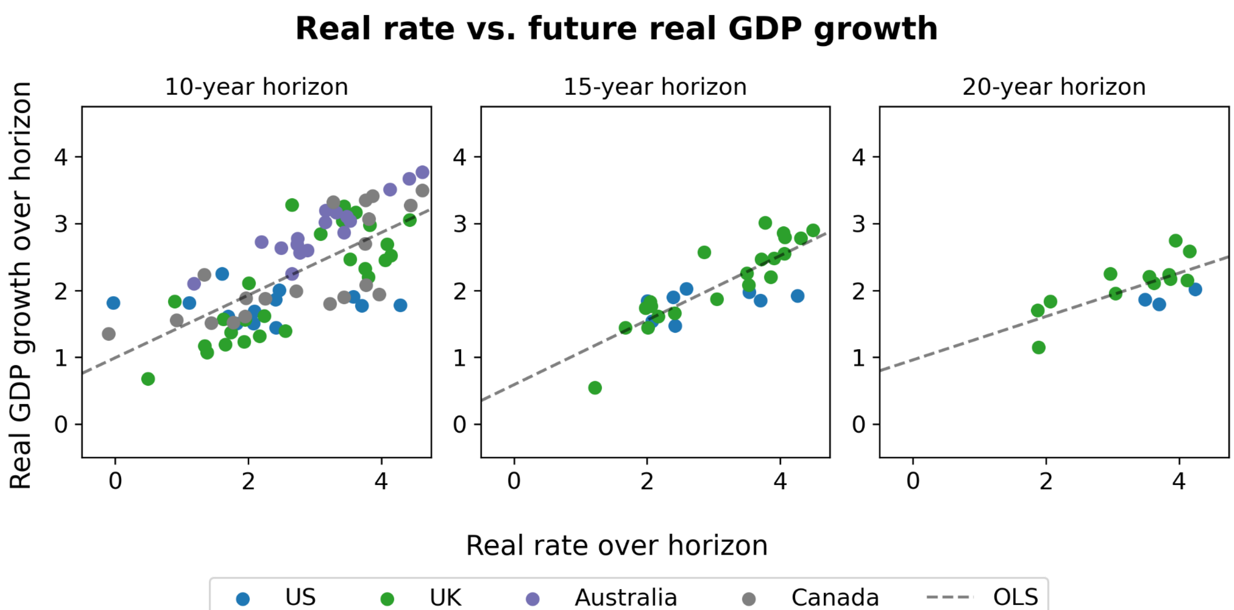
(b) In the long run, prices and wages are flexible, and therefore the real rate is only affected by *real, supply-side* factors like GDP growth.

This short run versus long run distinction is blurry and vague, so it is difficult to separate the data to do the *two* relevant analyses of "what drives short-term real rates" versus "what drives long-term real rates". Much analysis simply ignores the distinction.

<u>Together, one or more of these three issues – the nominal-real distinction; the lack of historical risk-free inflation-linked bonds; and the short- vs. long-run distinction – tangles up most research and popular discourse on real interest rates.</u>

Hence, Tyler's Third Law: "all propositions about real interest rates are wrong".

In the main post, we hope that by our use of data from *inflation-linked bonds* – rather than shoddily constructing pseudo data on inflation expectations, to use with nominal bond data – and being careful to work exclusively with *long-run* real rates, we have avoided the Third Law.



The above figure is from the main post. To see how to read these graphs, take for example the left-most graph ("10-year horizon") and pick a green dot. The x-axis then shows the level of the real interest rate in the UK, as reflected on 10-year inflation linked bonds, in some given year. The y-axis shows average real GDP growth over the following 10 years from that point. For data discussion and important statistical notes, see the main post.

Appendix 3. Asset pricing under existential risk: a literature review

1. SAVINGS AND "EXISTENTIAL" / DISASTER RISKS

Russett and Slemrod (1993)

- 1990 survey data
- Survey people about their savings behavior and their beliefs about nuclear war risk
  - Savings behavior: "Considering all your savings and reserve funds, during 1989 did you put more money into your savings and reserve funds than you took out, or did you take out more money than you put in?"
  - Nuclear war risk: "How likely do you think it is that we will get into a nuclear war within the next ten years? Do you think it is very likely, somewhat likely, somewhat unlikely, or very unlikely?"
- Find a negative relation (i.e. higher risk is associated with lower savings)
- Table:
  - Save: $\{-1, 0, 1\}$ for negative/zero/positive net saving
  - Dosave: if save == 1
  - Dissave: if save == -1
  - Safe: index of subjective probability of nuclear war
    - Very likely: 1
    - Somewhat likely: 2
    - Somewhat unlikely: 3
    - Very unlikely: 4
  - "D" prefix indicates change in variable

TABLE 2—EXPLAINING LEVELS OF 1989 SAVING, APRIL DATA ONLY

Independent variable	Polychotomous probit			Probit					
	Dependent variable								
	SAVE (i)	SAVE (ii)	SAVE (iii)	DOSAVE (iv)	DOSAVE (v)	DOSAVE (vi)	DISSAVE (vii)	DISSAVE (viii)	DISSAVE (ix)
SAFE	0.1310 [1.83]*		0.1271 [1.58][a]	0.1686 [2.11]*		0.1754 [1.96]*	−0.1146 [1.51][a]		−0.1023 [1.191]
DSAFE		0.0785 [1.33][a]	0.0322 [0.49]		0.0522 [0.84]	−0.0075 [0.11]		−0.0914 [1.48][a]	−0.0521 [0.76]
DFINPOS	0.3016 [4.10]**	0.2925 [4.00]**	0.2970 [4.03]**	0.2901 [3.51]**	0.2880 [3.49]**	0.2871 [3.47]**	−0.3069 [3.76]**	−0.2906 [3.58]**	−0.3028 [3.71]**
EDU	0.0581 [1.96]*	0.0616 [2.09]*	0.0570 [1.90]*	0.0756 [2.47]**	0.0777 [2.56]**	0.0743 [2.42]**	−0.0460 [1.59][a]	−0.0506 [1.76]*	−0.0445 [1.53][a]
AGE	0.0467 [2.14]*	0.0482 [2.22]*	0.0498 [2.27]*	0.0423 [1.77]*	0.0442 [1.86]*	0.0433 [1.81]*	−0.0570 [2.48]*	−0.0577 [2.53]**	−0.0607 [2.63]**
AGE2	−0.00046 [2.06]*	−0.00048 [2.14]*	−0.00050 [2.22]*	−0.00051 [2.09]*	−0.00053 [2.14]*	−0.00053 [2.14]*	0.00049 [2.14]*	0.00051 [2.18]*	0.0005 [2.31]**
INCOME	0.4024 [0.21]	0.2863 [0.15]	0.0720 [0.04]	1.3779 [0.65]	1.6421 [0.77]	1.2707 [0.59]	0.6981 [0.32]	1.1596 [0.53]	1.1379 [0.52]
HAPPY	0.1281 [1.31][a]	0.1333 [1.37][a]	0.1377 [1.40][a]	0.1766 [1.65]*	0.1770 [1.67]*	0.1727 [1.61][a]	−0.1085 [1.06]	−0.1056 [1.03]	−0.1212 [1.17]
CONSTANT	−2.0676 [3.58]**	−1.9992 [3.49]**	−2.2070 [3.73]**	−2.6014 [4.08]**	−2.3433 [3.75]**	−2.5888 [4.02]**	2.2028 [3.60]**	2.2100 [3.62]**	2.3901 [3.81]**
Number of observations:	431	432	429	431	432	429	431	432	429

Notes: Absolute values of *t* statistics are given in brackets. Income is measured in millions of dollars.
[a]Statistically significant at the 10-percent level.
*Statistically significant at the 5-percent level.
**Statistically significant at the 1-percent level.

- Also associated with willingness to have children

TABLE 5—EXPLAINING THE WILLINGNESS TO HAVE CHILDREN (ESTIMATION TECHNIQUE = POLYCHOTOMOUS PROBIT)

Independent variables	Dependent variable CHILD (April)	CHILD (October)
SAFE	0.3088	0.3045
	[4.79]**	[5.40]**
DFINPOS	0.0282	0.0822
	[0.39]	[1.18]
EDU	0.0523	0.0491
	[2.32]*	[1.87]*
AGE	0.0065	0.0138
	[0.32]	[0.67]
AGE2	−0.000093	−0.00019
	[0.45]	[0.90]
INCOME	4.0949	4.5523
	[1.93]*	[2.39]**
HAPPY	0.1934	0.3164
	[2.21]*	[3.52]**
CONSTANT	−0.8460	−0.6870
	[1.68]*	[1.24]
Number of observations:	423	416

Notes: Absolute values of *t* statistics are given in brackets. Income is measured in millions of dollars.
*Statistically significant at the 5-percent level.
**Statistically significant at the 1-percent level.

Russett, Cowden, Kinsella, and Murray (1994)

- Look at timeseries association between (1) savings and (2) survey of US expectations for nuclear war
    - Multiple survey sources from 1946-1965, 1976-1993; stitching/imputing/interpolating[!!] different questions together as best as possible
- Look at timeseries association between (1) savings and (2) Bulletin of Atomic Scientists index of international tensions/doomsday clock

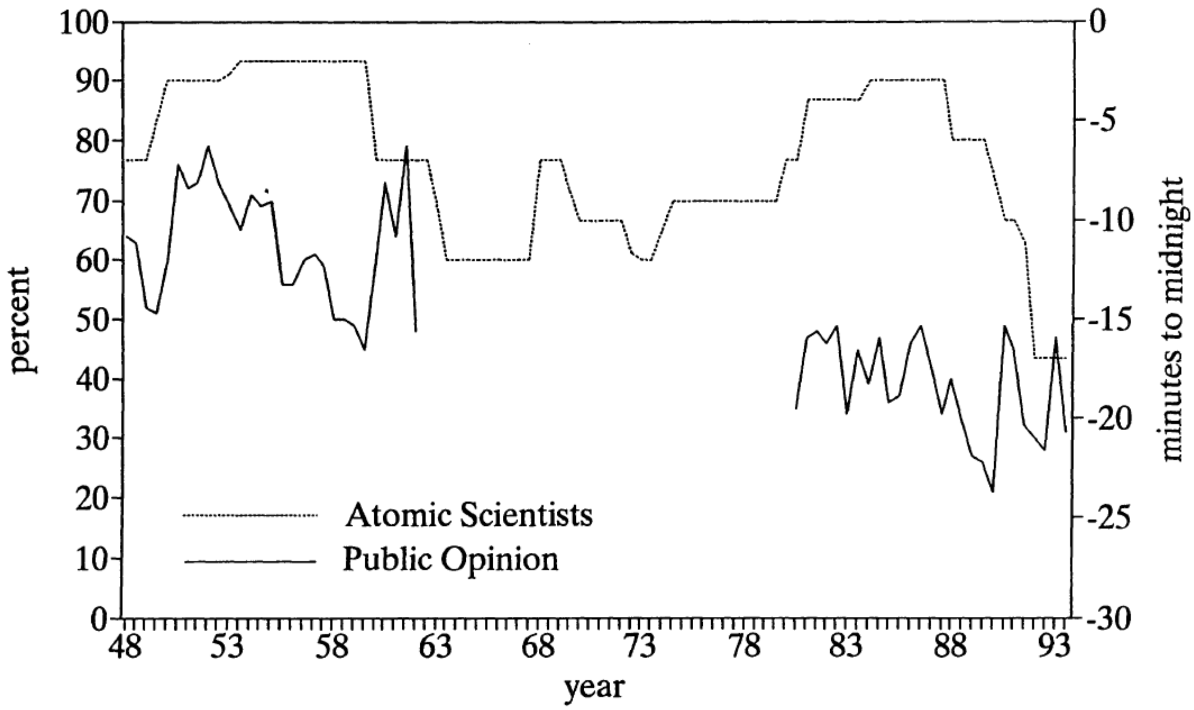


FIG. 1. Two Measures of Fear of War, 1948–1993

- Looks a bit like noise

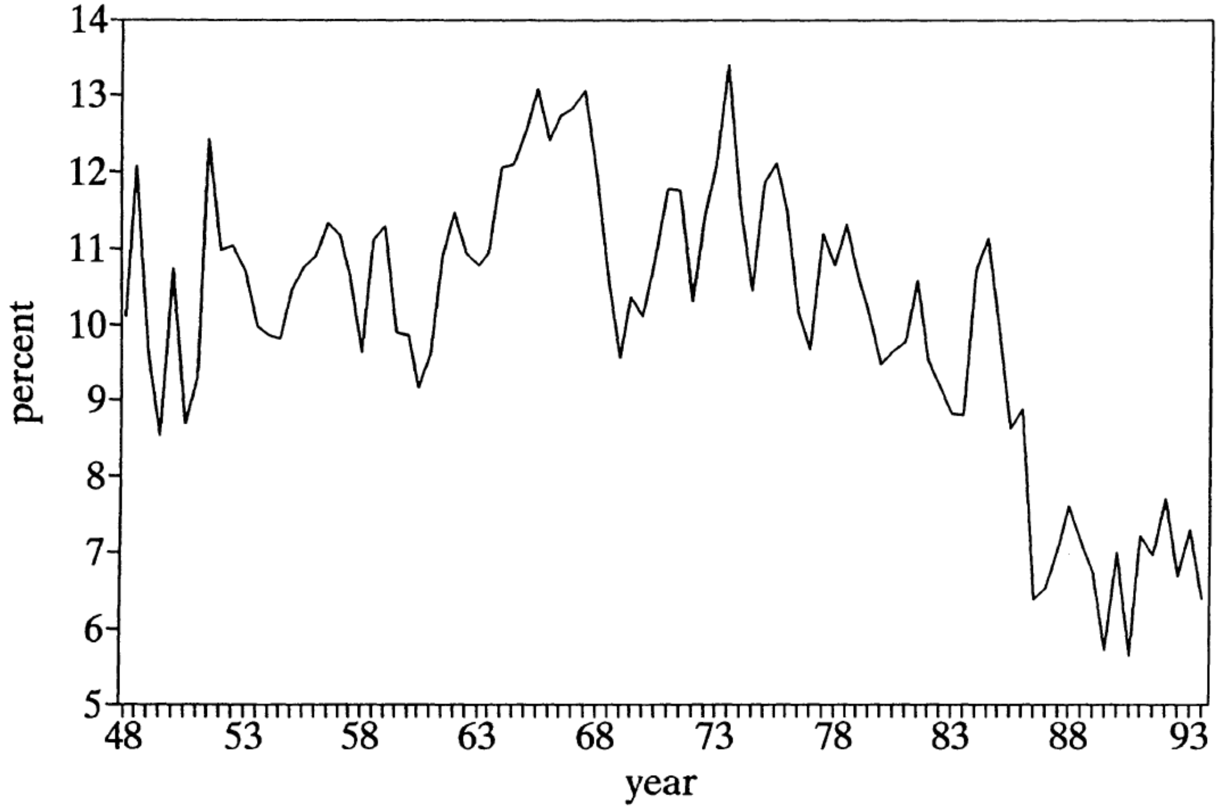


Fig. 2. U.S. Private Savings Rate, 1948–1993

- Regression:

TABLE 4. Explaining Time-series of Saving Rates

	1948–84 *Slemrod*	*1948–93* *A*	*1953–93* *B*	*1948–62* *C*	*1980–93* *D*
Minutes	−0.0017	−0.0007	−0.0006	0.0007	−0.0027
	(3.53)	(1.35)	(1.29)	(0.78)	(2.30)
Opinion				−0.0002	0.0003
				(1.43)	(1.19)
Expectations			−0.0001		−0.0002
			(0.48)		(0.65)
Income_t	0.150	0.328	0.304	0.131	0.309
	(2.57)	(7.52)	(5.85)	(1.30)	(1.43)
Income_{t-1}	−0.140	−0.270	−0.248	−0.375	−0.387
	(2.87)	(6.16)	(4.36)	(3.59)	(2.25)
Wealth_{t-1}	−0.014				
	(0.63)				
Stocks_{t-1}		−0.029	−0.035	0.056	−0.052
		(3.45)	(4.62)	(1.79)	(2.29)
Unemployment	−0.013	−0.017	−0.018	−0.014	−0.044
	(3.19)	(3.67)	(3.76)	(2.30)	(2.04)
Constant	0.115	0.105	0.143	0.431	0.555
	(2.74)	(2.79)	(3.33)	(2.21)	(2.03)
2-year dummy				−0.013	
				(1.63)	
5-year dummy				−0.012	
				(1.22)	
d.f.	31	84	73	20	17
R^2	0.64	0.85	0.89	0.59	0.84
Durbin-Watson	1.26	1.76	1.81	1.75	1.71
ρ		0.77	0.72		0.42

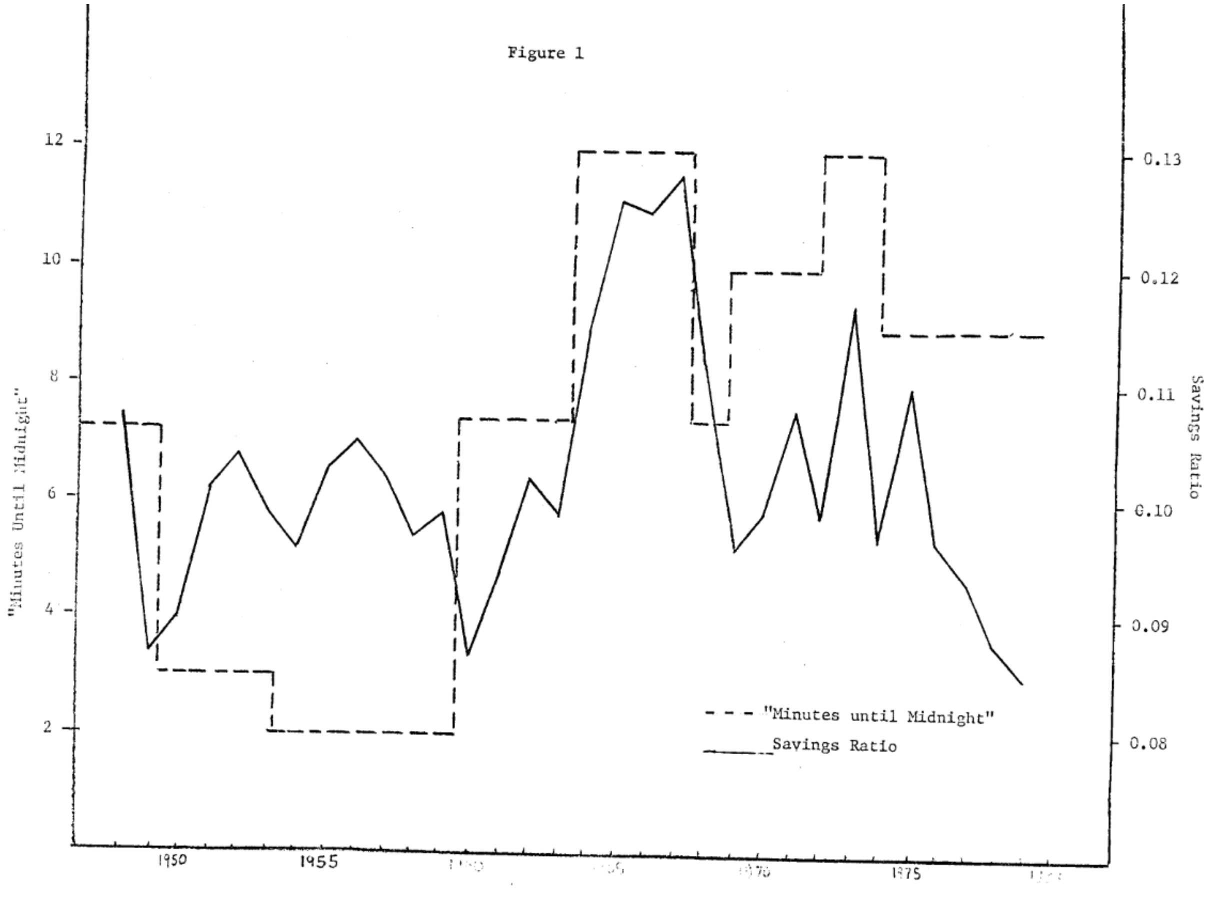
Figures in parentheses are t-statistics (absolute values). Except for the dependent variable and *Minutes*, *Opinion*, and *Expectations*, all series are natural logarithms. Models A, B, and D are corrected for first-order autocorrelation; the first observation is omitted in order to estimate ρ. We have changed the sign on Slemrod's *Minutes* coefficient for purposes of comparison.

- Why do they put both measures in the same regression…?

Related papers:

1. Slemrod (1986) does the same, but with just the BAS
2. Russett and Lackey (1987) use some European data

[Slemrod (1982)](#)



[Slemrod (1990)](#)

- Look at 19 OECD countries
- Gallup survey data from 1981-1984: perceived likelihood of nuclear war is negatively correlated with savings rate
    - Looks like it's really just driven by three outliers
- "A 10 percent increase in the fraction of the population that believes a world war is likely is associated with a decline of 4.1 percentage points in the net private saving rate"

FIGURE 1

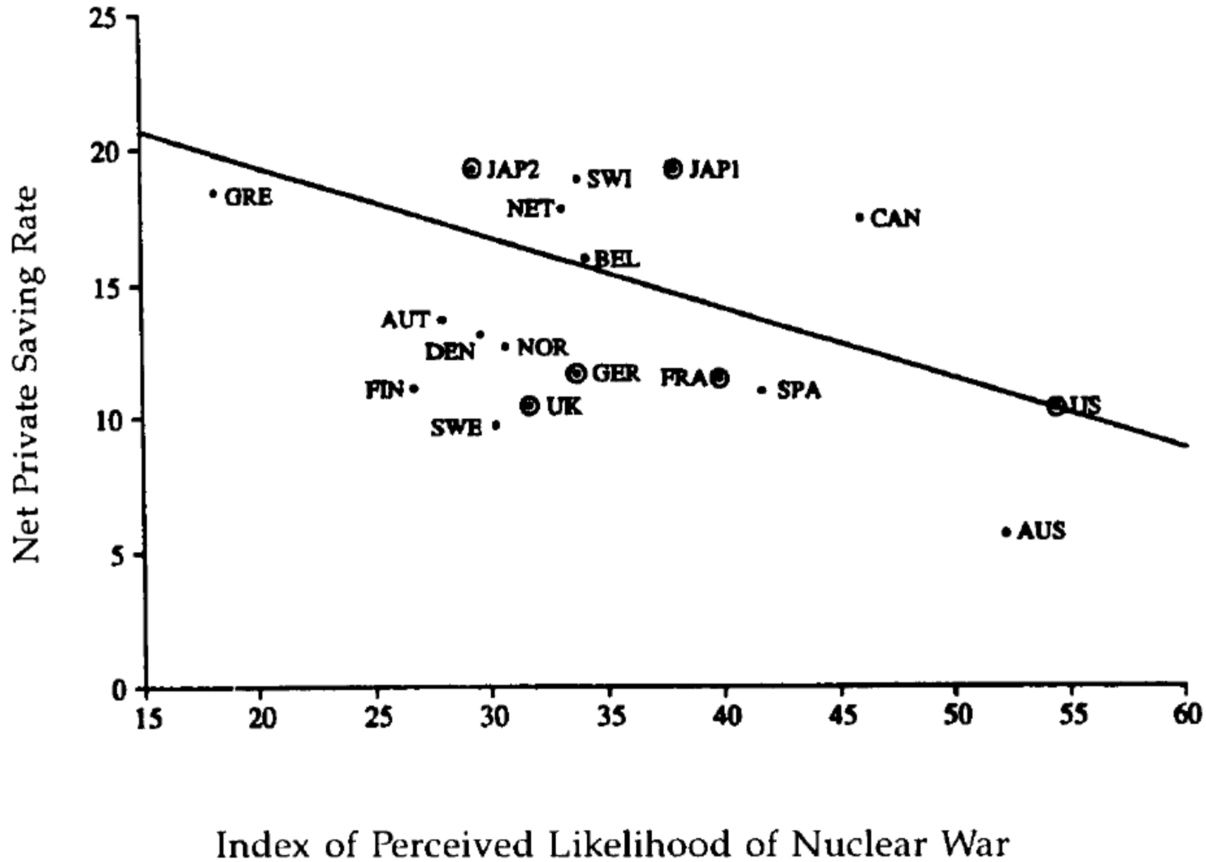


TABLE I

Fraction of Respondents Saying in 1986 that the Chance of World War Within Ten Years is 50 Percent or Greater, by Country

United States	49	Italy	22
South Africa (blacks)	49	Spain	22
Ecuador	45	Norway	21
Chile	43	Austria	20
Colombia	42	Great Britain	20
Australia	38	South Korea	19
Uruguay	38	Denmark	18
Brazil	34	Greece	18
Canada	34	Luxembourg	18
South Africa (whites)	33	Switzerland	18
India	32	West Germany	18
Argentina	30	Finland	17
Philippines	27	Hong Kong	17
Ireland	25	Japan	15
Portugal	25	Sweden	15
Belgium	24	Turkey	15
France	24	Netherlands	14

Source: The Gallup Poll, released January 11, 1987.

2. MARKETS AND WARS

[Bialkowski and Ronn (2017)]

- Polish and French capital markets did not(?) predict apocalypse in September 1939
    - My interpretation:
    - (1) these are only traded prices!
    - (2) there is probability of recoverability, as seen in other wars
    - (3) if(?) these are nominal bonds, then declines also reflect prospects for (hyper)inflation

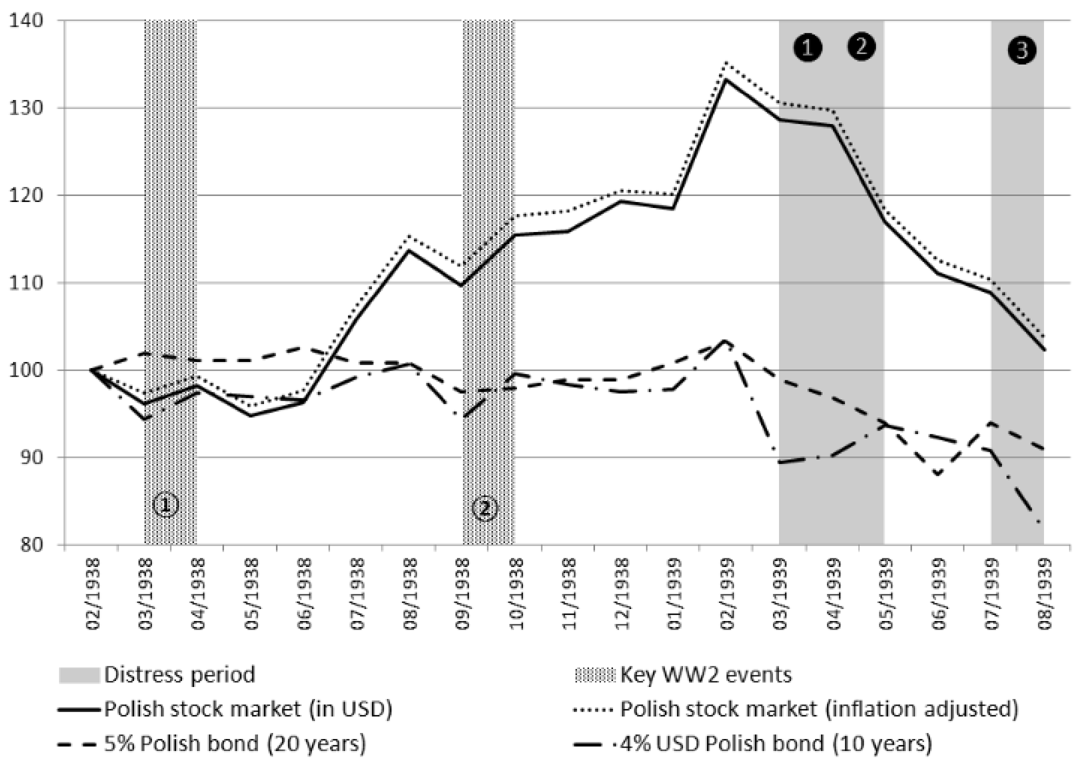


Figure 1: The figure displays performance of Polish stock and bond market during the period between February 1938 and August 1939. In addition the performance of Polish bonds held by local and foreign investors is shown. The dashed area corresponds to periods crucial for continuation of Polish stock and bond market. The areas are numerated as follows (on top): 1- British Guarantee to Poland, 2- Abrogation of German Polish Non-Aggression Pact, 3- Britain and France declared war on Germany after attack on Poland. On bottom of the figure the key events for WW2 period are highlighted: 1- Annexation of Austria, 2- Munich Accord and German demands on Poland.

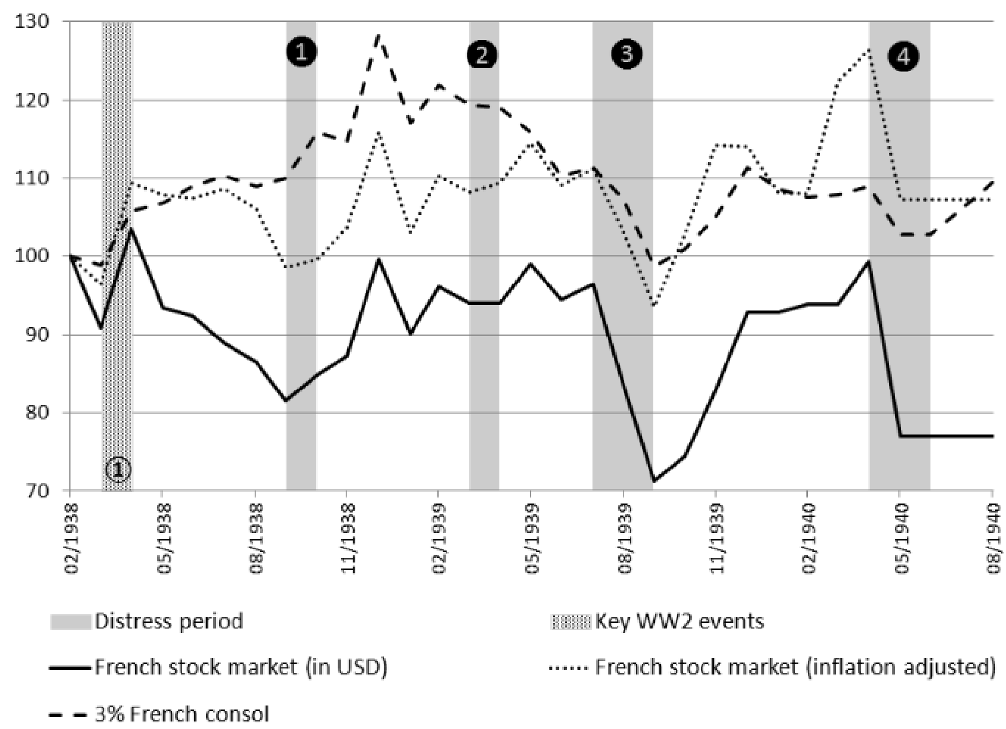


Figure 2: The figure displays performance of French stock and bond market during the period between February 1938 and August 1940. The dashed area corresponds to periods crucial for continuation of local stock and bond market. The areas are numerated as follow (on top): 1- Munich Accord, 2- British and French Guarantee to Poland, 3- Britain and France declared war on Germany 4- German victory in Battle of France. On bottom of the figure the key events for WW2 period are highlighted: 1- Annexation of Austria, 2-Beginning of war between the Soviet Union and Germany, 3- United States entered the War, 4- German setbacks at Stalingrad and El Alamein/German force entered Southern France, 5-Germany's first major defeat- Stalingrad, 6- D Day: The Allied invasion of France, 7-Germany surrenders to the allies.

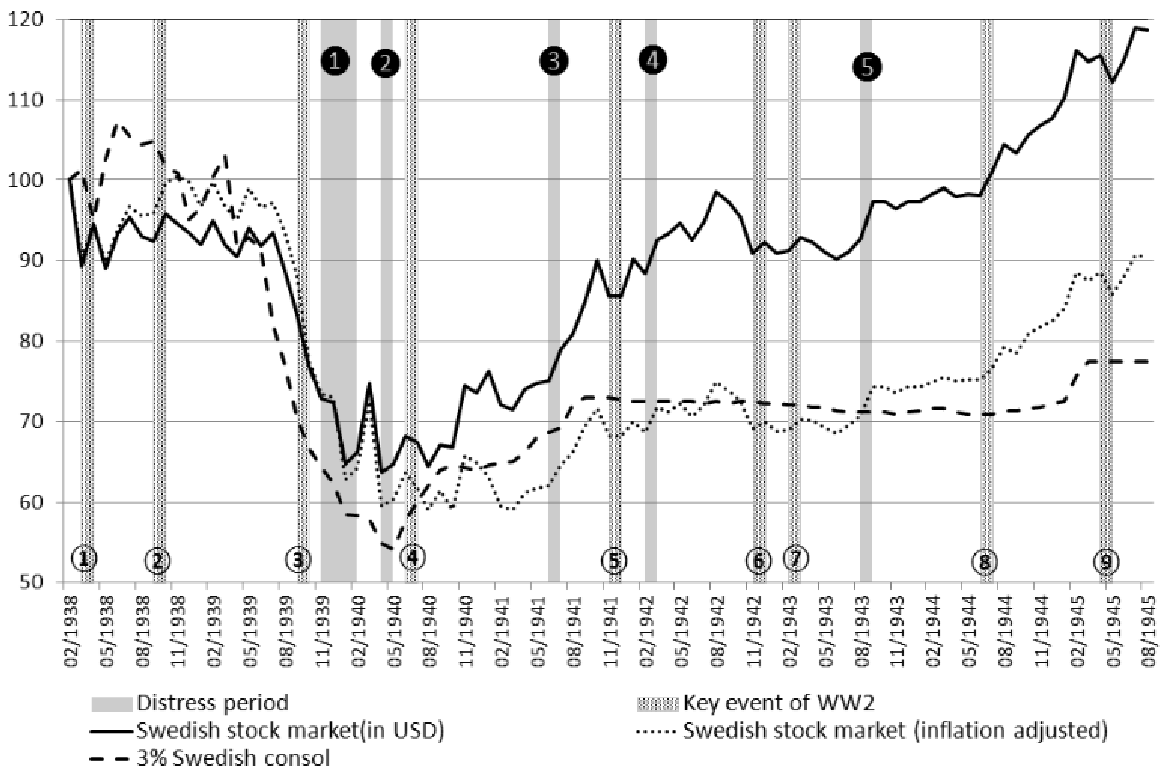


Figure 3: The figure displays performance of Swedish stock and bond market during the period between February 1938 and August 1945. The dashed area corresponds to periods crucial for continuation of local stock and bond market. The areas are numerated as follow(on top): 1- Soviet-Finnish war, 2- Norwegian campaign and German victory, 3- Midsummer crisis on transit of German war materials/beginning of war between the Soviet Union and Germany supported by Finland, 4- February crisis of 1942 and mobilisation , 5- Cancelation of transition-agreement. On bottom of the figure the key events for WW2 period are highlighted:1- Annexation of Austria, 2- Munich Accord, 3- Invasion of Poland by Germany, 4- German victory in of Battle of France, 5- United States entered the War, 6- German setbacks at Stalingrad and El Alamein, 7-Germany's first major defeat- Stalingrad, 8- D Day: The Allied invasion of France, 9-Germany surrenders to the allies.

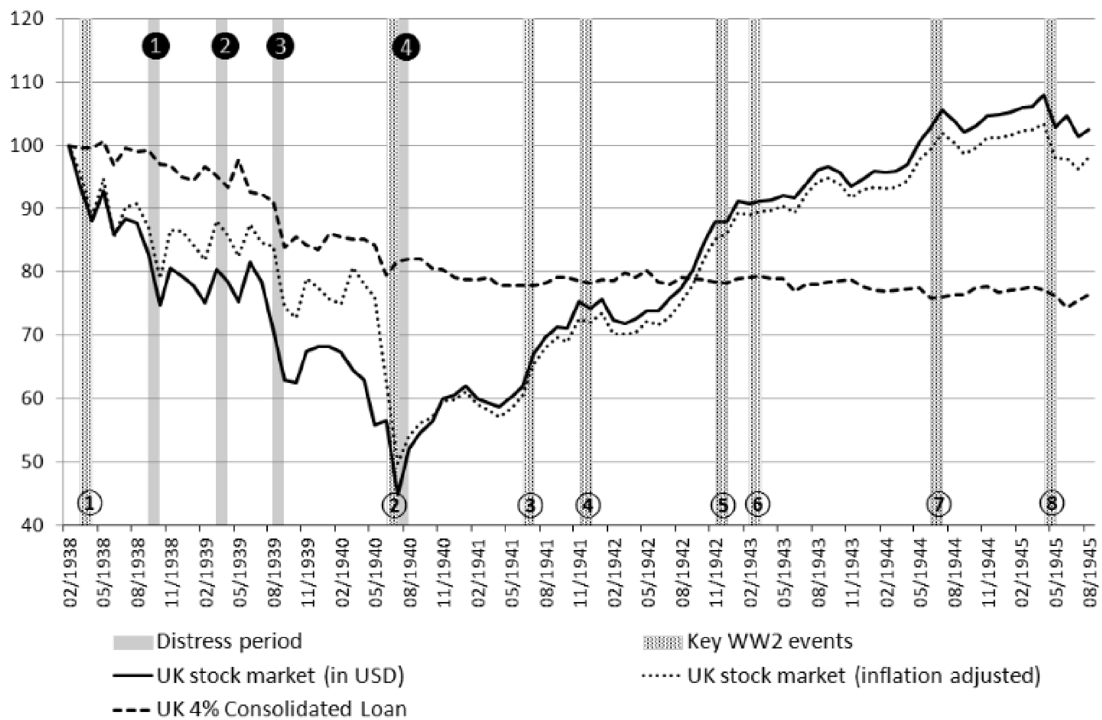


Figure 4: The figure displays performance of British stock and bond market during the period between February 1938 and August 1945. The dashed area corresponds to periods crucial for continuation of local stock and bond market. The areas are numerated as follow (on top): 1- Munich Accord, 2- British Guarantee to Poland, 3- Britain and France declared war on Germany 4- Beginning of Battle of Britain. On bottom of the figure the key events for WW2 period are highlighted: 1- Annexation of Austria, 2- German victory in of Battle of France, 3-Beginning of war between the Soviet Union and Germany 4- United States entered the War, 5- German setbacks at Stalingrad and El Alamein, 6-Germany's first major defeat- Stalingrad, 7- D Day: The Allied invasion of France, 8-Germany surrenders to the allies.

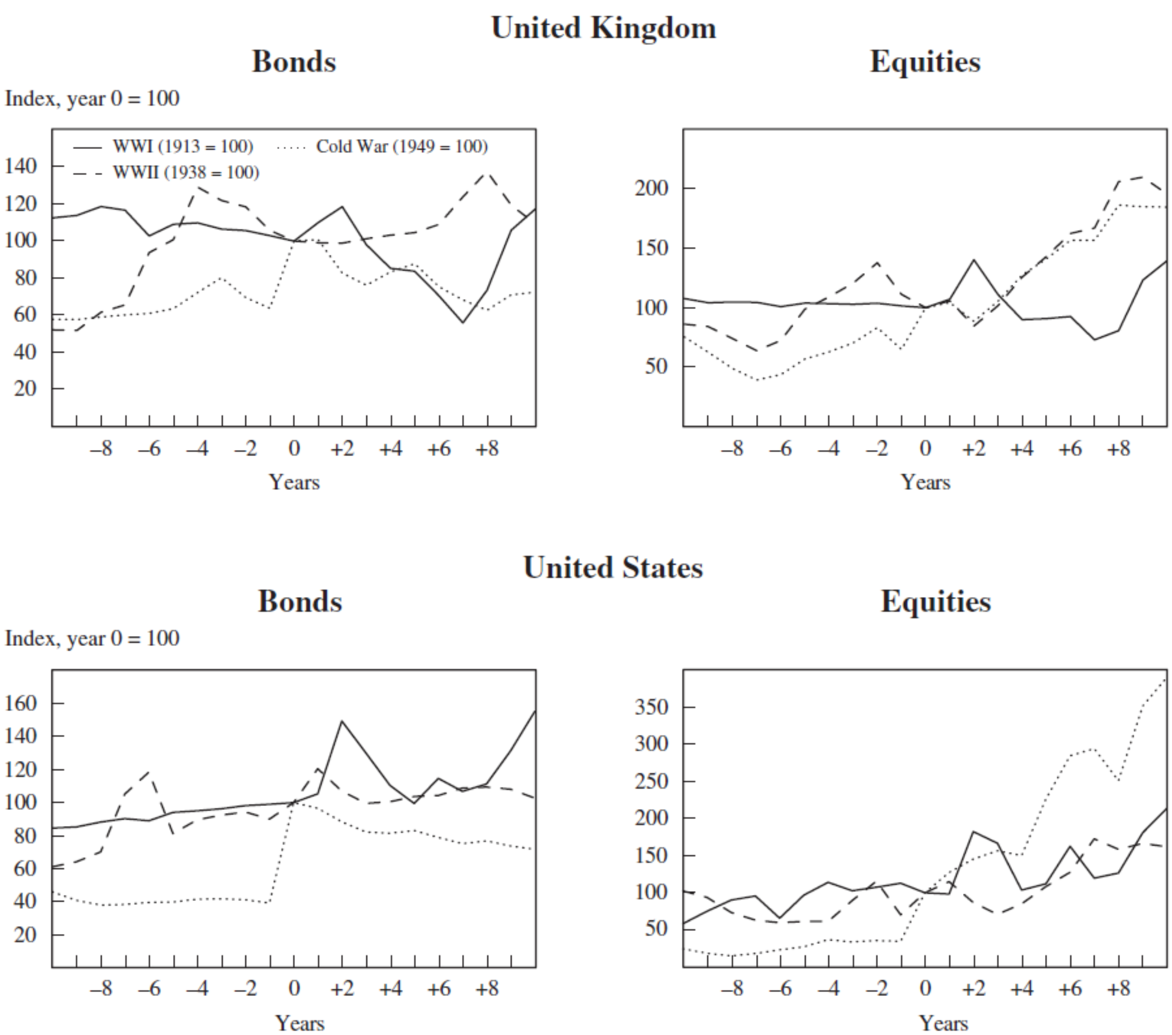
Ferguson (2008)

- Mostly narrative evidence of financial markets for WWI, WWII, early Cold War
- "The main conclusions of the paper are the following. The First World War was not anticipated. The right decision for investors would have been to shift into U.S. assets and out of U.K. assets before 1913. Instead investors got severely hit. The Second World War was, on the other hand, fully anticipated. Given the experience of the First World War, the smart money seems to have shifted from U.K. into U.S. assets in the 1930s. Interestingly, however, the financial consequences of the Second World War were very different from

those of the First: U.K. assets consistently outperformed U.S. assets. When the Korean War broke out, investors acted on the basis of their experience in the Second World War"

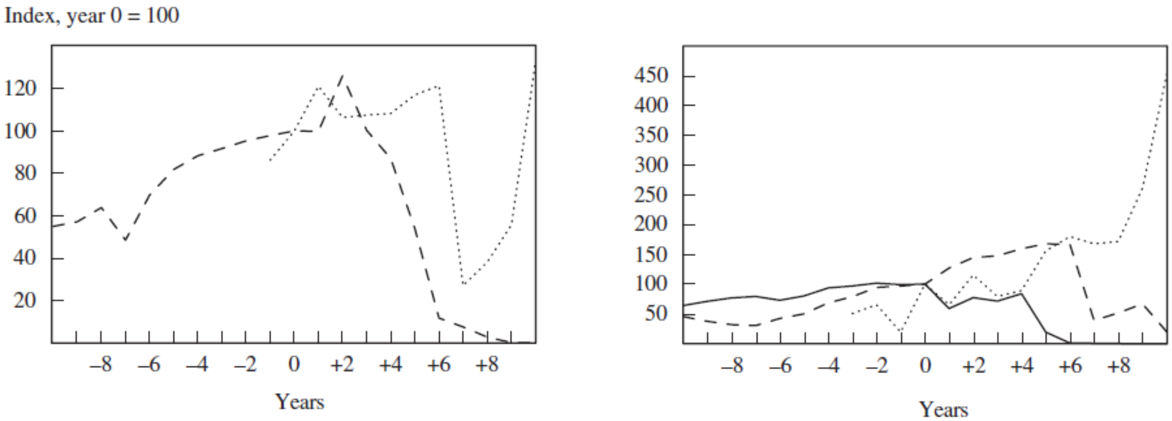
- Data from GFD
- Need to figure out: is he using total returns, priced in GBP…?
- SEE ALSO: Ferguson (2006), for 1848-WWI ('WWI was not expected by bond markets')

Figure 2. Real Performance of U.K., U.S., and German Government Bonds and Equities in Three World Wars[a]



Germany

Bonds   Equities[b]



Source: Global Financial Data.

a. All indexes reflect total returns in sterling terms, adjusted for consumer price inflation.

b. Index is for the German domestic market and reflects the limited choice open to German investors because of capital controls and restrictions on new equity issues.

Nominal long-term bond yields

United Kingdom   United States

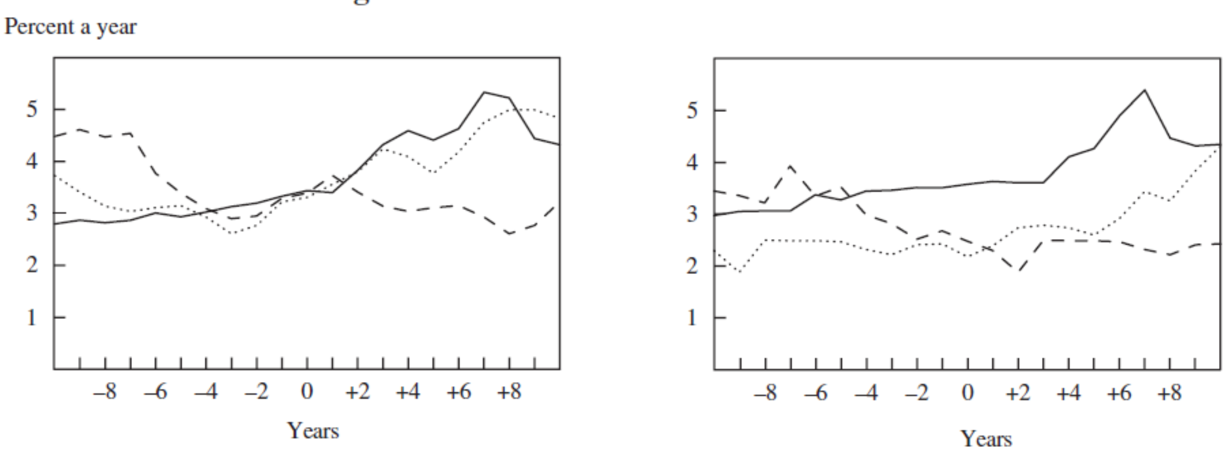
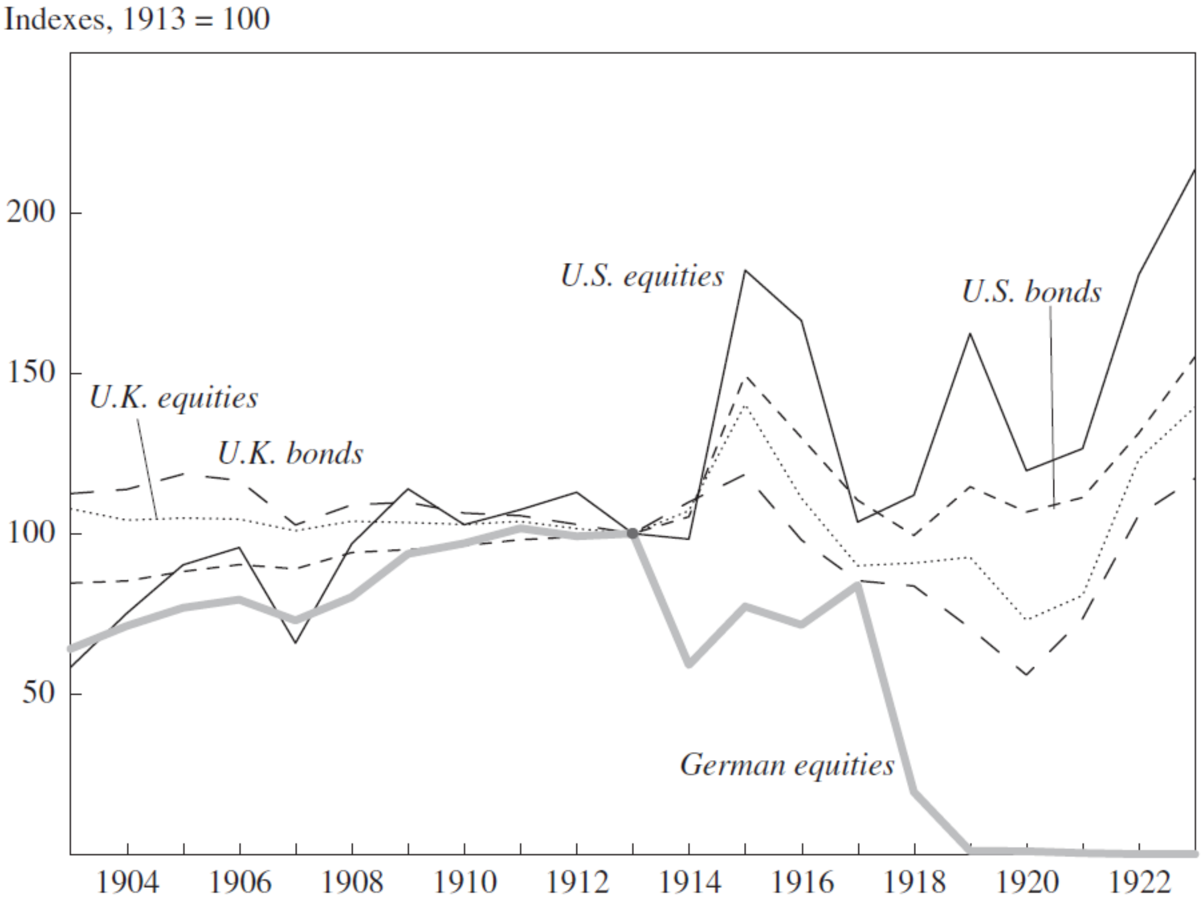


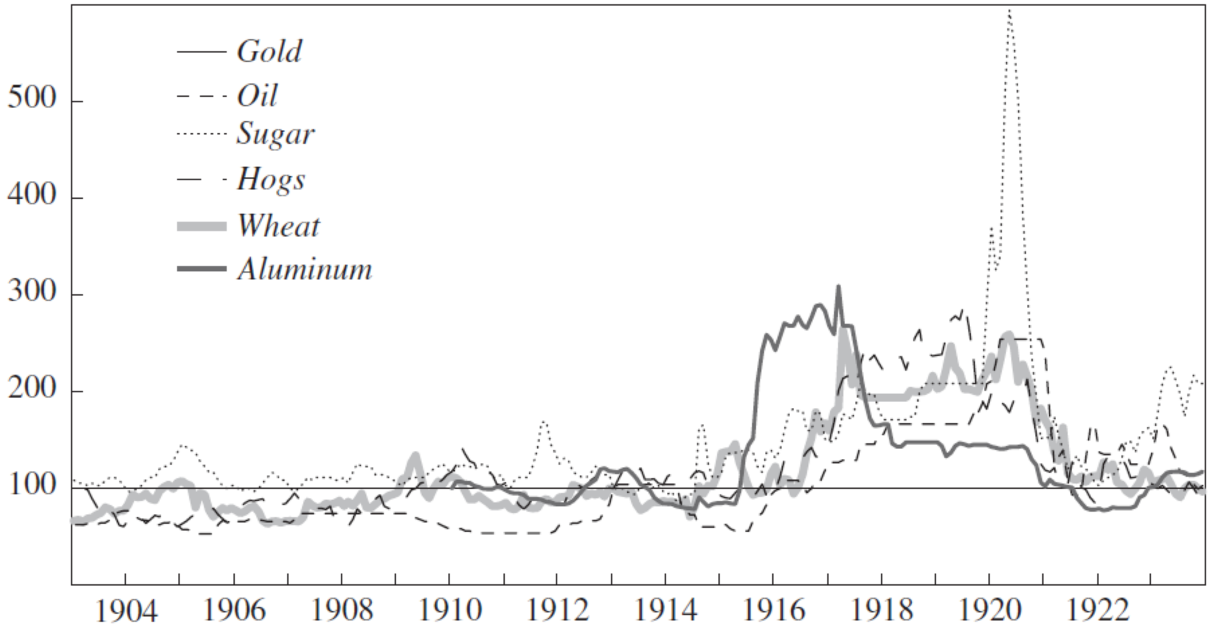
Figure 3. Inflation-Adjusted Total Returns for U.K., U.S., and German Securities before and after the First World War



Source: Global Financial Data.

Figure 5. Selected Commodity Prices before and after the First World War[a]

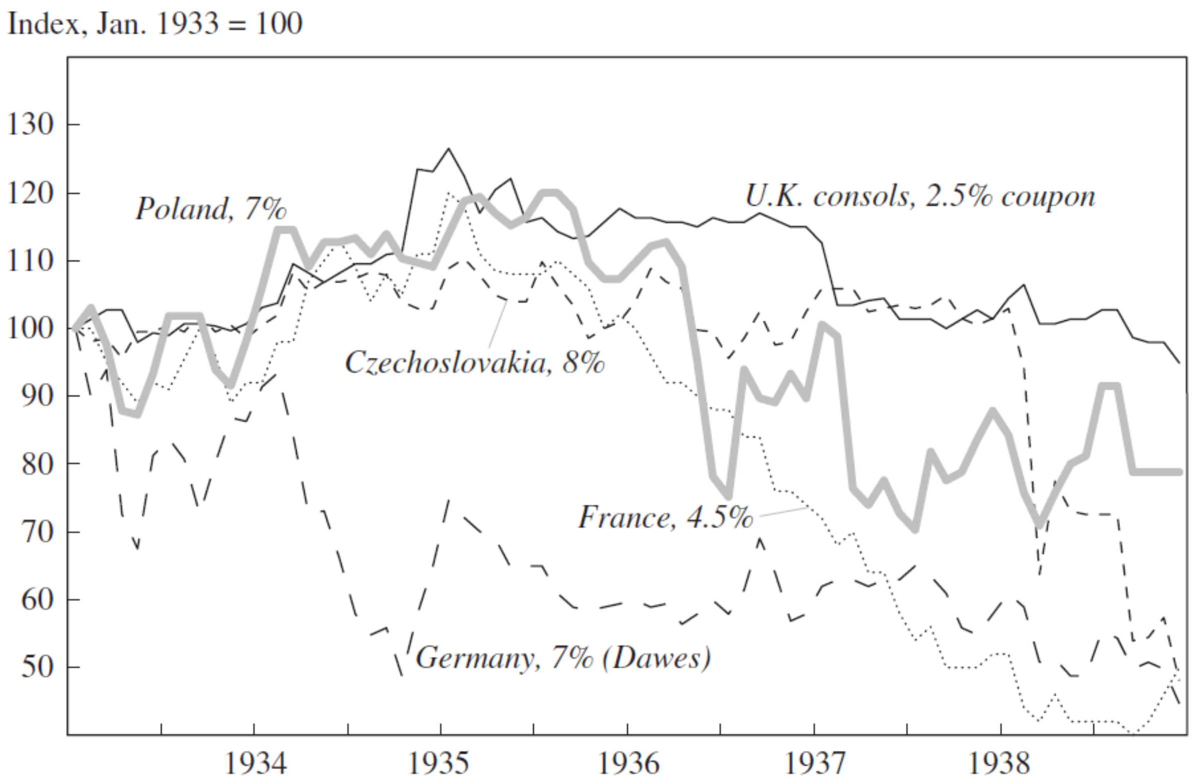
Indexes, Jan. 1913 = 100



Source: Global Financial Data.
a. Figure uses U.S. data, which are more readily available than U.K. data.

- Is this real or nominal?

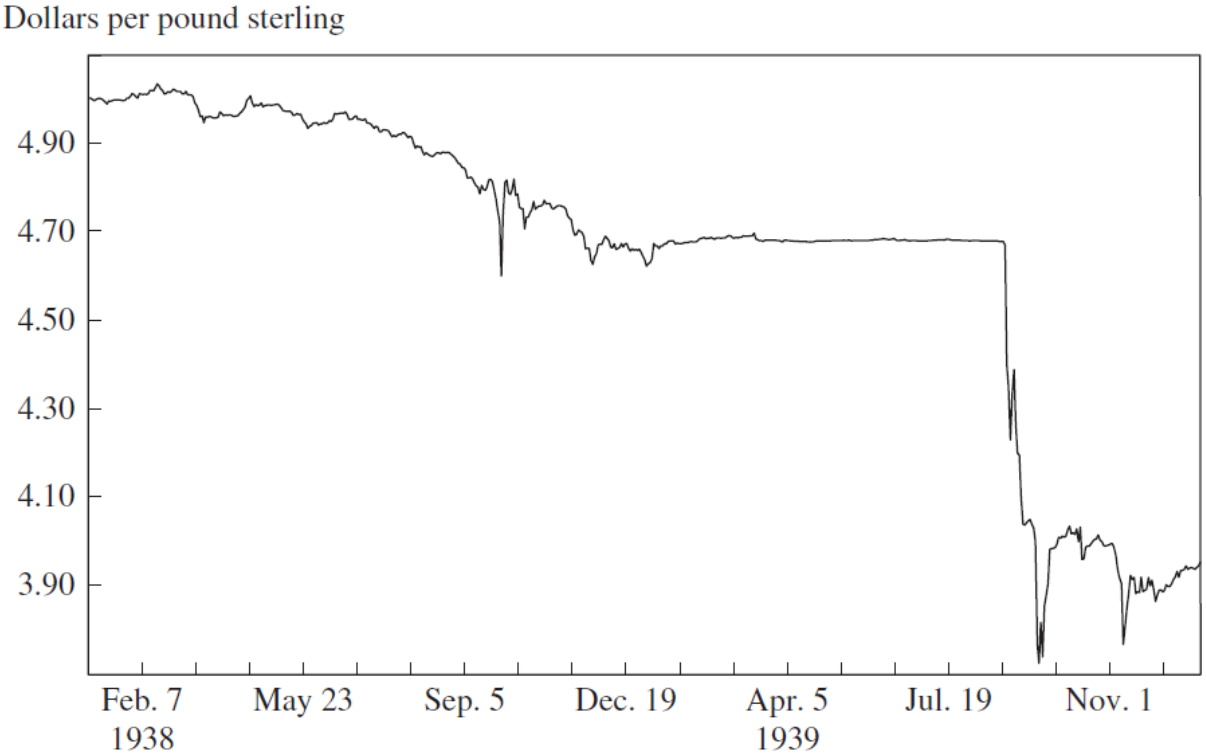
Figure 6. Prices in London of Selected Government Bonds, 1933–38



Source: *The Economist*, various issues. Figures for returns are not available.

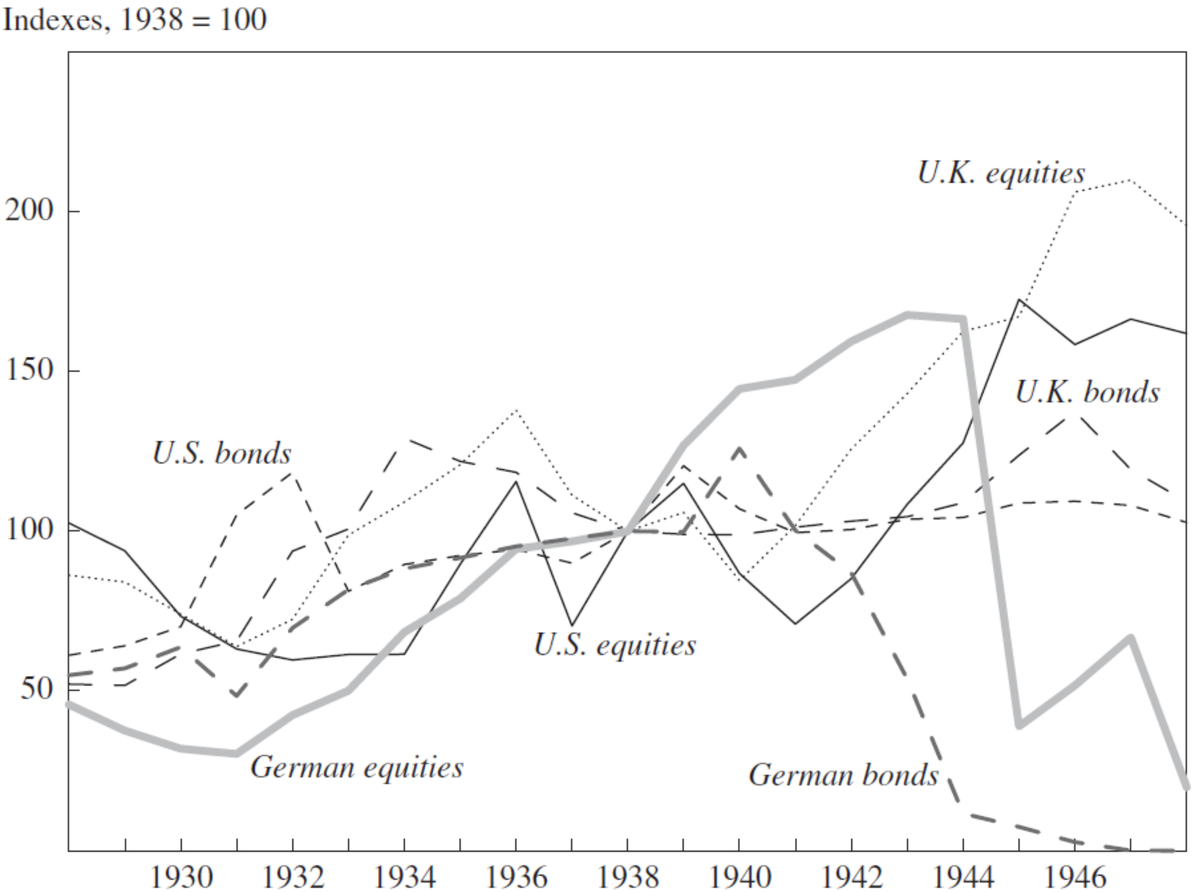
- “Financial market data support the proposition that, pace Keynes, investors had learned their history lesson. They understood, for example, that anything that raised the probability of another war was a signal to reduce their exposure to continental securities and currencies. As figure 6 shows, German bonds had sold off in London almost from the moment of Hitler’s appointment as chancellor of the Reich on January 30, 1933.70 French bonds began to slide downward in 1935, even before the remilitarization of the Rhineland. There was also a significant increase in the volatility of Polish bonds from the spring of 1936 and Czech bonds from the spring of 1938. Needless to say, many factors were at work in the bond market of the 1930s. The world was emerging from a deep depression”

Figure 7. U.K.-U.S. Exchange Rate, 1938–39



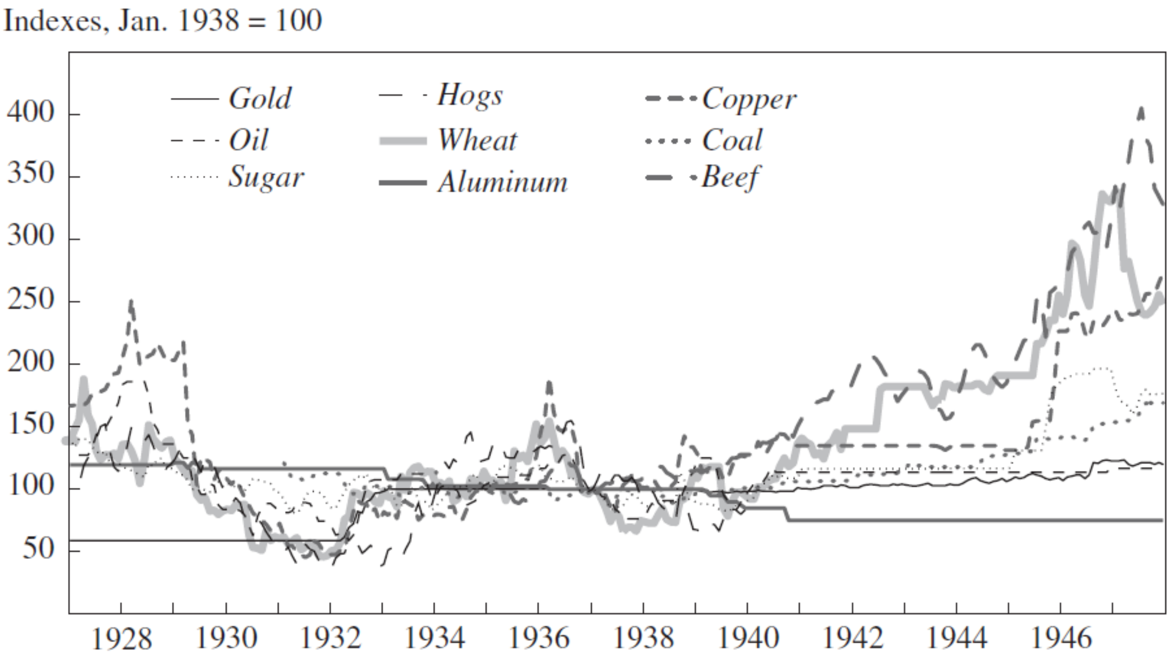
Source: Global Financial Data.

Figure 11. Inflation-Adjusted Total Returns for U.K., U.S., and German Securities before and after the Second World War



Source: Global Financial Data.

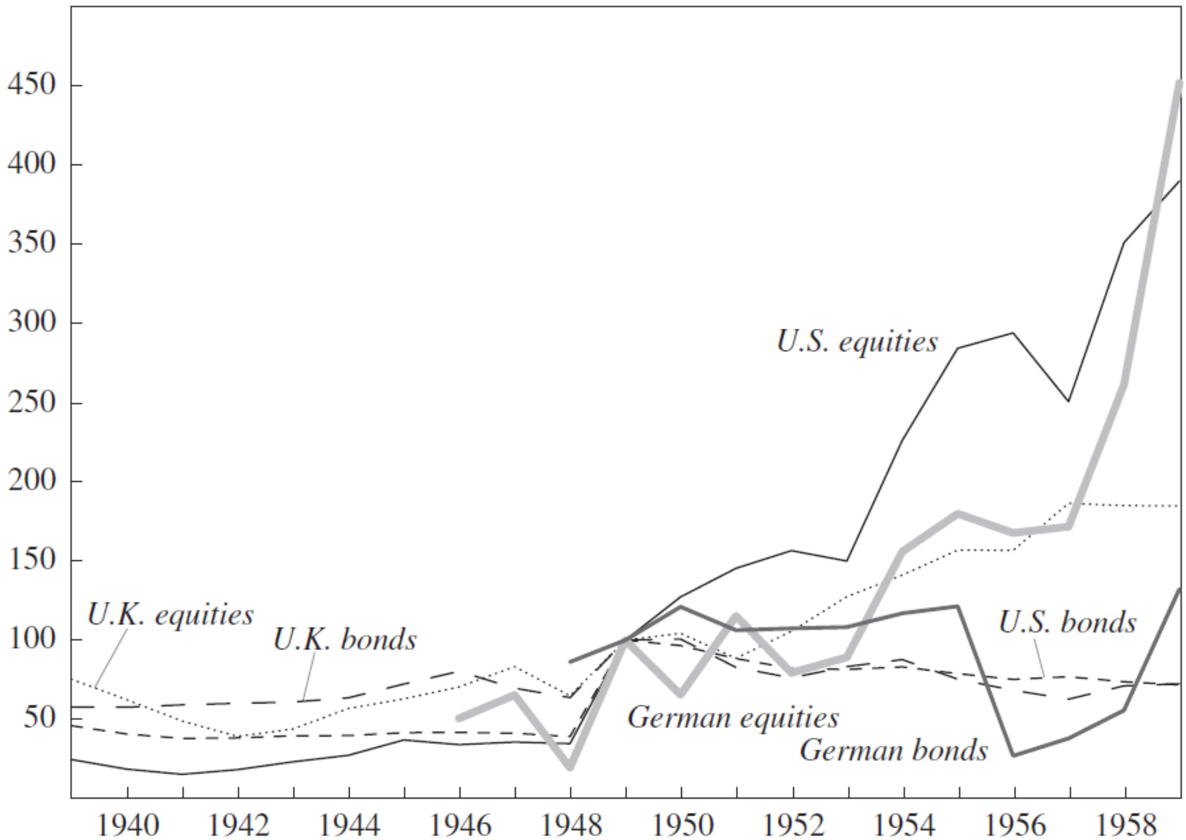
Figure 12. Selected Commodity Prices before and after the Second World War



Source: Global Financial Data.

Figure 13. Inflation-Adjusted Total Returns for U.K., U.S., and German Securities before and after the Korean War

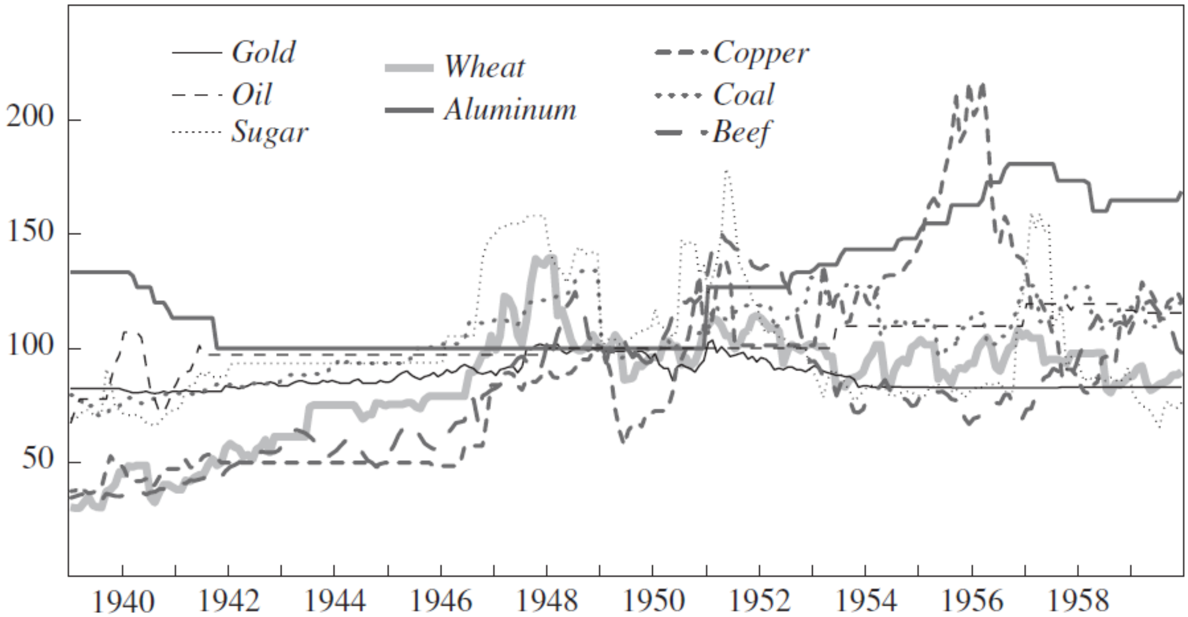
Indexes, 1949 = 100



Source: Global Financial Data.

Figure 14. Selected Commodity Prices before and after the Korean War

Indexes, Jan. 1949 = 100



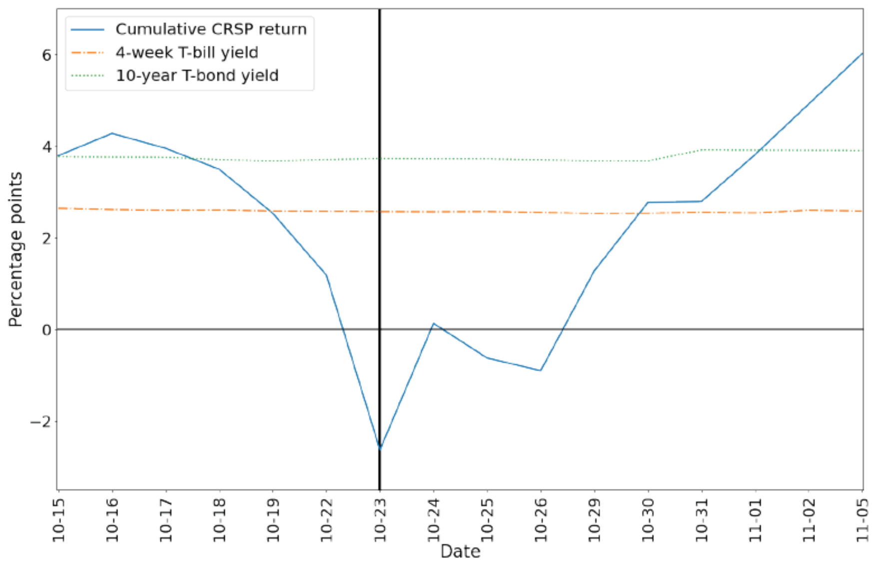
Source: Global Financial Data.

3. CUBAN MISSILE CRISIS

Finer (2022)

- 2022 UChicago JMP
- *Cross-sectional* asset pricing during Cuban missile crisis of more versus less exposed stocks
- Look at companies headquartered in 10 most populous US cities
    - Argue that (and show some narrative evidence from the time suggestively that) proximity to Cuba plausibly not that important, since Soviet missiles could hit anywhere anyway
- Aggregate market fell by 2.6%; these riskier stocks fell an additional 0.7pp (t=3.9)
    - Gap recovers as crisis abated
    - Robust to removing FF3 loadings
    - Not driven by a single municipal area
    - Also abnormally low returns for FL and TX firms
    - Placebo tests: eh
- Structurally/calibrating to standard risk aversion: survey evidence of beliefs of nuclear risk do not reconcile with the small change in asset prices

Figure 6: Observed Treasury and aggregate-equity movements around President Kennedy's 22 October 1962 19:00 EDT Cuba address. For the cumulative value-weighted CRSP return, a positive value on a date up to and including that of the address indicates a negative return through the date of the address, and a negative value after the address indicates a negative return from the first trading day after the address.



SOURCE: CRSP via WRDS; author's calculations

Figure 9: Impact of a headquarters' presence in a top-10 CBSA by population on cumulative returns around President Kennedy's 22 October 1962 Cuba address without economic controls. A negative value before the address indicates a positive return through the final trading day before the address. A negative value after the address indicates a negative return from the first trading day after the address. Clustering is by Fama-French 49 industry, and significance is asymptotic. The sample size for each window is 601 stocks.

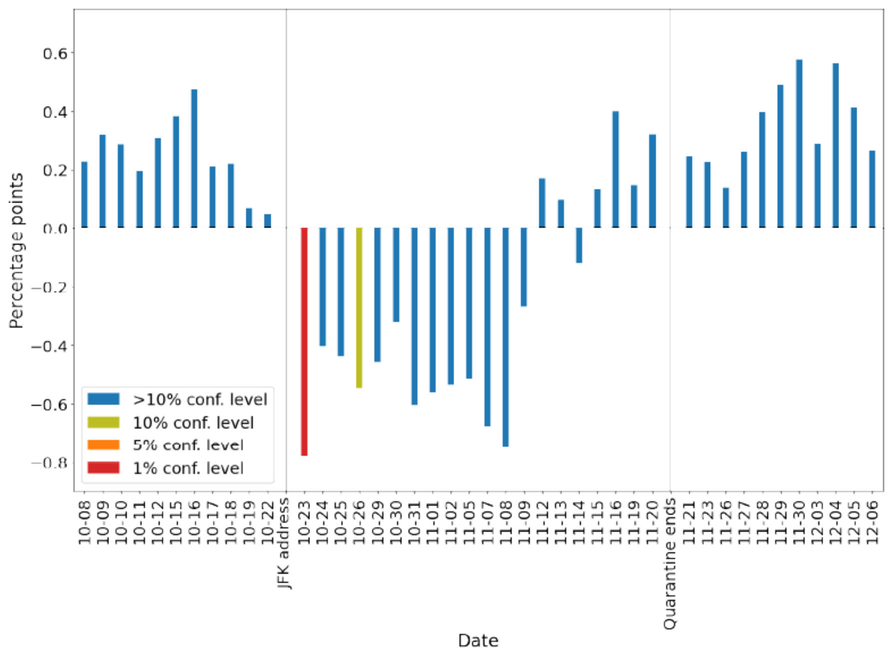


Figure 10: Baseline impact of a headquarters' presence in a top-10 CBSA by population on cumulative returns around President Kennedy's 22 October 1962 Cuba address. A negative value before the address indicates a positive return through the final trading day before the address. A negative value after the address indicates a negative return from the first trading day after the address. Fama-French 49 fixed effects and Fama-French 3 factor loadings are employed. Clustering is by Fama-French 49 industry, and significance is asymptotic. The within estimator is used, and industries with fewer than two firms or no geographic heterogeneity in the sample are dropped. The sample size for each window is 568 stocks.

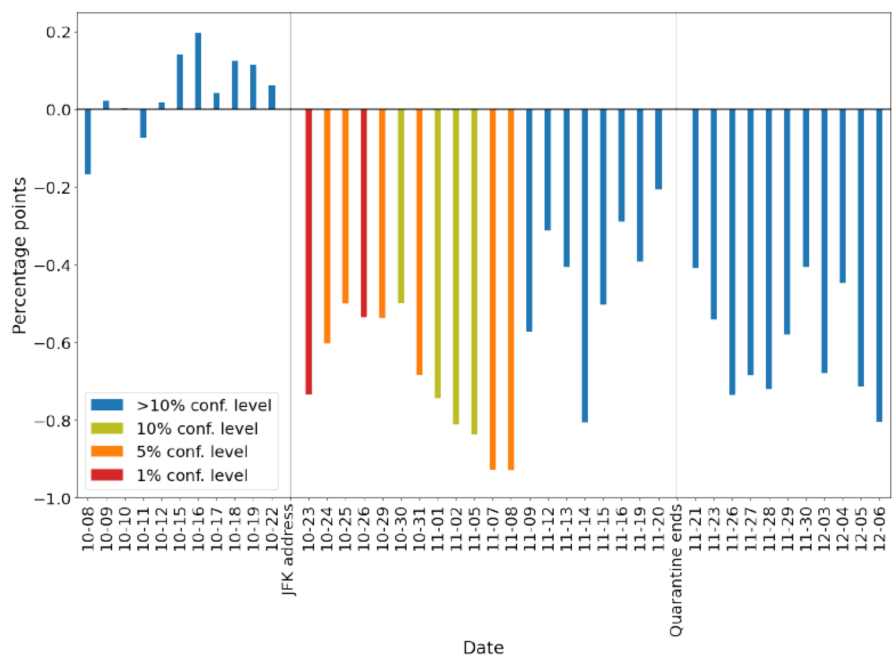
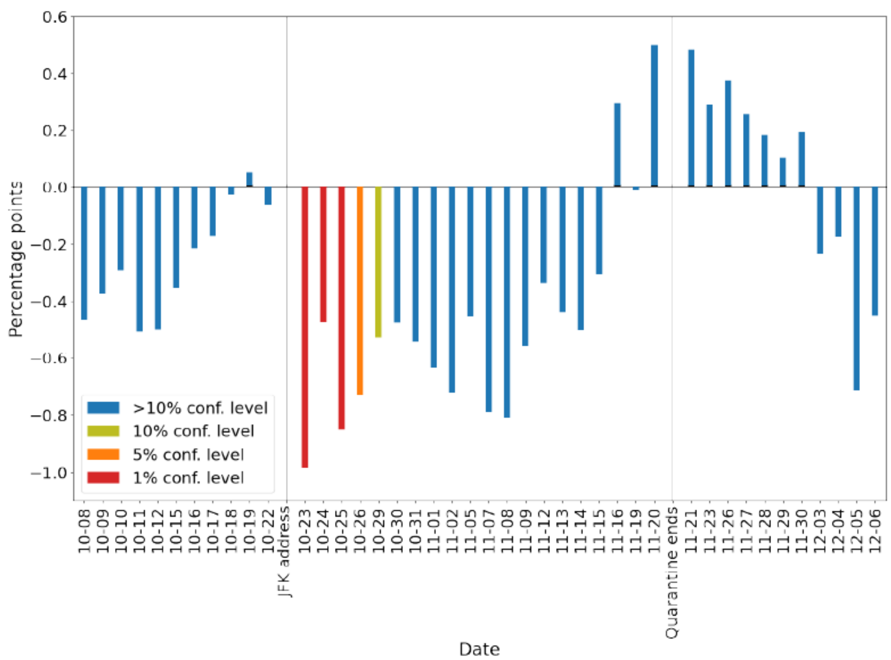


Figure 11: Impact amongst the top 50 per cent of sample firms by market capitalisation of a top-10-CBSA presence on cumulative returns around President Kennedy's 22 October Cuba address. A negative value before the address indicates a positive return through the final trading day before the address. A negative value after the address indicates a negative return from the first trading day after the address. Fama-French 49 fixed effects and Fama-French 3 factor loadings are employed. Clustering is by Fama-French 49 industry, and significance is asymptotic. The within estimator is used, and industries with fewer than two firms or no geographic heterogeneity in the sample are dropped. The sample size for each window is 277 stocks.



[Burdekin and Siklos (2022)](#)

- [Published version](#)
- "It appears then that markets assigned a very small risk to the crisis leading to the use of nuclear arsenals despite President Kennedy's pessimism at the height of the Cuban Missile Crisis. Gallup polls around the time of the crisis and soon after ([Smith 2003](#)) suggest that, whereas the public was very aware of tensions with Cuba and the financial implications, with a majority (59%) believing that Cuba was a threat to world peace, the danger of a war was nevertheless seen to be very low (5% by February 1963)."
- GFD for SP500 data; hand-collect (?!) data on daily equity prices in Canada/Mexico

Figure 1A: Stock Price Indexes in the US, Canada, and Mexico 1960-1965

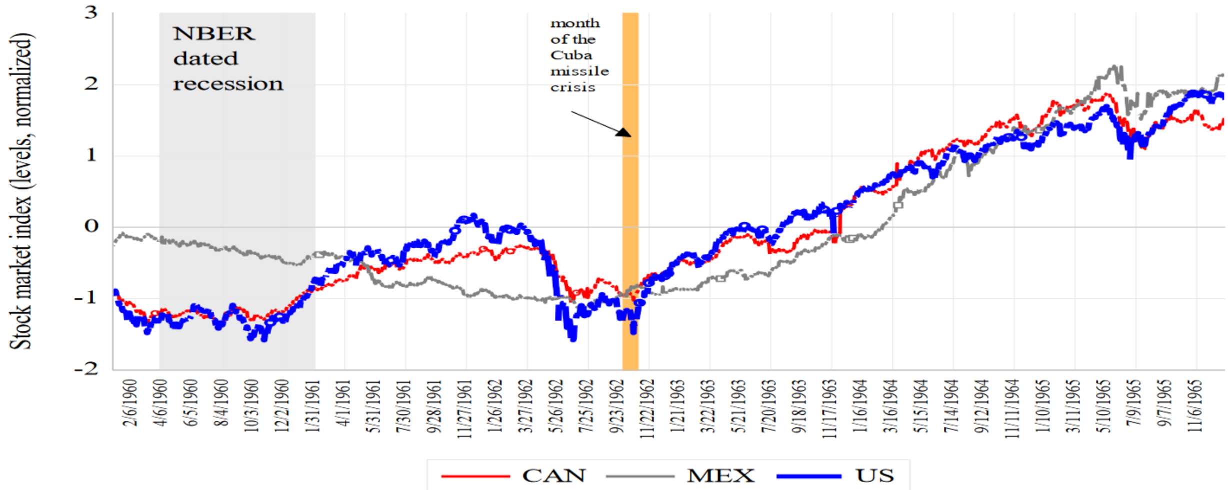


Figure 1B: Stock Price indexes in the US, Canada, and Mexico During 1962

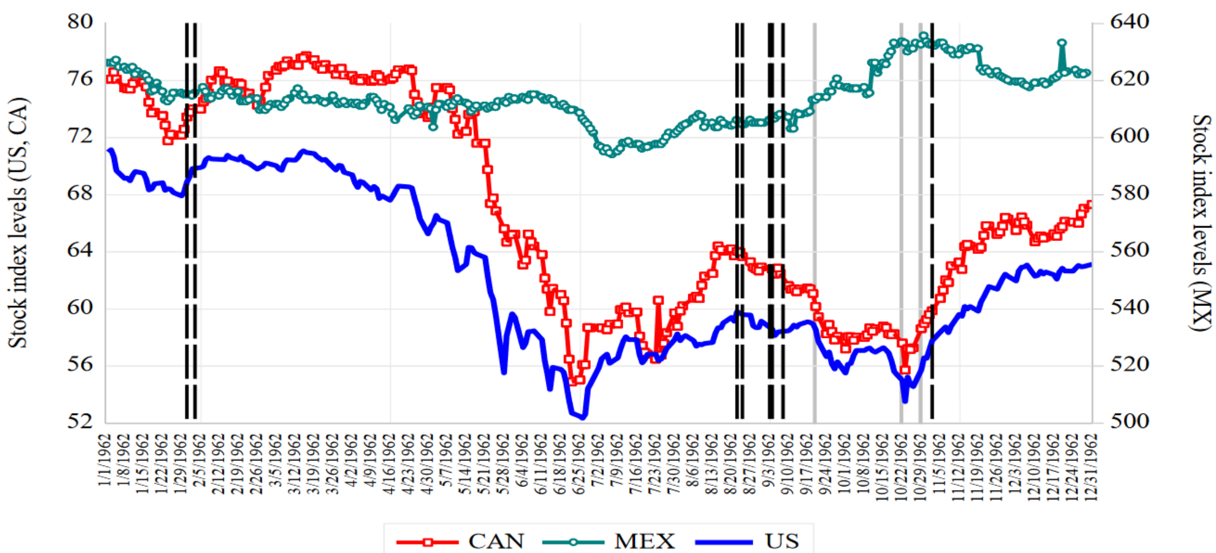
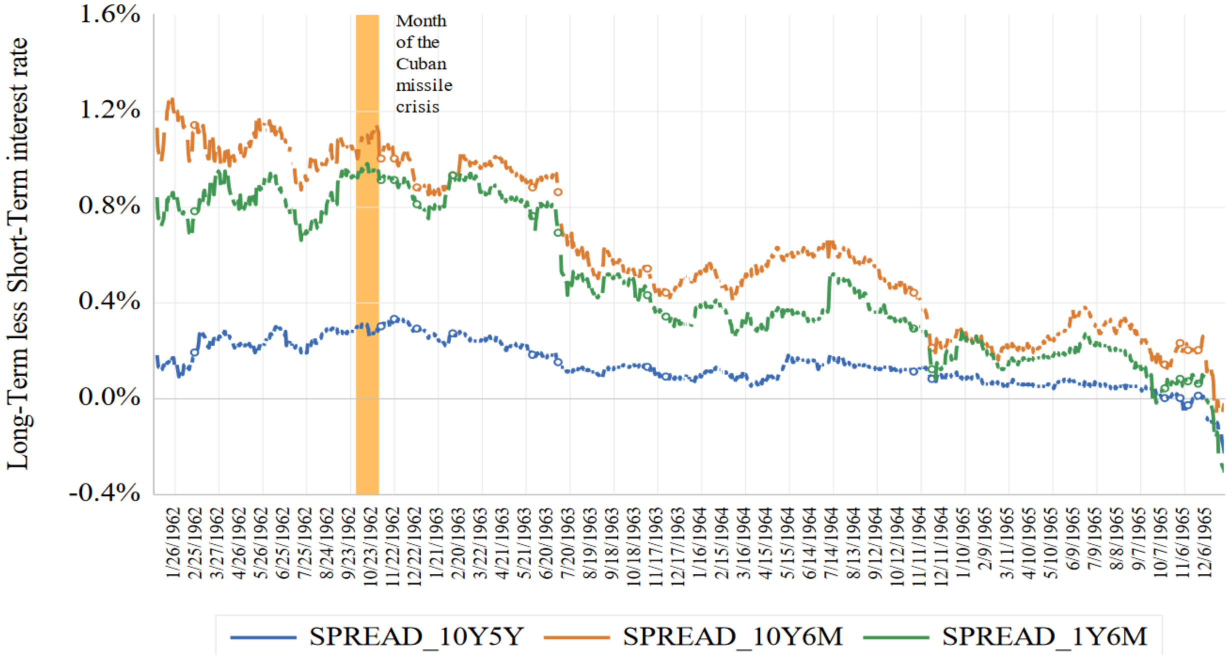
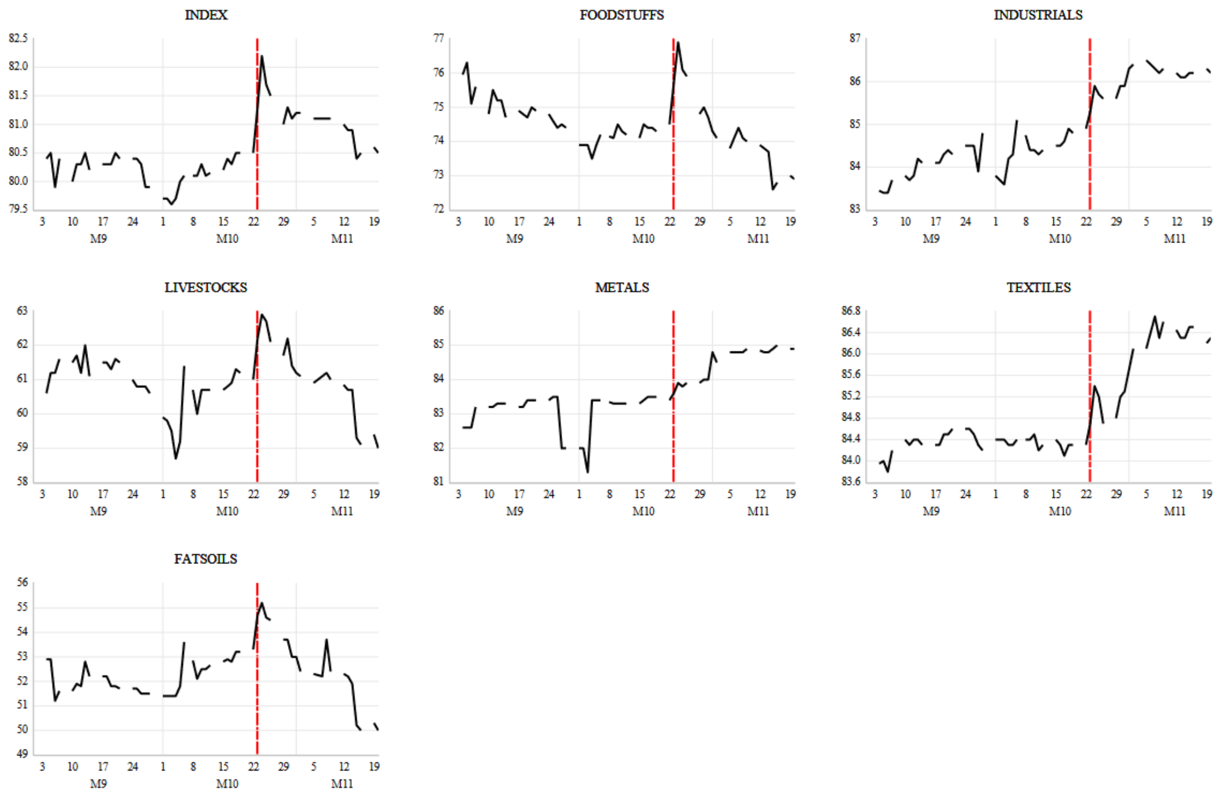


Figure 3: The Behavior of US Interest Rate Spreads 1962-1965



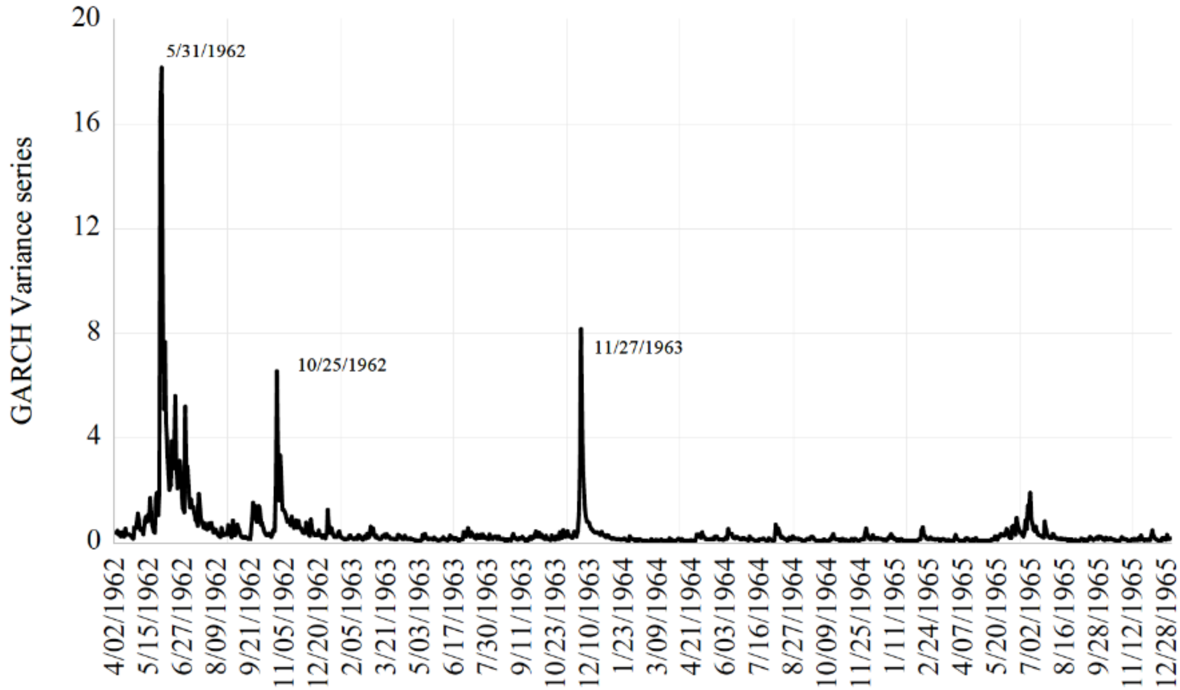
- Why are you only showing the spreads?

Figure 4: Commodity Price Behavior Around the Time of the Cuban Missile Crisis



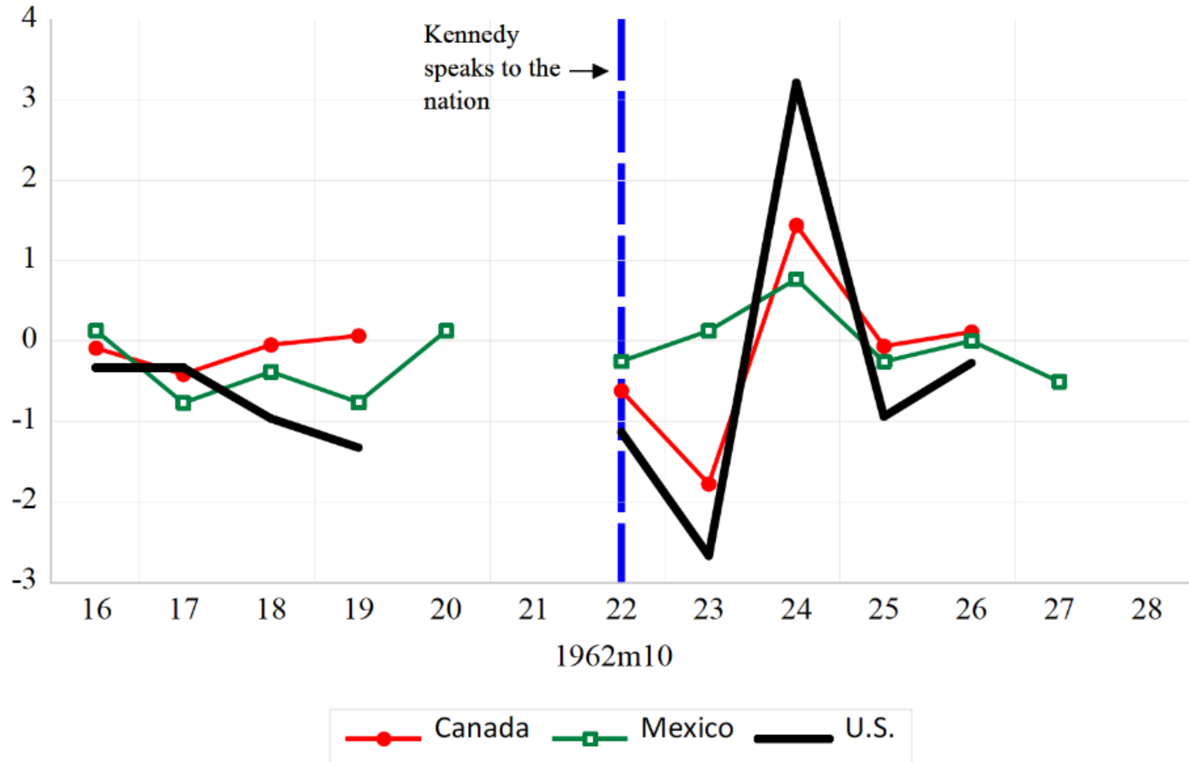
Note: Data as reported in daily issues of the *New York Times*.

Figure 5: Volatility in US Stock Returns



Note: Daily GARCH volatility series from the CGARH(1,1) estimates in Table 3.

Figure A1: Aggregate Returns Around the Time of President Kennedy's Address to the Nation



Source: Data source listed in the main text. Returns are ex dividends. The vertical axis is in percent. No trading on October 20-21, 1962.

[Raschky and Wang (2017)]

- "We exploit the timing of the Cuban Missile Crisis and the geographical variation in mortality risks individuals faced across states to analyse reproduction decisions during the crisis. The results of a difference-in-differences approach show evidence that fertility decreased in states that are farther from Cuba and increased in states with more military installations. Our findings suggest that individuals are more likely to engage in reproductive activities when facing high mortality risks, but reduce fertility when facing a high probability of enduring the aftermath of a catastrophe."

(a) (b)

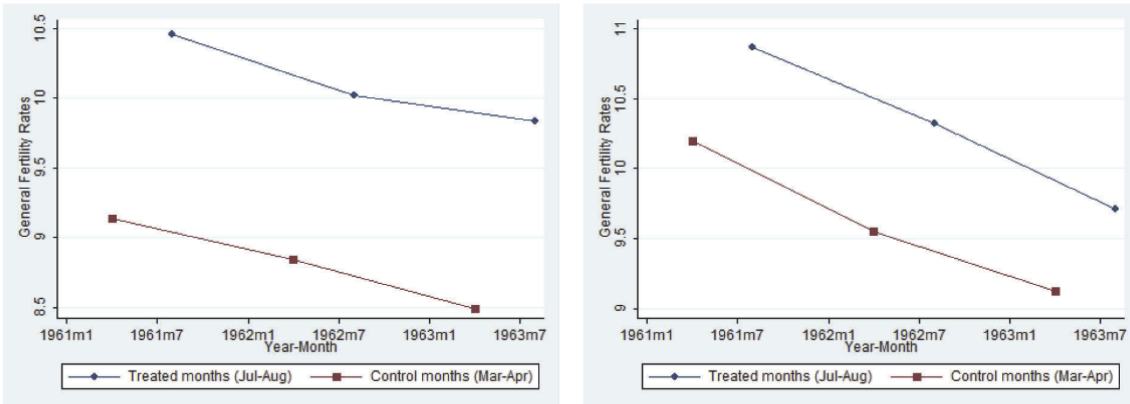


Figure 1. General fertility rates in control and treatment months. (a) Inside strike zone and with a high fraction of counties with military installations. (b) Outside strike zone and with a low fraction of counties with military installations.

- 🥴🥴🥴🥴🥴🥴🥴🥴

Smith (2003)

- Note Cuban missile crisis was Oct 15 – Nov 20, 1962
- As summarized in Burdekin and Siklos (2022): "Gallup polls around the time of the crisis and soon after (Smith 2003) suggest that, whereas the public was very aware of tensions with Cuba and the financial implications, with a majority (59%) believing that Cuba was a threat to world peace, the danger of a war was nevertheless seen to be very low (5% by February 1963)."

"What do you think is the most important problem facing the country today?"

Date	Mentioning International Relations (%)	Mentioning Cuba Only (%)	Total
6/60	52.7	.0	1,511
6/60	46.0	4.3	1,406
7/60	56.9	4.3	1,653
7/60	59.7	2.4	1,553
7/60	57.8	3.2	1,619
8/60	56.8	3.9	1,645
9/60	58.7	2.1	1,066
9/60	58.6	3.5	1,668
10/60	55.1	6.2	1,556
2/61	42.4	1.5	1,629
5/61	46.7	9.3	1,601
7/61	63.1	4.7	1,647
12/61	59.8	1.2	1,500
5/62	44.8	2.5	1,582
6/62	34.9	.5	1,527
8/62	50.9	1.8	1,499
9/62	64.9	23.8	1,701
10/62	65.6	25.0	1,644
11/62	72.2	30.8	1,583
12/62	60.9	20.5	1,482
3/64	28.4	3.6	1,676
4/64	27.9	5.4	1,661
5/64	24.3	1.7	1,581
6/64	20.2	1.7	1,634
8/64	40.8	.4	1,557
8/64	28.0	.9	1,569
9/64	33.2	3.4	1,600
10/64	40.8	1.0	1,550
2/65	52.5	.2	1,550
3/65	36.5	.1	1,541
3/65	53.2	.3	2,285
7/65	55.7	.5	2,407
8/65	57.2	.5	1,599
9/65	46.0	.2	1,571
10/65	55.0	.6	2,399
11/65	55.2	.3	1,646
5/66	56.9	.2	1,563
8/66	46.9	.0	1,509

NOTE.—Percentages are based on total number of mentions. The percentage mentioning Cuba is included in the total mentions in the first column.

2. *Gallup*, 9/20–9/25/1962 (N = 1,701): Have you heard or read about our troubles with Cuba?

	(%)
Yes	94
No	6

3. *Gallup*: Would you say there is much danger of world war or not much danger?

Date	*Much Danger* (%)	*Not Much* (%)	*Don't Know* (%)	N
7/2–7/7/54	59	27	14	1,500
6/23–7/2/61	49	39	12	1,625
5/31–6/5/62	37	52	11	1,512

4. *Gallup*: Do you think the United States will find itself in another world war within, say, the next year?

Date	*Yes* (%)	*No* (%)	*Don't Know* (%)	N
7/8–7/13/51	26	64	10	1,500
1/6–1/11/52	22	64	14	1,500
12/11–12/16/52	20	68	13	1,500
10/9–10/14/53	17	60	23	1,488
12/31/54–1/5/55	11	69	20	1,446
4/4–4/9/63[a]	5	76	20	1,570
3/3–3/8/66[b]	21	66	13	1,623

[a] Do you think we are likely to get into another world war in the next 5 years? [IF YES:] Do you think we are likely to get into another world war within the next year?

[b] Do you think we are likely to get into another world war within the next year?

5. *Gallup,* reported in Smith 1988: Do you think we are likely to get into another world war in the next 5 years?

Date	*Yes* (%)	*No* (%)	*Don't Know* (%)	*N*
10/50[a]	65	20	15	2,981
3/51[a]	76	16	8	1,368
7/52[a]	66	21	13	2,009
1/52[a]	65	21	14	1,944
12/52[a]	54	27	20	1,421
4/53[a]	46	28	26	1,468
10/53[a]	56	27	18	1,488
12/54[a]	50	31	19	1,446
4/57[b]	35	49	17	1,689
11/57	34	43	23	1,535
4/58	24	50	16	1,435
5/59	23	53	24	1,524
8/59	19	56	25	1,463
10/59	31	32	37	1,396
5/60	34	47	19	2,997
7/60	47	39	15	2,760
3/61	32	50	18	3,508
5/61	44	39	17	3,519
9/61	53	34	13	3,440
4/63	24	58	18	3,252
6/65	34	53	12	3,536

[a] Do you think the United States will find itself in another world war within, say, the next year? How about the next 5 years?

[b] Everybody hopes there will not be another world war, but what is your best guess, do you think there will be another world war within the next 5 years?

21A. *NORC458S*, 10/27–11/4/62 (N = 547): Thinking back over the last week (7 days)—for instance, taking the things that happened to you and your family during the week and the things that happened at work and during your leisure time—would you say that it was an ordinary week or was it different from most weeks?

	(%)
Ordinary	63.8
Different	36.0
Missing	.2

21B. [IF "DIFFERENT," ASK:] What made it so?

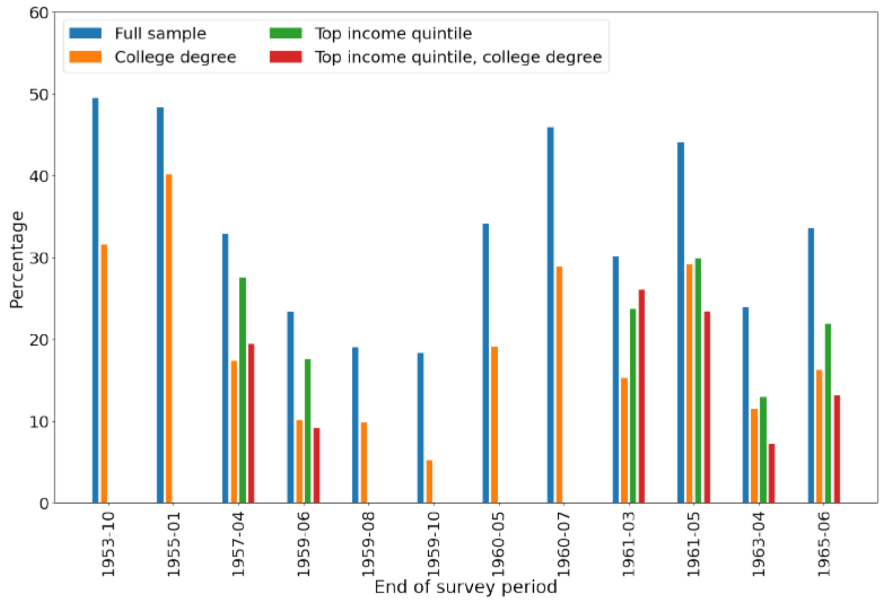
	(%)
Mentions of Cuba	11.2
Non-Cuba mentions	24.8
Not different	63.8
Missing	.2

22. *NORC458S*: In the last week or so, have there been any changes in your activities as a result of the Cuban situation? For example, is there anything that you did or did not do because of it?

	(%)
Yes, changes	11.5
No changes	88.0
Missing/don't know	.5

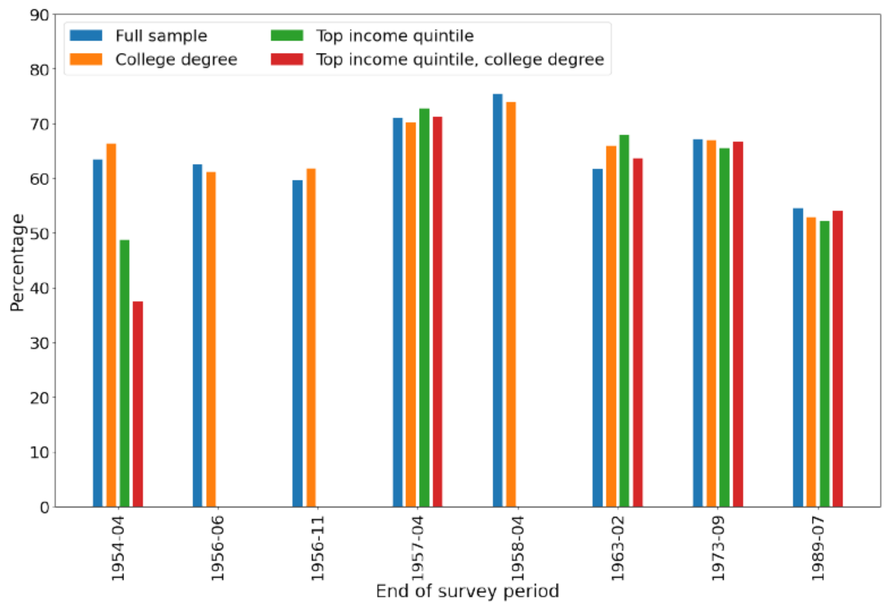
From Finer (2022):

Figure 2: Fraction of the American population who believe that a world war is likely within 5 years. The underlying surveys are presented in Table D.1. Approximate top income quintiles are derived from US Bureau of the Census Series P-60 reports. Income is reported as a range in the surveys.



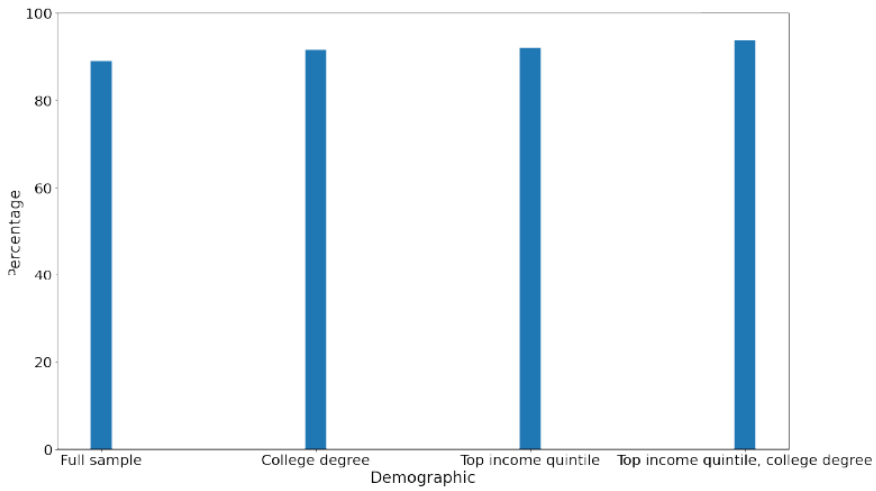
SOURCE: Gallup via Roper Centre; US Census Bureau; author's calculations

Figure 3: Fraction of the American population who expect the use of nuclear weapons in a major war. The underlying surveys are presented in Table D.2. Approximate top income quintiles through 1963 are derived from US Bureau of the Census Series P-60 reports. Top income quintiles in later years are obtained from US Census Bureau Table H-1. Income is reported as a range in the surveys.



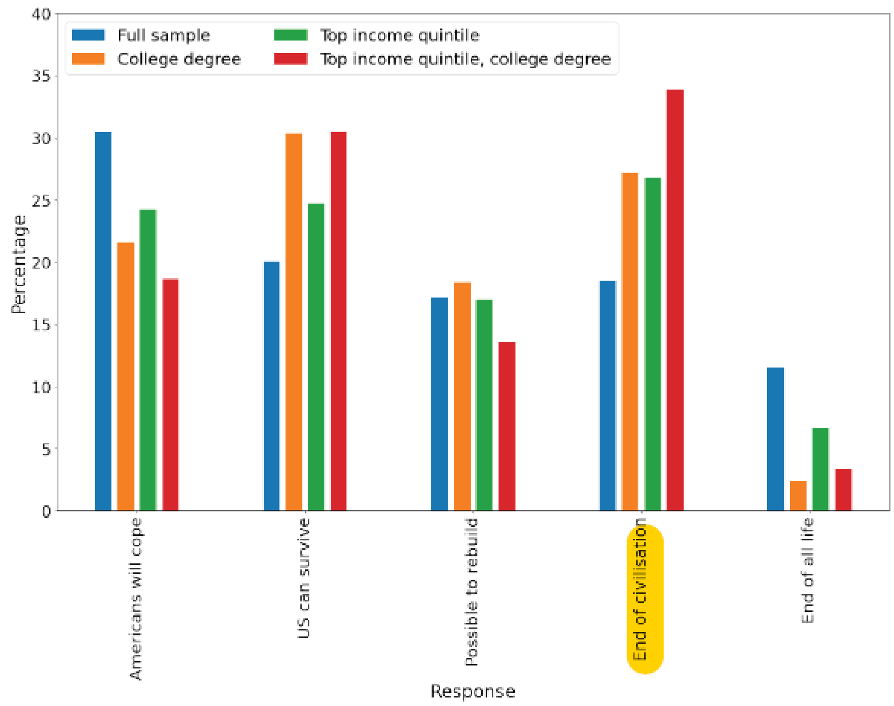
SOURCE: Gallup and Media General/Associated Press via Roper Centre; US Census Bureau; author's calculations

Figure 4: Fraction of the American population who believe that they would survive a nuclear war with $P \leq 0.5$. An approximate top income quintile is derived from US Bureau of the Census report P-60, no. 43. Income is reported as a range in the surveys.



SOURCE: Gallup Poll #1963-0668 via Roper Centre; US Census Bureau; author's calculations

Figure 5: American beliefs in December 1963 about the outcome of a nuclear war. Respondents were to select the statement that best reflected their beliefs. Americans will cope: "If nuclear war does come, people in the US will make the best of the situation." US can survive: "Although nuclear war would be a terrible thing, it would be possible to survive as a nation." Possible to rebuild: "Enough people would survive a nuclear war to pick up the pieces and carry on with a good chance of rebuilding a system which lives under American values, as we know them." End of civilisation: "A nuclear war would mean the end of civilisation as we know it." End of all life: "A nuclear war would mean the end of the world and all life in it." An approximate top income quintile is derived from US Bureau of the Census report P-60, no. 43. Income is reported as a range in the surveys.



SOURCE: NORC Amalgam Study #330 via Roper Centre; US Census Bureau; author's calculations

Newspaper articles

- Lots more digging could be done here, mostly for fun

Context:

- JFK speech was Monday Oct. 22, 1962 at 7pm
- News may have leaked in months prior though

Monday 10/22

- Front page: "Capital's crisis air hints at development on Cuba; Kennedy TV talk is likely"

Tuesday 10/23

- Front page:

"All the News That's Fit to Print"

The New York Times.

LATE CITY EDITION

U. S. Weather Bureau Report (Page 94) forecasts: Partly cloudy, breezy, cool today. Fair and cool tonight and tomorrow. Temp. range: 54—45; yesterday: 66—44.

VOL. CXII..No. 38,258. NEW YORK, TUESDAY, OCTOBER 23, 1962. FIVE CENTS

U.S. IMPOSES ARMS BLOCKADE ON CUBA ON FINDING OFFENSIVE-MISSILE SITES; KENNEDY READY FOR SOVIET SHOWDOWN

U. S. JUDGES GIVEN POWER TO REQUIRE VOTE FOR NEGROES

High Court Upholds Order Forcing the Registration of 54 in Alabama County

Special to The New York Times

WASHINGTON, Oct. 22 — The Supreme Court held today that Federal judges have the power to make state registrars put specific Negroes on the voting rolls.

Alabama had challenged an order by Federal District Judge Frank M. Johnson Jr. requiring the registration of 54 specific Negroes in Macon County, Ala. The order was upheld by the United States Court of Appeals for the Fifth Circuit.

Today the Supreme Court unaninously affirmed the disputed order. And it did so in a way that indicated once again its mood of impatience with Southern efforts to maintain denial of Negro rights.

One-Sentence Ruling

All that was before the court was an application for review of the Fifth Circuit decision. The usual alternatives would have been to deny the petition or to grant it and hear oral argument later.

Instead, the court granted review and then, summarily, af-

Chinese Open New Front; Use Tanks Against Indians

Nehru Warns of Peril to Independence —Reds Attack Near Burmese Border and Press Two Other Drives

Special to The New York Times

NEW DELHI, Oct. 22—Prime Minister Jawaharlal Nehru told the people of India tonight that the Chinese Communist attack was a threat to their liberty.

His grave warning followed word that the advancing Chinese had opened a third front in

Excerpts from Nehru's speech will be found on Page 2.

the Himalayas, near the Burmese border, and had used tanks for the first time. Five more Indian posts fell to the Chinese on the third day of savage fighting.

[A bid for negotiations for a peace accord was broadcast by the Chinese Communist radio early Tuesday, The Associated Press reported from Tokyo.]

In a broadcast, Mr. Nehru denounced the Peking regime as "a powerful and unscrupulous opponent, not caring for peace or peaceful methods."

"The time has come," he said, "for us to realize fully this menace that threatens the freedom of our people and the independence of our country."

Prime Minister Nehru said India would not abandon her economic development program and policy of nonalignment with international blocs, but called on the nation to switch "from the slow-moving methods of peacetime to those which produce results quickly."

"We must build up our military strength by all means at our disposal," he said.

The third front in the Himalayan fighting was opened early today when the Chinese attacked an Indian post at Kibitoo, on the border between

Continued on Page 3, Column 1

U.S. Bids U.N. Bar China; Denounces Attack on India

By SAM POPE BREWER

SHIPS MUST STOP

Other Action Planned If Big Rockets Are Not Dismantled

By JAMES RESTON

Special to The New York Times

WASHINGTON, Oct. 22—President Kennedy drew the line tonight, not with Cuba, but with the Soviet Union. After almost a generation of trying to keep the "cold war" from reaching a direct confrontation between United States and Soviet power, a decision has been made to force Soviet missile bases from this hemisphere at the risk of war.

This is the official interpretation of President Kennedy's speech tonight, and the orders to American forces bear it out. On the highest authority, it can be said that these orders include the following:

¶Ships carrying to Cuba weapons capable of striking the continental United States must either turn back or submit to search and seizure, or fight. If they try to run the blockade, a warning shot will be fired across their bows; if they still do not submit, they will be attacked.

¶This applies not only to ships but to any planes suspected of carrying additional offensive weapons to Cuba. There is no evidence that there are nuclear warheads in Cuba,

Associated Press Wirephoto

ANNOUNCES HIS ACTION: President Kennedy speaking to the nation last night on radio and television. He told of moves to keep offensive equipment away from Cuba.

TRAFFIC DELAYED AT BERLIN BORDER

Reds Start Intensive Check of Civilian Trucks an Hour Before Kennedy Speech

By SYDNEY GRUSON

Special to The New York Times

Moscow Says U.S. Holds 'Armed Fist' Over Cuba

By SEYMOUR TOPPING

Special to The New York Times

MOSCOW, Tuesday, Oct. 23—In a broadcast before President Kennedy's speech on the missile build-up in Cuba, the Moscow radio said that the unusual activity in Washington indicated that the United States "once again was raising its armed fist

BIG FORCE MASSES

PRESIDENT GRAVE

Asserts Russians Lied and Put Hemisphere in Great Danger

Text of the President's address is printed on Page 18.

By ANTHONY LEWIS

Special to The New York Times

WASHINGTON, Oct. 22 — President Kennedy imposed a naval and air "quarantine" tonight on the shipment of offensive military equipment to Cuba.

In a speech of extraordinary gravity, he told the American people that the Soviet Union, contrary to promises, was building offensive missile and bomber bases in Cuba. He said the bases could handle missiles carrying nuclear warheads up to 2,000 miles.

Thus a critical moment in the cold war was at hand tonight. The President had decided on a direct confrontation with — and challenge to — the power of the Soviet Union.

Direct Thrust at Soviet

Two aspects of the speech were notable. One was its direct thrust at the Soviet Union as the party responsible for the crisis. Mr. Kennedy treated Cuba and the Government of Premier Fidel Castro as a mere pawn in Moscow's hands and drew the issue as one with

Wednesday 10/24 (reporting on Tuesday 10/23)

- Business section(?): "Futures market soars with crisis"
    - o "The cold war came close enough to the hot stage this week to make prices skyrocket on the commodity futures exchanges, which have been somewhat casual about crises in recent years."

From Finer:

- The first financial reporting in The New York Times after the address was filled with references to the Crisis, e.g., Rutter (1962b) and Nuccio (1962), and, days later on 26 October, The New York Times notes that observers "believe that at least in the near-term future the course of the market would be decisively influenced by international developments...” (Rutter (1962a)). Kraus (1962c) reports that “the market practically ignored business and financial news” at the beginning of the Crisis. Writing shortly before the lifting of the quarantine, Abele (1962a) credits the Crisis with market gyrations over the previous weeks. “Fearful of a belligerent Soviet reaction to the American challenge, frenzied investors created a near Panic as they rushed to sell their securities.... The morale of the nation rallied strongly at the success of the American challenge. Spirits along Wall Street rose along with those of the rest of the country. So did stock prices” (Abele (1962a)).

4. RARE DISASTERS

Pindyck and Wang (2013)

- 1. Structural model of catastrophic-but-not existential risk (fraction of capital shock is destroyed)
- 2. Calibrate model to US postwar equities
- 3. Back out implied WTP for catastrophe insurance

Rare disaster lit: take probability of rare disasters from the data, estimate risk premium using a model;
Here: take equity returns from the data, estimate disaster probability using a model

Details:

- Model: EZW preferences, AK technology, with quadratic capital adjustment costs
- Calibration:
  - o Risk aversion of 3.1
  - o Catastrophic risks follow Pareto distribution
  - o Shocks arrive on average every 1.4 years, with a mean loss of 4%
    - Implying e.g.:
    - Probability of loss ≥10% in any given year is 8.7%
    - Probability of loss ≥15% in any given year is 2.3%
      - =57% chance of at least one such event over a 50-year period
    - Probability of loss ≥ 20% in any given year is 0.6%

To eliminate all shocks, society would accept a permanent 50% reduction in consumption (first row)
To eliminate all shocks ≥ 15%, society would accept a permanent 7% reduction in consumption

- Table 5

Chen, Joslin, and Tran (2012) point out that, if there is disagreement among investors, then asset prices will reflect the disaster probabilities of optimists! And therefore will be *underestimates* of these quantities

Caldara and Iacoviello (2022)

- News-based measure of geopolitical risk

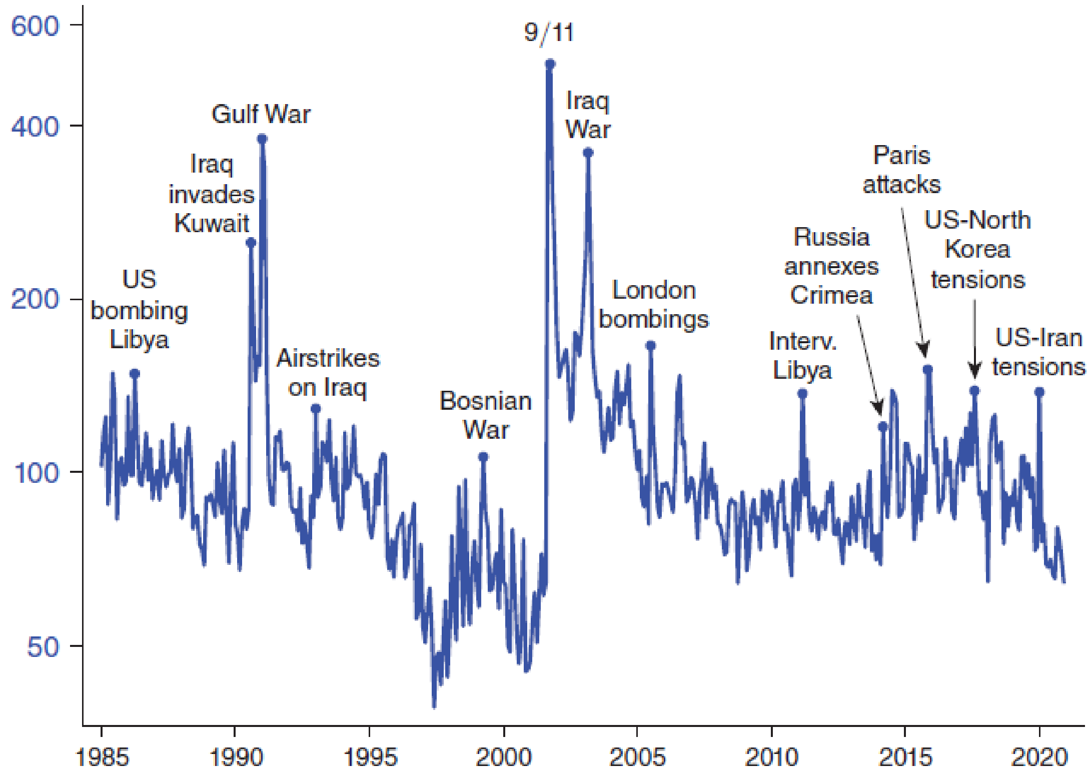


FIGURE 1. RECENT GPR INDEX FROM 1985

Recent GPR index from 1985 through 2020. Index is normalized to 100 throughout the 1985–2019 period.

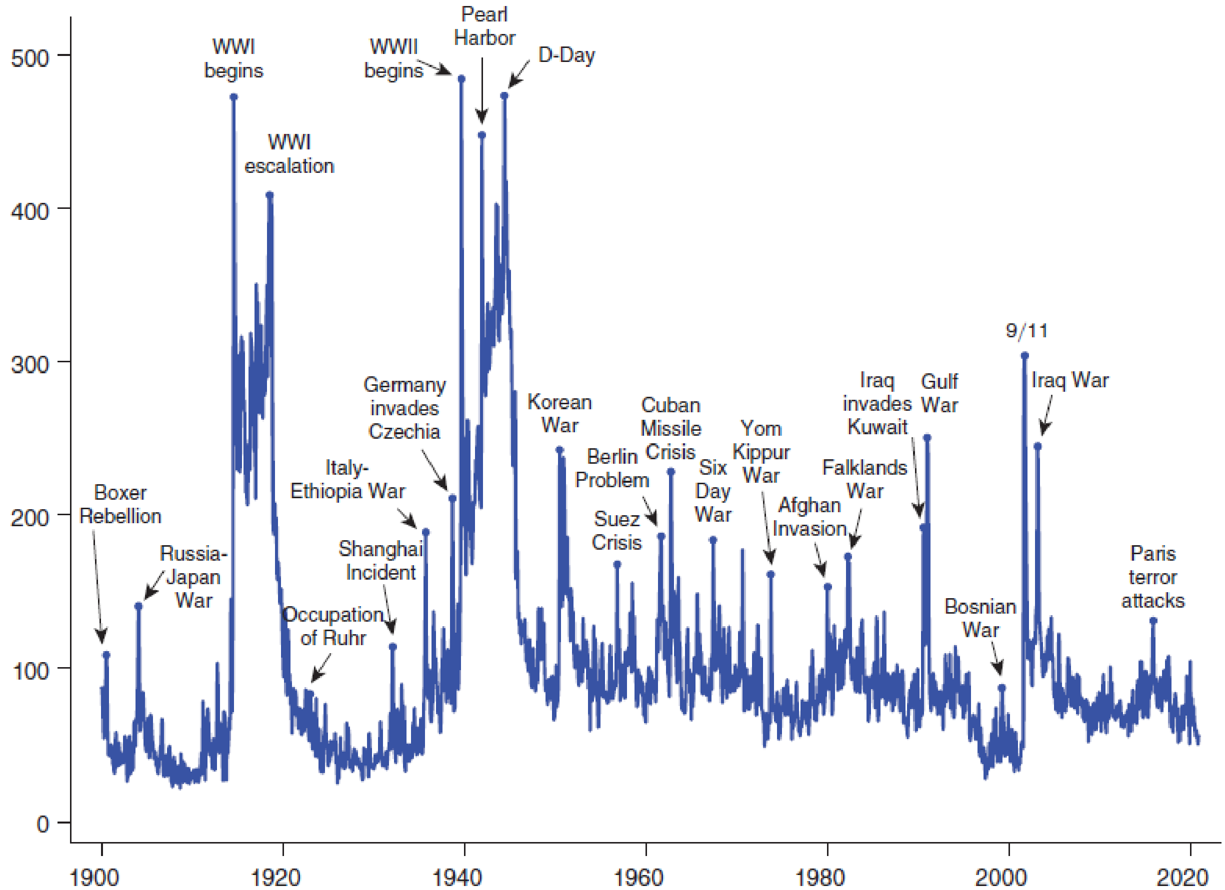


Figure 3. Historical GPR Index from 1900

Notes: Historical GPR Index from January 1900 through December 2020. Index is normalized to 100 throughout the 1900–2019 period.

5. INDIVIDUAL MORTALITY RISK

Baranov and Kohler (2018)

Title: The Impact of AIDS Treatment on Savings and Human Capital Investment in Malawi

Goal: estimates how life expectancy affects long term investment decisions

Context: antiretroviral therapy for AIDS in sub-Saharan Africa

Model: spatial and temporal variation in availability of ART

Punchline: ART availability increases savings and education due to changes in expected mortality risk

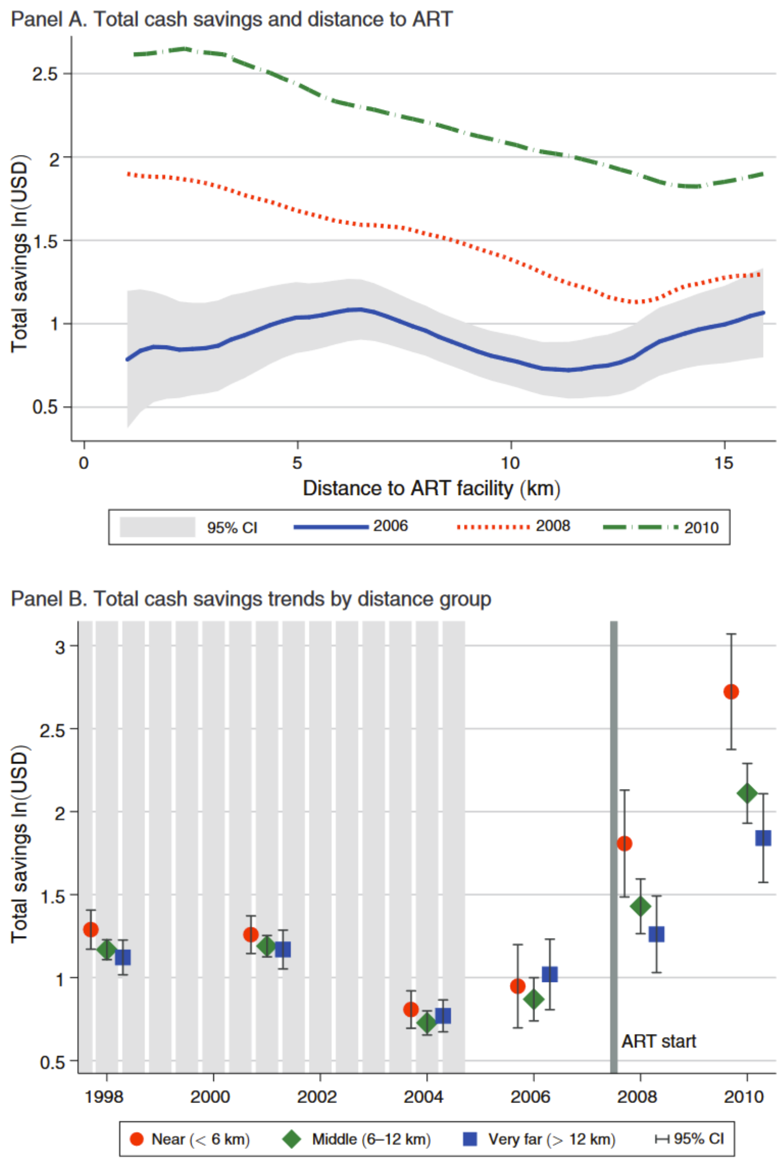


Figure 2. Trends in Saving by Distance to ART Facility

Notes: Figures show the variation in total cash savings (transformed using the inverse hyperbolic sine transformation) both as functions of ART proximity and time. Panel A shows the total savings as a function 2008 distance to ART using local linear regression for the three years that savings data were actually reported (2006, 2008, and 2010). For simplicity, a 95 percent confidence band was plotted only for year 2006. Panel B shows average total savings over time by splitting the sample into three groups: those near the ART facility (less than 6 km away, by road), those in the middle group (6–12 km away), and those far (more than 12 km away). Note the groups are time invariant, but ART only became available on average seven months before the 2008 survey wave. Thus, respondents in the near group are near the facility prior to 2008 but that facility does not provide ART. Panel B includes additionally "predicted" or imputed savings for years 1998, 2001, and 2004 (in shaded region) based on data on demographics, earnings, and assets available in those years. Due to slight differences in the distribution of respondents with respect to distance to ART by region, these averages have had region-by-year effects partialled out for both figures.

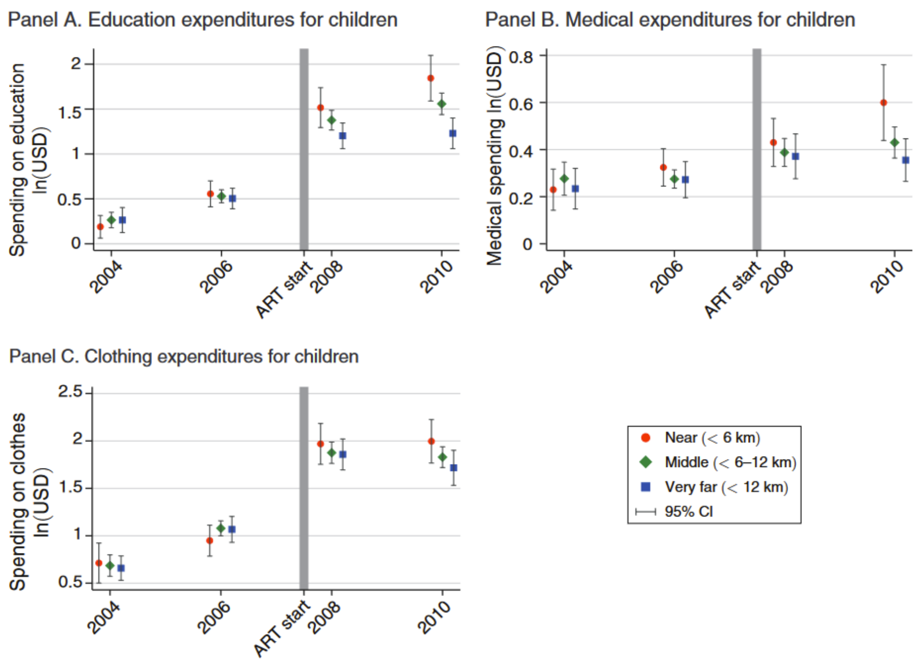


FIGURE 3. TRENDS IN HUMAN CAPITAL INVESTMENT BY DISTANCE TO ART FACILITY

Notes: Panels plot the average child expenditures (transformed by the inverse hyperbolic sine) over time using all 4 years of available data by splitting the sample into 3 groups: those near the ART facility (less than 6 km away, by road), those in the middle group (6–12 km away), and those far (more than 12 km away). Note the groups are time invariant, but ART only became available on average seven months before the 2008 survey wave. Thus, respondents in the near group are near the facility prior to 2008, but that facility does not provide ART. Due to slight differences in the distribution of respondents with respect to distance to ART by region, these averages have had region-by-year effects partialled out.

Hansen (2013)

Title: Life expectancy and human capital

Goal: estimates how life expectancy affects schooling outcomes

Context: international epidemiological transition in 1950s across a range of countries

Model: identified by large exogenous shock to life expectancy, especially from fall in pneumonia

Punchline: every extra year of life expectancy increases years of schooling by 0.17 years.

Hansen and Strulik (2017)

Title: Life expectancy and education

Goal: estimates how life expectancy affects schooling outcomes, and especially when life expectancy affects adults

Context: US cardiovascular revolution in 1970s

Model: identified from the large exogenous shock to life expectancy using diff-in-diff across states

Punchline: states with higher mortality rates from cardiovascular disease prior to the 1970s experienced greater increases in adult life expectancy when cardiovascular revolution arrived, and higher education enrolment, 0.19 to 0.41 more years of schooling per additional year of life

Jayachandran and Lleras-Muney (2009)

Title: Life Expectancy and Human Capital Investments

Goal: estimates how life expectancy affects schooling outcomes

Context: sudden drop in maternal mortality in Sri Lanka between 1946 and 1953, raised female life expectancy

Model: maternal mortality happens after education investment decisions but still early in adult life, and provide natural control group of men

Punchline: for every extra year of life expectancy, years of education increase by 0.11 years (3%)

Ciancio, Delavande, Kohler, and Kohler (2020)

Title: Mortality Risk Information, Survival Expectations and Sexual Behaviors

Goal: estimates how life expectancy affects long term investment decisions

Context: adults of age 45+ in Malawi had their pessimistic views about life expectancy updated

Model: randomised controlled trial for knowledge provision about mortality risks

Punchline: people with higher life expectancy do less sexually risky stuff and investment more in agriculture and livestock

6. OTHER ADJACENT LITERATURES

Climate risk

- Municipal bonds and sea level rise exposure
- Home prices and sea level rise exposure
- Claims about market efficiency
- Etc etc

Pandemic bonds

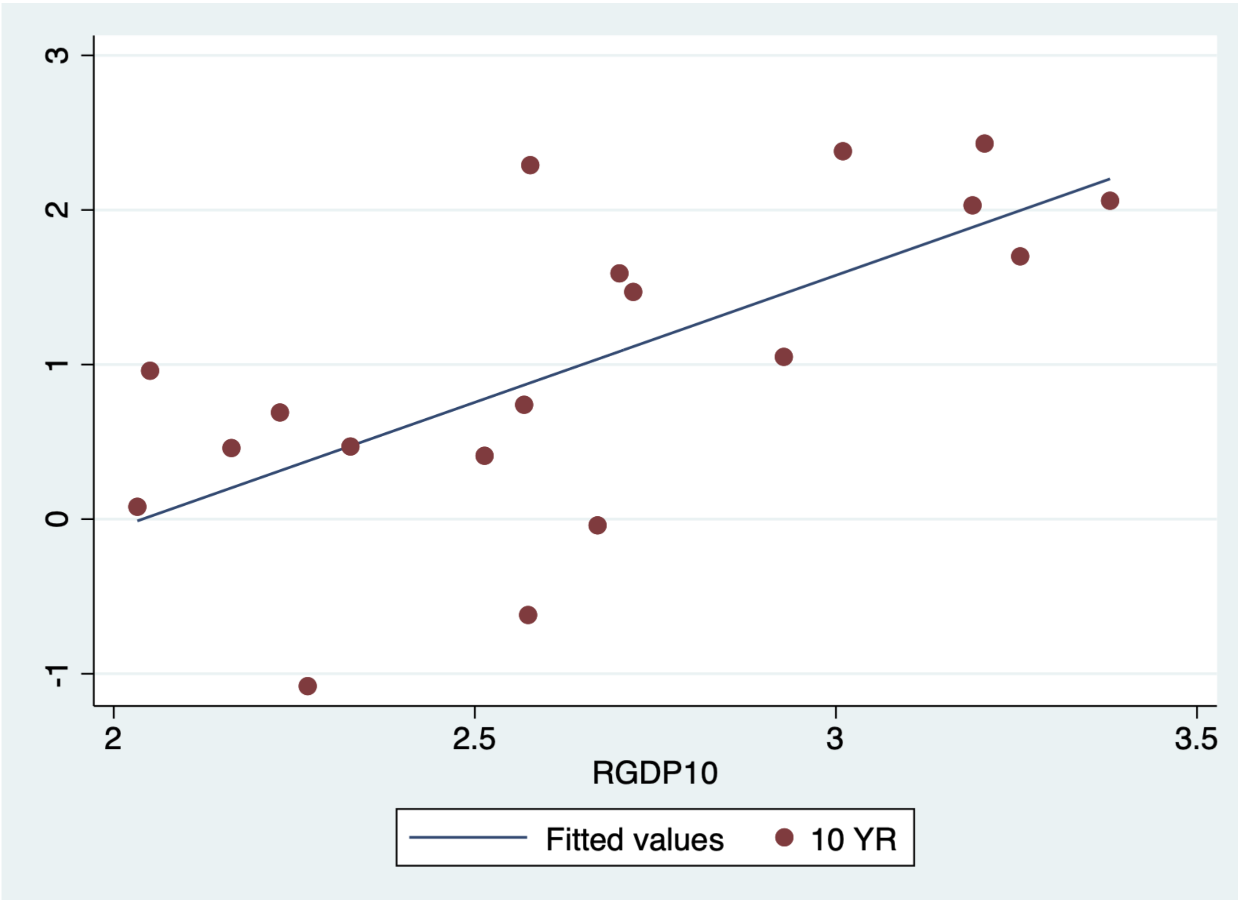
- [1][2][3][4][5]

Wolfers and Zitzwetiz on prediction markets and the Iraq war

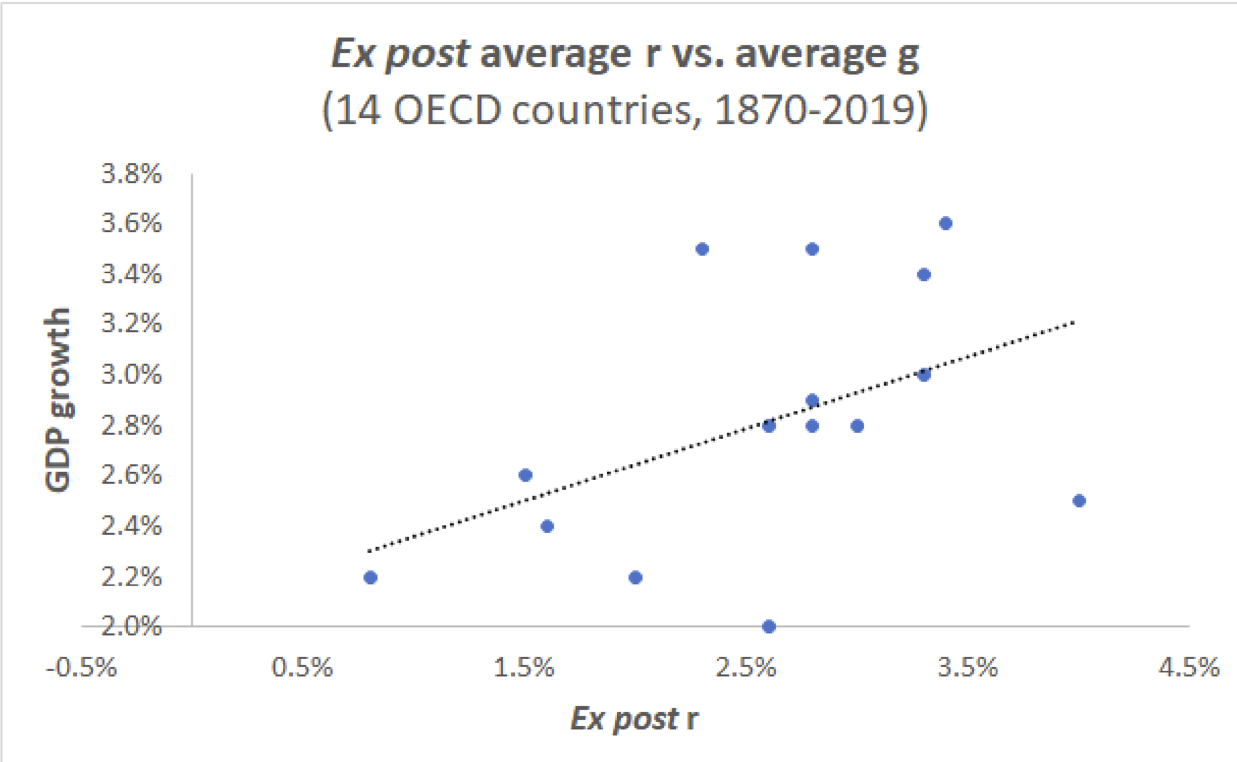
- Wolfers and Zitzewitz (2009)
- Leigh, Wolfers, and Zitzewitz (2003)

Appendix 4. Supplementary figures

Survey of Professional Forecasters (SPF) 10-year growth expectations (x-axis) vs. 10-year real rate from TIPS (y-axis)



Ex post average 10-year real rate (i.e., 10-year nominal rate minus realized inflation) versus average annual GDP growth for 14 OECD countries from 1870 to 2019. Data from Barro (2022), sourced from Global Financial Data. Do note the scale on the axes when interpreting.



Real interest rates versus future growth, as a timeseries: