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THE RATE OF RETURN ON EVERYTHING, 1870–2015

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ABSTRACT

What is the aggregate real rate of return in the economy? Is it higher than the growth rate of the economy and, if so, by how much? Is there a tendency for returns to fall in the long-run? Which particular assets have the highest long-run returns? We answer these questions on the basis of a new and comprehensive dataset for all major asset classes, including housing. The annual data on total returns for equity, housing, bonds, and bills cover 16 advanced economies from 1870 to 2015, and our new evidence reveals many new findings and puzzles.

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I. Introduction

What is the rate of return in an economy? It is a simple question, but hard to answer. The rate of return plays a central role in current debates on inequality, secular stagnation, risk premiums, and the decline in the natural rate of interest, to name a few. A main contribution of our paper is to introduce a large new dataset on the total rates of return for all major asset classes, including housing—the largest, but oft ignored component of household wealth. Our data cover most advanced economies—sixteen in all—starting in the year 1870.

Although housing wealth is on average roughly one half of national wealth in a typical economy (Piketty, 2014), data on total housing returns (price appreciation plus rents) has been lacking (Shiller, 2000, provides some historical data on house prices, but not on rents). In this paper we build on more comprehensive work on house prices (Knoll, Schularick, and Steger, 2017) and newly constructed data on rents (Knoll, 2017) to enable us to track the total returns of the largest component of the national capital stock.

We further construct total returns broken down into investment income (yield) and capital gains (price changes) for four major asset classes, two of them typically seen as relatively risky—equities and housing—and two of them typically seen as relatively safe—government bonds and short-term bills. Importantly, we compute actual asset returns taken from market data and therefore construct more detailed series than returns inferred from wealth estimates in discrete benchmark years for a few countries as in Piketty (2014).

We also follow earlier work in documenting annual equity, bond, and bill returns, but here again we have taken the project further. We re-compute all these measures from original sources, improve the links across some important historical market discontinuities (e.g., market closures and other gaps associated with wars and political instability), and in a number of cases we access new and previously unused raw data sources. In all cases, we have also brought in auxiliary sources to validate our data externally, and 100+ pages of online material documents our sources and methods. Our work thus provides researchers with the first broad non-commercial database of historical equity, bond, and bill returns—and the only database of housing returns—with the most extensive coverage across both countries and years.[1]

Our paper aims to bridge the gap between two related strands of the academic literature. The first strand is rooted in finance and is concerned with long-run returns on different assets. Dimson, Marsh, and Staunton (2009) probably marked the first comprehensive attempt to document and analyze long-run returns on investment for a broad cross-section of countries. Meanwhile, Homer and Sylla (2005) pioneered a multi-decade project to document the history of interest rates.

The second related strand of literature is the analysis of comparative national balance sheets over time, as in Goldsmith (1985a). More recently, Piketty and Zucman (2014) have brought together data

[1]For example, our work complements and extends the database on equity returns by Dimson, Marsh, and Staunton (2009). Their dataset is commercially available, but has a shorter coverage and does not break down the yield and capital gain components.

from national accounts and other sources tracking the development of national wealth over long time periods. They also calculate rates of return on capital by dividing aggregate capital income in the national accounts by the aggregate value of capital, also from national accounts.

Our work is both complementary and supplementary to theirs. It is complementary as the asset price perspective and the national accounts approach are ultimately tied together by accounting rules and identities. Using market valuations, we are able to corroborate and improve the estimates of returns on capital that matter for wealth inequality dynamics. Our long-run return data are also supplementary to the work of Piketty and Zucman (2014) in the sense that we greatly extend the number of countries for which we can calculate real rates of return back to the late nineteenth century.

The new evidence we gathered can shed light on active research debates, reaching from asset pricing to inequality. For example, in one contentious area of research, the accumulation of capital, the expansion of capital's share in income, and the growth rate of the economy relative to the rate of return on capital all feature centrally in the current debate sparked by Piketty (2014) on the evolution of wealth, income, and inequality. What do the long-run patterns on the rates of return on different asset classes have to say about these possible drivers of inequality?

In many financial theories, preferences over current versus future consumption, attitudes toward risk, and covariation with consumption risk all show up in the premiums that the rates of return on risky assets carry over safe assets. Returns on different asset classes and their correlations with consumption sit at the core of the canonical consumption-Euler equation that underpins textbook asset pricing theory (see, e.g., Mehra and Prescott, 1985). But tensions remain between theory and data, prompting further explorations of new asset pricing paradigms including behavioral finance. Our new data add another risky asset class to the mix, housing, and with it, new challenges.

In another strand of research triggered by the financial crisis, Summers (2014) seeks to revive the secular stagnation hypothesis first advanced in Alvin Hansen's (1939) AEA Presidential Address. Demographic trends are pushing the world's economies into uncharted territory as the relative weight of borrowers and savers is changing and with it the possibility increases that the interest rate will fall by an insufficient amount to balance saving and investment at full employment. What is the evidence that this is the case?

Lastly, in a related problem within the sphere of monetary economics, Holston, Laubach, and Williams (2017) show that estimates of the natural rate of interest in several advanced economies have gradually declined over the past four decades and are now near zero. What historical precedents are there for such low real rates that could inform today's policymakers, investors, and researchers?

The common thread running through each of these broad research topics is the notion that the rate of return is central to understanding long-, medium-, and short-run economic fluctuations. But which rate of return? And how do we measure it? For a given scarcity of funding supply, the risky rate is a measure of the profitability of private investment; in contrast, the safe rate plays an important role in benchmarking compensation for risk, and is often tied to discussions of monetary policy settings and the notion of the natural rate. Below, we summarize our main findings.

Main findings We present four main findings:

1. **On risky returns,** r^{risky}

   In terms of total returns, residential real estate and equities have shown very similar and high real total gains, on average about 7% per year. Housing outperformed equities before WW2. Since WW2, equities have outperformed housing on average, but had much higher volatility and higher synchronicity with the business cycle. The observation that housing returns are similar to equity returns, but much less volatile, is puzzling. Like Shiller (2000), we find that long-run capital gains on housing are relatively low, around 1% p.a. in real terms, and considerably lower than capital gains in the stock market. However, the rental yield component is typically considerably higher and more stable than the dividend yield of equities so that total returns are of comparable magnitude.

   Before WW2, the real returns on housing and equities (and safe assets) followed remarkably similar trajectories. After WW2 this was no longer the case, and across countries equities then experienced more frequent and correlated booms and busts. The low covariance of equity and housing returns reveals that there could be significant aggregate diversification gains (i.e., for a representative agent) from holding the two asset classes.

2. **On safe returns,** r^{safe}

   We find that the real safe asset return (bonds and bills) has been very volatile over the long-run, more so than one might expect, and oftentimes even more volatile than real risky returns. Each of the world wars was (unsurprisingly) a moment of very low safe rates, well below zero. So was the 1970s stagflation. The peaks in the real safe rate took place at the start of our sample, in the interwar period, and during the mid-1980s fight against inflation. In fact, the long decline observed in the past few decades is reminiscent of the secular decline that took place from 1870 to WW1. Viewed from a long-run perspective, the past decline and current low level of the real safe rate today is not unusual. The puzzle may well be why was the safe rate so high in the mid-1980s rather than why has it declined ever since.

   Safe returns have been low on average in the full sample, falling in the 1%–3% range for most countries and peacetime periods. While this combination of low returns and high volatility has offered a relatively poor risk-return trade-off to investors, the low returns have also eased the pressure on government finances, in particular allowing for a rapid debt reduction in the aftermath of WW2.

3. **On the risk premium,** $r^{risky} - r^{safe}$

   Over the very long run, the risk premium has been volatile. Our data uncover substantial swings in the risk premium at lower frequencies that sometimes endured for decades, and which far exceed the amplitudes of business-cycle swings.

In most peacetime eras, this premium has been stable at about 4%–5%. But risk premiums stayed curiously and persistently high from the 1950s to the 1970s, long after the conclusion of WW2. However, there is no visible long-run trend, and mean reversion appears strong. Interestingly, the bursts of the risk premium in the wartime and interwar years were mostly a phenomenon of collapsing safe returns rather than dramatic spikes in risky returns.

In fact, the risky return has often been smoother and more stable than the safe return, averaging about 6%–8% across all eras. Recently, with safe returns low and falling, the risk premium has widened due to a parallel but smaller decline in risky returns. But these shifts keep the two rates of return close to their normal historical range. Whether due to shifts in risk aversion or other phenomena, the fact that safe returns seem to absorb almost all of these adjustments seems like a puzzle in need of further exploration and explanation.

4. **On returns minus growth,** $r^{wealth} - g$

Piketty (2014) argued that, if investors' return to wealth exceeded the rate of economic growth, rentiers would accumulate wealth at a faster rate and thus worsen wealth inequality. Using a measure of portfolio returns to compute "r minus g" in Piketty's notation, we uncover an important finding. Even calculated from more granular asset price returns data, the same fact reported in Piketty (2014) holds true for more countries, more years, and more dramatically: namely "$r \gg g$."

In fact, the only exceptions to that rule happen in the years in or around wartime. In peacetime, r has always been much greater than g. In the pre-WW2 period, this gap was on average 5% (excluding WW1). As of today, this gap is still quite large, about 3%–4%, though it narrowed to 2% in the 1970s before widening in the years leading up to the Global Financial Crisis.

One puzzle that emerges from our analysis is that while "r minus g" fluctuates over time, it does not seem to do so systematically with the growth rate of the economy. This feature of the data poses a conundrum for the battling views of factor income, distribution, and substitution in the ongoing debate (Rognlie, 2015). The fact that returns to wealth have remained fairly high and stable while aggregate wealth increased rapidly since the 1970s, suggests that capital accumulation may have contributed to the decline in the labor share of income over the recent decades (Karabarbounis and Neiman, 2014). In thinking about inequality and several other characteristics of modern economies, the new data on the return to capital that we present here should spur further research.

II. A new historical global returns database

In this section, we will discuss the main sources and definitions for the calculation of long-run returns. A major innovation is the inclusion of housing. Residential real estate is the main asset in most household portfolios, as we shall see, but so far very little has been known about long-run

Table I: *Data coverage*

Country	Bills	Bonds	Equity	Housing
Australia	1870–2015	1900–2015	1870–2015	1901–2015
Belgium	1870–2015	1870–2015	1870–2015	1890–2015
Denmark	1875–2015	1870–2015	1873–2015	1876–2015
Finland	1870–2015	1870–2015	1896–2015	1920–2015
France	1870–2015	1870–2015	1870–2015	1871–2015
Germany	1870–2015	1870–2015	1870–2015	1871–2015
Italy	1870–2015	1870–2015	1870–2015	1928–2015
Japan	1876–2015	1881–2015	1886–2015	1931–2015
Netherlands	1870–2015	1870–2015	1900–2015	1871–2015
Norway	1870–2015	1870–2015	1881–2015	1871–2015
Portugal	1880–2015	1871–2015	1871–2015	1948–2015
Spain	1870–2015	1900–2015	1900–2015	1901–2015
Sweden	1870–2015	1871–2015	1871–2015	1883–2015
Switzerland	1870–2015	1900–2015	1900–2015	1902–2015
UK	1870–2015	1870–2015	1871–2015	1896–2015
USA	1870–2015	1871–2015	1872–2015	1891–2015

returns on housing. Our data on housing returns will cover capital gains, and imputed rents to owners and renters, the sum of the two being total returns.[2] Equity return data for publicly-traded equities will then be used, as is standard, as a proxy for aggregate business equity returns.[3]

The data include nominal and real returns on bills, bonds, equities, and residential real estate for Australia, Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The sample spans 1870 to 2015. Table I summarizes the data coverage by country and asset class.

Like most of the literature, we examine returns to national aggregate holdings of each asset class. Theoretically, these are the returns that would accrue for the hypothetical representative-agent investor holding each country's portfolio. An advantage of this approach is that it captures indirect holdings much better, although it leads to some double-counting thereby boosting the share of financial assets over housing somewhat. The differences are described in Appendix O.[4]

[2]Since the majority of housing is owner-occupied, and housing wealth is the largest asset class in the economy, owner-occupier returns and imputed rents also form the lion's share of the total return on housing, as well as the return on aggregate wealth.

[3]Moskowitz and Vissing-Jørgensen (2002) compare the returns on listed and unlisted U.S. equities over the period 1953–1999 and find that in aggregate, the returns on these two asset classes are similar and highly correlated, but private equity returns exhibit somewhat lower volatility. Moskowitz and Vissing-Jørgensen (2002) argue, however, that the risk-return tradeoff is worse for private compared to public equities, because aggregate data understate the true underlying volatility of private equity, and because private equity portfolios are typically much less diversified.

[4]Within country heterogeneity is undoubtedly important, but clearly beyond the scope of a study covering nearly 150 years of data and 16 advanced economies.

II.A. The composition of wealth

Figure I shows the decomposition of economy-wide investible assets and capital stocks, based on data for five major economies at the end of 2015: France, Germany, Japan, UK and US.[5] Investible assets shown in the left panel of Figure I (and in Table A.23) exclude assets that relate to intra-financial holdings and cannot be held directly by investors, such as loans, derivatives (apart from employee stock options), financial institutions' deposits, insurance and pension claims. Other financial assets mainly consist of corporate bonds and asset-backed securities. Other non-financial assets are other buildings, machinery and equipment, agricultural land, and intangible capital. The capital stock is business capital plus housing. Other capital is mostly made up of intangible capital and agricultural land. Data are sourced from national accounts and national wealth estimates published by the countries' central banks and statistical offices.[6]

Housing, equity, bonds, and bills comprise over half of all investible assets in the advanced economies today, and nearly two-thirds if deposits are included. The right-hand side panel of Figure I shows the decomposition of the capital stock into housing and various other non-financial assets. Housing is about one half of the outstanding stock of capital. In fact, housing and equities alone represent over half of total assets in household balance sheets (see Figures A.5 and A.6).

The main asset categories *outside* the direct coverage of this study are: commercial real estate, business assets, and agricultural land; corporate bonds; pension and insurance claims; and deposits. But most of these assets represent claims of, or are closely related to, assets that we do cover. For example, pension claims tend to be invested in stocks and bonds; listed equity is a levered claim on business assets of firms; land and commercial property prices tend to co-move with residential property prices; and deposit rates are either included in, or very similar to, our bill rate measure.[7]

Our data also exclude foreign assets. Even though the data on foreign asset holdings are relatively sparse, the evidence that we do have—presented in Appendix O.4—suggests that foreign assets have, through history, only accounted for a small share of aggregate wealth, and the return differentials between domestic and foreign asset holdings are, with few exceptions, not that large. Taken together, this means that our dataset almost fully captures the various components of the return on overall household wealth.

II.B. Historical returns data

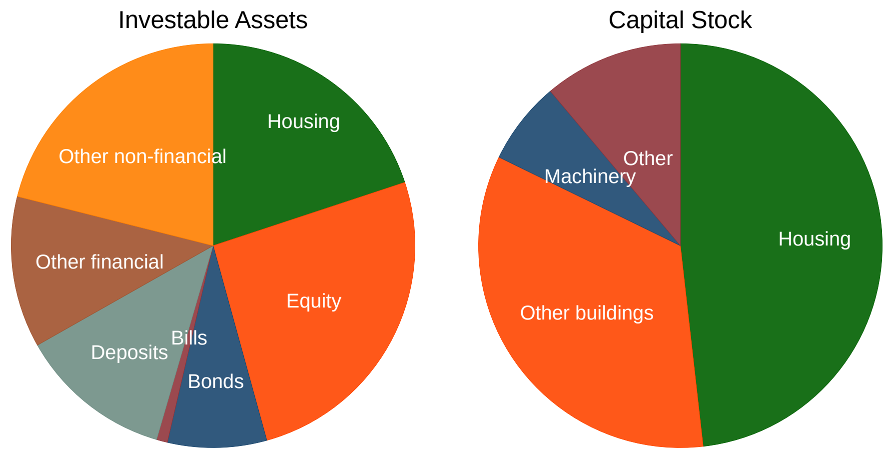
Bill returns The canonical risk-free rate is taken to be the yield on Treasury bills, i.e., short-term, fixed-income government securities. The yield data come from the latest vintage of the long-run

[5]Individual country data are shown Appendix Tables A.23 and A.24.

[6]Both decompositions also exclude human capital, which cannot be bought or sold. Lustig, Van Nieuwerburgh, and Verdelhan (2013) show that for a broader measure of aggregate wealth that includes human capital, the size of human wealth is larger than of non-human wealth, and its return dynamics are similar to those of a long-term bond.

[7]Moreover, returns on commercial real estate are captured by the levered equity returns of the firms that own this real estate, and hence are indirectly proxied by our equity return data.

Figure I: *Composition of investible assets and capital stock in the major economies*



Note: Composition of total investible assets and capital stock. Average of the individual asset shares of France, Germany, Japan, UK, and US, as of end-2015. Investible assets are defined as the gross total of economy-wide assets excluding loans, derivatives, financial institutions' deposits, insurance, and pension claims. Other financial assets mainly consist of corporate bonds and asset-backed securities. Other non-financial assets are other buildings, machinery and equipment, agricultural land, and intangible capital. The capital stock is business capital plus housing. Other capital is mostly made up by intangible capital and agricultural land. Data are sourced from national accounts and national wealth estimates published by the countries' central banks and statistical offices.

macrohistory database (Jordà, Schularick, and Taylor, 2017).[8] Whenever data on Treasury bill returns were unavailable, we relied on either money market rates or deposit rates of banks from Zimmermann (2017). Since short-term government debt was rarely used and issued in the earlier historical period, much of our bill rate data before the 1960s actually consist of deposit rates.[9]

Bond returns These are conventionally the total returns on long-term government bonds. Unlike earlier cross-country studies, we focus on the bonds listed and traded on local exchanges and denominated in local currency. This focus makes bond returns more comparable with the returns of bills, equities, and housing. Moreover, this results in a larger sample of bonds, and on bonds that are more likely to be held by the representative household in the respective country. For some countries and periods we have made use of listings on major global exchanges to fill gaps where domestic markets were thin, or local exchange data were not available (for example, Australian bonds listed in New York or London). Throughout the sample we target a maturity of around 10 years. For the second half of the 20th century, the maturity of government bonds is generally

[8] www.macrohistory.net/data

[9] In general, it is difficult to compute the total returns on deposits because of uncertainty about losses during banking crises, and we stick to the more easily measurable government bill and bond returns where these data are available. Comparisons with the deposit rate data in Zimmermann (2017), however, indicate that the interest rate differential between deposits and our bill series is very small, with deposit rates on average roughly 0.7 percentage points below bills—a return close to zero in real terms. The returns on government bills and deposits are also highly correlated over time.

accurately defined. For the pre-WW2 period we sometimes had to rely on data for perpetuals, i.e., very long-term government securities (such as the British consol). Although as a convention we refer here to government bills and bonds as "safe" assets, both are naturally exposed to inflation and default risk, for example. In fact, real returns on these assets fluctuate substantially over time as we shall see (specifically, Sections V and VI).

Equity returns These returns come from a broad range of sources, including articles in economic and financial history journals, yearbooks of statistical offices and central banks, stock exchange listings, newspapers, and company reports. Throughout most of the sample, we aim to rely on indices weighted by market capitalization of individual stocks, and a stock selection that is representative of the entire stock market. For some historical time periods in individual countries, however, we also make use of indices weighted by company book capital, stock market transactions, or weighted equally, due to limited data availability.

Housing returns We combine the long-run house price series introduced by Knoll, Schularick, and Steger (2017) with a novel dataset on rents drawn from the unpublished PhD thesis of Knoll (2017). For most countries, the rent series rely on the rent components of the cost of living of consumer price indices constructed by national statistical offices. We then combine them with information from other sources to create long-run series reaching back to the late 19th century. To proxy the total return on the residential housing stock, our returns include both rented housing and owner-occupied properties.[10] Specifically, wherever possible we use house price and rental indices that include the prices of owner-occupied properties, and the imputed rents on these houses. Imputed rents estimate the rent that an owner-occupied house would earn on the rental market, typically by using rents of similar houses that are rented. This means that, in principle, imputed rents are similar to market rents, and are simply adjusted for the portfolio composition of owner-occupied as opposed to rented housing. Imputed rents, however, are not directly observed and hence less precisely measured than market rents, and are typically not taxed.[11] To the best of our knowledge, we are the first to calculate total returns to housing in the literature for as long and as comprehensive a cross section of economies as we report.

Composite returns We compute the rate of return on safe assets, risky assets, and aggregate wealth, as weighted averages of the individual asset returns. To obtain a representative return from the investor's perspective, we use the outstanding stocks of the respective asset in a given country as weights. To this end, we make use of new data on equity market capitalization (from Kuvshinov and Zimmermann, 2018) and housing wealth for each country and period in our sample, and combine

[10]This is in line with the treatment of housing returns in the existing literature on returns to aggregate wealth—see, for example, Piketty et al. (2018) and Rognlie (2015).

[11]We discuss the issues around imputed rents measurement, and our rental yield series more generally in Section III.C.

them with existing estimates of public debt stocks to obtain the weights for the individual assets. A graphical representation of these asset portfolios, and further description of their construction is provided in the Appendix O.3. Tables A.28 and A.29 present an overview of our four asset return series by country, their main characteristics and coverage. The paper comes with an extensive data appendix that specifies the sources we consulted and discusses the construction of the series in greater detail (see the Data Appendix, Sections U, V, and W for housing returns, and Section X for equity and bond returns).

II.C. Calculating returns

The total annual return on any financial asset can be divided into two components: the capital gain from the change in the asset price P, and a yield component Y, that reflects the cash-flow return on an investment. The total nominal return R for asset j in country i at time t is calculated as:

$$\text{Total return:} \quad R^j_{i,t} = \frac{P^j_{i,t} - P^j_{i,t-1}}{P^j_{i,t-1}} + Y^j_{i,t}\,. \tag{1}$$

Because of wide differences in inflation across time and countries, it is helpful to compare returns in real terms. Let $\pi_{i,t} = (CPI_{i,t} - CPI_{i,t-1})/CPI_{i,t-1}$ be the realized consumer price index (CPI) inflation rate in a given country i and year t. We calculate inflation-adjusted *real returns* r for each asset class as,

$$\text{Real return:} \quad r^j_{i,t} = (1 + R^j_{i,t})/(1 + \pi_{i,t}) - 1\,. \tag{2}$$

These returns will be summarized in period average form, by country, or for all countries.

Investors must be compensated for risk to invest in risky assets. A measure of this "excess return" can be calculated by comparing the real total return on the risky asset with the return on a risk-free benchmark—in our case, the government bill rate, $r^{bill}_{i,t}$. We therefore calculate the excess return ER for the risky asset j in country i as

$$\text{Excess return:} \quad ER^j_{i,t} = r^j_{i,t} - r^{bill}_{i,t}\,. \tag{3}$$

In addition to individual asset returns, we also present a number of weighted "composite" returns aimed at capturing broader trends in risky and safe investments, as well as the "overall return" or "return on wealth." Appendix O.3 provides further details on the estimates of country asset portfolios from which we derive country-year specific weights.

For safe assets, we assume that total public debt is divided equally into bonds and bills since there are no data on their market shares (only for total public debt) over our full sample. As a result, we compute the safe asset return as:

$$\text{Safe return:} \quad r^{safe}_{i,t} = \frac{r^{bill}_{i,t} + r^{bond}_{i,t}}{2}\,. \tag{4}$$

The risky asset return is calculated as a weighted average of the returns on equity and on housing. The weights w represent the share of asset holdings of equity and of housing stocks in the respective country i and year t, scaled to add up to 1. We use stock market capitalization and housing wealth to calculate each share and hence compute risky returns as:

$$\text{Risky return:} \quad r_{i,t}^{risky} = r_{i,t}^{equity} \times w_{i,t}^{equity} + r_{t}^{housing} \times w_{i,t}^{housing} . \tag{5}$$

The difference between our risky and safe return measures then provides a proxy for the aggregate risk premium in the economy:

$$\text{Risk premium:} \quad RP_{i,t} = r_{i,t}^{risky} - r_{i,t}^{safe} . \tag{6}$$

The "return on wealth" measure is a weighted average of returns on risky assets (equity and housing) and safe assets (bonds and bills). The weights w here are the asset holdings of risky and safe assets in the respective country i and year t, scaled to add to 1.[12]

$$\text{Return on wealth:} \quad r_{i,t}^{wealth} = r_{i,t}^{risky} \times w_{i,t}^{risky} + r_{i,t}^{safe} \times w_{i,t}^{safe} . \tag{7}$$

Finally, we also consider returns from a global investor perspective in Appendix I. There we measure the returns from investing in local markets in U.S. dollars (USD). These returns effectively subtract the depreciation of the local exchange rate vis-a-vis the dollar from the nominal return:

$$\text{USD return:} \quad R_{i,t}^{j,USD} = (1 + R_{i,t}^{j}) / (1 + \hat{s}_{i,t}) - 1 , \tag{8}$$

where $\hat{s}_{i,t}$ is the rate of depreciation of the local currency versus the U.S. dollar in year t.

The real USD returns are then computed net of U.S. inflation $\pi_{US,t}$:

$$\text{Real USD return:} \quad r_{i,t}^{j,USD} = (1 + R_{i,t}^{j,USD}) / (1 + \pi_{US,t}) - 1 . \tag{9}$$

II.D. Constructing housing returns using the rent-price approach

This section briefly describes our methodology to calculate total housing returns. We provide further details as needed later in Section III.C and in Appendix U. We construct estimates for total returns on housing using the rent-price approach. This approach starts from a benchmark rent-price ratio (RI_0/HPI_0) estimated in a baseline year ($t = 0$). For this ratio we rely on net rental yields from the Investment Property Database (IPD).[13] We can then construct a time series of returns by

[12] For comparison, Appendix P provides information on the equally-weighted risky return, and the equally-weighted rate of return on wealth, both calculated as simple averages of housing and equity, and housing, equity and bonds respectively.

[13] These net rental yields use rental income net of maintenance costs, ground rent, and other irrecoverable expenditure. These adjustments are discussed exhaustively in the next section. We use net rather than gross yields to improve comparability with other asset classes.

combining separate information from a country-specific house price index series (HPI_t/HPI_0) and a country-specific rent index series (RI_t/RI_0). For these indices we rely on prior work on housing prices (Knoll, Schularick, and Steger, 2017) and new data on rents (Knoll, 2017). This method assumes that the indices cover a representative portfolio of houses. Under this assumption, there is no need to correct for changes in the housing stock, and only information about the growth rates in prices and rents is necessary.

Hence, a time series of the rent-price ratio can be derived from forward and back projection as

$$\frac{RI_t}{HPI_t} = \left[\frac{(RI_t/RI_0)}{(HPI_t/HPI_0)}\right]\frac{RI_0}{HPI_0}. \tag{10}$$

In a second step, returns on housing can then be computed as:

$$R^{housing}_{t+1} = \frac{RI_{t+1}}{HPI_t} + \frac{HPI_{t+1} - HPI_t}{HPI_t}. \tag{11}$$

Our rent-price approach is sensitive to the choice of benchmark rent-price-ratios and cumulative errors from year-by-year extrapolation. We verify and adjust rent-price approach estimates using a range of alternative sources. The main source for comparison is the balance sheet approach to rental yields, which calculates the rent-price ratio using national accounts data on total rental income and housing wealth. The "balance sheet" rental yield RY^{BS}_t is calculated as the ratio of total net rental income to total housing wealth:

$$RY^{BS}_t = \text{Net rental income}_t/\text{Housing Wealth}_t, \tag{12}$$

This balance sheet rental yield estimate can then be added to the capital gains series in order to compute the total return on housing from the balance sheet perspective. We also collect additional point-in-time estimates of net rental yields from contemporary sources such as newspaper advertisements. These measures are less sensitive to the accumulated extrapolation errors in equation (10), but are themselves measured relatively imprecisely.[14] Wherever the rent-price approach estimates diverge from these historical sources, we make adjustments to benchmark the rent-price ratio estimates to these alternative historical measures of the rental yield. We also construct two additional housing return series—one benchmarked to all available alternative yield estimates, and another using primarily the balance sheet approach. The results of this exercise are discussed in Section III.C. Briefly, all the alternative estimates are close to one another, and the differences have little bearing on any of our results.

[14] We discuss the advantages and disadvantages of these different approaches in Section III.C. Broadly speaking, the balance sheet approach can be imprecise due to measurement error in total imputed rent and national housing wealth estimates. Newspaper advertisements are geographically biased and only cover gross rental yields, so that the net rental yields have to be estimated.

III. Rates of return: Aggregate trends

Our headline summary data appear in Table II and Figure II. The top panel of Table II shows the full sample (1870–2015) results whereas the bottom panel of the table shows results for the post-1950 sample. Note that here, and throughout the paper, rates of return are always annualized. Units are always expressed in percent per year, for raw data as well as for means and standard deviations. All means are arithmetic means, except when specifically referred to as geometric means.[15] Data are pooled and equally-weighted, i.e., they are raw rather than portfolio returns. We will always include wars so that results are not polluted by bias from omitted disasters. We do, however, exclude hyperinflation years (but only a few) in order to focus on the underlying trends in returns, and to avoid biases from serious measurement errors in hyperinflation years, arising from the impossible retrospective task of matching within-year timing of asset and CPI price level readings which can create a spurious, massive under- or over-statement of returns in these episodes.[16]

The first key finding is that residential real estate, not equity, has been the best long-run investment over the course of modern history. Although returns on housing and equities are similar, the volatility of housing returns is substantially lower, as Table II shows. Returns on the two asset classes are in the same ballpark—around 7%—but the standard deviation of housing returns is substantially smaller than that of equities (10% for housing versus 22% for equities). Predictably, with thinner tails, the compounded return (using the geometric average) is vastly better for housing than for equities—6.6% for housing versus 4.7% for equities. This finding appears to contradict one of the basic tenets of modern valuation models: higher risks should come with higher rewards.

Differences in asset returns are not driven by unusual events in the early pre-WW2 part of the sample. The bottom panel of Table II makes this point. Compared to the full sample results in the top panel, the same clear pattern emerges: stocks and real estate dominate in terms of returns. Moreover, average returns post–1950 are similar to those for the full sample even though the postwar subperiod excludes the devastating effects of the two world wars. Robustness checks are reported in Figures **??**, A.2, and A.3. Briefly, the observed patterns are not driven by the smaller European countries in our sample. Figure **??** shows average real returns weighted by country-level real GDP, both for the full sample and post–1950 period. Compared to the unweighted averages, equity performs slightly better, but the returns on equity and housing remain very similar, and the returns

[15]In what follows we focus on conventional average annual real returns. In addition, we often report period-average geometric mean returns corresponding to the annualized return that would be achieved through reinvestment or compounding. For any sample of years T, geometric mean returns are calculated as

$$\left(\prod_{t\in T}(1+r^j_{i,t})\right)^{\frac{1}{T}} - 1.$$

Note that the arithmetic period-average return is always larger than the geometric period-average return, with the difference increasing with the volatility of the sequence of returns.

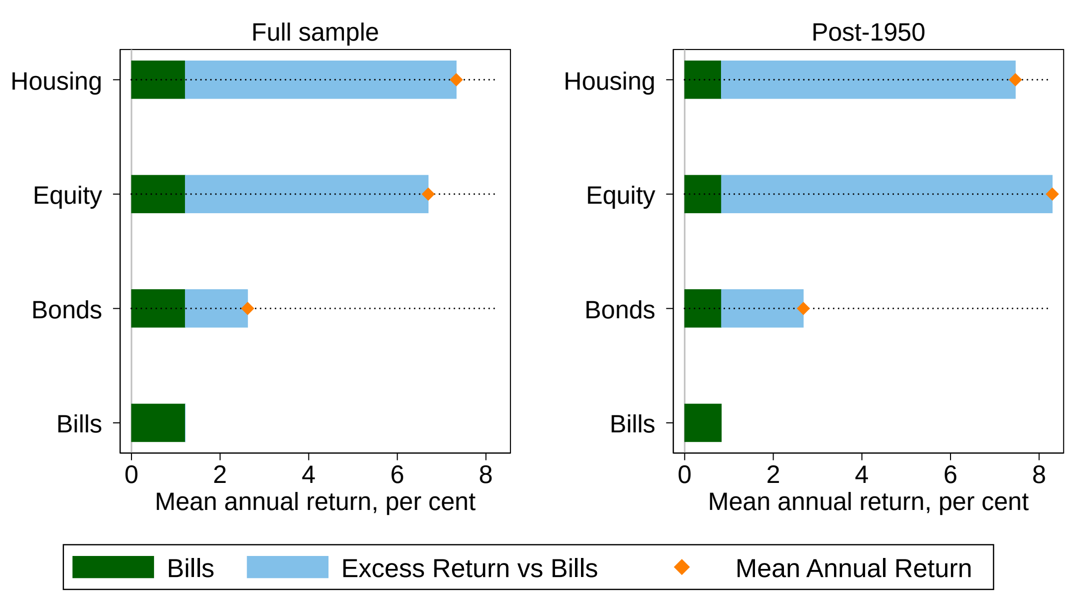
[16]Appendix G and Table A.12 do, however, provide some rough proxies for returns on different asset classes during hyperinflations.

Table II: *Global real returns*

	Real returns				Nominal Returns			
	Bills	Bonds	Equity	Housing	Bills	Bonds	Equity	Housing
Full sample:								
Mean return p.a.	1.03	2.53	6.88	7.06	4.58	6.06	10.65	11.00
Standard deviation	6.00	10.69	21.79	9.93	3.32	8.88	22.55	10.64
Geometric mean	0.83	1.97	4.66	6.62	4.53	5.71	8.49	10.53
Mean excess return p.a.	.	1.51	5.85	6.03				
Standard deviation	.	8.36	21.27	9.80				
Geometric mean	.	1.18	3.77	5.60				
Observations	1767	1767	1767	1767	1767	1767	1767	1767
Post-1950:								
Mean return p.a.	0.88	2.79	8.30	7.42	5.39	7.30	12.97	12.27
Standard deviation	3.42	9.94	24.21	8.87	4.03	9.81	25.03	10.14
Geometric mean	0.82	2.32	5.56	7.08	5.31	6.88	10.26	11.85
Mean excess return p.a.	.	1.91	7.42	6.54				
Standard deviation	.	9.21	23.78	9.17				
Geometric mean	.	1.51	4.79	6.18				
Observations	1022	1022	1022	1022	1022	1022	1022	1022

Note: Annual global returns in 16 countries, equally weighted. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for all four asset returns. Excess returns are computed relative to bills.

Figure II: *Global real rates of return*



Notes: Arithmetic average real returns p.a., unweighted, 16 countries. Consistent coverage within each country: each country-year observation used to compute the average has data for all four asset returns.

and riskiness of all four asset classes are very close to the unweighted series in Table II.

The results could be biased due to the country composition of the sample at different dates given data availability. Figure A.2 plots the average returns for sample-consistent country groups, starting at benchmark years—the later the benchmark year, the more countries we can include. Again, the broad patterns discussed above are largely unaffected.

We also investigate whether the results are biased due to the world wars. Figure A.3 plots the average returns in this case. The main result remains largely unchanged. Appendix Table A.3 also considers the risky returns during wartime in more detail, to assess the evidence for rare disasters in our sample. Returns during both wars were indeed low and often negative, although returns during WW2 in a number of countries were relatively robust.

Finally, our aggregate return data take the perspective of a domestic investor in a representative country. Appendix Table A.14 instead takes the perspective of a global USD-investor, and assesses the USD value of the corresponding returns. The magnitude and ranking of returns are similar to those reported in Table II, although the volatilities are substantially higher. This is to be expected given that the underlying asset volatility is compounded by the volatility in the exchange rate. We also find somewhat higher levels of USD returns, compared to those in local currency.

What comes next in our discussion of raw rates of return? We will look more deeply at risky rates of return, and delve into their time trends and the decomposition of housing and equity returns into the capital gain and yield components in greater detail in Section IV. We will do the same for safe returns in Section V. But first, to justify our estimates, since these are new data, we have to spend considerable time to explain our sources, methods, and calculations. We next compare our data to other literature in Section III.A. We subject the equity returns and risk premium calculation to a variety of accuracy checks in Section III.B. We also subject the housing returns and risk premium calculation to a variety of accuracy checks in Section III.C. Section III.D then discusses the comparability of the housing and equity return series. For the purposes of our paper, these very lengthy next four subsections undertake the necessary due diligence and discuss the various quality and consistency checks we undertook to make our data a reliable source for future analysis—and only after that is done do we proceed with analysis and interpretation based on our data.

However, we caution that all these checks may be as exhausting as they are exhaustive and a time-constrained reader eager to confront our main findings may jump to the end of this section and resume where the analytical core of the paper begins at the start of Section IV on page 33.

III.A. Comparison to existing literature

Earlier work on asset returns has mainly focused on equities and the corresponding risk premium over safe assets (bills or bonds), starting with Shiller's analysis of historical US data (Shiller, 1981), later extended to cover post-1920 Sweden and the UK (Campbell, 1999), and other advanced economies back to 1900 (Dimson, Marsh, and Staunton, 2009), or back to 1870 (Barro and Ursúa, 2008). The general consensus in this literature is that equities earn a large premium over safe assets.

The cross-country estimates of this premium vary between 7% in Barro and Ursúa (2008) and 6% in Dimson, Marsh, and Staunton (2009) using arithmetic means. Campbell (1999) documents a 4.7% geometric mean return premium instead.

We find a similarly high, though smaller, equity premium using our somewhat larger and more consistent historical dataset. Our estimate of the risk premium stands at 5.9% using arithmetic means, and 3.8% using geometric means (see Table II). This is lower than the estimates by Campbell (1999) and Barro and Ursúa (2008). The average risk premium is similar to that found by Dimson, Marsh, and Staunton (2009), but our returns tend to be slightly lower for the overlapping time period.[17] Details aside, our data do confirm the central finding of the literature on equity market returns: stocks earn a large premium over safe assets.

Studies on historical housing returns, starting with the seminal work of Robert Shiller (see Shiller, 2000, for a summary), have largely focused on capital gains. The rental yield component has received relatively little attention, and in many cases is missing entirely. Most of the literature pre-dating our work has therefore lacked the necessary data to calculate, infer, or discuss the total rates of return on housing over the long run. The few studies that take rents into account generally focus on the post-1970s US sample, and often on commercial real estate. Most existing evidence either places the real estate risk premium between equities and bonds, or finds that it is similar to that for equities (see Favilukis, Ludvigson, and Van Nieuwerburgh, 2017; Francis and Ibbotson, 2009; Ilmanen, 2011; Ruff, 2007). Some studies have even found that over the recent period, real estate seems to outperform equities in risk-adjusted terms (Cheng, Lin, and Liu, 2008; Shilling, 2003).

The stylized fact from the studies on long-run housing capital appreciation is that over long horizons, house prices only grow a little faster than the consumer price index. But again, note that this is *only* the capital gain component in (1). Low levels of real capital gains to housing was shown by Shiller (2000) for the US, and is also true, albeit to a lesser extent, in other countries, as documented in Knoll, Schularick, and Steger (2017). Our long-run average capital appreciation data for the US largely come from Shiller (2000), with two exceptions. For the 1930s, we use the more representative index of Fishback and Kollmann (2015) that documents a larger fall in prices during the Great Depression. From 1975 onwards, we use a Federal Housing Finance Agency index, which has a slightly broader coverage. Appendix M compares our series with Shiller's data and finds that switching to Shiller's index has no effect on our results for the US. See also the Online Appendix of Knoll et al. (2017) for further discussion.

However, our paper turns this notion of low housing returns on its head—because we show that including the yield component in (1) in the housing return calculation generates a housing risk premium roughly as large as the equity risk premium. Prior to our work on historical rental yields this finding could not be known. Coincidentally, in our long-run data we find that most of the real

[17]Our returns are substantially lower for France and Portugal (see Appendix Table A.18). These slightly lower returns are largely a result of more extensive consistency and accuracy checks that eliminate a number of upward biases in the series, and better coverage of economic disasters. We discuss these data quality issues further in Section III.B. Appendix L compares our equity return estimates with the existing literature on a country basis.

equity return also comes from the dividend yield rather than from real equity capital gains which are low, especially before the 1980s. Thus the post-1980 observation of large capital gain components in both equity and housing total returns is completely unrepresentative of the normal long-run patterns in the data, another fact underappreciated before now.

Data on historical returns for all major asset classes allow us to compute the return on aggregate wealth (see equation 7). In turn, this return can be decomposed into various components by asset class, and into capital gains and yields, to better understand the drivers of aggregate wealth fluctuations. This connects our study to the literature on capital income, and the stock of capital (or wealth) from a national accounts perspective. Even though national accounts and national balance sheet estimates have existed for some time (see Goldsmith, 1985b; Kuznets, 1941), it is only recently that scholars have systematized and compared these data to calculate a series of returns on national wealth.[18]

Piketty, Saez, and Zucman (2018) compute balance sheet returns on aggregate wealth and for individual asset classes using post-1913 US data. Balance sheet return data outside the US are sparse, although Piketty and Zucman (2014) provide historical estimates at benchmark years for three more countries, and, after 1970, continuous data for an additional five countries. Appendix R compares our market-based return estimates for the US with those of Piketty et al. (2018). Housing returns are very similar. However, equity returns are several percentage points above our estimates, and those in the market-based returns literature more generally. Part of this difference reflects the fact that balance sheet returns are computed to measure income before corporate taxes, whereas our returns take the household perspective and are therefore net of corporate tax. Another explanation for the difference is likely to come from some measurement error in the national accounts data.[19] When it comes to housing, our rental yield estimates are broadly comparable and similar to those derived using the balance sheet approach, for a broad selection of countries and historical time spans.[20]

Our dataset complements the market-based return literature by increasing the coverage in terms of assets, return components, countries, and years; improving data consistency and documentation; and making the dataset freely available for future research. This comprehensive coverage can also help connect the market-based return estimates to those centered around national accounts concepts. We hope that eventually, this can improve the consistency and quality of both market-based returns and national accounts data.

[18]The return on an asset from a national accounts perspective, or the "balance sheet approach" to returns, r_t^{BS} is the sum of the yield, which is capital income (such as rents or profits) in relation to wealth, and capital gain, which is the change in wealth not attributable to investment. See Appendix R and equation (13) for further details.

[19]See Appendix R for more detail. In brief, the main conceptual difference between the two sets of estimates, once our returns are grossed up for corporate tax, is the inclusion of returns on unlisted equities in the national accounts data. But existing evidence suggests that these return differentials are not large (Moskowitz and Vissing-Jørgensen, 2002), and the size of the unlisted sector not sufficiently large to place a large weight of this explanation, which leads us to conjecture that there is some measurement error in the national income and wealth estimates that is driving the remaining difference.

[20]See Section III.C and Appendix U for more detail.

III.B. Accuracy of equity returns

The literature on equity returns has highlighted two main sources of bias in the data: weighting and sample selection. Weighting biases arise when the stock portfolio weights for the index do not correspond with those of a representative investor, or a representative agent in the economy. Selection biases arise when the selection of stocks does not correspond to the portfolio of the representative investor or agent. This second category also includes issues of survivorship bias and missing data bias arising from stock exchange closures and restrictions.

We consider how each of these biases affect our equity return estimates in this section. An accompanying Appendix Table A.29 summarizes the construction of the equity index for each country and time period, with further details provided in Appendix X.

Weighting bias The best practice when weighting equity indices is to use market capitalization of individual stocks. This approach most closely mirrors the composition of a hypothetical representative investor's portfolio. Equally-weighted indices are likely to overweight smaller firms, which tend to carry higher returns and higher volatility.

The existing evidence from historical returns on the Brussels and Paris stock exchanges suggests that using equally-weighted indices biases returns up by around 0.5 percentage points, and their standard deviation up by 2–3 percentage points (Annaert, Buelens, Cuyvers, De Ceuster, Deloof, and De Schepper, 2011; Le Bris and Hautcoeur, 2010). The size of the bias, however, is likely to vary across across markets and time periods. For example, Grossman (2017) shows that the market-weighted portfolio of UK stocks outperformed its equally-weighted counterpart over the period 1869–1929.

To minimize this bias, we use market-capitalization-weighted indices for the vast majority of our sample (see Appendix Table A.29 and Appendix X). Where market-capitalization weighting was not available, we have generally used alternative weights such as book capital or transaction volumes, rather than equally-weighted averages. For the few equally-weighted indices that remain in our sample, the overall impact on aggregate return estimates ought to be negligible.

Selection and survivorship bias Relying on an index whose selection does not mirror the representative investor's portfolio carries two main dangers. First, a small sample may be unrepresentative of overall stock market returns. And second, a sample that is selected ad-hoc, and especially ex-post, is likely to focus on surviving firms, or successful firms, thus overstating investment returns. This second bias extends not only to stock prices but also to dividend payments, as some historical studies only consider dividend-paying firms.[21] The magnitude of survivorship bias has generally been found to be around 0.5 to 1 percentage points (Annaert, Buelens, and De Ceuster,

[21] As highlighted by Brailsford, Handley, and Maheswaran (2012), this was the case with early Australian data, and the index we use scales down the series for dividend-paying firms to proxy the dividends paid by all firms, as suggested by these authors.

2012; Nielsen and Risager, 2001), but in some time periods and markets it could be larger (see Le Bris and Hautcoeur, 2010, for France).

As a first best, we always strive to use all-share indices that avoid survivor and selection biases. For some countries and time periods where no such indices were previously available, we have constructed new weighted all-share indices from original historical sources (e.g., early historical data for Norway and Spain). Where an all-share index was not available or newly constructed, we have generally relied on "blue-chip" stock market indices. These are based on an ex-ante value-weighted sample of the largest firms on the market. It is updated each year and tends to capture the lion's share of total market capitalization. Because the sample is selected ex-ante, it avoids ex-post selection and survivorship biases. And because historical equity markets have tended to be quite concentrated, "blue-chip" indices have been shown to be a good proxy for all-share returns (see Annaert, Buelens, Cuyvers, De Ceuster, Deloof, and De Schepper, 2011). Finally, we include non-dividend-paying firms in the dividend yield calculation.

Stock market closures and trading restrictions A more subtle form of selection bias arises when the stock market is closed and no market price data are available. One way of dealing with closures is to simply exclude them from the baseline return comparisons. But this implicitly assumes that the data are "missing at random"—i.e., that stock market closures are unrelated to underlying equity returns. Existing research on rare disasters and equity premiums shows that this is unlikely to be true (Nakamura, Steinsson, Barro, and Ursúa, 2013). Stock markets tend to be closed precisely at times when we would expect returns to be low, such as periods of war and civil unrest. Return estimates that exclude such rare disasters from the data will thus overstate stock returns.

To guard against this bias, we include return estimates for the periods of stock market closure in our sample. Where possible, we rely on alternative data sources to fill the gap, such as listings of other exchanges and over-the-counter transactions—for example, in the case of WW1 Germany we use the over-the-counter index from Ronge (2002) and for WW2 France we use the newspaper index from Le Bris and Hautcoeur (2010). In cases where alternative data are not available, we interpolate the prices of securities listed both before and after the exchange was closed to estimate the return (if no dividend data are available, we also assume no dividends were paid).[22]

Even though this approach only gives us a rough proxy of returns, it is certainly better than excluding these periods, which effectively assumes that the return during stock market closures is the same as that when the stock markets are open. In the end, we only have one instance of stock market closure for which we are unable to estimate returns—that of the Tokyo stock exchange in 1946–1947. Appendix H further assesses the impact of return interpolation on the key moments of our data and finds that, over the full sample, it is negligible.

[22]For example, the Swiss stock exchange was closed between July 1914 and July 1916. Our data for 1914 capture the December 1913–July 1914 return, for 1915 the July 1914–July 1916 return, and for 1916 the July 1916–December 1916 return. For the Spanish Civil war, we take the prices of securities in end-1936 and end-1940, and apportion the price change in-between equally to years 1937–1939.

Table III: *Geometric annual average and cumulative total equity returns in periods of stock market closure*

Episode	Real returns		Nominal returns		Real capitalization	
	Geometric average	Cumulative	Geometric average	Cumulative	Geometric average	Cumulative
Spanish Civil War, 1936–40	-4.01	-15.09	9.03	41.32	-10.22	-35.04
Portuguese Revolution, 1974–77	-54.98	-90.88	-44.23	-82.65	-75.29	-98.49
Germany WW1, 1914–18	-21.67	-62.35	3.49	14.72		
Switzerland WW1, 1914–16	-7.53	-14.50	-0.84	-1.67	-8.54	-16.34
Netherlands WW2, 1944–46	-12.77	-20.39	-5.09	-8.36		

Note: Cumulative and geometric average returns during periods of stock market closure. Estimated by interpolating returns of shares listed both before an after the exchange was closed. The change in market capitalization compares the capitalization of all firms before the market was closed, and once it was opened, and thus includes the effect of any new listings, delistings and bankruptcies that occured during the closure.

Table III shows the estimated stock returns during the periods of stock exchange closure in our sample. The first two columns show average and cumulative real returns, and the third and fourth columns show the nominal returns. Aside from the case of WW1 Germany, returns are calculated by comparing the prices of shares listed both before and after the market closure. Such a calculation may, however, overstate returns because it selects only those companies that "survived" the closure. As an additional check, the last two columns of Table III show the inflation-adjusted change in market capitalization of stocks before and after the exchange was closed. This serves as a lower bound for investor returns because it would be as if we assumed that all delisted stocks went bankrupt (i.e., to a zero price) during the market closure.

Indeed, the hypothetical investor returns during the periods of market closure are substantially below market averages. In line with Nakamura, Steinsson, Barro, and Ursúa (2013), we label these periods as "rare disasters." The average per-year geometric mean return ranges from a modestly negative –4% p.a. during the Spanish Civil War, to losses of roughly 55% p.a. during the three years after the Portuguese Carnation Revolution. Accounting for returns of delisted firms is likely to bring these estimates down even further, as evinced by the virtual disappearance of the Portuguese stock market in the aftermath of the revolution.

Having said this, the impact of these rare events on the average cross-country returns (shown in Table II) is small, around –0.1 percentage points, precisely because protracted stock market closures are very infrequent. The impact on country-level average returns is sizeable for Portugal and Germany (around –1 percentage point), but small for the other countries (–0.1 to –0.4 percentage points). Appendix G provides a more detailed analysis of returns during consumption disasters. On average, equity returns during these times are low, with an average cumulative real equity return drop of 6.7% during the disaster years.

Lastly, Nakamura, Steinsson, Barro, and Ursúa (2013) also highlight a more subtle bias arising from asset price controls. This generally involves measures by the government to directly control transaction prices, as in Germany during 1943–47, or to influence the funds invested in the domestic stock market (and hence the prices) via controls on spending and investment, as in France during WW2 (Le Bris, 2012). These measures are more likely to affect the timing of returns rather than their long-run average level, and should thus have little impact on our headline estimates. For example, Germany experienced negative nominal and real returns despite the WW2 stock price controls; and even though the policies it enacted in occupied France succeeded in generating high nominal stock returns, the real return on French stocks during 1940–44 was close to zero. Both of these instances were also followed by sharp drops in stock prices when the controls were lifted.[23]

III.C. Accuracy of housing returns

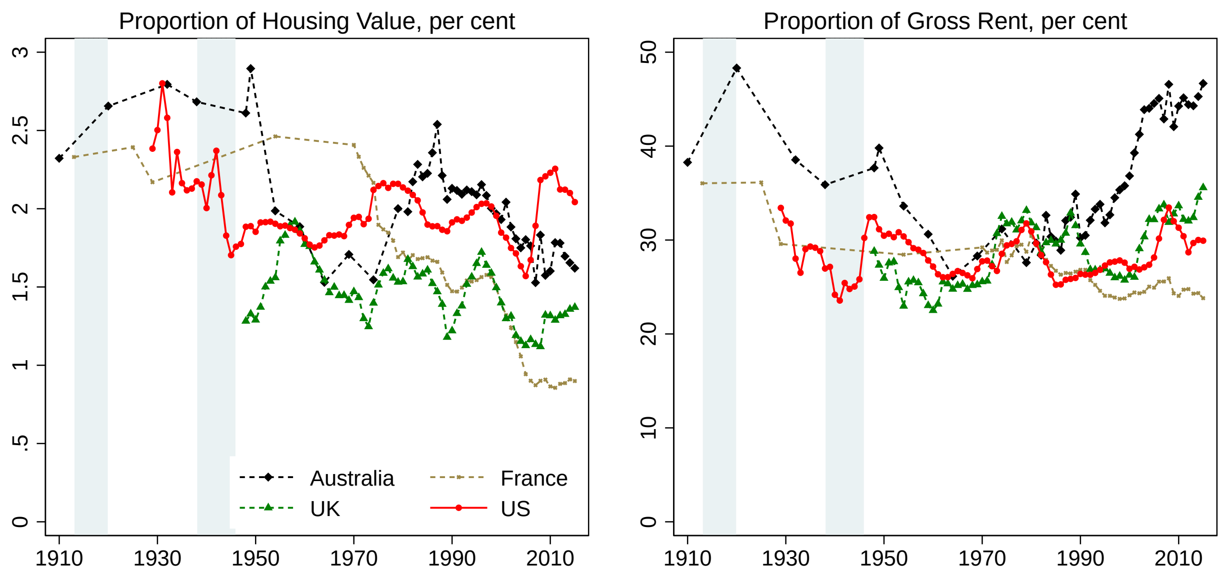
The biases that affect equity returns—weighting and selection—can also apply to returns on housing. There are also other biases that are specific to housing return estimates. These include costs of running a housing investment, and the benchmarking of rent-price ratios to construct the historical rental yield series. We discuss each of these problematic issues in turn in this section. Our focus throughout is mainly on rental yield data, as the accuracy and robustness of the house price series has been extensively discussed in Knoll, Schularick, and Steger (2017) in their online appendix.

Maintenance costs Any homeowner incurs costs for maintenance and repairs which lower the rental yield and thus the effective return on housing. We deal with this issue by the choice of the benchmark rent-price ratios. Specifically, we anchor to the Investment Property Database (IPD) whose rental yields reflect net income—net of property management costs, ground rent, and other irrecoverable expenditure—as a percentage of the capital employed. The rental yields calculated using the rent-price approach detailed in Section II.D are therefore net yields. To enable a like-for-like comparison, our historical benchmark yields are calculated net of estimated running costs and depreciation. Running costs are broadly defined as housing-related expenses excluding interest, taxes, and utilities—i.e., maintenance costs, management, and insurance fees.

Applying the rent-price approach to net yield benchmarks assumes that running costs remain stable relative to gross rental income over time within each country. To check this, Figure III presents historical estimates of running costs and depreciation for Australia, France, UK, and US, calculated as the sum of the corresponding housing expenditures and fixed capital consumption items in the national accounts. The left-hand panel presents these as a proportion of total housing value, and the right-hand panel as a proportion of gross rent. Relative to housing value, costs have been stable over the last 40 years, but were somewhat higher in the early-to-mid 20th century. This is to be expected since these costs are largely related to structures, not land, and structures constituted a greater share of housing value in the early 20th century (Knoll, Schularick, and Steger, 2017). Additionally, structures themselves may have been of poorer quality in past times. When taken as a proportion of gross rent, however, as shown in the right-hand panel of Figure III, housing costs have been

[23]The losses in the German case are difficult to ascertain precisely because the lifting of controls was followed by a re-denomination that imposed a 90% haircut on all shares.

Figure III: *Costs of running a housing investment*



Note: Total costs include depreciation and all other housing-related expenses excluding interest, taxes and utilities (mainly maintenance and insurance payments). Costs are estimated as the household consumption of the relevant intermediate housing input, or fixed housing capital, in proportion to total housing wealth (left panel), or total gross rent (right panel).

relatively stable, or at least not higher historically than they are today. This is likely because both gross yields and costs are low today, whereas historically both yields and costs were higher, with the two effects more or less cancelling out. This suggests that the historical rental yields that we have calculated using the rent-price approach are a good proxy for net yields.

Rental yield benchmarking To construct historical rental yield series using the rent-price approach, we start with a benchmark rent-price ratio from the Investment Property Database (IPD), and extend the series back using the historical rent and house price indices (see Section II.D).[24] This naturally implies that the level of returns is sensitive to the choice of the benchmark ratio. Moreover, past errors in rent and house price indices can potentially accumulate over time and may cause one to substantially over- or understate historical rental yields and housing returns. If the historical capital gains are overstated, the historical rental yields will be overstated too.

To try to avert such problems, we corroborate our rental yield estimates using a wide range of alternative historical and current-day sources. The main source of these independent comparisons comes from estimates using the balance sheet approach and national accounts data. As shown in equation 12, the "balance sheet" rental yield is the ratio of nationwide net rental income to total housing wealth. Net rental income is computed as gross rents paid less depreciation, maintenance

[24]For Australia and Belgium, we instead rely on yield estimates from transaction-level data (Fox and Tulip (2014) and `Numbeo.com`, which are more in line with current-day and alternative historical estimates than IPD.

and other housing-related expenses (excluding taxes and interest), with all data taken from the national accounts. The balance sheet approach gives us a rich set of alternative rental yield estimates both for the present day and even going back in time to the beginning of our sample in a number of countries. The second source for historical comparisons comes from advertisements in contemporary newspapers and various other contemporary publications. Third, we also make use of alternative current-day benchmarks based on transaction-level market rent data, and the rental expenditure and house price data from numbeo.com.[25] For all these measures, we adjust gross yields down to obtain a proxy for net rental yields.

Historical sources offer point-in-time estimates which avoid the cumulation of errors, but can nevertheless be imprecise. The balance sheet approach relies on housing wealth and rental income data, both of which are subject to potential measurement error. For housing wealth, it is inherently difficult to measure the precise value of all dwellings in the economy. Rental income is largely driven by the imputed rents of homeowners, which have to be estimated from market rents by matching the market rent to owner-occupied properties based on various property characteristics. This procedure can suffer from errors both in the survey data on property characteristics and market rents, and the matching algorithm.[26] Newspaper advertisements are tied to a specific location, and often biased towards cities. And transaction-level or survey data sometimes only cover the rental sector, rather than both renters and homeowners.

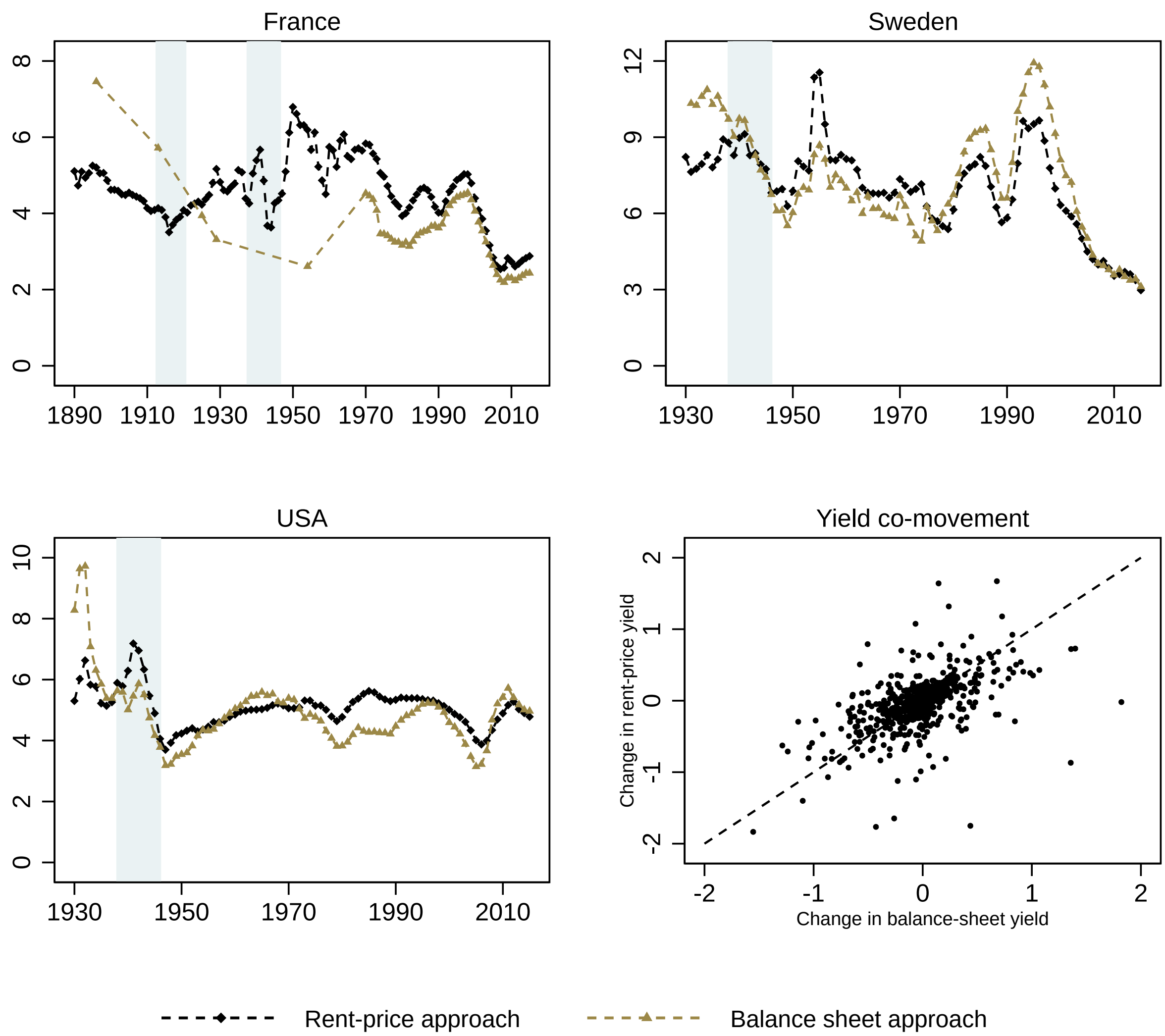
Given the potential measurement error in all the series, our final rental yield series uses data from both the rent-price approach and the alternative benchmarks listed above. More precisely, we use the following method to construct our final "best-practice" rental yield series. If the rent-price approach estimates are close to alternative measures, we keep the rent-price approach data. This is the case for most historical periods in our sample. If there is a persistent level difference between the rent-price approach and alternative estimates, we adjust the benchmark yield to better match the historical and current data across the range of sources. This is the case for Australia and Belgium. If the levels are close for recent data but diverge historically, we adjust the historical estimates to match the alternative benchmarks. For most countries such adjustments are small or only apply to a short time span, but for Finland and Spain they are more substantial. Appendix U details the alternative sources and rental yield construction, including any such adjustments, for each country.

How large is the room for error in our final housing return series? To get a sense of the differences, Figure IV compares the rent-price approach of net rental yield estimates (black diamonds) with those using the balance sheet approach (brown triangles). The first three panels show the time series of the two measures for France, Sweden, and US, and the bottom-right panel shows the correlation

[25]The high-quality transaction level data are available for Australia and the US, from Fox and Tulip (2014) (sourced from RP Data) and Giglio, Maggiori, and Stroebel (2015) (sourced from Trulia) respectively. We use the Fox and Tulip (2014) yield as benchmark for Australia. For the US, we use IPD because it is in line with several alternative estimates, unlike Trulia data which are much higher. See Appendix U for further details.

[26]For example, in the UK a change to imputation procedures in 2016 and the use of new survey data resulted in historical revisions which almost tripled imputed rents (see Office for National Statistics, 2016). We use a mixture of the old and new/revised data for our historical estimates.

Figure IV: *Comparison of the rent-price and balance-sheet approaches for historical rental yields*



Note: The rent-price approach uses the baseline estimates in this paper. The balance sheet approach estimates the net yield in each year as total rental expenditure less housing running costs and depreciation, in proportion to total housing wealth.

Table IV: *Impact of using different rental yield benchmarks*

	Equity	Housing				
		Baseline	Low initial benchmark	High intial benchmark	Historical bench-marks	Balance sheet approach
Mean return p.a.	6.88	7.06	6.29	7.89	6.83	6.30
Standard deviation	21.79	9.93	9.89	10.03	9.93	9.95
Geometric mean	4.66	6.62	5.85	7.45	6.39	5.86
Observations	1767	1767	1767	1767	1767	1767

Note: Average total real returns across 16 countries, equally weighted.

between changes in rent-price and balance sheet yields in nine countries (Australia, Denmark, France, Germany, Italy, Japan, Sweden, UK, and US).[27] The level of the rent-price ratio using the two approaches is similar, both in the modern day and historically.[28] The two yield measures also follow a very similar time series pattern, both in the three countries depicted in panels 1–3, and the broader sample of countries summarized in the bottom-right panel.

Table IV provides a more comprehensive comparison. Columns 1 and 2 present the arithmetic and geometric mean, and the standard deviation, for the baseline measures of equity and housing annual real total returns in our sample (also shown in Table II). Column 3 instead uses the lowest possible initial benchmark for the housing series.[29] The resulting returns are around 0.8 percentage points (henceforth, pps) lower, in both arithmetic and geometric mean terms. Column 4 instead uses the highest available benchmark, thus raising housing returns by 0.8 pps. Column 5 uses historical benchmarks for all rental yield series before 1980, i.e., we use these benchmarks as the main source for the yields, and only use the rent-price approach for interpolation.[30] This makes very little difference to the returns, lowering them by around 0.2 pps. The last column 6 instead uses the balance sheet approach as the baseline estimate, both for the current and historical period. It then uses the rent-price approach to fill the gaps and interpolate between the balance sheet estimates. [31] Finally, we compute the total balance sheet return on housing as the sum of capital gains and the

[27]We limit our analysis to countries where the balance sheet approach data goes back at least several decades.

[28]For France, the historical data disagree somewhat, with balance sheet approach estimates both above and below the rent-price approach for some years. We further confirm the housing return series for France using returns on housing investment trusts, documented in the subsequent sections.

[29]For example, the balance sheet approach yield in 2013 Danish data is lower than the IPD yield; hence column 3 uses the 2013 balance sheet yield as the initial benchmark. For countries where we benchmark to historical rental yields, we use the same historical benchmark for all three series. For example, for Australia, we use a historical benchmark yield in 1949. So the "high" housing return series uses the high rental yield benchmark for 1950–2015, and the historical benchmark for 1900–1949.

[30]For example, the series for Denmark is benchmarked to the lower balance sheet approach yield estimates for 1890–1910 and 1950–1970, and newspaper estimates for 1920–1940 (also see Appendix Figure A.14).

[31]Newspaper yield estimates are used as additional benchmarks for interpolation

balance sheet yield.[32] The resulting return is 0.8 pps lower than our baseline estimates.

Taken together, this analysis suggests that the potential margins for error are small. Even under the more stringent checks, housing returns remain within a percentage point of our baseline estimates. The average return is always similar to equities in arithmetic mean terms, and always above equities when using the geometric mean.

Geographic coverage and selection biases Our data aim to approximate the return on a representative agent's housing portfolio. Selection bias means that the selection of properties in our dataset does not mirror the balance sheet of the representative agent. The main reason for this bias is selective geographical coverage. Housing returns can vary a lot by location, and our data are based on a sample of housing transactions.

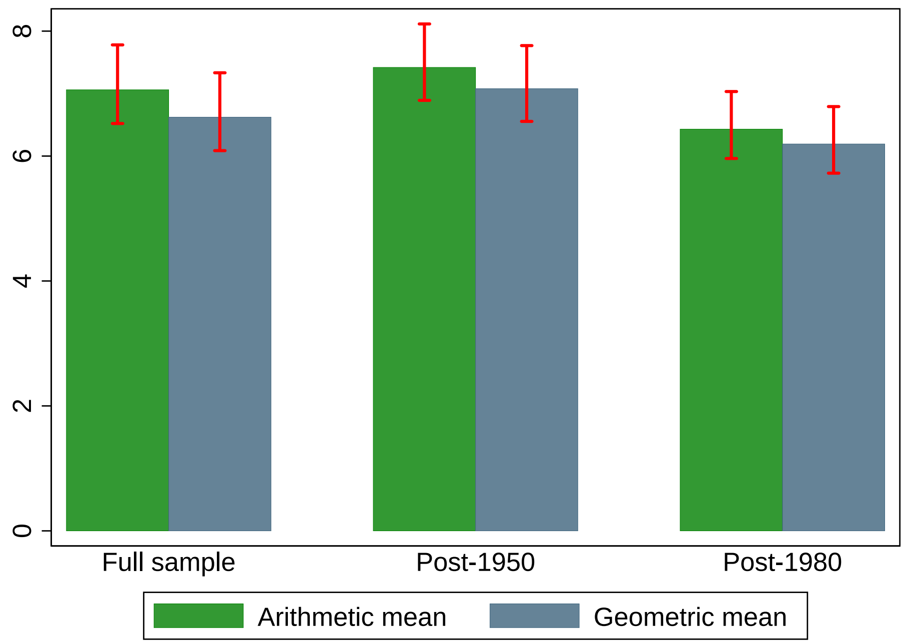
To make our samples as representative as possible, we strive to attain a broad geographic coverage for both house price and rental data. Knoll, Schularick, and Steger (2017) discuss the potential location biases in house price data, but find that the house price trends in their, and hence our, dataset should be representative of country-level trends. When it comes to rents, the benchmark IPD yields are based on portfolios of institutional investors, which are slightly biased towards cities. This would lead to lower yields than the national average. On the other hand, investors may select higher-yielding properties within any given city. Comparisons with aggregate balance sheet approach data and alternative estimates indicate that, on average, IPD yields tend to be representative at country level. Further, IPD yields are capitalization weighted, which again better captures the yield on a representative portfolio. Finally, we aim for national coverage with the historical rental indices used for extrapolation, and historical balance sheet benchmarks.

Despite this, it is likely that both our house price and rental data are somewhat biased towards cities and urban areas, especially for historical periods—simply because urban housing data are more widely available and researched. Even though this would affect the level of capital gain and yield, it should have little influence on total returns, since cities tend to have higher capital gains, but lower rental yields.[33] Additionally, Knoll, Schularick, and Steger (2017) show that the rural-urban divide has a relatively small impact on capital gains. Relatedly, we can establish some bounds on how much our rental yields can vary with the choice of location. In 2013, `Numbeo.com` data suggest that price-rent ratios in and out of city centres differ by less than 3 times annual rent. The rental yield is the inverse of these price-rent ratios. This motivates us to construct a lower bound rent-price ratio as $RP_{low} = 1/(1/RP_{actual} + 3)$ and an upper bound rent-price ratio as $RP_{high} = 1/(1/RP_{actual} - 3)$ for each country in 2013 to estimate upper and lower bounds of our housing returns depending on

[32] This means that we use market-based house price data for capital gains, which is also common practice in the balance sheet approach computation, due to the large potential for error when estimating housing capital gains as a residual between wealth changes and investment. Piketty et al. (2018) use Shiller (2000) house price data for the balance sheet return computation.

[33] Eisfeldt and Demers (2015) study the geographical distribution of returns on single family rentals in the US from 1970s to today and find that lower capital gain areas tend to have much higher rental yields, and there is very little geographic variation in total returns.

Figure V: *Sensitivity of housing returns to a rent-price location correction*



Note: Bars show the arithmetic- and geometric- average housing returns for selected sub-periods. Error bars show the impact on historical returns of increasing or reducing the benchmark price/rent ratio by ± 3, which broadly captures the difference between in- and out-of-city-center locations.

the choice of location. Given the currently high price-rent ratios, these adjustments have a relatively small impact on our data. Figure V shows that increasing or reducing the price-rent ratio by 3 changes annual return estimates by about ±1 pps per year relative to our preferred baseline.

This suggests that the level of housing returns in our dataset should be representative of a country-wide portfolio. Still, it could be that returns on locations not included in our sample display higher volatility. For example, the post-1975 US indices are based on conforming mortgages and may exclude the more volatile segments of the market. To assess the likely magnitude of this bias, Table V compares the recent level and volatility of the US conforming mortgage based OFHEO house price indices with those that cover other segments of the market as well, which are sourced from Zillow.[34] Comparing columns 2 and 3 of Table V, the nationwide moments of the data are similar across the two measures—but, as expected, the OFHEO data display slightly higher real capital gains and slightly lower volatility, because they have a less comprehensive coverage of the areas that were hit hardest by the subprime crisis, which receives a relatively high weight in the 1995–2015 US sample used here.

Columns 3–5 of Table V also show that the volatility of the housing series increases as we move from the aggregate portfolio (column 2) to the subnational and local level. The standard deviation of Zipcode-level housing returns is roughly one-third higher than that in the national data. If investors

[34]As we show later in Section IV.C, almost all the volatility in housing returns comes about from house prices. Therefore for the analysis of volatility, we focus on house prices rather than rental yields.

Table V: *Level and volatility of real housing capital gains at different levels of coverage and aggregation*

	Baseline	Zillow			
	National	National	State	County	Zipcode
Mean real capital gain p.a.	1.42	0.79	1.07	0.53	0.92
Standard deviation	4.67	5.67	6.05	6.28	7.46

Note: US data, 1995–2015. Average annual real capital gain and standard deviation of house prices. Baseline data are sourced from the OFHEO index. Zillow data are sourced from the Zillow Home Value Index which covers around 95% of the US housing stock, and are averages of monthly values. National data are the returns and volatility of prices for a nationwide housing, and the other figures cover a representative state, county or zipcode level porftolio respectively.

owned one undiversified house whose price tracks the neighborhood index, the risk and return characteristics of this portfolio would be somewhat closer to those of the aggregate equity index, although the gap would still be large.

Of course, it is much more difficult to invest in a diversified housing portfolio than a well-diversified equity portfolio. That being said, Benhabib and Bisin (2016) show that most equity is also held in an undiversified manner. The data regarding returns on individual housing and private equity returns are, however, at this point in time, very sparse. To understand exactly how these risk-return characteristics play out at a disaggregated level, a more detailed study of individual portfolios and returns is necessary. This would be a worthy goal of future research.

Another selection bias comes about from the fact that rent data largely come from the rental market, whereas the majority of housing stock is held by owner-occupiers. To guard against this, we rely on rental indices that, whenever possible, account for the growth of imputed rents. Additionally, we benchmark our series to the balance sheet yield data that are constructed to cover the total housing stock. Still, imputed rents are measured with error, and may not reflect the cost that the homeowner would pay on the rental market. If owning is relatively cheaper than renting—for example, due to tax exemptions or long-run house price appreciation—homeowners would purchase larger or better houses than they would rent, and imputed rents would overstate the value of housing services accruing to homeowners. On the other hand, buying a house is subject to credit constraints, which means that renters can afford better houses than homeowners all else equal. In this case, imputed rents would understate the flow value of housing services. Overall, the direction of any potential bias is unclear and leaves much scope for future work.

Finally, the portfolio selection in the price and rent series is subject to survivorship bias. In general, our price and rental yield estimates aim to capture transaction or appraisal values, and rental costs on a broad and impartially selected portfolio of properties. Some survivorship bias may, however, enter the series for the following reasons. First, indices that rely on an ex-post selection of cities may inadvertently choose the more "successful" cities over the less successful ones. Second, houses that decline in value are likely to lose liquidity and be sold less frequently, hence carrying a lower weight in the index. And third, chain-linking historical house price and rent indices to compute annual returns will generally ignore the impact of large destructions of the housing stock, in particular those occurring during wartime.

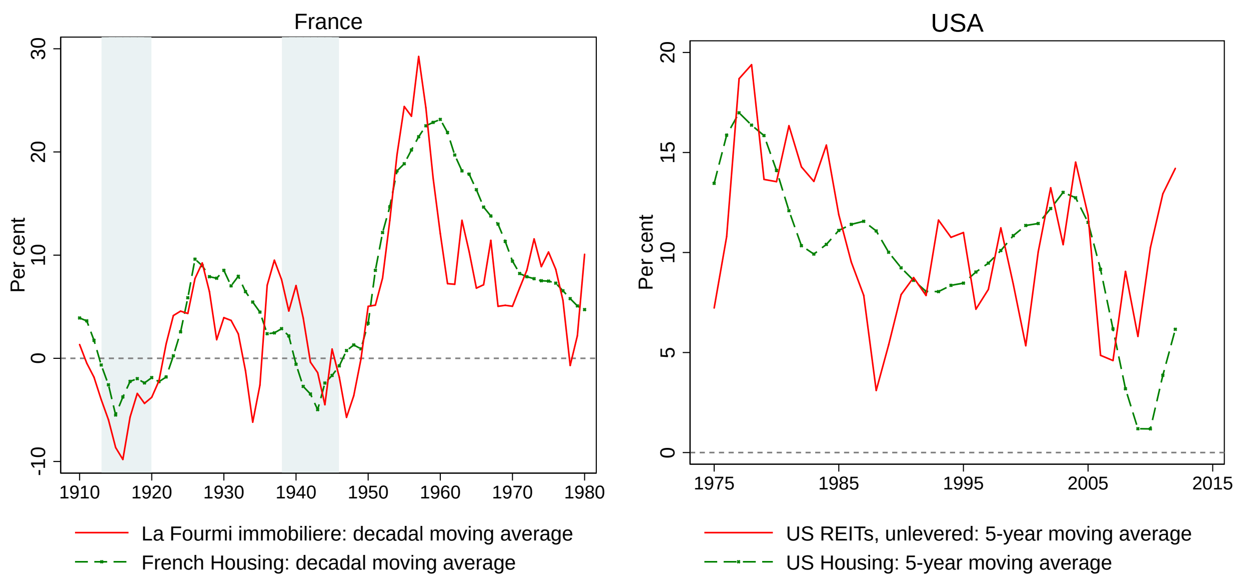
Several factors suggest that the impact of survivorship bias on housing returns should be limited. First, Figure V and Knoll, Schularick, and Steger (2017) show that any location-specific bias in our estimates is likely to be small. Second, if the magnitude of survivorship bias is similar to that in equity markets (Section III.B), then the bias is also unlikely to be large. Third, the low liquidity and weight of houses with declining prices is in some ways similar to the documented negative returns on delisted equities (Shumway, 1997; Shumway and Warther, 1999), which in general cannot be incorporated into the stock return series due to the lack of data. Therefore this bias should be less of a concern when comparing housing and equity returns. Finally, similarly to the stock market closures discussed in Section III.B, even though capital stock destruction during wars can have a substantial impact on returns in specific years, it is unlikely to profoundly affect cross-country long-run returns due to the rarity of such events.[35] And as Figure IX later shows, the main facts in the data are similar for countries that experienced major war destruction on their own territory versus countries that did not (e.g., Australia, Canada, Sweden, Switzerland, and US). Further, Appendix Table A.5 shows that housing offers a similar return relative to equity on average even after wars are excluded.

Returns on real estate investment trusts Another way to check our housing returns is to compare them to the historical returns on housing investment trusts. These trusts offer independent estimates of returns. Real estate investment trusts, or REITs, are investment funds that specialize in the purchase and management of residential and commercial real estate. Many of these funds list their shares on the local stock exchange. The return on these shares should closely track total real estate returns. Differences will arise because the REIT portfolio is more geographically concentrated, its assets often contain non-residential property, and share price fluctuations may reflect expectations of future earnings and sentiment, as well as underlying portfolio returns. Further, the REIT portfolio returns should be net of taxes and transaction costs as well as housing running costs, and may therefore be somewhat lower than our housing series. Still, returns on the REIT portfolio should be comparable to housing and can be used to check the general plausibility of our return series.

Figure VI compares our historical housing returns (dashed line) with those on investments in REITs (solid line) in France and US, two countries for which longer-run REIT return data are available. The REIT returns series for France refers to shares of the fund "La Fourmi Immobiliere" (see Simonnet, Gallais-Hamonno, and Arbulu, 1998). The fund acquired a portfolio of 15 properties in Paris between 1900 and 1913, worth around 36 million euros at 2015 prices, and its shares were listed on the Paris stock exchange between 1904 and 1997. We exclude the period after 1985, when

[35] As a reasonable upper bound, existing estimates suggest that around 33%–40% of the German housing stock was destroyed by Allied bombing during WW2 (Akbulut-Yuksel, 2014; Diefendorf, 1993), but this would lower the full-sample country-specific average annual real total return by only about 0.30 pps per year.

Figure VI: *Returns on housing compared to real estate investment funds*



Note: Total real return on housing, and shares of housing investment firms in France and US. Moving averages. Following Giacomini, Ling, and Naranjo (2015), we assume a 45% leverage ratio for US REITs.

"La Fourmi Immobiliere" was taken over by AGF. For the US, we use the FTSE NAREIT residential total return index after 1994, and the general FTSE equity NAREIT before. REIT returns have to be unlevered to capture the returns on the REIT housing portfolio. "La Fourmi Immobiliere" had an unlevered balance sheet structure, hence we do not adjust their returns. We assume a REIT leverage of 45% for the U.S. following Giacomini, Ling, and Naranjo (2015). Returns for France are presented as decadal moving averages, and for the US as five-year moving averages, given the shorter span of the US data.

Comparing the solid and dashed lines in Figure VI, the long-run levels of unlevered REIT and housing returns are remarkably similar. The time trend also follows a similar pattern, especially in France. The REIT returns, however, tend to be somewhat more volatile—most likely because they reflect changes in the market's valuations of future earnings, as well as the current portfolio performance. The REIT returns also seem to be affected by the general ups and downs of the stock market: for example, the 1987 "Black Monday" crash and dot-com bust in the U.S., as well as the 1930s Great Depression and 1960s stock crises in France. This suggests that the valuations of the funds' housing portfolios may have been affected by shifts in general stock market sentiment, possibly unrelated to housing market fundamentals.

Overall, the returns on real estate investment funds serve to confirm the general housing return level in our dataset. The comparison also suggests that returns in housing markets tend to be smoother than those in stock markets. The next section examines various factors that can affect the comparability of housing and equity returns more generally.

III.D. Comparability of housing and equity returns

Even if the fundamentals driving housing and equity returns (expected dividend/profit, and rental flows) are similar, investor returns for the two asset classes may differ for a number of reasons including taxes, transaction costs, and the financial structure of the investment claim. In this subsection we consider such comparability issues.

Transaction costs The conventional wisdom is that while bonds and equities can be purchased with low transaction costs and at short notice, the seller of a house typically incurs significant costs. We provide a rough estimate of how transaction costs affect our return estimates for housing. We perform a simple back-of-the-envelope calculation to do this using contemporary data on average holding periods of residential real estate and average transaction costs incurred by the buyer. According to the (OECD, 2012), average round-trip transaction costs across 13 of the 16 countries in our sample amount to about 7.7 percent of the property's value.[36]

However, these simple cost ratios need to be adjusted for the typical trading frequency of each asset. According to the American Community Survey of 2007, more than 50 percent of U.S. homeowners had lived in their current home for more than 10 years. Current average holding periods are similar in, e.g., the U.K., Australia and the Netherlands. Another way to estimate housing turnover is using housing sales data, which for the US gives us an average holding period of close to 20 years.[37] Either way, accounting for transaction costs would thus lower the average annual return to housing to less than 100 basis points (e.g., 77 basis points per year based on a 7.7% cost incurred every 10 years).

For equities, the cost of each individual transaction is much smaller, but the number of transactions is much higher. Jones (2002) estimates that at the New York Stock exchange over the period 1900–2001, the average transaction cost was around 80 bps (half bid-ask spread of 30 bps plus commission rate of 50 bps), while turnover was roughly 60% per year, resulting in the annual average equity transaction costs of 40 bps. Comparing this number to the back-of-the-envelope housing transaction cost estimates reported above, it seems that even though equity transaction costs are probably somewhat lower, the difference between two asset classes is likely to be small—and no more than 0.5 pps per year.

The fact that housing faces much higher costs per each transaction, however, means that the realized housing transaction costs may understate the "shadow" utility cost which would include the suboptimal allocation choices from staying in the same house and not moving, for example. It might also reduce the volatility of housing returns, making them react more sluggishly to shocks. This means that the relatively modest short-run volatility of housing returns could mask more

[36]Data are available for Australia, Belgium, Switzerland, Germany, Denmark, Finland, France, U.K., Japan, the Netherlands, Norway, Sweden, and the U.S. Transaction costs are highest in Belgium amounting to nearly 15 percent of the property value and lowest in Denmark amounting to only 1 percent of the property value.

[37]Between April 2017 and March 2018, 5.5 millions existing homes were sold in the US at an average price of $250,000, which amounts to roughly one-twentieth of the total US housing stock.

pronounced fluctuations at lower frequencies. Appendix K and Table A.17 compare equity and housing return volatility over longer horizons of up to 20 years. It turns out that the standard deviation of housing returns is always around one-half that of equity returns, regardless of the time horizon, which suggests that housing returns not only have lower short-run volatility, but also less pronounced swings at all longer horizons.

Leverage Household-level returns on real estate and equity will be affected by the structure of the household balance sheet, and how these investments are financed. Jordà, Schularick, and Taylor (2016) show that advanced economies in the second half of the 20th century experienced a boom in mortgage lending and borrowing. This surge in household borrowing did not only reflect rising house prices, it also reflected substantially higher household debt levels relative to asset values (and relative to household incomes). The majority of households in advanced economies today hold a leveraged portfolio in their local real estate market. As with any leveraged portfolio, this significantly increases both the risk and the return associated with the investment. And today, unlike in the early twentieth century, houses can be levered much more than equities. The benchmark rent-price ratios from the IPD used to construct estimates of the return to housing refer to rent-price ratios of unleveraged real estate. Consequently, the estimates presented so far constitute only un-levered housing returns of a hypothetical long-only investor, which is symmetric to the way we (and the literature) have treated equities.

However, computing raw returns to housing and equity indices neglects the fact that an equity investment contains embedded leverage. The underlying corporations have balance sheets with both debt and equity liabilities. Thus, reconciliation is needed, and two routes can be taken. For truly comparable raw un-levered returns, equity returns could be de-levered. Alternatively, for truly comparable levered returns, housing returns would have to be levered up to factor in the actual leverage (using mortgages) seen on household balance sheets. Is this a big deal in practice? We argue that it does not bias our conclusions significantly based on some elementary calculations.

Consider, for example, the second reconciliation of levering up housing returns. Let the real long-term mortgage borrowing rate be r_0, and α be the leverage of the average house proxied by total mortgages divided by the value of the housing stock. Then we can solve for levered real housing returns TR' as a function of un-levered real housing returns TR using the formula $TR' = (TR - \alpha r_0))/(1 - \alpha)$. In our data, $TR \approx 7.0\%$ and $\alpha \approx 0.2$. Using long bond return as a proxy for r_0 of around 2.5% p.a., this would imply $TR' = 8.1\%$.[38] In other words, for the representative agent the levered housing return is about 110 bps higher than the unlevered housing return (8.1% versus 7%), a small difference. Such adjustments appear to be inconsequential for the main conclusions we present in this paper. In fact, they would bolster one of our central new claims

[38]For evidence on α, the average economy wide housing leverage measured by total mortgages divided by the value of the housing stock, see Jordà, Schularick, and Taylor (2016). If one preferred to use the mortgage rate rather than the long bond in this calculation, the evidence in Zimmermann (2017) points to an average real mortgage rate r_m of around 3% p.a. This would imply $TR' = 8\%$, only slightly lower than the figure quoted in the main text.

which is that real housing returns at least match or even exceed real equity returns in the long run when the two are compared on an equal footing.

Taxes When computing equity and housing returns we do not account for taxes. From an investor's perspective accounting for taxes is clearly important. Typically, equity capital gains—and, for some countries and periods, even dividend income—have been subject to a capital gains tax. When dividends are not taxed as capital gains, they tend to be taxed as income. In some countries, housing capital gains are subject to capital gains taxes, but owner-occupied houses in particular have been granted exemptions in many cases. Imputed rents of homeowners are, unlike dividend income, almost never taxed. Additionally, housing tends to be subject to asset-specific levies in the form of property taxes, documented extensively in Appendix Y.

For both equities and housing, the level and applicability of taxes has varied over time. For housing, this variation in treatment also extends to assessment rules, valuations, and tax band specifications. As a ballpark estimate, the impact of property taxes would lower real estate returns by less than 1.0 pps per year relative to equity (see Appendix Y for further details). The various exemptions for homeowners make the impact of capital gains taxes on real estate returns even harder to quantify but such exemptions also imply that differential tax treatment is unlikely to play an important role in explaining differences in the return between equities and housing.[39]

Since quantifying the time- and country-varying effect of taxes on returns with precision is beyond the scope of this study, throughout this paper we focus on pre-tax returns from an investor perspective. Importantly, these pre-tax returns are net of corporate profit taxes, which are netted out before the cashflow payment to the investor. Studies of returns from an aggregate wealth perspective such as Piketty, Saez, and Zucman (2018) typically compute business equity returns gross of corporate tax. Appendix S discusses the impact of adding back corporate taxes on our return data. Equity returns before corporate tax would be roughly 1 percentage point higher than our baseline estimates (Table A.27). This adjustment is, however, very much an upper bound on the housing-equity return differential for the following reasons. First, as noted above, a true like-for-like comparison should also delever equity returns and compare the returns on business and housing wealth. Appendix S Table A.27 estimates that first adding back corporate taxes, and then delevering equity returns leaves them approximately equal to the baseline estimates that we report. Second, the total tax burden on the pre-corporate-tax equity returns is likely to be higher than on housing, since in light of the various homeowner exemptions, the post-corporate-tax burden on the two assets appears to be roughly similar. Third, the returns on the two asset classes are similar before 1920, when the corporate tax rate was close to zero.

[39]Note that whilst this is true for aggregate or owner-occupied housing, the tax burden on landlords is likely to be somewhat higher than that on holders of listed equity, because landlords do not benefit from the homeowner exemptions to property taxes, and their rental income is taxed.

Table VI: *Impact of using end-of-year versus yearly-average asset prices*

	Equity (MSCI index)		Housing (this paper)
	End-of-year	Yearly average	Yearly average
Mean return p.a.	8.70	7.51	6.55
Standard deviation	27.56	22.00	7.45
Observations	694	694	694

Note: Annual global real returns in 16 countries, equally weighted, 1970–2015. End-of-year returns are computed using the return index value for the last day of the year. Yearly average returns are computed using the average index value throughout the year.

Temporal aggregation and return averaging The way house and equity price indices are constructed is likely to influence the volatility of the return series. The house price indices used for return calculations (e.g., indices from national statistical agencies) tend to be an *average* of all transactions in a given year, or use a sample of transactions or appraisal values throughout the year. But the equity prices used for return calculations, by the usual convention followed here, on the contrary, compare *end-of-year* prices of shares. The use of end-of-year rather than yearly-average prices mechanically makes equity returns more volatile.

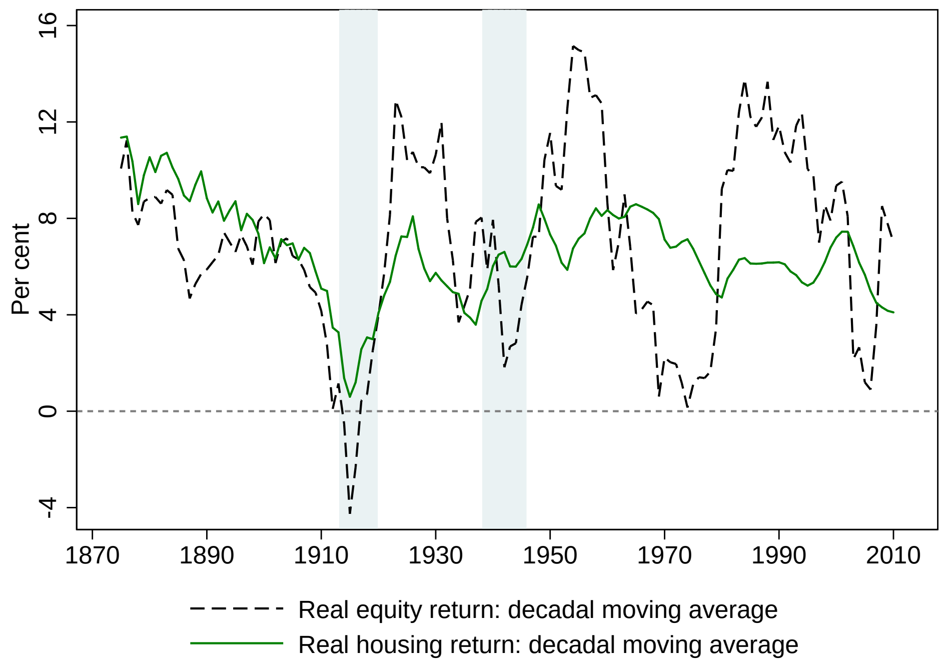
We can assess the magnitude of this effect by constructing an equity return index based on annual averages of daily data, to mimic the way housing returns are computed, and then comparing it to a "normal" return using end-of-year index values. For this robustness exercise we use daily MSCI equity returns data for 1970–2015. Table VI presents the end-of-year and yearly-average real equity returns in the first two columns, and our yearly-average housing returns for the same time period in the third column. Comparing the first two columns shows that yearly averaging lowers the standard deviation of returns by around one-fifth, or 5 pps. It also lowers the average return by around 1 ppt, because the return series is a transformation of the raw price data, and lowering the variance reduces the mean of the return. But the standard deviation of the smoothed yearly-average equity series is still almost three times that of housing over the same time period.

Because historical house price data sometimes rely on relatively few transactions, they are likely to be somewhat less smooth than averages of daily data. Therefore Table VI provides an upper bound of the impact of averaging on our return series. Even taking this upper bound at face value, the averaging of house price indices is likely to explain some, but far from all, of the differences in volatility of equity and housing returns.

IV. Risky rates of return

At this waystation the lengthy pilgrimage of Section III ends: the numerous details of how we compiled our data; the many important, but somewhat technical, aspects of data construction; the extensive accuracy checks. In these next sections the pace picks up and the focus turns to

Figure VII: *Trends in real returns on equity and housing*



Note: Mean returns for 16 countries, weighted by real GDP. Decadal moving averages.

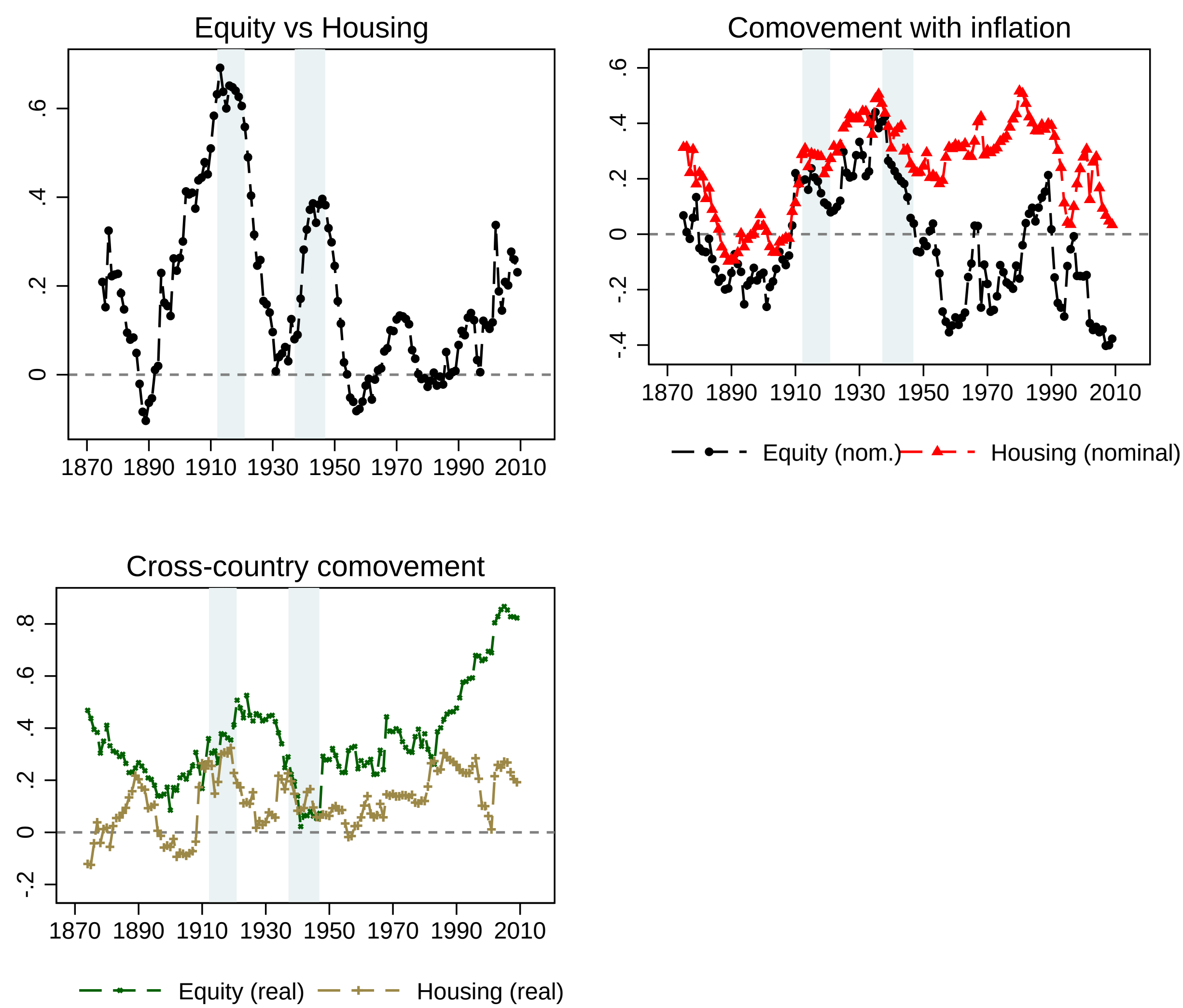
analysis and interpretation of the data. We examine broad trends and explore their implications for how we think about macroeconomics and finance, confronting the four big themes laid out in the introduction: the long-run behavior of risky returns, safe returns, risk premia, and "r minus g." Readers who skipped the better part of Section III are welcomed to rejoin the flow here.

IV.A. Global returns

We first turn in Figure VII to a more detailed inspection of the returns on the risky assets, equity and housing. The global returns are GDP-weighted averages of the 16 countries in our sample. Although we do not show the unweighted data, the corresponding figure would look very similar. We smooth the data using a decadal moving averages as explained earlier. For example, the observation reported in 1900 is the average of data from 1895 to 1905. Figure VII shows the trends in decadal-average real returns on housing (solid line) and equity (dashed line) for our entire sample. In addition, Figure VIII displays the average rolling decadal correlation of annual risky returns between asset classes, across countries, and with inflation.

Risky returns were high in the 1870s and 1880s, fell slowly at first, but then sharply after 1900, with the decade-average real equity returns turning negative during WW1. Risky returns recovered quickly in the 1920s, before experiencing a drop in the the Great Depression, especially for equities. Strikingly, after WW2 the trajectories of returns for the two risky asset classes had similar long-run means but over shorter periods diverged markedly from each other.

Figure VIII: *Correlations across risky asset returns*



Note: Rolling decadal correlations. The global correlation coefficient is the average of individual countries for the rolling window. Cross-country correlation coefficient is the average of all country pairs for a given asset class. Country coverage differs across time periods.

Equity returns have experienced many pronounced global boom-bust cycles, much more so than housing returns, with average real returns as high as +16% and as low as −4% over entire decades. Equity returns fell in WW2, boomed in the post-war reconstruction, and fell off again in the climate of general macroeconomic instability in the 1970s. Equity returns bounced back following a wave of deregulation and privatization in the 1980s. The next major event was the Global Financial Crisis, which exacted its toll on equities and to some extent housing, as we shall see.

Housing returns, on the other hand, have remained remarkably stable over almost the entire post-WW2 period. As a consequence, the correlation between equity and housing returns, depicted in the top left panel of Figure VIII, was highly positive before WW2, but has all but disappeared over the past five decades. The low covariance of equity and housing returns over the long run reveals potential attractive gains from diversification across these two asset classes that economists, up to now, have been unable to measure or analyze.

In terms of relative returns, we see that housing persistently outperformed equity up until WW1, even though both of these asset returns followed a broadly similar temporal pattern. In recent decades, equities have slightly outperformed housing in (arithmetic, not geometric) average, but with much higher volatility and cyclicality. Furthermore, upswings in equity prices have generally not coincided with times of low growth or high inflation, when standard asset pricing theory would say high returns would have been particularly valuable.

The top-right panel of Figure VIII examines the correlation between risky rates of return and inflation. It shows that equity co-moved negatively with inflation in the 1970s, while housing provided a more robust hedge against an unusually rapid surge consumer prices. In fact, apart from the interwar period, when the world was gripped by a broad deflationary bias, we find that equity returns have co-moved negatively with inflation in almost all eras. Moreover, the big downswings in equity returns in the two world wars and the 1970s coincided with periods of generally poor economic performance.

In the past two decades equity returns have also become highly correlated across countries, as shown by the sharp rise in the degree of cross-country comovement in the bottom-left panel of Figure VIII, measured as the average of all country-pair correlations for a given window.[40] A well-diversified global equity portfolio has thus become less of a hedge against country-specific risk (Quinn and Voth, 2008). As is a matter of debate, this may reflect greater freedom to arbitrage and trade across equity markets globally, or an increase in the global shocks to which firms, especially those in the typical equity index, are increasingly exposed. In contrast to equities, cross-country housing returns have remained relatively uncorrelated, perhaps because housing assets remain less globally tradable than equities, or because they are more exposed to idiosyncratic country-level shocks.

IV.B. Country returns

Next we explore risky returns in individual countries. Table VII shows returns on equities and housing by country for the full sample and for the post-1950 and post-1980 subsamples. Long-run risky asset returns for most countries are close to 6%–8% per year, a figure which we think represents a robust and strong real return to risky capital. Still, the figures also show an important degree of

[40]We report the average of all country-pair combinations for a given window, calculated as

$$Corr_{i,t} = \frac{\sum_j \sum_{k \neq j} Corr(r_{i,j,t \in T}, r_{i,k,t \in T})}{\sum_j \sum_{k \neq j} 1}$$

for asset i (here: equities or housing), and time window $T = (t-5, t+5)$. Here j and k denote the country pairs, and r denotes real returns, constructed as described in Section II.C.

Table VII: *Real rates of return on equity and housing*

Country	Full Sample		Post 1950		Post 1980	
	Equity	Housing	Equity	Housing	Equity	Housing
Australia	7.79	6.37	7.53	8.29	8.70	7.16
Belgium	6.23	7.89	9.65	8.14	11.49	7.20
Denmark	7.49	8.22	9.73	7.04	13.30	5.14
Finland	10.03	9.58	12.89	11.18	16.32	9.47
France	3.21	6.39	6.01	9.68	9.61	5.78
Germany	7.11	7.82	7.53	5.30	10.07	4.13
Italy	7.25	4.77	6.09	5.55	9.45	4.57
Japan	6.00	6.54	6.21	6.74	5.62	3.58
Netherlands	6.96	7.28	9.19	8.53	11.51	6.41
Norway	5.67	8.03	7.33	9.10	12.22	9.82
Portugal	4.51	6.31	4.84	6.01	8.60	7.15
Spain	5.83	5.21	7.75	5.83	11.96	4.62
Sweden	8.02	8.30	11.37	8.94	15.87	9.00
Switzerland	6.51	5.63	8.37	5.64	9.29	6.19
UK	6.83	5.44	9.10	6.57	9.11	6.81
USA	8.46	6.10	8.89	5.76	9.31	5.86
Average, unweighted	6.67	7.26	8.30	7.47	10.78	6.43
Average, weighted	7.12	6.72	8.19	6.40	9.08	5.50

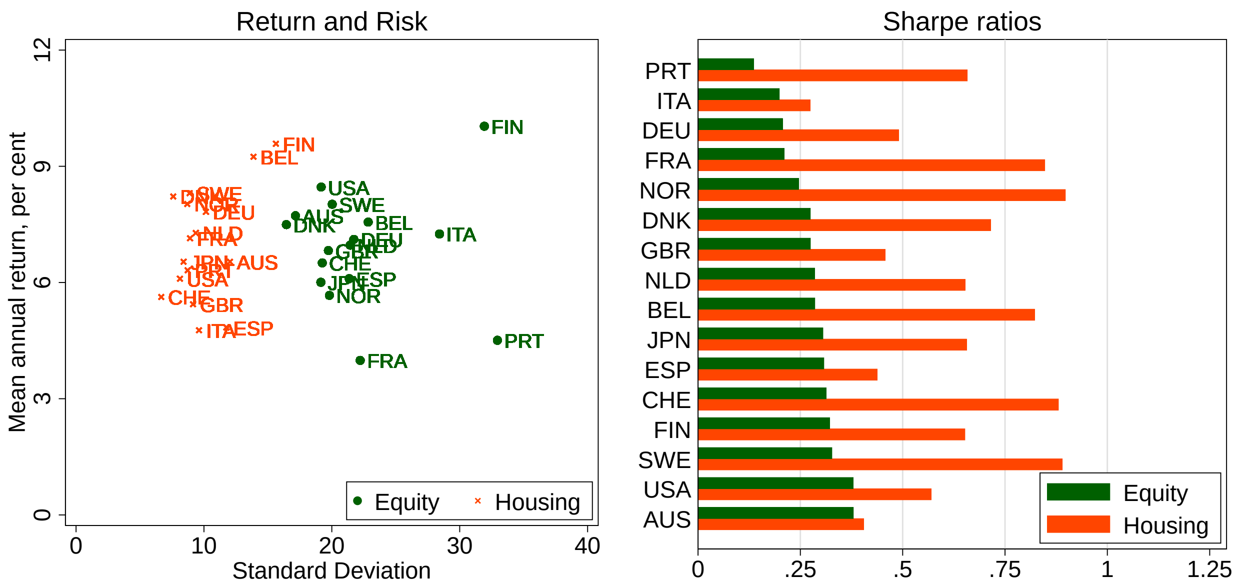
Note: Average annual real returns. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both real housing and equity returns. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

heterogeneity among countries. Many of the countries that experienced large political shocks show lower equity returns. This is the case for Portugal and Spain which both underwent prolonged civil strife, and France which undertook a wave of nationalizations in the aftermath of WW2. French equity returns are also negatively affected by the fallout from the world wars, and the fallout from an oil crisis in the 1960s (for more detail, see Blancheton, Bonin, and Le Bris, 2014; Le Bris and Hautcoeur, 2010). In contrast, real equity returns in Finland have been as high as 10%, on average throughout the sample. Housing returns also show considerable heterogeneity. Returns on housing have been high on average in the Nordic countries, but low in Italy and Spain. US risky asset returns fall roughly in the middle of the country-specific figures, with equity returns slightly above average, and housing returns slightly below. Our estimates of post-WW2 US housing returns are in line with those in Favilukis, Ludvigson, and Van Nieuwerburgh (2017).[41] The degree of heterogeneity and the relative ranking of returns is broadly similar when comparing the full sample to the post-1950 period.

This country-level evidence reinforces one of our main findings: housing has been as good a long-run investment as equities, and possibly better. Housing has offered a similar return to equity in the majority of countries and time periods. In the long-run, housing outperformed equities in

[41] Favilukis, Ludvigson, and Van Nieuwerburgh (2017) estimate a gross nominal return on US housing of 9%–11%, based on three data sources going back to 1950s and 1970s. This implies a net real return of around 5%–7% (once inflation, maintenance and running costs are subtracted), in line with our estimates in Table VII.

Figure IX: *Risk and return of equity and housing*



Note: Left panel: average real return p.a. and standard deviation. Right panel: Sharpe ratios, measured as $(\bar{r}_i - \bar{r}_{bill})/\sigma_i$, where i is the risky asset with $\bar{r}_i$ mean return and σ_i standard deviation. 16 countries. Consistent coverage within each country.

absolute terms in 6 countries, and equities outperformed housing in 5. Returns on the two assets were about the same in the remaining 5 countries. After WW2, housing was the best-performing asset class in 3 countries, and equities in 9.

However, although aggregate total returns on equities exceed those on housing for certain countries and time periods, equities do not outperform housing in simple risk-adjusted terms. Figure IX compares the risk and returns of housing and equities for each country. The left panel plots average annual real returns on housing and equities against their standard deviation. The right panel shows the Sharpe ratios for equities and housing for each country in the sample.[42] Housing provides a higher return per unit of risk in each of the 16 countries in our sample, with Sharpe ratios on average more than double those for equities.

IV.C. Decomposition of returns

To further look into the underlying drivers of housing and equity returns, we decompose them into the capital gain (price) and yield (dividend or rent) components. To be consistent with the data in Section III and Table II, we decompose *real* total return into *real* capital gain—that is, the price change net of inflation—and dividend or rental yield—that is, the nominal yield as proportion of

[42] The Sharpe ratio is calculated as $(\bar{r}_i - \bar{r}_{bill})/\sigma_i$, where i is the risky asset (housing or equity) with $\bar{r}_i$ mean return and σ_i standard deviation.

Table VIII: *Total return components for equity and housing*

	Equity			Housing		
	Real capital gain	Dividend income	Real total return	Real capital gain	Rental income	Real total return
Full sample:						
Mean return p.a.	2.78	4.17	6.82	1.61	5.50	6.92
Standard deviation	21.37	1.74	21.89	9.87	2.05	10.40
Geometric mean	0.57	4.16	4.58	1.15	5.48	6.43
Observations	1707	1707	1707	1707	1707	1707
Post-1950:						
Mean return p.a.	4.73	3.80	8.36	2.39	5.22	7.38
Standard deviation	23.70	1.81	24.24	8.59	1.93	8.95
Geometric mean	2.03	3.79	5.62	2.06	5.21	7.04
Observations	995	995	995	995	995	995

Note: Average annual real capital gain, dividend or rental income, and total return across 16 countries, unweighted. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both equity and housing returns, capital gains and yields. Dividend and rental income expressed in percent of previous year's asset price.

the previous year's share or house price.[43] Yet caveats arise. In principle, it is not entirely clear whether inflation should be subtracted from the capital gain or yield component. Moreover, firms may buyback shares to generate low-tax capital gains instead of paying out higher-taxed dividends; thus, the manner of distribution of total returns may not be invariant to circumstances.

Table VIII decomposes equity and housing returns into capital gains and dividends or rents, for the full cross-country sample and the period after 1950. Over the full sample, most of the real return is attributable to the yield. Dividends account for roughly 60% of real equity returns, and rents for roughly 80% of real housing returns. In terms of geometric means (Table VIII, row 3), almost all of both equity and housing returns are attributable to, respectively, dividend and rental income. After 1950, capital gains become more important for both equities and housing. For equities, real capital gains account for the majority of the total return after 1950, and for housing for roughly one-third.

The importance of dividends and rents is partly a matter of convention. Appendix N and Appendix Table A.20 computes the equivalent decomposition for nominal returns, and finds that the capital gain versus dividend/rental income split is then closer to roughly 50/50. Nevertheless,

[43]The small residual difference between combined capital gain and dividend income, and the equity total return, accounts for gain and loss from capital operations such as stock splits or share buybacks, and income from reinvestment of dividends.

Table IX: *Total return components for equity and housing by country*

	Equity				Housing			
	Real capital gain	Dividend income	Real total return	Capital gain share	Real capital gain	Rental income	Real total return	Capital gain share
Australia	3.06	4.90	7.79	0.38	2.53	3.99	6.37	0.24
	(16.30)	(1.08)	(16.94)		(11.94)	(0.92)	(11.92)	
Belgium	2.53	3.83	6.23	0.40	1.95	6.15	7.89	0.14
	(22.92)	(1.64)	(23.61)		(15.05)	(1.46)	(15.51)	
Denmark	2.71	4.95	7.49	0.35	1.26	7.13	8.22	0.08
	(16.14)	(2.09)	(16.45)		(7.02)	(2.42)	(7.60)	
Finland	5.19	5.08	10.03	0.51	2.82	7.14	9.58	0.17
	(31.18)	(1.95)	(31.93)		(14.61)	(2.86)	(15.62)	
France	-0.37	3.73	3.21	0.09	1.55	5.09	6.39	0.13
	(21.57)	(1.33)	(22.14)		(9.39)	(1.14)	(10.03)	
Germany	2.74	4.08	7.11	0.40	1.86	6.03	7.82	0.13
	(20.99)	(1.58)	(21.72)		(9.24)	(2.61)	(10.16)	
Italy	3.78	3.61	7.25	0.51	1.45	3.49	4.77	0.18
	(27.99)	(1.34)	(28.42)		(9.28)	(1.59)	(9.61)	
Japan	3.12	2.65	6.00	0.54	2.00	4.70	6.54	0.18
	(18.94)	(1.77)	(19.15)		(7.99)	(1.24)	(8.41)	
Netherlands	3.38	4.87	8.10	0.41	1.75	5.96	7.51	0.13
	(19.21)	(1.57)	(19.61)		(8.22)	(1.68)	(8.76)	
Norway	1.61	4.21	5.67	0.28	1.49	6.72	8.03	0.10
	(19.33)	(1.60)	(19.82)		(8.26)	(1.19)	(8.70)	
Portugal	2.92	2.28	5.11	0.56	1.13	4.47	5.21	0.12
	(34.34)	(1.22)	(34.73)		(9.26)	(1.98)	(9.37)	
Spain	1.80	4.53	5.83	0.28	1.26	4.16	5.21	0.13
	(20.48)	(2.30)	(21.15)		(11.59)	(1.60)	(12.00)	
Sweden	4.08	4.12	8.02	0.50	1.39	7.12	8.30	0.09
	(19.54)	(1.05)	(20.03)		(8.46)	(1.61)	(8.88)	
Switzerland	3.17	3.20	6.27	0.50	0.81	4.54	5.24	0.08
	(20.61)	(1.46)	(20.73)		(6.50)	(0.62)	(6.74)	
UK	2.48	4.53	6.83	0.35	1.63	3.94	5.44	0.17
	(19.12)	(1.39)	(19.73)		(8.94)	(0.86)	(9.15)	
USA	4.19	4.38	8.46	0.49	0.90	5.33	6.10	0.08
	(18.90)	(1.57)	(19.17)		(7.84)	(0.75)	(8.12)	

Note: Arithmetic average of annual real capital gain, dividend or rental income, and total return, full sample. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both equity and housing returns, capital gains and yields. Dividend and rental income expressed as percentage of previous year's asset price. Capital gain share is the proportion of real total return attributable to real capital gains.

without dividends or rents, the real returns on both assets would be low, especially in geometric mean terms. This is consistent with the existing literature on real house prices: Shiller (2000) documents that house prices in the US moved in line with inflation before the 2000s bubble, and Knoll, Schularick, and Steger (2017) show that real house prices in advanced economies were more or less flat before 1950. This is also true in our data: the pre-1950 annual real housing capital gains are just 0.5%. Post-1950 capital gains are somewhat higher at 2.5%, but still only half the magnitude of the rental yields. Adding rents to the equation radically changes the picture, and brings the long-run housing total return close to 7%. Interestingly, the broad picture is similar for equities: the real equity capital gain before 1950 is, on average, just 0.4%, compared to 4.7% per year after 1950. However, the contribution of dividend and rental income means that housing and equity returns were high both before and after 1950.

While most of the return can be attributed to dividends and rents, almost all of the volatility comes from equity and house prices, i.e., the capital gains component. Table VIII row 2 shows that both dividends and rents are very stable, with a standard deviation of dividend/rental yields of about 2%. Prices, on the contrary, move around much more, with standard deviation roughly equal to that of total returns (21.4% for equities and 9.9% for housing). The higher variability of equity returns, and the superior risk-adjusted performance of housing can, therefore, largely be attributed to the lower volatility of house prices compared to those of equities. An additional factor is that capital gains—the more volatile component—account for a relatively larger share of equity returns.

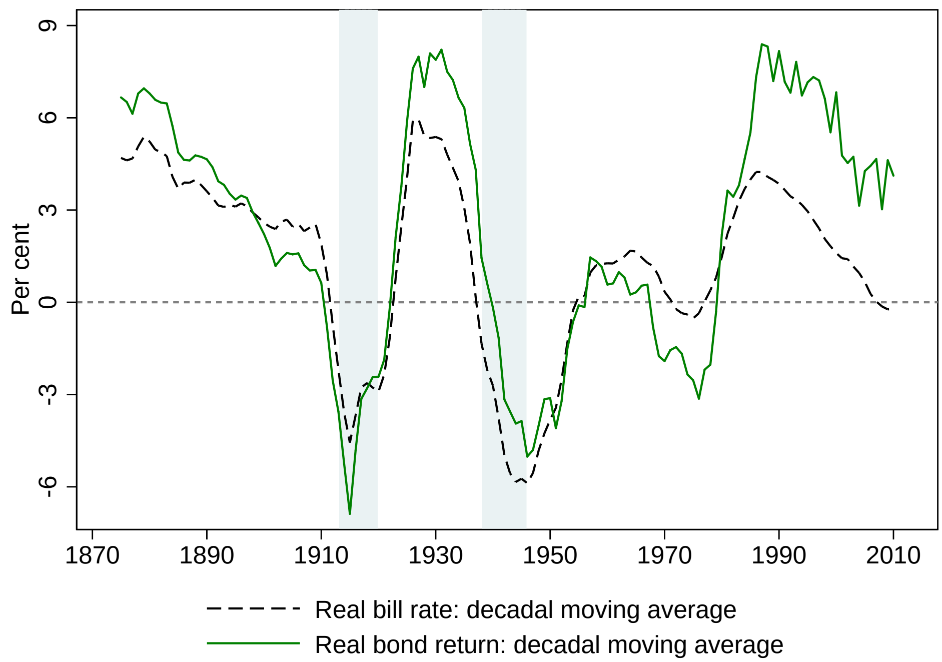
Since aggregate equity prices are subject to large and prolonged swings, a representative investor would have to hold on to his equity portfolio for longer in order to ensure a high real return. Aggregate housing returns, on the other hand, are more stable because swings in aggregate house prices are generally less pronounced. National aggregate housing portfolios have had comparable real returns to national aggregate equity portfolios, but with only half the volatility.

Table IX examines the relative importance of capital gains versus dividends/rents at the country level (figures are arithmetic means and standard deviations). Additionally we report the share of real total return accounted for by capital gains. The fact that the majority of housing returns come from yields is true across all countries. The lowest real capital gains are observed in Switzerland, and the highest in Finland, but none exceed 3% per year in the full sample. Rents are relatively more important in the US, accounting for roughly 90% of returns, but this is not unusual: Denmark, Sweden and Switzerland have the same share of capital gains as the US. For equities, the picture is more mixed. Seven countries, including the US, have a roughly 50/50 split between real capital gain and dividend yield shares. Other countries record low or negative real capital gains over the full sample, and especially so in geometric mean terms (see Appendix Table A.22).

V. Safe rates of return

Turning to safe asset returns, Figure X shows the trends in real returns on government bonds (solid line) and bills (dashed line) since 1870. Again, returns are GDP-weighted averages of the 16

Figure X: *Trends in real returns on bonds and bills*



Note: Mean returns for 16 countries, weighted by real GDP. Decadal moving averages.

countries in our sample; the corresponding unweighted figure would look very similar. We smooth the data using a decadal moving averages as explained earlier.

Three striking features of Figure X deserve comment. First, low real rates and, in fact, negative real rates have been relatively common during modern financial history. Second, for the most part, returns to long-term and short-term safe assets have tracked each other very closely—with a premium of about 1% that has widened considerably since the well-documented decline of the mid-1980s (see, e.g., Holston, Laubach, and Williams, 2017). Third, a major stylized fact leaps out once we compare the safe rates of return in Figure X to the risky rates of return in Figure VII above. Prior to WW2, real returns on housing, safe assets, and equities followed remarkably similar trajectories. After WW2 this was no longer the case.

Safe rates are far from stable in the medium-term. There is enormous time-series, as well as cross-country, variability. In fact, real safe rates appear to be as volatile as real risky rates (sometimes more volatile), a topic we return to in the next section. Considerable variation in the risk premium often comes from sharp changes in safe real returns, not from real returns on risky assets.

Two four-decade-long declines in real rates stand out: (1) from 1870 to WW1 (with a subsequent further collapse during the war); and (2) the well-documented decline that started in the mid-1980s. We could add to this list the briefer, albeit more dramatic decline that followed the Great Depression into WW2. Some observers have therefore interpreted the recent downward trend in safe rates as a sign of a new era of "secular stagnation" (see, e.g., Summers, 2014).

However, in contrast to 1870–1913 and the 1930s, the more recent decline is characterized by a much higher term premium—a feature with few precedents in our sample.[44] There are other periods in which real rates remained low, such as in the 1960s. They were pushed below zero, particularly for the longer tenor bonds, during the 1970s inflation spike, although here too term premiums remained relatively tight. Returns also dipped dramatically during both world wars. This is perhaps to be expected: demand for safe assets spikes during disasters although the dip may also reflect periods of financial repression and high inflation that usually emerge during times of conflict, and which often persist into peacetime. Thus, from a broad historical perspective, high rates of return on safe assets and high term premiums are more the exception than the rule.

Summing up, over more than 140 years from the late 19th to the 21st century, real returns on safe assets have been low—on average 1% for bills and 2.5% for bonds—relative to alternative investments. Although the return volatility—measured as annual standard deviation—is lower than that of housing and equities, these assets offered little protection during high-inflation eras and during the two world wars, both periods of low consumption growth.

Again moving on to examine correlations, Figure XI explores additional key moments of the data. The top-left panel plots the correlation between real bond and real bill returns, again using decadal rolling windows and computed as the cross-sectional average of correlations. In parallel to our discussion of the term premium, real returns on bonds and bills have been highly correlated for most of the sample up until the 1960s. From the 1970s onwards, the era of fiat money and higher average inflation, this correlation has become much weaker, and near zero at times, coinciding with a widening term premium.

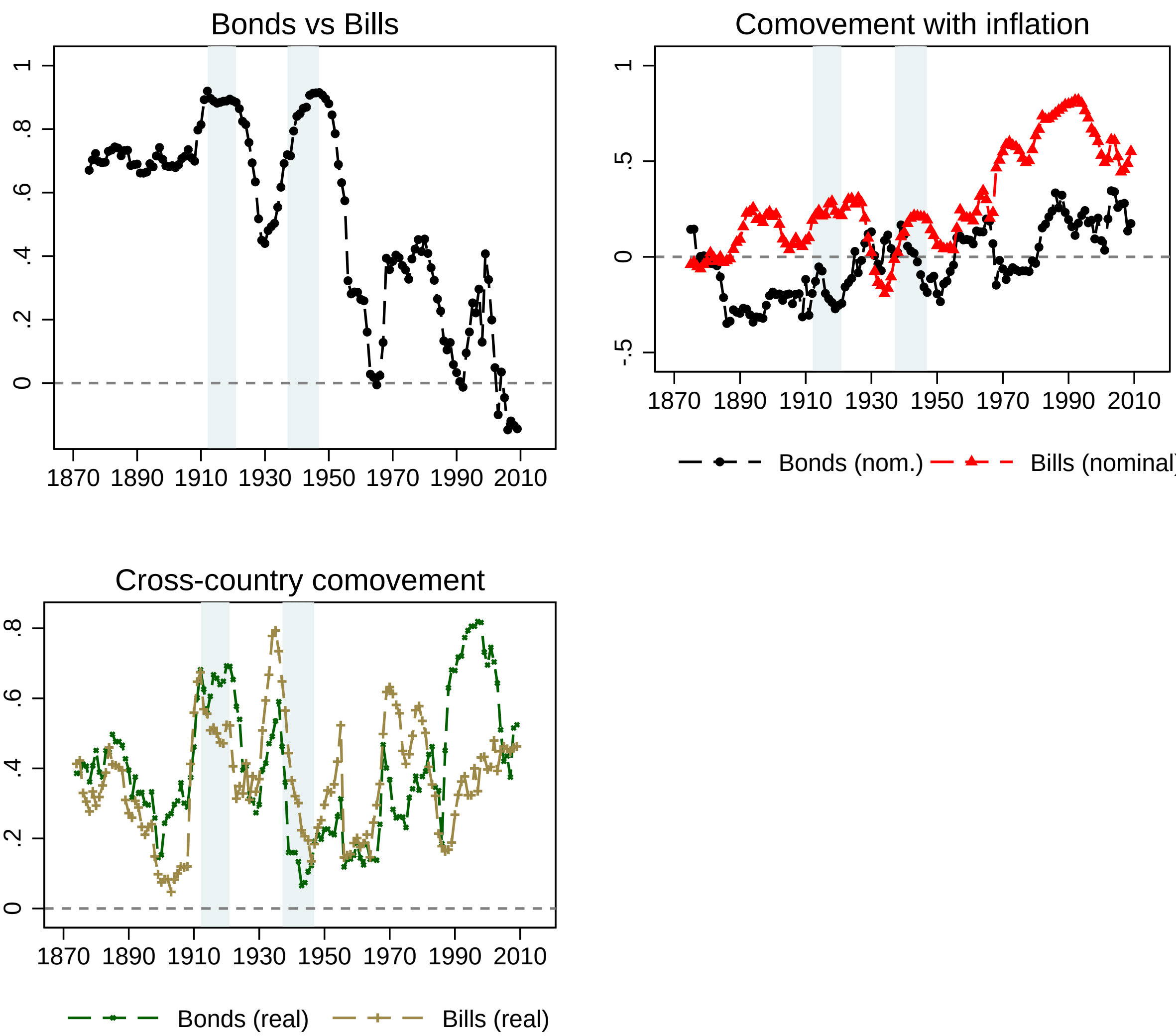
The top right panel of Figure XI displays the correlation between nominal safe asset returns and inflation, both for real bond and real bill returns. The figure shows that safe assets provided more of an inflation hedge starting in the 1970s, around the start of the era of modern central banking. However, as Figure X showed, both bonds and bills have experienced prolonged periods of negative real returns—both during wartime inflations, and in the high-inflation period of the late 1970s. Although safe asset rates usually comove positively with inflation, they do not always compensate the investor fully.

The bottom panel of Figure XI displays the cross correlation of safe returns over rolling decadal windows, averaged for all country-pair combinations, to examine how much risk can be diversified with debt instruments. Cross-country real safe returns have exhibited positive comovement throughout history. The degree of comovement shows a few marked increases in WW1 and in the 1930s. The effect of these major global shocks on individual countries seems to have resulted in a higher correlation of cross-country asset returns.

Turning to cross-sectional features, Table X shows country-specific safe asset returns for three

[44]One important qualification is that this is the ex post, not ex ante term premium. It therefore includes any unexpected shocks that affect either the short rate or the long-run bond return series. Furthermore, because the long-run bond return measure includes capital gains, and the short-term rate measure is the yield only (since the security matures within one year), most of the post-1980 increase in the term premium is driven by higher capital gains on long-term government bonds.

Figure XI: *Correlations across safe asset returns*



Note: Rolling decadal correlations. The global correlation coefficient is the average of individual countries for the rolling window. Cross-country correlation coefficient is the average of all country pairs for a given asset class. Country coverage differs across time periods.

samples: all years, post-1950, and post-1980. Here the experiences of a few countries stand out. In France, real bill returns have been negative when averaged over the full sample. In Portugal and Spain, they have been approximately zero. In Norway, the average return on bills has been negative for the post-1950 sample. However, most other countries have experienced reasonably similar returns on safe assets, in the ballpark of 1%–3%.

Aside from the investor perspective discussed above, safe rates of return have important implications for government finances, as they measure the cost of raising and servicing government debt. What matters for this is not the level of real return *per se*, but its comparison to real GDP growth, or $r^{safe} - g$. If the rate of return exceeds real GDP growth, $r^{safe} > g$, reducing the debt/GDP

Table X: *Real rates of return on bonds and bills*

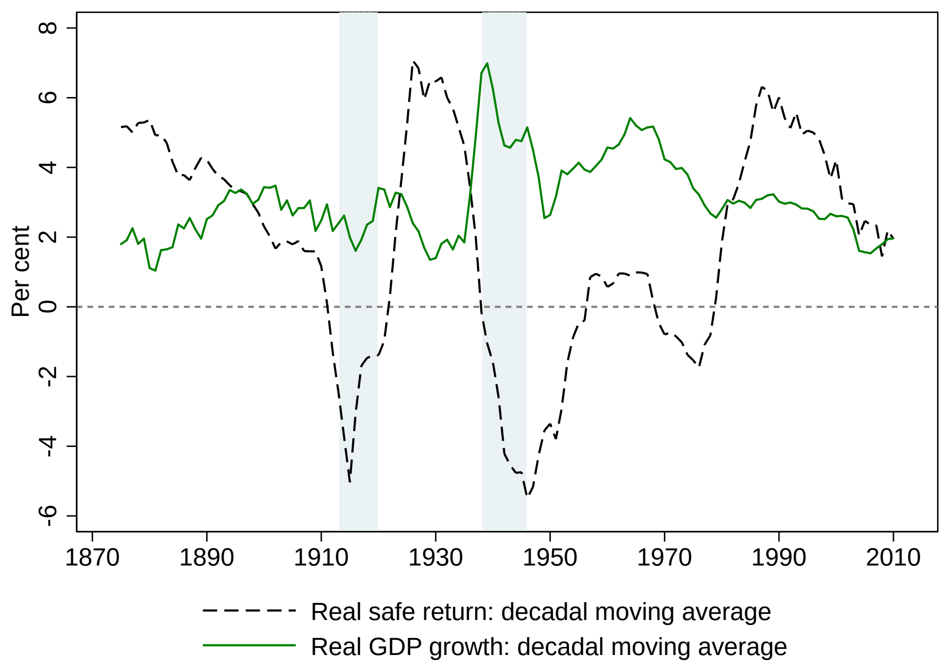
Country	Full Sample		Post 1950		Post 1980	
	Bills	Bonds	Bills	Bonds	Bills	Bonds
Australia	1.29	2.24	1.32	2.45	3.23	5.85
Belgium	1.21	3.01	1.61	3.86	2.51	6.24
Denmark	3.08	3.58	2.18	3.50	2.80	7.13
Finland	0.64	3.22	0.63	4.86	2.61	5.76
France	-0.47	1.54	0.96	2.97	2.24	6.96
Germany	1.51	3.15	1.86	3.70	1.97	4.23
Italy	1.20	2.53	1.30	2.83	2.42	5.85
Japan	0.68	2.54	1.36	2.83	1.48	4.53
Netherlands	1.37	2.71	1.04	2.14	2.08	5.59
Norway	1.10	2.55	-0.26	1.94	1.50	5.62
Portugal	-0.01	2.23	-0.65	1.59	0.65	6.25
Spain	-0.04	1.41	-0.32	1.21	2.20	5.72
Sweden	1.77	3.25	0.82	2.71	1.52	6.60
Switzerland	0.89	2.41	0.12	2.33	0.33	3.35
UK	1.16	2.29	1.14	2.63	2.70	6.67
USA	2.23	2.85	1.43	2.77	1.91	5.90
Average, unweighted	1.14	2.61	0.91	2.77	2.01	5.77
Average, weighted	1.34	2.51	1.23	2.70	1.98	5.64

Note: Average annual real returns. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both real bill and bond returns. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

ratio requires continuous budget surpluses. When r^{safe} is less than g, however, a reduction in debt/GDP is possible even with the government running modest deficits. Existing evidence points to $r^{safe} < g$ being the norm rather than the exception, both in recent years and broader historical data (Ball, Elmendorf, and Mankiw, 1998; Mehrotra, 2017).

Figure XII plots the representative "safe rate of return" as the arithmetic average of bond and bill returns (dashed line) alongside real GDP growth (solid line), again as decadal moving averages. Starting in the late 19th century, safe rates were higher than GDP growth, meaning that any government wishing to reduce debt had to run persistent budget surpluses. Indeed, this was the strategy adopted by Britain to pay off the debt incurred during the Napoleonic War (Crafts, 2016). The two world wars saw low real returns, but nevertheless a large debt accumulation to finance the wartime effort. The aftermath of these two wars, however, offered vastly different experiences for public finances. After WW1, safe returns were high and growth low, requiring significant budgetary efforts to repay the war debts. This was particularly difficult for many countries given the large interlocking reparations imposed by the Treaty of Versailles, and the turbulent macroeconomic environment at the time. After WW2, on the contrary, high growth and inflation helped greatly reduce the value of national debt, creating $r^{safe} - g$ gaps as large as –10 percentage points.

Figure XII: *Trends in real return on safe assets and GDP growth*



Note: Mean returns and GDP growth for 16 countries, weighted by real GDP. Decadal moving averages. The safe rate of return is an arithmetic average of bonds and bills.

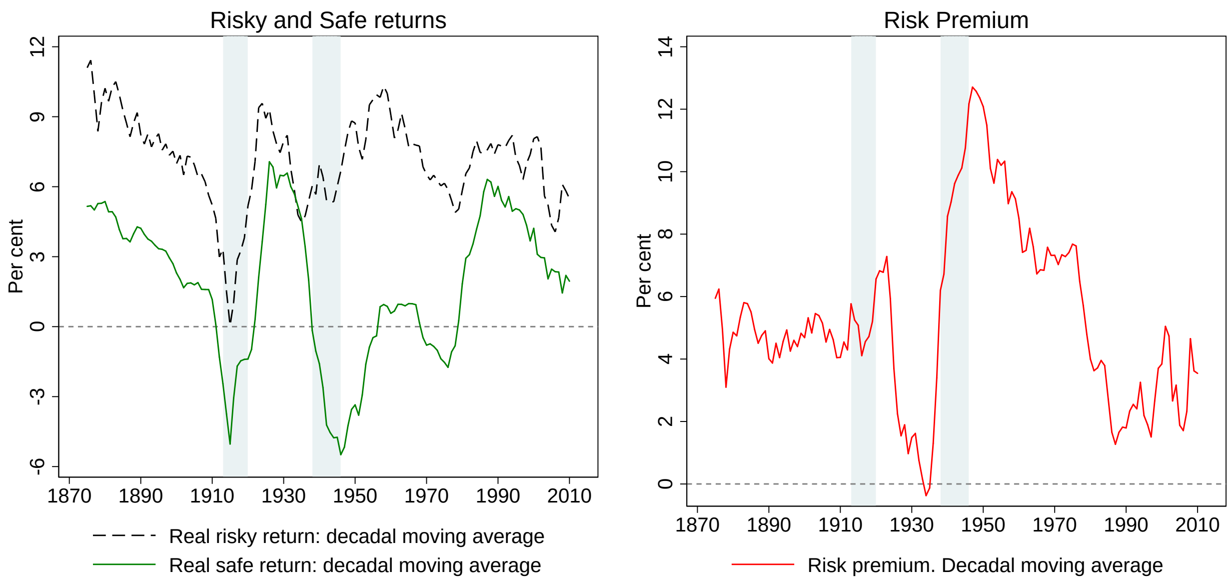
More recently, the Great Moderation saw a reduction in inflation rates and a corresponding increase in the debt financing burden, whereas the impact of $r^{safe} - g$ in the aftermath of the Global Financial Crisis remains broadly neutral, with the two rates roughly equal. On average throughout our sample, the real growth rate has been around 1 percentage point higher than the safe rate of return (3% growth versus 2% safe rate), meaning that governments could run small deficits without increasing the public debt burden.

In sum, real returns on safe assets have been quite low across the advanced countries over the last 150 years. In fact, for some countries, these returns have often been persistently negative. Periods of unexpected inflation, in war and peace, have often diluted returns, and flights to safety may have depressed safe returns even further in the more turbulent periods of global financial history. The low return for investors has, on the flipside, implied a low financing cost for governments, which was particularly important in reducing the debts incurred during WW2.

VI. Risky versus safe returns

Having established the general trends in each risky and safe asset class, we now turn to examine broader patterns of returns across the different asset classes. We start by comparing returns on risky and safe assets. Figure XIII depicts the trends in global safe and risky asset returns, again using decadal moving averages of GDP-weighted global return series.

Figure XIII: *Global real risky vs. real safe return*



Note: Mean returns for 16 countries, weighted by real GDP. Decadal moving averages. Within each country, the real risky return is a weighted average of equities and housing, and safe return - of bonds and bills. The within-country weights correspond to the shares of the respective asset in the country's wealth portfolio. Risk premium = risky return - safe return.

The risky return in each country is a weighted average of housing and equity returns, with weights corresponding to equity market capitalization and housing wealth in each respective country. The safe return is a simple unweighted average of bonds and bills.[45] The left panel of Figure XIII shows the risky and safe asset returns, and the right panel depicts the risk premium, calculated as the risky minus safe difference.

As in Sections IV and V, the data presented in this Section measure ex post returns and risk premiums, inclusive of capital gains. For some of the debates that we touch on, however, a forward-looking expected return measure would have been preferable. Realized returns are likely to fall below ex ante return expectations during periods of large negative shocks, such as the two world wars, and rise above them in times of high capital gains, such as that between 1980 and today. Long-run data on expected returns are, however, difficult to obtain. Our focus on long run trends, to an extent, allows us to look through some of the unexpected shocks that drive a wedge between ex ante and ex post returns. Nevertheless, the discussion in this section should be treated with a note of caution.

Both risky and safe returns were high during the 19th century but had been gradually declining in the run up to WW1, after which they declined sharply, as is to be expected. After the war, returns

[45]For details on the construction of the weighted returns and the asset weights, see Section II.C and Appendix O.3. Appendix P further compares the portfolio-weighted returns to equally-weighted returns, i.e., a simple average of housing and equity.

were recovering during the 1920s. From 1930 onwards, the risky return stayed high and relatively stable, whereas the safe return dropped sharply and remained low until the late 1970s, before increasing and falling back again during the past three decades. These findings have implications for current debates around secular stagnation and the pricing, or mis-pricing, of risk.

Secular stagnation is associated with low rates of return, driven by an excess of savings or a general unwillingness to borrow and invest. These in turn reflect a variety of potential factors, including: (1) lower rates of productivity growth; (2) lower fertility and mortality rates; (3) a decline in the relative price of investment goods; (4) greater firm level market power; and (5) higher income inequality (Eggertsson, Mehrotra, and Robbins, 2017; Rachel and Smith, 2015; Thwaites, 2015).

Indeed, we can see that the safe return fell sharply during the 1930s, when Hansen (1939) originally proposed the secular stagnation hypothesis. That time also coincided with a demographic bust and was preceded by a big rise in income inequality in the run-up to the Great Depression. The safe return has been falling again since the mid-1980s as many have noted.[46] Understandably, this has led some observers to suggest that advanced economies are again in danger of entering secular stagnation, e.g., Summers (2014), and Eggertsson and Mehrotra (2014).

But the picture changes radically when we consider the trend in risky returns in addition to safe returns. Unlike safe returns, risky returns have remained high and broadly stable through the best part of the last 100 years, and show little sign of a secular decline. Turning back to the trend for safe assets, even though the safe return has declined recently, much as it did at the start of our sample, it remains close to its historical average. These two observations call into question whether secular stagnation is quite with us. The high and stable risky return coupled with falling safe rates could also be consistent with the notion of a "safety trap" brought about by the relative shortage of safe assets (Caballero and Farhi, 2017). However with risk premiums still not far off their historical averages, the evidence for a safety trap is thus far also not clear-cut.

We now turn to examine the long-run developments in the ex post risk premium, i.e., the spread between safe and risky returns (right panel of Figure XIII). This spread was low and stable at around 5 percentage points before WW1. It rose slightly after WW1, before falling to an all-time low of near zero by around 1930. The decades following the onset of WW2 saw a dramatic widening in the risk premium, with the spread reaching its historical high of around 14 percentage points in the 1950s, before falling back to around its historical average.

Interestingly, the period of high risk premiums coincided with an era of few systemic banking crises. In fact, not a single such crisis occurred in our advanced-economy sample between 1946 and 1973. By contrast, banking crises appear to have been relatively more frequent when risk premiums were low. This finding speaks to the recent literature on the mispricing of risk around financial crises. Among others, Krishnamurthy and Muir (2017) argue that when risk is underpriced, i.e., risk premiums are excessively low, severe financial crises become more likely.

[46]Note that the safe interest rate—i.e. the component of the safe return that excludes capital gains, and is more relevant for the secular stagnation and safety trap debates, has also fallen sharply since 1980. However, like the bill rate in Figure X, it remains close to its historical average.

Table XI: *Real risky and safe asset returns across countries and time*

Country	Full Sample		1950–1980		Post 1980	
	Risky return	Safe return	Risky return	Safe return	Risky return	Safe return
Australia	6.96	1.77	6.51	-1.34	7.71	4.54
Belgium	8.31	1.82	9.68	1.05	7.99	4.38
Denmark	8.02	3.05	8.57	0.49	6.84	4.97
Finland	10.87	2.16	13.47	1.28	13.06	4.18
France	6.54	0.54	12.33	-1.15	6.61	4.60
Germany	7.90	3.34	7.00	1.77	5.20	3.10
Italy	5.32	2.28	7.08	-0.83	5.21	4.14
Japan	6.79	1.29	10.86	0.05	4.81	3.00
Netherlands	7.30	1.31	10.26	-0.89	7.42	3.83
Norway	7.96	1.59	7.75	-2.34	10.65	3.56
Portugal	6.46	0.45	5.19	-3.30	7.41	3.45
Spain	5.39	0.68	7.27	-3.56	5.46	3.96
Sweden	8.52	2.35	8.67	-1.12	11.42	4.06
Switzerland	6.51	1.57	6.07	0.25	7.76	1.84
UK	6.35	1.51	8.33	-1.36	7.66	4.69
USA	7.12	1.92	6.44	-0.32	7.28	3.91
Average, unweighted	7.44	1.88	8.48	-0.81	7.65	3.89
Average, weighted	7.22	1.89	7.88	-0.56	6.66	3.81

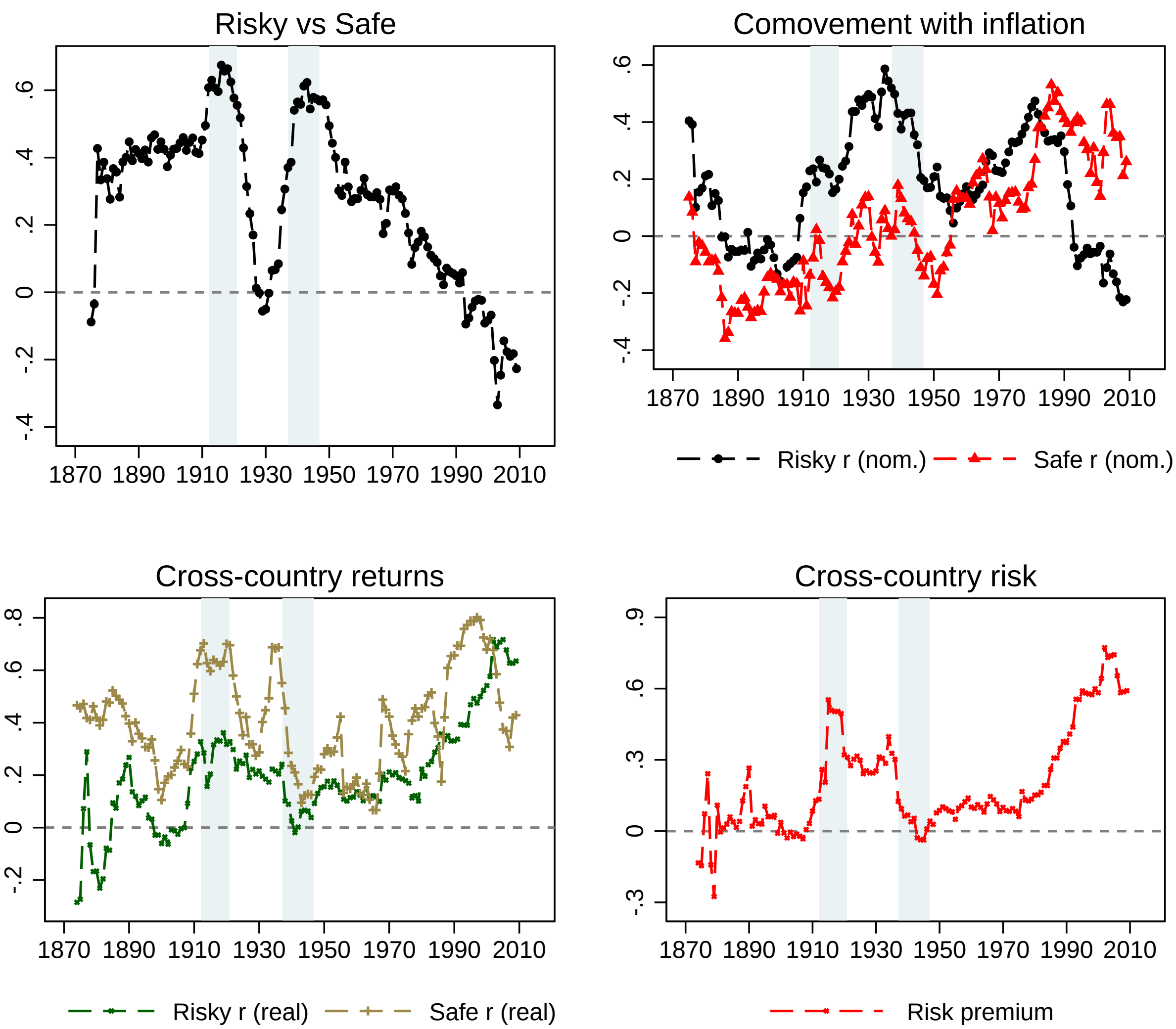
Note: Average annual real returns. Real risky return is a weighted average of equity and housing, and safe return - of bonds and bills. The weights correspond to the shares of the respective asset in the country's wealth portfolio. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the risky and safe return. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

The long-run trends in risk premiums presented here seem to confirm this hypothesis. Appendix F further examines how these long-run movements in the risk premium, and the returns on the individual risky and safe asset classes, correspond to the changing monetary regimes, and finds, in accordance with Figure XIII, that the risk premium during the Bretton-Woods fixed exchange rate era was unusually high by historical standards, driven largely by the low, even negative, safe asset returns, but also by reasonably high housing returns.

Table XI zooms in to examine the evolution of safe and risky asset returns across different countries, as well as time periods. To enable a comparison with the aggregate trends in Figure XIII, we split the post-WW2 period into two subperiods: 1950–1980, when global risk premiums were high and global safe returns low, and post-1980, which saw an initial recovery, and subsequent decline in global safe returns.

The vast majority of countries in our sample follow similar patterns. The risky return is largely stable across time, even though it varies somewhat across countries: from just over 5% in Italy and Spain to 11% in Finland. Risk premiums were at or near their highest level in almost every country

Figure XIV: *Correlations across risky and safe asset returns*



Note: Rolling decadal correlations. The global correlation coefficient is the average of individual countries for the rolling window. Cross-country correlation coefficient is the average of all country pairs for a given asset class. Country coverage differs across time periods.

during the period 1950–1980, largely due to low returns on safe assets. The real safe rate of return was close to zero or negative for the majority of the countries in the sample, with the lowest level of −3.5% observed in Spain and Portugal, and only Belgium, Finland and Germany experiencing robustly positive real returns. Meanwhile, risky returns were also somewhat above their long-run level in a number of countries, but the differences are relatively smaller than those for safe rates. The post-1980 period saw a recovery in safe returns across the board, with the recent downward trend not yet apparent in these longer-run period averages. Risky returns, meanwhile, were close to their historical levels in most countries, with only Japan experiencing a strong decline following the bursting of its asset price bubble in the 1990s.

We now turn to examine the correlations between risky and safe returns, which are displayed in Figure XIV. The top-left panel of this figure shows the rolling decadal correlation between the risky and safe returns, calculated as the average of rolling correlations in individual countries in a similar fashion to the calculations in Figure VIII. Throughout most of the historical period under consideration, risky and safe returns had been positively correlated. In other words, safe assets have not generally provided a hedge against risk since safe returns were low when risky returns were low—in particular during both world wars—and vice versa. This positive correlation has weakened over the more recent decades, and turned negative from the 1990s onwards. This suggests that safe assets have acted as a better hedge for risk during both the Great Moderation and the recent Global Financial Crisis.

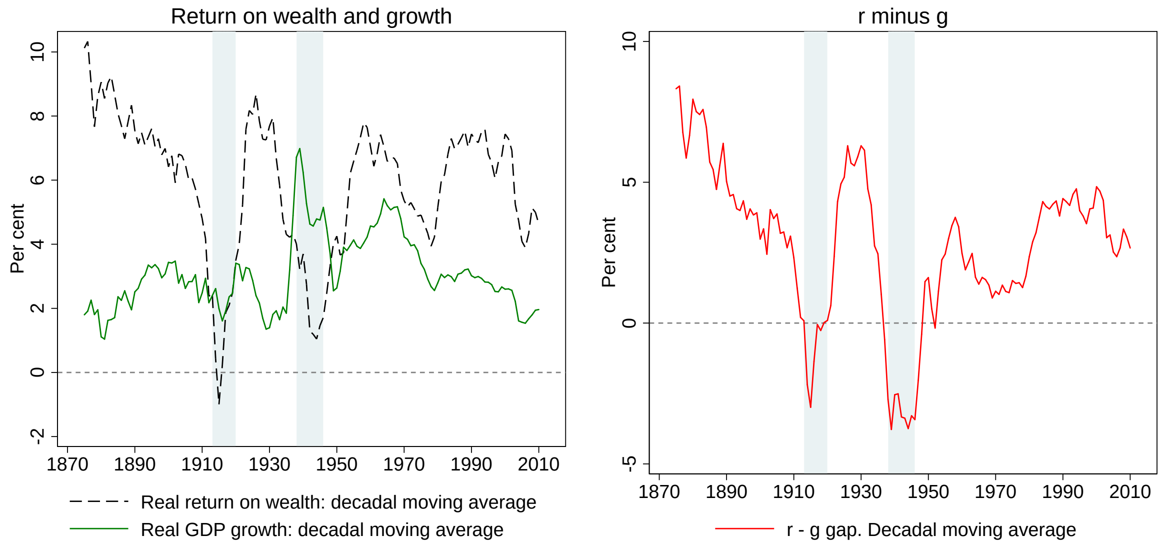
The top-right panel of Figure XIV shows the comovement of risky and safe nominal returns with inflation. Mirroring our findings presented in the preceding sections, safe returns have tended to comove more strongly with inflation, particularly during the post-WW2 period. Moving to cross-country correlations depicted in the bottom two panels of Figure XIV, historically safe returns in different countries have been more correlated than risky returns. This has reversed over the past decades, however, as cross-country risky returns have become substantially more correlated. This seems to be mainly driven by a remarkable rise in the cross-country correlations in risk premiums, depicted in the bottom-right panel of Figure XIV. This increase in global risk comovement may pose new challenges to the risk-bearing capacity of the global financial system, a trend consistent with other macro indicators of risk-sharing (Jordà, Schularick, and Taylor, 2017).

VII. r versus g

Our analysis also provides insights into the debate on inequality. Piketty (2014) and Piketty and Zucman (2014) argue that inequality and wealth-to-income ratios in advanced economies have followed a U-shaped pattern over the past century and a half. They further hypothesize that wealth inequality may continue to rise in the future, along with a predicted decline in the rate of economic growth. The main theoretical argument for this comes about from a simple relation: $r > g$. In their approach, a higher spread between the real rate of return on wealth, denoted r, and the rate of real GDP growth, g, tends to magnify the steady-state level of wealth inequality. Benhabib and Bisin (2016) show that in a wide class of models featuring stochastic returns to wealth, a higher gap between r and g increases the Pareto index of the steady-state wealth distribution, making it more unequal.

Of course, this is not the only channel through which rates of return can impact the wealth distribution. Rate of return differentials between asset classes can affect the wealth distribution if there are systematic differences in the portfolio composition between rich and poor households as Kuhn, Schularick, and Steins (2017) show, or if rates of returns vary with portfolio size as stressed by Piketty (2014). Studying administrative Swedish data, Bach, Calvet, and Sodini (2016) find that wealthy households earn higher returns on their portfolios, and Fagereng, Guiso, Malacrino,

Figure XV: *Real return on wealth and real GDP growth*



Note: Mean returns and real GDP growth for 16 countries, weighted by real GDP. Decadal moving averages. Within each country, the real return on wealth is a weighted average of bonds, bills, equity and housing. The within-country weights correspond to the shares of the respective asset in each country's wealth portfolio.

and Pistaferri (2016) use Norwegian tax data to document substantial heterogeneity in wealth returns. Rates of return on wealth are beginning to receive attention in the theoretical literature. For instance, Benhabib and Bisin (2016) point to return differences of assets as one potential channel to explain diverging trends between income and wealth inequality, and Garbinti, Goupille-Lebret, and Piketty (2017) show that asset price effects played an important role in shaping the French wealth distribution over the past 200 years. Further, wealth inequality may depend not only on the magnitude of r in relation to g, but also on return volatility. Higher return volatility can increase the dispersion of wealth outcomes, and make the distribution of wealth more unequal.

To bring our data to bear on these debates, we construct a measure of the world's real return on wealth as a weighted average of real returns on bonds, equities, and housing—reflecting the typical portfolio of a private household end-investor. We then compare this measure to the rate of real GDP growth of economies over the long-run. Importantly, our approach differs from Piketty (2014) in that we rely on annual returns from observed market prices and yields for each individual asset class, rather than implicit returns derived from aggregate balance sheet data at selected benchmark dates. This, we think, is more robust and provides a vital cross check for the core argument.

Similarly to the risky returns in Section VI, we weight the individual returns by the size of the respective asset portfolio: stock market capitalization, housing wealth, and public debt (divided equally between bonds and bills).[47] Figure XV displays the long-run trends in the global real rate of

[47]For details on the construction of the weighted returns and the asset weights, see Section II.C and Appendix O.3. Appendix P further compares the portfolio-weighted returns to equally-weighted returns, with the equally-weighted return on wealth a simple average of equity, housing, and bonds.

return on wealth (dashed line) and the global real GDP growth rate (solid line) since the late 19th century, again using decadal moving averages of GDP-weighted data.

Our data show that the trend long-run real rate of return on wealth has consistently been *much* higher than the real GDP growth rate. Over the past 150 years, the real return on wealth has substantially exceeded real GDP growth in 13 decades, and has only been below GDP growth in the two decades corresponding to the two world wars. That is, in peacetime, r has always exceeded g. The gap between r and g has been persistently large. Since 1870, the weighted average return on wealth (r) has been about 6.0%, compared to a weighted average real GDP growth rate (g) of 3.0%, with the average $r - g$ gap of 3.0 percentage points, which is about the same magnitude as the real GDP growth rate itself. The peacetime gap between r and g has been larger still, averaging around 3.8 percentage points.

Table XII shows how the rate of return on wealth and the GDP growth rate have varied across different countries and time periods. Despite some variation, the positive gap between r and g is a persistent feature of the data: r is bigger than g in every country and every time period that we consider. The last few decades prior to the Global Financial Crisis saw a general widening of this gap, mirroring the aggregate pattern shown in Figure XV.

As previously discussed, returns on housing play an important part in this story—but with scant data until now, their exact role was unclear. The high level of housing returns that we have uncovered serves to push up the level of r, and thus, potentially, wealth inequality. But what is the counterfactual? We need to bear in mind that housing wealth is more equally distributed than, for instance, equities (see, e.g., Kuhn et al., 2017), and returns on housing are less volatile than those on shares—with both of these factors serving to flatten the distribution of wealth changes, making the overall impact of housing returns on wealth inequality less clear-cut and offering substantial scope for further research.

Rognlie (2015) notes that recent trends in wealth and income could be influenced primarily by what has happened in housing. Real house prices have experienced a dramatic increase in the past 40 years, coinciding with the rapid expansion of mortgage lending (Jordà, Schularick, and Taylor, 2015, 2016; Knoll, Schularick, and Steger, 2017). This is very much evident from Table IX. Measured as a ratio to GDP, rental income has been growing, as Rognlie (2015) argues. However, the rental yield has declined slightly—given the substantial increase in house prices—so that total returns on housing have remained pretty stable, as we have discussed. In this sense, recent housing trends have diverged little.

Our data allow us to more formally examine whether movements in the $r - g$ gap are more closely related to return fluctuations or movements in the real GDP growth rate. Appendix Q and Table A.26 document the correlations between $r - g$ and g, and $r - g$ and r across different time horizons, for the full sample and the period after 1950. Overall, the correlation between $r - g$ and g is negative, and somewhat stronger at longer horizons, with the correlation coefficients ranging between –0.2 and –0.6 depending on the historical subperiod and time window. At the same time, the $r - g$ gap is even more robustly related to changes in the return on wealth r, with a positive

Table XII: *Return on wealth and GDP growth across countries and time*

Country	Full Sample		Post 1950		Post 1980	
	Return on wealth	GDP growth	Return on wealth	GDP growth	Return on wealth	GDP growth
Australia	5.91	3.51	7.39	3.73	7.53	3.19
Belgium	6.38	2.32	7.29	2.68	6.90	2.17
Denmark	7.37	2.70	7.21	2.51	6.62	1.60
Finland	9.76	3.49	11.92	3.16	11.81	2.16
France	4.92	2.55	7.76	3.17	6.29	1.92
Germany	7.07	2.81	5.26	2.80	4.72	2.40
Italy	5.08	3.82	5.07	3.30	5.01	1.37
Japan	5.59	4.18	6.35	4.20	4.23	2.09
Netherlands	5.33	3.16	6.67	3.21	6.71	2.29
Norway	6.86	3.06	7.67	3.45	9.35	2.80
Portugal	5.87	3.39	5.65	3.48	6.99	2.13
Spain	4.58	3.21	5.50	4.03	5.34	2.56
Sweden	7.41	2.89	8.69	2.86	9.87	2.36
Switzerland	5.63	2.33	5.98	2.69	7.03	1.95
UK	4.75	2.09	5.90	2.49	7.23	2.45
USA	6.03	3.38	5.91	3.33	6.58	2.82
Average, unweighted	6.30	2.86	6.92	3.23	7.01	2.26
Average, weighted	5.98	3.04	6.09	3.33	6.08	2.48

Note: Average annual real returns. Real return on wealth is a weighted average of bonds, bills, equity and housing. The weights correspond to the shares of the respective asset in each country's wealth portfolio. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the real return on wealth and the real GDP growth rate. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

correlation between the two and a correlation coefficient of around 0.9, both over short and long run. This suggests that both falling GDP growth and higher returns would tend to increase the $r - g$ gap, although historically much of the changes in $r - g$ have come about from movements in the return on wealth. During peacetime r has been quite stable, and so has been the $r - g$ gap.

Since the 1970s, the stable and high levels of the rate of return on wealth have coincided with high and rising wealth-to-income ratios (see Piketty and Zucman, 2014, and Appendix Figure A.7). Together, these two facts have meant that the capital share of GDP has increased across advanced economies (Karabarbounis and Neiman, 2014). A large part of these high returns, and of the increase in wealth ratios, can be attributed to high capital gains on risky assets, namely housing and equity. Rognlie (2015) argues that house prices have played an important role in the evolution of wealth-to-income ratios in the US. Kuvshinov and Zimmermann (2018) show that most of the recent increase in the value of listed firms in our cross-country sample is accounted for by higher equity valuations.

These high capital gains in recent decades have allowed the stock of measured wealth to rise without running into diminishing returns. Understanding the drivers behind these long-run trends in returns and valuations seems key to disentangling the underlying causes behind the recent upsurge in wealth, inequality, and the capital share of income.

VIII. Conclusion

In this paper we provide an investigation of the long history of advanced economy asset returns for all the major categories of the investible wealth portfolio. Our work brings new stylized facts to light and rigorously documents many broad patterns that have stimulated so much research in core areas of economics and finance over the last two centuries.

The returns to risky assets and risk premiums have been high and stable over the past 150 years. Substantial diversification opportunities exist between risky asset classes, and across countries. Arguably the most surprising result of our study is that long run returns on housing and equity look remarkably similar. Yet while returns are comparable, residential real estate is less volatile on a national level, opening up new and interesting risk premium puzzles.

Our research speaks directly to the relationship between r, the rate of return on wealth, and g, the growth rate of the economy, that figures prominently in the current debate on inequality. One robust finding in this paper is that $r \gg g$: globally, and across most countries, the weighted rate of return on capital was twice as high as the growth rate in the past 150 years.

These and other discoveries can provide a rich agenda for future research, by us and by others. Many issues remain to be studied, among them determining the particular fundamentals that drive the returns on each of the asset classes in typical economies. For now, we hope our introduction of this new compilation of asset return data can provide the evidentiary basis for new lines of exploration in years to come.

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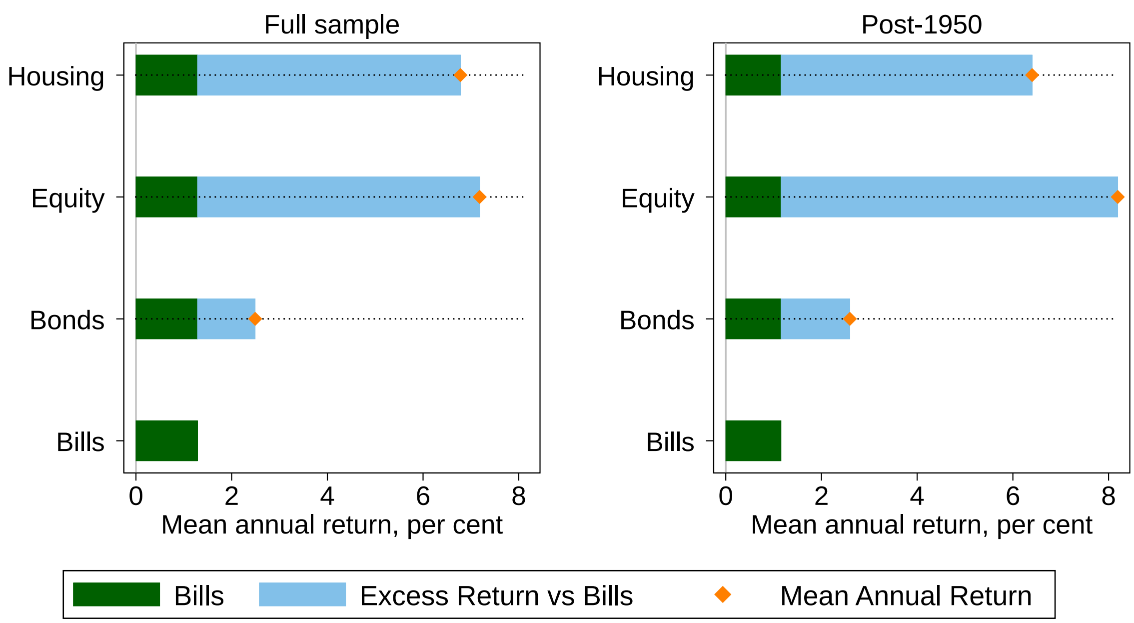
Online Appendix

The Rate of Return on Everything, 1870–2015

A. The effect of GDP weighting

Figure A.1: *GDP-weighted returns*



Notes: Arithmetic average real returns p.a., weighted by real GDP. Consistent coverage within each country: each country-year observation used to compute the average has data for all four asset returns.

This chart shows global average returns for the four asset classes weighted by country GDP, effectively giving greater weight to the largest economies in our sample, namely the U.S., Japan, and Germany. The overall effects are relatively minor. For the full sample, returns on equity and housing are similar at around 7% in real terms. For the post-1950 period, equities outperform housing by about 2pps. on average. The post-1990 housing bust in Japan and the underperformance of the German housing market contribute to this result.

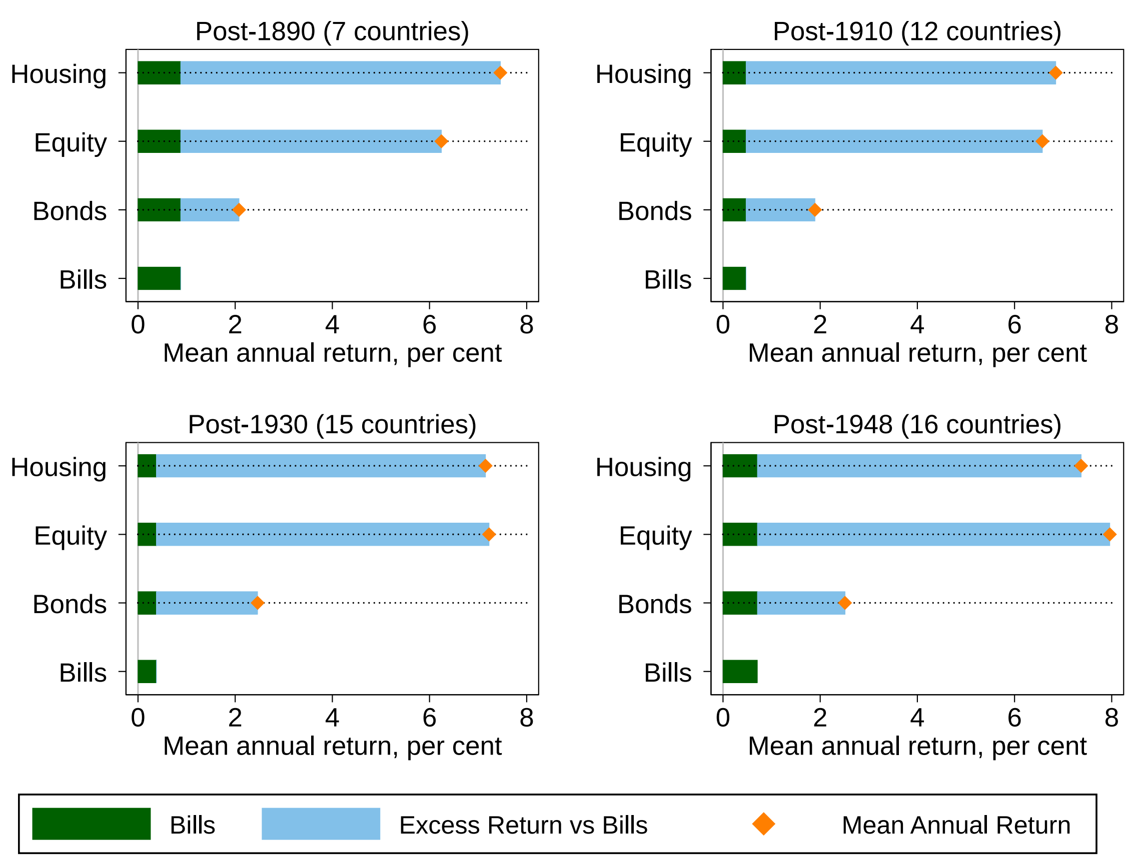
B. More on sample consistency

Throughout the paper, we always use a sample that is consistent within each table and graph, that is, for any table that shows returns on bills, bonds, equity, and housing, each yearly observation has data for all four asset returns. For tables showing bonds versus bills only, each yearly observation has data on both bonds and bills, but may be missing data for equities or housing. At the same time, returns for different countries generally cover different time periods.

Here we investigate whether adjusting for sample consistency affects our results. First, Figure A.2 plots returns for samples that are consistent both within and across countries, starting at benchmark years. The later the benchmark year, the more countries we can include. The resulting return patterns confirm that the basic stylized facts reported earlier continue to hold even under these more stringent sampling restrictions, and regardless of the time period under consideration.

Next, we consider whether going to a fully "inconsistent" sample —that is, taking the longest time period available for each asset, without within-country consistency— would change the results. Table A.1 thus shows returns for the maximum possible sample for each asset. Table A.2, on the contrary, shows returns for a sample that is consistent within each country, across all four asset classes. The results in this table can be compared to Table II in the main text. On balance, the choice of the sample makes almost no difference to our headline results.

Figure A.2: *Consistent samples*



Note: Average real returns p.a. (unweighted). Consistent coverage across and within countries.

Table A.1: *Returns using longest possible sample for each asset*

Country	Bills	Bonds	Equity	Housing
Australia	2.02	2.17	8.39	6.37
Belgium	1.68	3.01	5.89	7.89
Denmark	2.98	3.59	7.54	8.22
Finland	0.64	3.22	9.42	9.58
France	-0.47	0.84	3.21	6.39
Germany	1.50	3.12	8.83	7.82
Italy	1.20	2.11	6.09	4.77
Japan	0.63	2.54	9.64	6.54
Netherlands	1.37	2.71	6.96	7.22
Norway	1.10	2.55	5.67	8.33
Portugal	-0.01	2.76	4.05	6.31
Spain	0.70	1.34	5.77	5.21
Sweden	1.77	3.25	8.00	8.30
Switzerland	1.64	2.41	6.50	5.63
UK	1.16	2.29	6.86	5.44
USA	2.23	2.85	8.40	6.10
Average, unweighted	1.18	2.61	7.02	7.18
Average, weighted	1.34	2.48	7.40	6.69

Note: Average annual real returns. Longest possible sample used for each asset class, i.e. returns are not consistent across assets or within countries. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.2: *Returns using the full within-country-consistent sample*

Country	Bills	Bonds	Equity	Housing
Australia	1.29	2.26	7.72	6.54
Belgium	0.77	2.87	6.78	8.64
Denmark	2.99	3.50	7.39	8.29
Finland	0.08	4.25	10.03	9.58
France	-0.47	1.54	3.99	7.14
Germany	2.65	4.03	7.11	7.82
Italy	1.37	3.19	7.25	4.77
Japan	0.39	2.18	6.00	6.54
Netherlands	0.78	1.85	6.96	7.28
Norway	0.90	2.29	5.67	8.03
Portugal	-0.48	1.37	4.51	6.31
Spain	-0.03	1.39	6.32	5.09
Sweden	1.56	3.14	8.02	8.30
Switzerland	0.81	2.33	6.69	5.77
UK	1.15	1.88	6.83	5.44
USA	1.52	2.33	8.46	6.10
Average, unweighted	1.21	2.62	6.70	7.33
Average, weighted	1.29	2.49	7.18	6.78

Note: Average annual real returns. Returns consistent within countries, i.e. each yearly observation for a country has data on each of the four asset classes. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

C. Returns during world wars

Table A.3: *Real returns on risky assets during world wars*

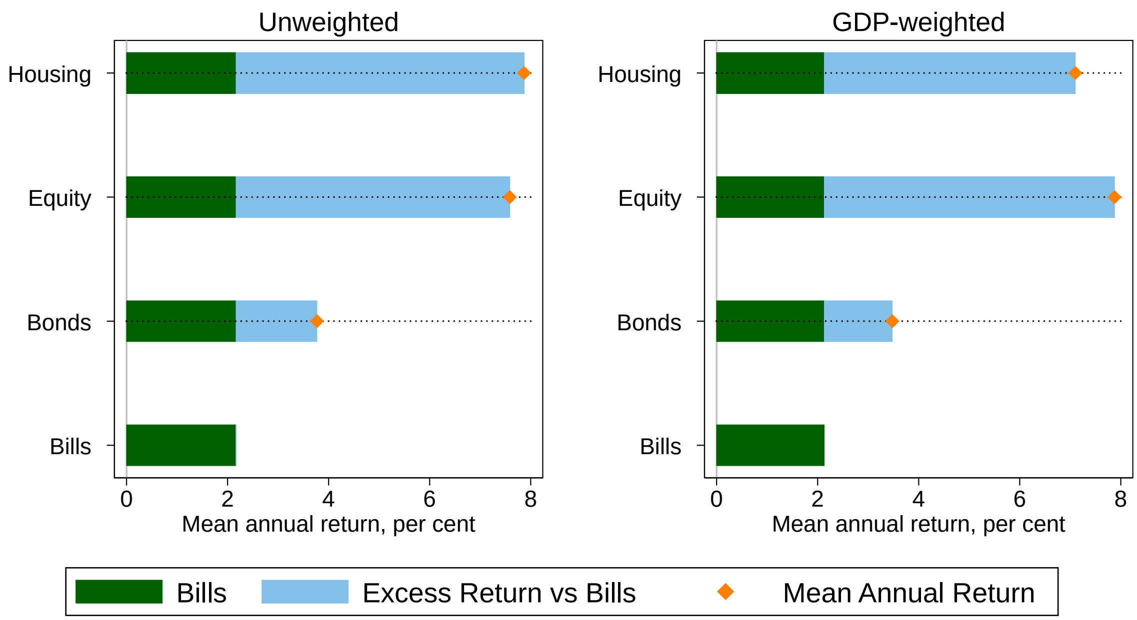
Country	World War 1		World War 2	
	Equity	Housing	Equity	Housing
Australia	0.20	1.22	4.86	4.12
Belgium	-3.75	-5.84	3.12	8.69
Denmark	6.70	4.35	2.85	11.75
Finland	4.68		0.55	-9.79
France	-12.48	-9.37	-4.05	-1.51
Germany	-12.37	-26.53	3.82	
Italy	-6.11			
Japan	15.88			
Netherlands	-0.20	5.07	5.71	9.10
Norway	-6.00	-1.38	0.62	2.54
Portugal	-3.99		3.96	
Spain	-5.77	-0.71	-0.73	-4.56
Sweden	-15.72	-3.93	5.56	7.89
Switzerland	-11.19	-4.46	1.32	3.08
UK	-6.67	-0.72	4.56	1.60
USA	0.96	0.06	4.90	8.47
Average, unweighted	-3.70	-1.84	2.65	3.85
Average, weighted	-3.69	-2.02	5.39	6.77

Note: Average annual real returns. We include one year from the immediate aftermath of the war, such that World war 1 covers years 1914—1919, and World War 2 – 1939—1946. Period coverage differs across and within countries. We exclude World War 2 periods for Italy and Japan because of hyperinflation. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

The performance of different assets during the major wars is an important issue for asset pricing models that argue that high risk premiums on equities reflect the risk of economy-wide disasters. This argument rests on the work of Barro (2006), developed further in collaboration with Emi Nakamura, John Steinsson and Jose Ursua (Barro and Ursua, 2008; Nakamura, Steinsson, Barro, and Ursúa, 2013). Table A.3 shows the returns of housing and equity markets during WW1 and WW2. The data confirm large negative returns in different countries, especially during WW1. In both wars, housing markets tended to outperform equity, making it potentially more difficult to explain the large housing risk premium that we find. This being said, the positive returns in various countries during WW2 are in some cases influenced by price controls affecting our CPI measure and direct government interventions into asset markets that aimed at keeping prices up (see Le Bris, 2012, for the case of France). Further, as we do not adjust our return series for changes in the housing stock, the series here underestimate the negative impact of wartime destruction on housing investments. As a result, the war time returns shown here likely mark an upper bound, and wars can still be seen as periods with typically low returns on risky assets.

D. Returns excluding world wars

Figure A.3: *Returns excluding world wars, full sample*



Note: Average real returns p.a., excluding world wars. Consistent coverage within each country.

In Figure A.3 we exclude WW1 and WW2 from the calculation of aggregate returns, but maintain the within country consistency of the sample, as before. As expected, excluding the wars pushes up aggregate returns somewhat, but overall risk premiums and the relative performance of the different assets classes remain comparable.

Table A.4: *Real returns on bonds and bills, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Bills	Bonds	Bills	Bonds
Australia	1.29	2.24	1.73	2.65
Belgium	1.21	3.01	1.83	3.65
Denmark	3.08	3.58	3.80	4.39
Finland	0.64	3.22	2.17	5.34
France	-0.47	1.54	0.89	3.12
Germany	1.51	3.15	2.46	4.06
Italy	1.20	2.53	2.63	4.23
Japan	0.68	2.54	1.85	3.80
Netherlands	1.37	2.71	2.22	3.70
Norway	1.10	2.55	1.91	3.56
Portugal	-0.01	2.23	0.94	3.30
Spain	-0.04	1.41	1.17	2.73
Sweden	1.77	3.25	2.59	4.39
Switzerland	0.89	2.41	1.67	3.47
UK	1.16	2.29	2.03	3.22
USA	2.23	2.85	3.00	3.60
Average, unweighted	1.14	2.61	2.19	3.84
Average, weighted	1.34	2.51	2.27	3.52

Note: Average annual real returns. Returns excluding wars omit periods 1914—1919 and 1939—1947. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both real bill and bond returns. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.4 displays country returns for bills and bonds including and excluding war periods. The effect on returns on bonds and bills, both weighted and unweighted, is substantial. The rate of return on bills almost doubles in real terms when the two war windows are excluded, and returns on bonds jump by about 1 percentage point.

Table A.5: *Real returns on equity and housing, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Equity	Housing	Equity	Housing
Australia	7.79	6.37	8.47	6.95
Belgium	6.23	7.89	7.47	8.73
Denmark	7.49	8.22	7.87	8.08
Finland	10.03	9.58	11.73	11.31
France	3.21	6.39	4.75	7.76
Germany	7.11	7.82	7.28	8.13
Italy	7.25	4.77	6.60	4.51
Japan	6.00	6.54	6.75	6.79
Netherlands	6.96	7.28	7.39	7.22
Norway	5.67	8.03	6.56	8.85
Portugal	4.51	6.31	4.51	6.31
Spain	5.83	5.21	6.92	6.41
Sweden	8.02	8.30	9.51	8.98
Switzerland	6.51	5.63	8.01	6.44
UK	6.83	5.44	7.82	5.69
USA	8.46	6.10	9.28	6.22
Average, unweighted	6.67	7.26	7.57	7.88
Average, weighted	7.12	6.72	7.86	7.10

Note: Average annual real returns. Returns excluding wars omit periods 1914—1919 and 1939—1947. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both real housing and equity returns. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

In Table A.5 we look at the performance of risky assets for the full sample and excluding war periods. The effects are visible, but less strong than in the case of bonds and bills before. Excluding war years pushes up returns on equity and housing by 50 to 80 basis points. These effects are largely independent of the GDP-weighting.

Table A.6: *Real risky and safe asset returns, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Risky return	Safe return	Risky return	Safe return
Australia	6.96	1.77	7.46	2.20
Belgium	8.31	1.82	8.53	2.61
Denmark	8.02	3.05	7.88	3.82
Finland	10.87	2.16	12.68	3.55
France	6.54	0.54	7.39	2.01
Germany	7.90	3.34	8.19	3.36
Italy	5.32	2.28	5.01	2.94
Japan	6.79	1.29	7.11	2.08
Netherlands	7.30	1.31	7.36	2.39
Norway	7.96	1.59	8.83	2.55
Portugal	6.46	0.45	6.46	0.45
Spain	5.39	0.68	6.26	1.96
Sweden	8.52	2.35	9.51	3.41
Switzerland	6.51	1.57	7.37	2.50
UK	6.35	1.51	6.91	2.39
USA	7.12	1.92	7.45	2.73
Average, unweighted	7.44	1.88	8.09	2.93
Average, weighted	7.22	1.89	7.67	2.80

Note: Average annual real returns. Returns excluding wars omit periods 1914—1919 and 1939—1947. Real risky return is a weighted average of equity and housing, and safe return - of bonds and bills. The weights correspond to the shares of the respective asset in the country's wealth portfolio. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the risky and safe return. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.6 underlines the outperformance of risky assets once we exclude the wars. Average safe returns are about 1 percentage point lower in the full sample, relative to the sample that exclude war years. By contrast, risky returns only rise by between 40 and 60 basis points when we exclude wars. As discussed above the measurement of returns in wars is problematic and we are inclined not to read too much into the relative outperformance of risky assets in war times.

Table A.7: *Return on capital and GDP growth, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Return on wealth	GDP growth	Return on wealth	GDP growth
Australia	5.91	3.51	6.48	3.64
Belgium	6.38	2.32	6.77	2.51
Denmark	7.37	2.70	7.32	2.75
Finland	9.76	3.49	11.63	3.63
France	4.92	2.55	6.03	2.75
Germany	7.07	2.81	7.30	2.98
Italy	5.08	3.82	4.94	3.23
Japan	5.59	4.18	6.31	4.31
Netherlands	5.33	3.16	5.86	3.16
Norway	6.86	3.06	7.71	3.13
Portugal	5.87	3.39	5.87	3.39
Spain	4.58	3.21	5.69	3.44
Sweden	7.41	2.89	8.45	2.97
Switzerland	5.63	2.33	6.56	2.55
UK	4.75	2.09	5.50	2.23
USA	6.03	3.38	6.63	3.19
Average, unweighted	6.30	2.86	7.12	2.93
Average, weighted	5.98	3.04	6.69	2.97

Note: Average annual real returns. Returns excluding wars omit periods 1914—1919 and 1939—1947. Real return on wealth is a weighted average of bonds, bills, equity and housing. The weights correspond to the shares of the respective asset in each country's wealth portfolio. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the real return on wealth and the real GDP growth rate. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.7 looks at the effects of war periods on the aggregate return on capital and GDP growth on a country level and for the global sample. The aggregate return on capital is about 75 basis points higher outside world wars, while GDP growth rates are barely affected as the war effort boosted GDP in many countries in the short term.

E. Returns before the Global Financial Crisis

Table A.8: *Asset returns before the Global Financial Crisis*

Country	Bills	Bonds	Equity	Housing
Australia	1.30	1.95	8.20	6.49
Belgium	1.35	2.86	6.07	8.22
Denmark	3.31	3.56	7.18	8.73
Finland	0.76	3.10	10.65	9.96
France	-0.46	1.17	3.20	6.69
Germany	1.64	3.13	7.21	7.80
Italy	1.30	2.24	8.16	5.32
Japan	0.74	2.51	6.25	6.88
Netherlands	1.48	2.50	7.19	7.77
Norway	1.14	2.41	5.63	8.14
Portugal	-0.00	1.64	5.50	7.19
Spain	0.01	0.95	6.21	5.89
Sweden	1.86	3.09	7.81	8.32
Switzerland	0.99	2.17	6.59	5.40
UK	1.32	2.16	7.11	5.74
USA	2.43	2.71	8.55	6.29
Average, unweighted	1.24	2.42	6.79	7.50
Average, weighted	1.46	2.36	7.23	6.93

Note: Average annual real returns excluding the Global Financial Crisis (i.e. sample ends in 2007). Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for returns on all four asset classes. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

This Table cuts the sample off in 2007, i.e., before the Global Financial Crisis. Comparing this table to Tables 4 and 5 in the main text shows that the effects are relatively minor. The crisis only shaves off about 10-20 basis points from equity and housing returns, and adds about 10 basis points to bills and bonds.

Table A.9: *Risky and safe returns, including and excluding the GFC*

Country	Full Sample		Excluding the GFC	
	Risky return	Safe return	Risky return	Safe return
Australia	6.96	1.77	7.16	1.63
Belgium	8.31	1.82	8.58	1.80
Denmark	8.02	3.05	8.28	3.15
Finland	10.87	2.16	11.38	2.19
France	6.54	0.54	6.82	0.36
Germany	7.90	3.34	7.90	3.49
Italy	5.32	2.28	5.93	2.18
Japan	6.79	1.29	7.03	1.28
Netherlands	7.30	1.31	7.70	1.19
Norway	7.96	1.59	8.04	1.52
Portugal	6.46	0.45	7.36	-0.26
Spain	5.39	0.68	6.06	0.47
Sweden	8.52	2.35	8.44	2.30
Switzerland	6.51	1.57	6.44	1.49
UK	6.35	1.51	6.66	1.52
USA	7.12	1.92	7.22	1.91
Average, unweighted	7.44	1.88	7.65	1.84
Average, weighted	7.22	1.89	7.38	1.87

Note: Average annual real returns excluding the Global Financial Crisis (i.e. sample ends in 2007). Real risky return is a weighted average of equity and housing, and safe return - of bonds and bills. The weights correspond to the shares of the respective asset in the country's wealth portfolio. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the real risky and the real safe return. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

This Table recalculates risky and safe returns including and excluding the Global Financial Crisis on a country level and for the global average. As noted before, the effects are quantitatively small. Excluding the crisis boosts risky returns by 10-20 basis, and lower safe returns by no more than 5 basis points. In light of the long time horizon of nearly 150 years, asset performance in the recent crisis plays a minor role for the returns presented here.

F. Returns across different monetary regimes

Table A.10: *Returns across different monetary regimes*

	Bills	Bonds	Equity	Housing	Risk premium
Gold standard (1870–1913)					
Mean return p.a.	3.06	2.81	5.96	7.49	4.25
Standard deviation	3.22	5.00	8.65	8.87	7.29
Geometric mean	3.01	2.69	5.60	7.14	4.01
Observations	305	305	305	305	301
Amended gold standard (1919–1938)					
Mean return p.a.	4.25	7.11	7.63	7.86	2.39
Standard deviation	7.77	13.58	21.58	12.04	13.53
Geometric mean	3.96	6.29	5.52	7.25	1.51
Observations	264	264	264	264	264
Bretton-Woods (1946–1973)					
Mean return p.a.	-0.82	-1.01	6.43	8.98	9.70
Standard deviation	5.59	8.85	21.00	11.17	10.00
Geometric mean	-1.00	-1.44	4.44	8.45	9.29
Observations	403	403	403	403	403
Floating exchange rates (1974–2015)					
Mean return p.a.	1.38	4.34	8.56	6.30	4.42
Standard deviation	3.39	10.82	26.29	7.61	11.49
Geometric mean	1.32	3.79	5.27	6.03	3.84
Observations	670	670	670	670	670

Note: Annual global returns and risk premiums in 16 countries, equally weighted. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for all four asset returns. Risk premium is the risky return (weighted average of equities and housing) minus the safe return (weighted average of bonds and bills).

Table A.10 examines how the returns on the four asset classes in this paper, and the risk premium, vary across monetary regimes. We roughly divide the time period in this study into the fixed exchange rates under the pre WW1 gold standard, the amended interwar gold standard, the Bretton-Woods era, and the post-Bretton-Woods floating exchange rates. Consistent with Figures VII and XIII, the returns on the risky assets have been stable across all four regimes. The volatility of equity returns has generally increased overtime, starting at levels comparable to housing under the Gold Standard, before reaching a peak of 26% under floating exchange rates. Housing returns were highest during the Bretton-Woods era (average 9% p.a.), whereas equity returns—during the recent floating exchange rate period (average 8.6% p.a.). Real bond and bill returns have, on the contrary, been much more variable across these different regimes, mirroring the pattern discussed in Section VI: they were high during the gold standard, both pre WW1 and interwar, and low—in fact, negative—during Bretton-Woods. The risk premium has also varied across these four regimes, with the swings largely driven by those in the safe rate. As discussed in Section VI, the risk premium was highest during the Bretton-Woods era, which also saw remarkably few financial crises.

G. Returns during disasters

Table A.11: *Returns during consumption disasters*

Country	Consumption			Real returns			
	Peak	Trough	Drop	Equity	Housing	Bonds	Bills
Australia	1913	1918	23.8	3.69	12.43	-4.62	-5.92
	1927	1932	23.4	14.40	-0.28	18.83	35.88
	1938	1944	30.1	5.70	35.89	0.49	-8.45
Belgium	1913	1917	44.5	-54.74	-33.05		
	1937	1942	53.0	-15.22	-35.88	-61.72	-66.44
Denmark	1919	1921	24.1	-37.32	-5.60	-37.63	-19.08
	1939	1941	26.1	-13.93	-3.64	-16.06	-14.06
	1946	1948	14.4	9.08	51.83	1.96	4.93
Finland	1913	1918	36.0	-7.43		-72.72	-60.10
	1928	1932	19.9	-6.10	17.14	49.87	49.00
	1938	1944	25.4	12.13	-45.62	-32.83	-38.39
	1989	1993	14.0	-57.92	-17.40	32.92	30.18
France	1912	1915	21.5	-7.11	16.14	-19.25	7.93
	1938	1943	58.0	110.36	-11.38	-19.55	-45.70
Germany	1912	1918	42.5	-39.37		-52.74	-50.38
	1928	1932	12.1	-54.91	15.25	12.24	45.08
	1939	1945	41.2	79.03			1.91
Netherlands	1889	1893	9.8		21.90	21.46	12.20
	1912	1918	44.0	10.55	27.55	-25.95	-15.59
	1939	1944	54.5	48.15	87.58	-19.97	-26.12
Norway	1916	1918	16.9	9.76	-1.40	-26.97	-26.54
	1919	1921	16.1	-43.18	4.65	-28.47	-11.32
	1939	1944	10.0	27.47	-2.47	-16.72	-25.84
Portugal	1913	1919	21.5	-21.90		-46.06	-53.88
	1934	1936	12.1	33.56		35.30	8.91
	1939	1942	10.4	5.76		-4.54	0.99
	1974	1976	9.8	-73.88	-32.62	-53.52	-28.47
Spain	1913	1915	12.8	-4.97	8.23	-0.18	8.35
	1929	1930	10.1	-0.24	6.10	-1.51	0.68
	1935	1937	46.1	42.88	-5.45	3.65	
	1940	1945	14.5	-23.44	-16.64		-42.18
	1946	1949	13.1	-9.90	-21.44	-32.36	-28.93
Sweden	1913	1917	11.5	-8.83	5.83	-22.59	-9.90
	1920	1921	13.2	-20.13	14.01	-12.25	3.46
	1939	1945	18.2	16.00	30.53	-34.64	-18.16

Continued overleaf

Returns during consumption disasters, continued

Country	Consumption			Real returns			
	Peak	Trough	Drop	Equity	Housing	Bonds	Bills
Switzerland	1912	1918	10.8	-34.04	-28.62	-28.50	-27.71
	1939	1945	17.3	-15.15	-9.19	-20.37	-23.49
UK	1915	1918	16.7	-34.12	8.93	-48.94	-31.30
	1938	1943	16.9	-12.27		-10.14	-27.42
USA	1917	1921	16.4	-49.07	-11.88	-44.32	-36.24
	1929	1933	20.8	-51.64	-5.58	50.71	46.35
Averages:							
All disasters			23.3	-6.71	2.23	-14.94	-12.46
Consistent sample			22.0	-8.94	3.59	-14.74	-9.30
No WW2			21.2	-19.68	0.74	-12.05	-5.35

Note: Consumption and cumulative real total returns on each asset class during consumptions disasters. Disaster dates from Barro and Ursúa (2008). Cumulative consumption drop from peak to trough year, and cumulative real returns from one year before consumption peak to one year before the trough. Negative return means an asset return drop during disaster. Disasters with missing or poor quality asset return data excluded. All-disaster average uses all disasters where we have data for the particular asset class. Consistent sample average uses only those disasters with data for all four assets. No WW2 average excludes World War 2.

Table A.11 summarises returns on the four asset classes during consumption disasters. Disaster dates and consumption data are taken from Barro and Ursúa (2008). A disaster is defined as a real consumption drop of 10% or more. Asset returns are from this paper, and include both the capital gain and yield components, net of inflation. As in Barro and Ursúa (2008), the return figures are from the year before consumption peak to the year before the trough, and do not typically correspond to peak-to-trough asset price declines. We exclude those disasters where asset data are missing, or unreliable—for example, due to a hyperinflation—from the comparison. Despite these, the data for remaining disasters are imperfect, largely due to various potential biases discussed in Sections III.B and III.C. There is likely to be some upward bias to returns because equity returns do not fully capture the effect of delistings, and housing returns do not fully capture the effect of wartime housing stock destruction. Some returns may also be subject to market intervention and price controls, especially during WW2. Still, we have strived to improve the data quality and coverage of asset return data during disasters, and hope that the above comparison provides a best-practice assessment of asset market performance during these time periods.

The upper part of Table A.11 lists the cumulative returns on each of the four asset classes during individual disaster episodes. Most disasters occur during the two world wars and the Great Depression. The several additional country-specific events include the Portuguese Carnation revolution (1974) and the Spanish Civil War (1936–1940). For most disasters, returns on all assets are low and typically negative. The disaster that had the most pronounced impact on asset markets is the Portuguese Carnation Revolution of 1974. In the aftermath of the revolution, equity returns fell by three-quarters, housing returns by one-third, and bill and bond returns by between one-third and one-half.

Some disasters saw postive returns, in particular for the risky asset classes. This is especially true for a number of countries during the WW2 German occupation. Equity returns in France,

Table A.12: *Returns during hyperinflations*

Episode	Real returns			Nominal returns			Inflation
	Bills	Bonds	Equity	Bills	Bonds	Equity	
Finland, 1917–1918	-69.54	-60.67	-60.76	4.00	34.29	33.96	241.41
Germany, 1920–1924	-100.00	-100.00	-29.03	36.95	90.37	2.25e+13	3.17e+13
Italy, 1943–1944	-76.35	-70.08	-43.40	5.10	32.96	151.53	344.39
Japan, 1944–1947	-97.66	-97.59		8.30	11.58		4522.09

Note: Cumulative real and nominal returns during hyperinflations. No housing returns data are available for these episodes. Because of potential timing differences and uncertainties about inflation rates, the returns are potentially subject to a large measurement error.

Netherlands and Germany during WW2 rose by between 50 and 100 per cent in real terms. Much of this is likely due to financial repression by the occupying government, aimed at directing funds to the stock market in order to finance the war effort (see Le Bris, 2012, for the case of France). As discussed in Section III.B, timing also played a role: for a while, the government was able to intervene in markets and sustain high returns, but asset prices usually underwent a correction at some point. Taking the French case again, the stock market fell by a factor of 18 (95%) between years 1943 and 1950, more than reversing the gains made during 1938–1943. Some of the high housing returns observed during WW2 could be driven by price and rent controls, and the fact that our data do not account for wartime destruction. To this purpose, when comparing averages at the bottom of Table A.11, we have included a comparison for disasters outside of the Second World War.

The disasters with the worst asset market performance were not necessarily those with the highest consumption drops. For example, the Portuguese revolution only saw a 10% consumption drop, and is excluded from some measures of consumption disastes such as that in Nakamura, Steinsson, Barro, and Ursúa (2013). The years leading up to the Spanish Civil War, on the contrary, saw a 46% consumption drop while the stock market boomed.

On average, consumption disasters are associated with low and negative asset returns (Table A.11, bottom panel). Safe assets do the worst, largely because they provide a poor hedge for inflation risk. Housing returns, on average, seem more robust to disasters, recording a low but positive real return (+2.2% cumulative), even excluding the period of WW2 that saw widespread housing market controls and war destruction (+0.7% cumulative real return excluding WW2). Equities do much worse in disasters outside of WW2, with an average cumulative real return of -20%, compared to -6.7% return in all disasters. This is consistent with the notion that stock markets were artificially supported through regulations and financial repression in some countries during the Second World War.

One type of disaster event that we exclude from our main sample are hyperinflations. We do this because of very large measurement error during these time periods: not only are price changes and capital gains on assets measured imprecisely, but timing matters a lot: for example, if the price change is measured from June one year to June the next, but asset prices are measured in December each year, and the inflation rate is increasing sharply, real returns would be vastly overstated. Nevertheless, our data do allow us to make some tentative estimates on the size of returns during these time periods. These are presented in Table A.12. We do not have any housing return data for hyperinflation periods, but we have equity, bond and bill return data for three episodes (Finland post WW1, Germany 1920s and Italy WW2), and bond and bill return data for the post WW2 hyperinflation in Japan.

One can see that the nominally fixed assets—bonds and bills—fare worst during these time periods. Domestic government debt holders were more or less wiped out during the German hyperinflation, and lost most of their capital during the Japanese post-WW2 episode. Equity holders fare somewhat better, but still suffer losses. During the German hyperinflation, for example, equities generally kept pace with the explosive growth in consumer prices. Including hyperinflations in our sample would have a very small effect on the aggregate average equity returns because of the infrequency of these episodes, and the fact that equity holders are not generally wiped out during hyperinflations. Cross-country arithmetic average returns on bonds and bills would also change little, but the geometric mean return on these two assets would fall to near zero, reflecting the highly negative real returns on these assets during the German hyperinflation.

H. Returns without interpolation

Table A.13: *Returns with and without interpolation*

	Baseline		No interpolation	
	Equity	Housing	Equity	Housing
Mean return p.a.	6.73	6.93	6.86	6.99
Standard deviation	21.91	10.31	21.80	10.15
Observations	1790	1790	1783	1782

Note: Equity and housing returns with (baseline) and without interpolation. Interpolation only used to cover the following disaster periods. Equity: Spanish Civil War, Portuguese Carnation Revolution. Housing: Belgium WW1, Sweden WW1, Spanish Civil War. We only interpolate either house prices or rents, never both. 16 countries, unweighted.

For a very small number of observations, we interpolate our equity and housing return series to obtain a proxy of the annual return during disasters, for example when the stock exchange was closed or when only either annual rental or house price data exist, but not both. These cover selected periods in WW1, the Spanish Civil War and the Portuguese Carnation Revolution, with a total of 7 observations for equities and 8 for housing. Table A.13 compares our baseline interpolated returns with those without interpolation. The returns and their volatility (annual standard deviation) are almost identical, albeit interpolated returns are slightly lower because they better proxy the returns during disaster periods.

I. US Dollar returns

Table A.14: *Global real returns for a US-Dollar investor*

	Real returns				Nominal Returns			
	Bills	Bonds	Equity	Housing	Bills	Bonds	Equity	Housing
Full sample:								
Mean return p.a.	1.97	3.52	7.89	8.17	4.41	5.93	10.45	10.84
Standard deviation	12.05	15.49	24.98	15.72	11.63	14.81	25.21	16.09
Geometric mean	1.18	2.33	5.02	6.99	3.69	4.86	7.62	9.64
Mean excess return p.a.	0.21	1.76	6.13	6.41				
Standard deviation	11.23	14.63	24.63	15.73				
Geometric mean	-0.47	0.71	3.32	5.23				
Observations	1767	1767	1767	1767	1767	1767	1767	1767
Post-1950:								
Mean return p.a.	2.26	4.12	9.62	9.02	5.72	7.60	13.22	12.70
Standard deviation	10.59	13.75	26.32	14.89	10.95	13.88	26.81	15.34
Geometric mean	1.72	3.23	6.50	8.04	5.17	6.73	10.11	11.70
Mean excess return p.a.	0.80	2.66	8.16	7.56				
Standard deviation	10.58	13.83	26.11	15.02				
Geometric mean	0.25	1.75	5.06	6.54				
Observations	1022	1022	1022	1022	1022	1022	1022	1022

Note: Global average US-Dollar returns, equally weighted. Real returns subtract US inflation. Excess returns are over US Treasury bills. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for all four asset returns.

Table A.14 shows nominal and real returns from the perspective of a U.S. dollar (USD) investor. The Table can be directly compared to Table II in the paper. Overall, calculating returns in dollars increases their volatility, since returns now also fluctuate with nominal exchange rate movements. It also adds up to 1 percentage point to the local currency returns reported in Table II. The higher average return is, for the most part, driven by the higher volatility—exchange rate movements amplify both positive and negative returns, but because returns are on average positive, the average return increases. The effects are stronger after WW2, going hand-in-hand with the greater exchange rate volatility after the collapse of the Bretton Woods system.

Table A.15: *USD returns by country*

Country	Bills	Bonds	Equity	Housing
Australia	1.77	2.59	8.53	7.28
Belgium	0.96	3.27	7.36	8.92
Denmark	3.63	4.12	7.94	8.93
Finland	1.93	6.48	12.08	12.00
France	1.05	3.10	5.16	8.87
Germany	4.33	5.81	8.75	9.69
Italy	2.85	4.81	8.73	6.37
Japan	2.37	4.15	8.00	8.74
Netherlands	1.87	2.93	7.91	8.67
Norway	1.64	3.04	6.72	8.88
Portugal	0.23	2.11	6.09	7.10
Spain	0.93	2.36	7.47	6.38
Sweden	2.08	3.64	8.63	8.87
Switzerland	2.04	3.62	7.62	7.14
UK	1.89	2.66	7.66	6.25
USA	1.52	2.33	8.46	6.10
Average, unweighted	2.08	3.55	7.67	8.36
Average, weighted	2.03	3.28	7.95	7.63

Note: Average annual real US-Dollar returns. Calculated as nominal US-Dollar return minus US inflation. Period coverage differs across countries. Consistent coverage within countries. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

In Table A.15 we display Dollar returns for individual asset classes and individual countries for the full sample. For US-Dollar based fixed income investors, Germany and Finland offered the highest returns. In housing markets, Germany and Finland again stand out, and high returns are seen in Belgium, France, Netherlands and the Scandinavian countries. In equity markets, Finland, Italy, and Sweden were the best performing markets.

J. Risky returns ranked by country

Table A.16: *Risky returns ranked by country*

Country	Full sample	Post-1950	Post-1980
Finland	10.87	13.10	13.06
Sweden	8.52	10.23	11.42
Belgium	7.60	8.72	7.99
Denmark	8.01	7.85	6.84
Norway	7.96	9.32	10.65
Germany	7.90	5.83	5.20
Average, unweighted	7.44	8.10	7.65
Netherlands	7.30	8.77	7.42
USA	7.12	7.03	7.28
Australia	6.96	8.43	7.71
Japan	6.79	7.05	4.81
France	6.54	9.09	6.61
Switzerland	6.51	7.04	7.76
Portugal	6.46	6.21	7.41
UK	6.35	7.85	7.66
Spain	5.39	6.17	5.46
Italy	5.32	5.85	5.21

Note: Average annual real risky returns. Real risky return is a weighted average of equity and housing. The weights correspond to the shares of the respective asset in the country's wealth portfolio. Period coverage differs across countries. The figure is the unweighted arithmetic average of individual country returns.

In Table A.16 we rank risky returns in the different countries. We calculate risky returns as a combination of equity and housing weighted by the share of each asset in the country's total wealth portfolio. North-western Europe—essentially the Scandinavian countries plus Germany and Belgium—stands out as the region with the highest aggregate returns on risky assets. The U.S. returns are about average, while the southern European countries have comparatively low long-run returns.

K. Risky returns over longer time horizons

Table A.17: *Equity and housing return moments over longer time horizons*

	1-year (baseline)		5-year		10-year		20-year	
	Equity	Housing	Equity	Housing	Equity	Housing	Equity	Housing
Mean return p.a.	6.88	7.06	7.11	7.00	7.11	7.16	7.24	7.10
Standard deviation	21.79	9.93	9.12	5.39	7.42	4.02	6.41	2.75
Observations	1767	1767	337	337	152	152	58	58

Note: Average global real returns in 16 countries averaged over 1-year, 5-year, 10-year and 20-year non-overlapping windows.

Table A.17 computes average equity and housing returns over longer time horizons. Because of high transaction costs, housing returns are likely to exhibit much more sluggish responses to shocks than equity returns, and display larger volatility or variability at medium to long horizons. Columns 1 and 2 present the baseline 1-year returns compared to average returns over 5, 10 and 20-year windows. The volatility of both equity and housing returns falls, the longer the smoothing window. But the two fall at the same rate, and the standard deviation of housing returns is always around half of equity returns, regardless of the time horizon.

L. Equity return comparison with existing sources

Table A.18: *Real equity returns in our dataset compared to existing literature*

	Full sample	Post-1900	Dimson et al.	Barro and Ursua
Australia	8.39	7.81	8.93	10.27
Belgium	5.89	5.65	5.32	
Denmark	7.54	7.49	7.10	7.50
Finland	9.42	9.72	10.23	12.68
France	3.21	2.27	5.83	5.43
Germany	8.83	9.11	9.18	7.58
Italy	6.09	5.68	6.35	5.10
Japan	9.64	8.60	9.50	9.28
Netherlands	6.96	6.96	6.92	9.01
Norway	5.67	5.73	7.20	7.16
Portugal	4.05	3.36	8.66	
Spain	5.77	5.77	5.77	6.10
Sweden	8.00	7.94	7.87	9.23
Switzerland	6.50	6.50	6.19	7.26
UK	6.86	6.74	7.06	6.41
USA	8.40	8.43	8.59	8.27
Average, unweighted	7.02	6.69	7.50	7.95
Average, weighted	7.40	7.18	7.71	7.83

Note: Average annual real equity returns. Period coverage differs across countries. Consistent coverage within countries. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns. Full sample estimates cover our entire dataset, post-1900 estimates are our data restricted to years 1900 and after. Dimson et al. data are from the Dimson-Marsh-Staunton dataset, which covers the period from 1900 onwards. Barro and Ursua are data from Barro and Ursúa (2008), some series starting in 1870 and others in later years. Barro and Ursua weighted average is weighted by 2000 real GDP.

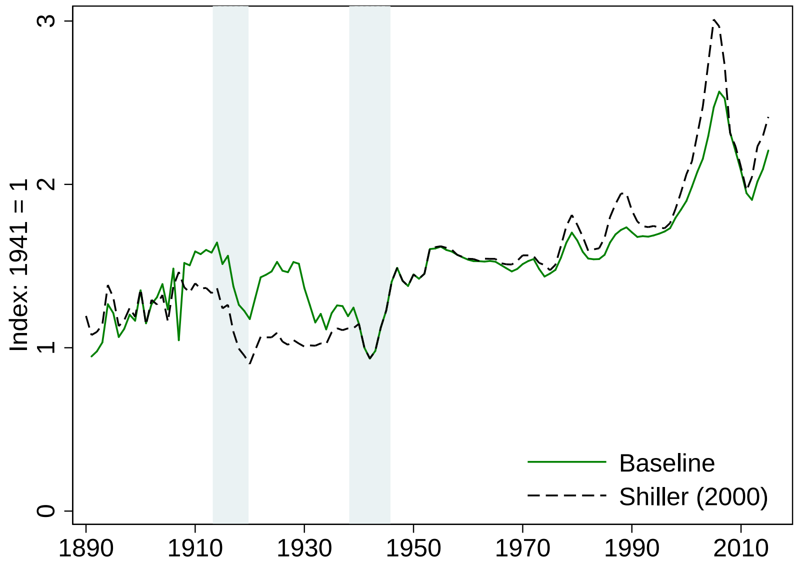
Table A.18 compares our equity return estimates with those in the existing literature, using the updated dataset in Dimson, Marsh, and Staunton (2009) (DMS), and the data in Barro and Ursúa (2008) (BU), with the latter sourced from *Global Financial Data*. Our equity return estimates are similar to those of DMS and BU, but generally slightly lower, with the largest differences in the returns for France and Portugal. The lower returns for France come from a higher-quality value weighted index in Le Bris and Hautcoeur (2010), which eliminates a number of accuracy problems in older indices, mainly related to selection bias and weighting, and hence results in lower returns than the indices used in DMS and BU.[48] The low returns for Portugal are partly attributable to better coverage of the market crash after the Carnation Revolution of 1974 (see Section III.B and Table III). The volatility of equity returns is similar across the different sources. The standard deviation of equity returns in our dataset is 21.8 percentage points p.a., compared to 24.4 in DMS and 23.1 in BU.[49]

[48] See Le Bris and Hautcoeur (2010) for a further discussion of these issues.

[49] The BU standard deviation figure is an average of country-specific standard deviations; whereas our and DMS standard deviation is computed across the whole cross-country portfolio.

M. Housing return comparison to Shiller

Figure A.4: *Real house price index in this paper compared to Shiller*



Note: Real house price indices, normalised to equal 1 in 1941. Our house price index is sourced from Knoll et al. (2017). Shiller house price index from Shiller (2000), updated.

Table A.19: *Comparison of our housing return estimates to the Shiller series*

	Shiller (2000)	Our baseline		
	Real capital gain	Real capital gain	Rental yield	Total return
Mean return p.a.	0.76	0.90	5.33	6.10
Standard deviation	6.35	7.84	0.75	8.12
Geometric mean	0.56	0.61	5.32	5.80
Observations	125	125	125	125

Note: Real housing returns, capital gains and rental yield for the US. Shiller data use the house price index from Shiller (2000).

The house price index in this paper is sourced from Knoll et al. (2017). Figure A.4 compares this house price index with that in Shiller (2000). The main difference between the indices in Knoll et al. (2017) and Shiller (2000) is that Knoll et al. (2017) use the index in Fishback and Kollmann (2015) for the period 1929–1940, which is a hedonic index based on 106 cities, and has wider geographic coverage than the Shiller (2000) index of 5 cities during this period. We normalize the indices to equal 1 in 1941 the point before which we use a different index to Shiller. The Fishback and Kollmann (2015) index registers larger house price falls in the Great Depression, which means that extrapolated back, the house prices in the early 20th century are somewhat higher. Knoll et al. (2017) also use the FHFA OFHEO index for the period 1975–2012, which reports similar growth to Shiller's index. Across the full sample, the differences between the two indices are small. For further detail on the differences between the two series and the underlying methodologies used, see Online Appendix of Knoll et al. (2017). The first two columns of Table A.19 summarize the key moments of the two indices. The real capital gains and their standard deviation are almost identical for the two series. Table A.19 adds the rental yield estimates to arrive at a total housing return figure for the US. As discussed in Section IV.C, most of the real return in our series comes from the rental yield, both for the US and other countries—although the rental yield share in returns is higher in the US than in most countries, and the real capital gain—lower.[50] Therefore, for our index as for that in Shiller (2000), real capital gains are low but total housing returns are high. For equities too—especially in geometric mean terms—most of the real return comes about from the dividend yield (see Section IV.C and Appendix N).

[50] As in Section IV.C, we subtract the inflation rate from the capital gain rather than yield.

N. Further detail on housing and equity return decomposition

Table A.20: *Total nominal return components for equity and housing*

	Equity			Housing		
	Capital gain	Dividend income	Total return	Capital gain	Rental income	Total return
Full sample:						
Mean return p.a.	6.59	4.17	10.77	5.55	5.50	11.05
Standard deviation	21.89	1.74	22.36	10.34	2.05	10.69
Geometric mean	4.48	4.16	8.64	5.08	5.48	10.57
Observations	1707	1707	1707	1707	1707	1707
Post-1950:						
Mean return p.a.	9.25	3.80	13.06	7.02	5.22	12.24
Standard deviation	24.45	1.81	25.08	9.79	1.93	10.22
Geometric mean	6.59	3.79	10.34	6.62	5.21	11.82
Observations	995	995	995	995	995	995

Note: Average annual nominal capital gain, dividend or rental income, and total return across 16 countries, unweighted. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both equity and housing returns, capital gains and yields. Dividend and rental income expressed in percent of previous year's asset price.

Tables A.20–A.22 present some alternative decompositions of risky returns into capital gain and dividend or rental income. Table A.20 shows the decomposition of *nominal* returns, and does not take a stance on subtracting inflation from capital gains or dividend/rental income. The nominal return is split roughly 50/50 between capital gains and dividend or rental income, with, as in Table VIII, a somewhat higher share of the equity returns accoutned for by capital gains. After 1950, roughly three-quarters of the nominal equity return comes about from capital gains. Table A.21 shows the nominal return decomposition by country. Capital gains account for most of the nominal return in every country, whereas rental yield accounts for most of the housing return in all but two countries, with the remaining two countries split roughly equally between dividends and capital gains. Table A.22 goes back to the real return decomposition (aggregates show in Table VIII), but now shows the by-country splits in geometric mean terms. The importance of dividend and rental income becomes rather ubiquitous. The geometric real capital gain for housing in the US is low at 0.6, echoing the findings of Shiller (2000) (see also Table A.19).Even though real capital gains n the US are the lowest in our sample, their level is by no means unusual—for example, both Spain and Sweden display similarly low capital gains, and several countries record lower geometric total returns than the US. Portugal stands out as the only country with a negative cumulative real geometric return on a risky asset (equities), largely driven by the damage done by the Carnation Revolution, and generally low dividend income.[51]

[51]The Portuguese equity returns in Table A.22 are from year 1948 onwards, to maintain consistency with housing data. For the period from 1870 to today, the geometric mean real total return on Portuguese equities is above zero.

Table A.21: *Total nominal return components for equity and housing by country*

	Equity				Housing			
	Capital gain	Dividend income	Total return	Capital gain share	Capital gain	Rental income	Total return	Capital gain share
Australia	6.92	4.90	11.82	0.59	6.57	3.99	10.57	0.45
	(16.53)	(1.08)	(17.18)		(13.60)	(0.92)	(13.69)	
Belgium	6.84	3.83	10.67	0.64	5.78	6.15	11.93	0.32
	(23.73)	(1.64)	(24.35)		(10.09)	(1.46)	(9.94)	
Denmark	5.75	4.95	10.69	0.54	4.24	7.13	11.37	0.23
	(17.39)	(2.09)	(17.91)		(7.77)	(2.42)	(7.82)	
Finland	10.43	5.08	15.50	0.67	8.44	7.14	15.58	0.37
	(30.75)	(1.95)	(31.35)		(14.54)	(2.86)	(15.59)	
France	4.67	3.73	8.40	0.56	7.06	5.09	12.15	0.41
	(20.89)	(1.33)	(21.31)		(9.20)	(1.14)	(9.75)	
Germany	4.29	4.08	8.72	0.51	3.50	6.03	9.52	0.22
	(21.16)	(1.58)	(21.83)		(10.20)	(2.61)	(10.85)	
Italy	9.14	3.61	12.75	0.72	7.29	3.49	10.77	0.51
	(30.40)	(1.34)	(30.69)		(14.74)	(1.59)	(15.03)	
Japan	6.78	2.65	9.81	0.72	5.89	4.70	10.60	0.39
	(18.50)	(1.77)	(18.85)		(9.60)	(1.24)	(9.97)	
Netherlands	6.82	4.87	11.71	0.58	5.25	5.96	11.21	0.31
	(19.28)	(1.57)	(19.72)		(8.59)	(1.68)	(9.14)	
Norway	4.71	4.21	8.88	0.53	4.62	6.72	11.34	0.26
	(19.92)	(1.60)	(20.34)		(8.08)	(1.19)	(8.31)	
Portugal	9.86	2.28	12.16	0.81	8.54	4.47	13.01	0.49
	(37.95)	(1.22)	(38.24)		(11.44)	(1.98)	(12.51)	
Spain	7.40	4.53	11.65	0.62	7.20	4.16	11.36	0.46
	(20.62)	(2.30)	(21.21)		(12.95)	(1.60)	(13.28)	
Sweden	7.12	4.12	11.17	0.63	4.34	7.12	11.47	0.23
	(19.94)	(1.05)	(20.40)		(7.48)	(1.61)	(7.83)	
Switzerland	5.76	3.20	8.93	0.64	3.57	4.54	8.11	0.28
	(19.78)	(1.46)	(19.81)		(6.10)	(0.62)	(6.19)	
UK	6.20	4.53	10.73	0.58	5.39	3.94	9.33	0.41
	(20.89)	(1.39)	(21.70)		(9.81)	(0.86)	(9.97)	
USA	6.70	4.38	11.08	0.60	3.54	5.33	8.87	0.25
	(18.22)	(1.57)	(18.45)		(8.24)	(0.75)	(8.40)	

Note: Arithmetic average of annual nominal capital gain, dividend or rental income, and total return, full sample. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both equity and housing returns, capital gains and yields. Dividend and rental income expressed as percentage of previous year's asset price. Capital gain share is the proportion of nominal total return attributable to nominal capital gains.

Table A.22: *Real geometric return components for equity and housing by country*

	Equity				Housing			
	Real capital gain	Dividend income	Real total return	Capital gain share	Real capital gain	Rental income	Real total return	Capital gain share
Australia	1.69	4.90	6.37	0.26	2.05	3.99	5.90	0.21
	(16.87)	(1.03)	(16.75)		(9.04)	(0.89)	(8.76)	
Belgium	-0.05	3.82	3.57	0.01	0.87	6.14	6.79	0.07
	(23.04)	(1.58)	(23.08)		(14.78)	(1.38)	(14.47)	
Denmark	1.44	4.93	6.23	0.23	1.01	7.10	7.95	0.07
	(15.96)	(1.99)	(15.65)		(7.00)	(2.27)	(7.15)	
Finland	1.03	5.06	5.78	0.17	1.85	7.10	8.52	0.12
	(28.56)	(1.86)	(28.33)		(13.69)	(2.67)	(13.99)	
France	-2.62	3.73	0.90	0.41	1.10	5.08	5.90	0.10
	(21.59)	(1.28)	(21.58)		(9.60)	(1.08)	(9.77)	
Germany	0.69	4.06	5.08	0.14	1.45	5.99	7.36	0.11
	(20.43)	(1.51)	(19.67)		(9.10)	(2.43)	(9.28)	
Italy	0.24	3.60	3.66	0.06	1.10	3.47	4.39	0.14
	(26.69)	(1.29)	(26.53)		(8.10)	(1.54)	(8.23)	
Japan	1.46	2.63	4.34	0.36	1.70	4.70	6.22	0.16
	(18.13)	(1.72)	(17.93)		(7.73)	(1.19)	(7.80)	
Netherlands	1.55	4.86	6.27	0.24	1.43	5.94	7.16	0.11
	(19.39)	(1.49)	(18.99)		(8.07)	(1.58)	(8.16)	
Norway	-0.24	4.19	3.79	0.05	1.16	6.71	7.68	0.08
	(19.53)	(1.53)	(19.31)		(8.17)	(1.12)	(8.11)	
Portugal	-2.76	2.27	-0.67	0.55	0.69	4.45	4.79	0.08
	(34.92)	(1.19)	(35.02)		(9.54)	(1.87)	(9.16)	
Spain	-0.18	4.50	3.81	0.04	0.63	4.15	4.56	0.07
	(19.90)	(2.18)	(19.71)		(11.16)	(1.53)	(11.10)	
Sweden	2.17	4.11	6.08	0.35	1.01	7.11	7.92	0.07
	(19.68)	(1.01)	(19.51)		(8.81)	(1.50)	(8.57)	
Switzerland	1.13	3.19	4.26	0.26	0.61	4.54	5.03	0.06
	(20.27)	(1.41)	(19.83)		(6.46)	(0.59)	(6.43)	
UK	0.68	4.52	5.02	0.13	1.25	3.94	5.05	0.14
	(19.34)	(1.32)	(18.83)		(8.77)	(0.83)	(8.70)	
USA	2.35	4.37	6.66	0.35	0.61	5.32	5.80	0.05
	(19.47)	(1.51)	(18.81)		(7.63)	(0.71)	(7.46)	

Note: Geometric average of annual real capital gain, dividend or rental income, and total return, full sample. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both equity and housing returns, capital gains and yields. Dividend and rental income expressed as percentage of previous year's asset price. Capital gain share is the proportion of real total return attributable to real capital gains.

O. Further detail on the composition of wealth

O.1 Investible assets and capital stock

Table A.23: *Composition of investible assets by country*

Country	Housing	Equity	Bonds	Bills	Deposits	Other financial	Other non-financial
France	23.2	28.0	5.1	1.5	10.4	11.9	19.8
Germany	22.2	24.2	5.6	0.2	14.0	17.3	16.4
Japan	10.9	13.4	13.1	1.5	18.9	12.9	29.4
UK	27.5	24.8	6.1	0.2	10.7	12.6	18.1
USA	15.8	38.5	9.7	0.9	7.4	6.0	21.7
Average share	19.9	25.8	7.9	0.9	12.3	12.1	21.1

Note: Ratios to total investable assets, percentage points. End-2015.

Table A.24: *Composition of capital stock by country*

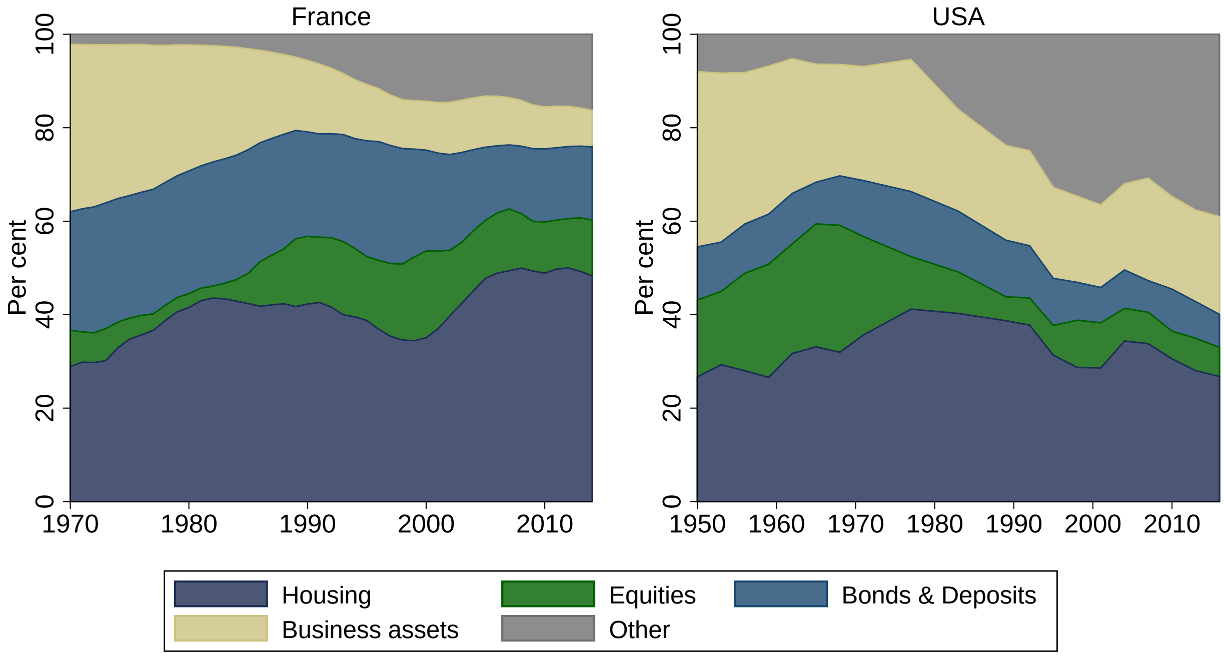
Country	Housing	Other buildings	Machinery and equipment	Other non-financial
France	53.9	25.5	4.4	16.2
Germany	57.6	38.0	1.2	3.1
Japan	27.0	47.1	6.7	19.2
UK	60.2	22.5	9.5	7.8
USA	42.2	37.0	11.4	9.3
Average share	48.2	34.0	6.6	11.1

Note: Ratios to total capital stock, percentage points. End-2015.

Tables A.23 and A.24 show the individual-country investible asset and capital stock shares of each individual class. The average shares correspond to those in Section II.A Figure I. Housing, equity, bonds and bills account for the majority of investible assets, and housing—for around half of capital stock in most countries. Japan stands out as having a relatively large stock of government bonds and non-residential real estate, and the US for relatively high equity wealth. In relative terms, UK has the highest share of housing in investible assets and capital stock.

O.2 Household balance sheet composition

Figure A.5: *Household balance sheet composition in the US and France*



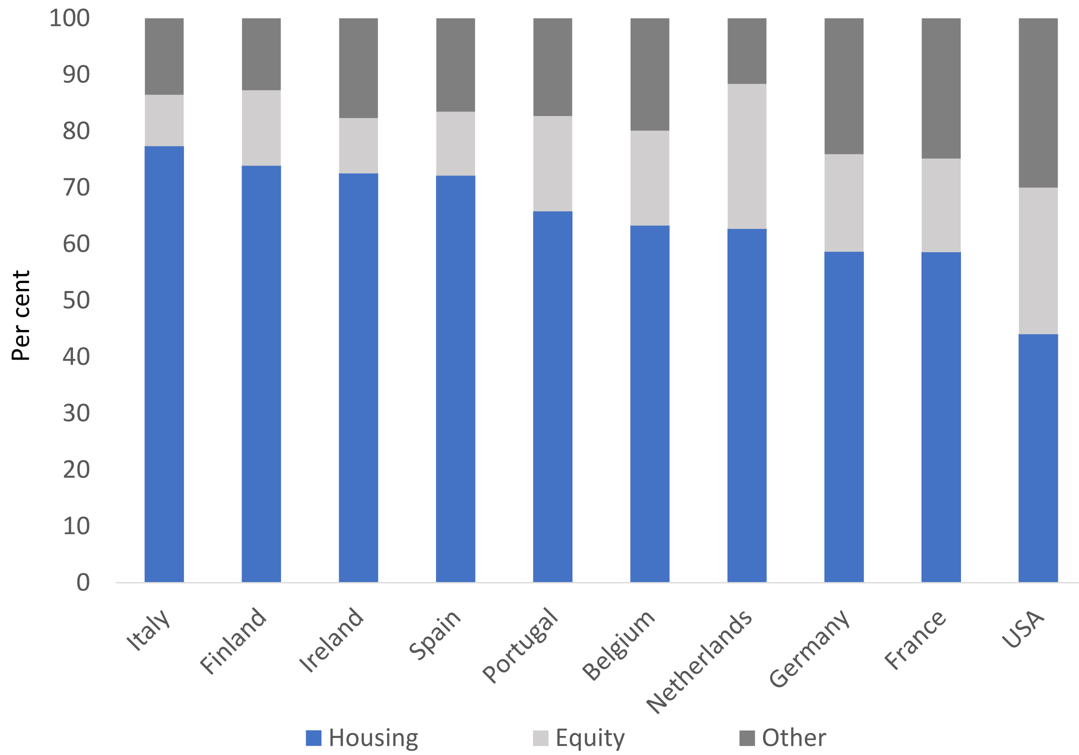
Note: Ratio of each asset class to total household assets, in percent. Housing assets are net of mortgage debt. Other assets include agricultural land, pension, insurance and investment fund claims. Sources: Survey of Consumer Finances and French Distributional National Accounts.

This paper measures returns on the major asset classes from the perspective of a representative household. To gauge the relative importance of these assets on household balance sheets, Figure A.5 plots the historical composition of assets held by households in France and the US, from the mid twentieth century to today. The data for France come from the Distributional National Accounts in Garbinti, Goupille-Lebret, and Piketty (2017), and US data are from the Historical Survey of Consumer Finances in Kuhn, Schularick, and Steins (2017). The figures present the share of each asset class in total household assets, with housing measured net of mortgage debt. Residential real estate (dark blue area) is by far the largest asset on household balance sheets. Taken together, housing and equity assets account for 40–50% of total household assets in both countries.

Bonds and deposits represent between 10 and 20 percent of assets. Aside from corporate bonds, the return on these assets is well proxied by our government bond and bill series.[52] Business assets—the light yellow bar—account for between 10 and 30 percent of wealth, depending on the country and time period. The equity returns in our sample can be used as a proxy for the levered return on business assets. Other assets include agricultural land–the remaining non-financial asset—and other financial assets, which mainly consist of pension fund and insurance claims. Returns on these claims should, in turn, be closely related to the equity and bond series in our sample. The share of other financial assets has been growing over the past several decades, largely reflecting the fact

[52] Data on the total returns on corporate bonds are generally sparse, but the small amount of data that we have suggest that corporate bond returns fall in-between those of government bonds and equities, and somewhat closer to government bonds in terms of level and volatility, with a roughly 1 percentage point spread between long-run government and corporate bond returns.

Figure A.6: *Household balance sheet composition throughout advanced economies, 2013-2014*



Note: Ratio of each asset class to total household assets, in percent. Housing assets are net of mortgage debt. Other assets include business wealth, agricultural land, bonds, deposits, pension, insurance and investment fund claims. Source: ECB Household Finance and Consumption Survey and Survey of Consumer Finances.

that, especially in the US, an increasing proportion of equities is held indirectly through financial intermediaries.

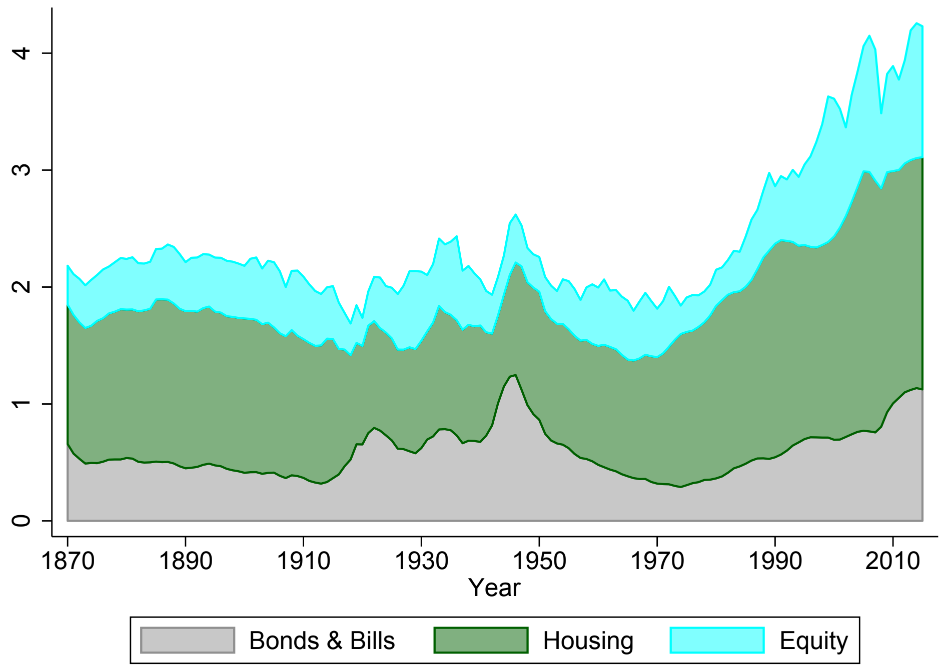
Figure A.6 shows the balance sheet composition for a larger selection of countries in 2013-2014, using data from the ECB Household Finance and Consumption Survey and the Survey of Consumer Finances. In other European countries, the role of housing and equities is even more important than in France and the US. In Italy, housing accounts for close to 80% of household wealth, and housing and equities together for nearly 90%. These data suggest that for our cross-country sample, the share of housing and equity assets in household balance sheets is likely to be somewhat larger than that pictured for the US and France in Figure A.5.

O.3 The historical global asset portfolio

For the historical dataset in this paper, we measure the size of each asset class in country portfolios in order to calculate weighted returns, such as the return on total wealth in Section II.C. Due to the lack of consistent historical data on household balance sheets of the type shown in Figure A.6, we focus solely on the assets in our study: equity, housing, bonds and bills. As outlined in Section II.C, we weight the individual asset returns within each country according to the market-capitalization shares of the respective asset types in the country's investible wealth portfolio, to arrive at the composite return measures. Thus, by this choice of method, significant non-market asset weights are not included, notably non-traded equity wealth.

Figure A.7 shows the evolution of marketable wealth in advanced economies from the late 19th

Figure A.7: *Assets considered in this study as a share of GDP*



Note: Average of asset-to-GDP shares in individual countries, weighted by real GDP. Equity is the total stock market capitalization. Housing is the stock of housing wealth. Bonds and bills are the stock of public debt.

century to today. In line with the more recent data on household balance sheets (Figures A.5 and A.6), housing has been the dominant asset in the countries' portfolios throughout the sample. Public debt has tended to increase in size after wars, and most recently after the Global Financial Crisis. The stock market has tended to be small relative to housing, but has increased in size during the last several decades. The last four decades have also seen a marked increase in the aggregate stock of assets pictured in Figure A.7, in line with the findings of Piketty and Zucman (2014), who cover a broader selection of assets, but have fewer countries and observations in their sample. Taken together, the assets in our study add up to over four times the national income. For the modern period, this constitutes around 70% of total national wealth as measured by Piketty and Zucman (2014).

The sources for the asset portfolio data are as follows. The data on equity wealth come from Kuvshinov and Zimmermann (2018), and measure the total stock market capitalization of the specific country. These series cover the total size of the domestic stock market, excluding foreign-owned companies, and aggregating across multiple stock exchanges within the country, excluding cross listings, at each year in the historical sample. Due to data limitations we have had to rely on data for individual markets for a number of countries and historical periods (e.g., only counting the Lisbon listings, but not the Porto listings for Portugal), and rely on interpolation to construct some of the early annual estimates. The stock market capitalization data are sourced from a wide variety of publications in academic journals, historical statistical publications, and disaggregated data on stock listings and company reports of listed firms.

To measure the value of housing wealth for each country, we went back to the historical national wealth data to trace the value of buildings and the underlying land over the past 150 years. We heavily relied on the national wealth estimates by Goldsmith (Garland and Goldsmith, 1959;

Goldsmith, 1962, 1985) as well as the on the collection of national wealth estimates from Piketty and Zucman (2014) for the pre-WW2 period. We also drew upon the work of economic and financial historians, using the national wealth estimates of Stapledon (2007) for Australia, Abildgren (2016) for Denmark, Artola Blanco, Bauluz, and Martínez-Toledano (2017) for Spain, Waldenström (2017) for Sweden, and Saez and Zucman (2016) for the US. For the postwar decades, we turned to published and unpublished data from national statistical offices such as the U.K. Office of National Statistics or Statistics Netherlands (1959). Particularly for the earlier periods, many of the sources provided estimates for benchmark years rather than consistent time series of housing wealth. In these cases, we had to use interpolation to arrive at annual estimates.

We use total public debt from the latest vintage of the long-run macrohistory database (Jordà, Schularick, and Taylor, 2017) as a proxy for the stock of bonds and bills, and divide public debt equally between these two financial instruments.

Even though the data come from different sources than the household balance sheets in Figures A.5 and A.6, the relative shares of the three asset classes are similar to the shares of similar asset holdings in the household portfolios. Under both definitions, residential real estate is the largest asset in the portfolio. The share of equity in marketable wealth (Figure A.7) is somewhat larger than in household balance sheets, but since some equity is held indirectly, and equity to some extent proxies the levered return on business wealth, the relative weight in our data is broadly reflected of equity returns' contribution to the overall return on household wealth. Finally, the public debt share is similar to bonds and deposits in French household wealth data (Figure A.5, left-hand graph), and to bonds, deposits and part of indirectly held assets in the US balance sheets (Figure A.5, right-hand graph).

O.4 Foreign assets

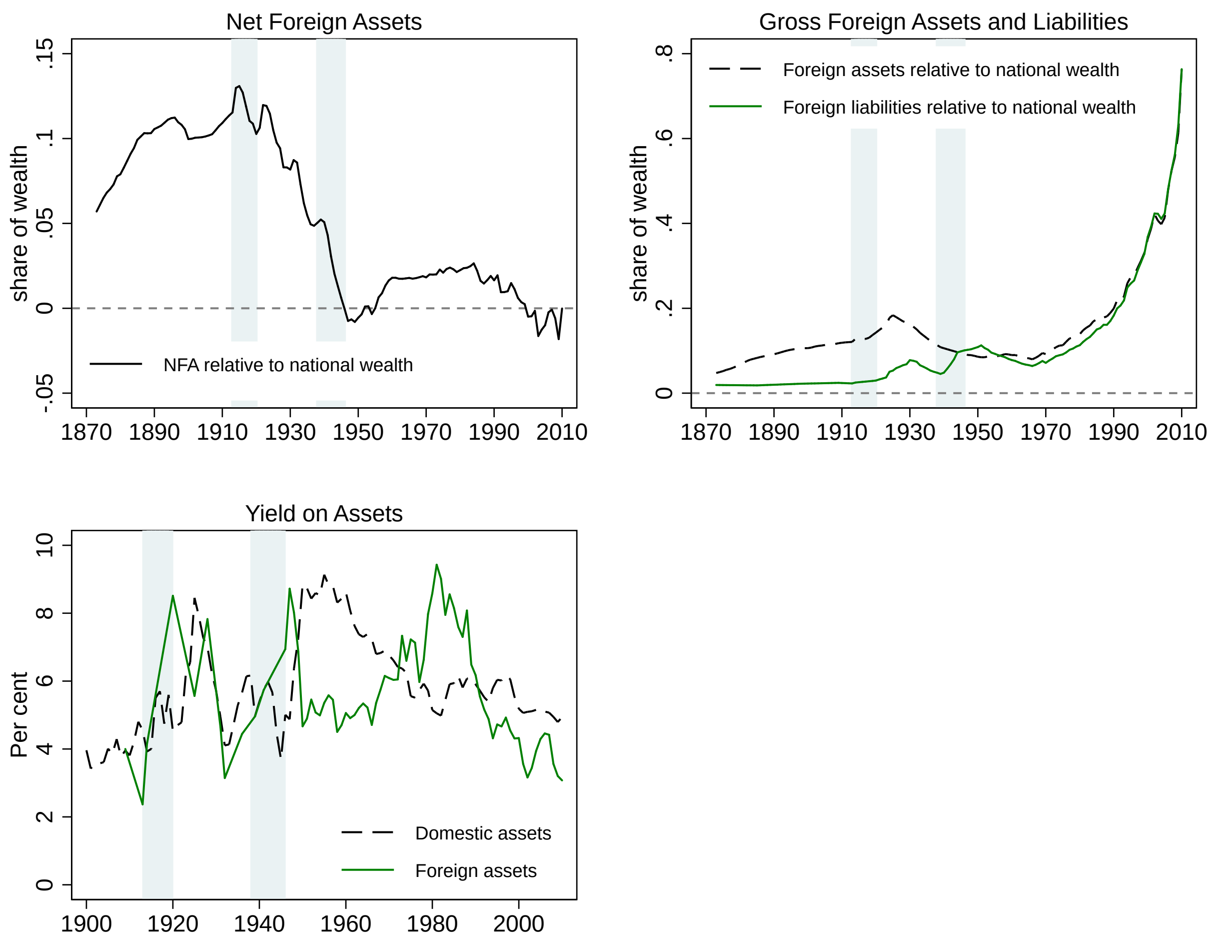
The returns in our dataset are calculated from the perspective of an investor in the domestic market, and therefore exclude the return on foreign investments. But households also hold foreign assets, and the return on these assets may impact the return on the overall household portfolio. Including these assets in our portfolio could lower the return for some countries and periods, if they held large foreign investments in foreign asset markets that were subject to subsequent disasters, such as the investments in Russia before the 1917 revolution. On the other hand, returns for some periods and countries may be higher if we include the profitable colonial asset holdings, or those in fast-growing emerging markets.

Long run data on returns on foreign assets are generally sparse. To an extent, the returns from a global investor perspective in Table A.14 try to abstract from the national dimension and get around the issue of foreign holdings. Still, these returns only cover the countries in our dataset, and do not inform us about country-specific portfolios of foreign investments.

To further analyze the potential impact of foreign asset holdings on our findings, Figure A.8 plots the size of foreign assets and a rough proxy of the asset return, using data for four countries—France, Germany, UK, and US—collected by Piketty and Zucman (2014). The top-left panel of Figure A.8 shows the share of net foreign assets in national wealth. This has generally been small, with a high of around 10% at the turn of the 20th century (equivalent to 60–80% of national income), and near-zero net positions since the end of WW2. These zero net positions, however, mark a sharp increase in gross foreign assets and liabilities (Figure A.8, right-hand panel), which have been edging towards 80% of national wealth in late 2000s. Despite these large gross positions, the net income on foreign assets and liabilities remains small, and therefore unlikely to materially affect returns on household wealth.

We can use the asset income reported in national accounts to obtain a proxy of the yield on

Figure A.8: *Size and yield on foreign assets*



Note: Unweighted average of four countries: France, Germany, UK and US. Data from Piketty and Zucman (2014). Shaded areas indicate world wars. Yield on wealth calculated as domestic or foreign capital income received in proportion to (domestic or foreign) wealth.

foreign assets and compare it to that on domestic assets, with the two depicted in the bottom panel of Figure A.8. The balance sheet yield on foreign assets, calculated as foreign capital income relative to foreign assets (Figure A.8, bottom panel, solid line) is similar to that on domestic assets (Figure A.8, bottom panel, dashed line), both in terms of size and time trend. These yield measures exclude capital gains, and are likely to understate negative returns due to foreign asset market disasters. Recent research by Meyer, Reinhart, and Trebesch (2015), however, shows that the average return on risky foreign assets, even during asset market disasters, is surprisingly high. Meyer et al. (2015) find that the total return on defaulted foreign government bonds is generally positive and higher than inflation, using historical data that covers all foreign bonds listed on major exchanges back to the early 1800s—largely due to high pre-default interest payments, and low haircuts in the event of default.

P. Equally-weighted portfolio returns

Table A.25: *Equally-weighted portfolio returns*

Country	Portfolio weights		Equal weights	
	Risky return	Return on wealth	Risky return	Return on wealth
Australia	6.96	5.91	7.13	5.51
Belgium	8.31	6.38	7.71	6.10
Denmark	8.02	7.37	7.74	6.27
Finland	10.87	9.76	9.81	7.95
France	6.54	4.92	5.56	4.22
Germany	7.90	7.07	7.47	6.32
Italy	5.32	5.08	6.01	5.07
Japan	6.79	5.59	6.27	4.91
Netherlands	7.30	5.33	7.12	5.36
Norway	7.96	6.86	6.85	5.33
Portugal	6.46	5.87	5.41	4.06
Spain	5.39	4.58	5.70	4.27
Sweden	8.52	7.41	8.16	6.49
Switzerland	6.51	5.63	6.23	4.93
UK	6.35	4.75	6.13	4.72
USA	7.12	6.03	7.28	5.63
Average, unweighted	7.44	6.30	7.01	5.54
Average, weighted	7.22	5.98	6.98	5.49

Note: Average annual real returns for the full sample. The portfolio-weighted averages use country-specific stocks of housing, equity, bonds and bills as weights for the individual asset returns. Portfolio-weighted risky return is a weighted average of housing and equity, using stock market capitalization and hosuing wealth as weights. Portfolio-weighted real return on wealth is a weighted average of equity, housing, bonds and bills, using stock market capitalization, housing wealth and public debt stock as weights. Equally-weighted risky return is an unweighted average of housing an equity. Equally-weighted return on wealth is an unweighted average of housing, equity and bonds. Period coverage differs across countries. Consistent coverage within countries: each country-year observation used to compute the statistics in this table has data for both the real risky return, and the return on overall wealth. The average, unweighted and average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.25 assesses the impact of portfolio weighting on our return estimates. The weighting has a relatively small impact on the risky rates, because returns on housing and equity are generally similar. It raises the return on capital by around one percentage point, because the outstanding stock of public debt is substantially smaller than that of risky assets. The basic stylized facts of $r \gg g$, and high long-run risky returns continue to hold regardless of the weighting, both on average and across the individual countries in our sample.

Q. Correlations between r and g

Table A.26: *Correlations between return on wealth and real GDP growth across different time horizons*

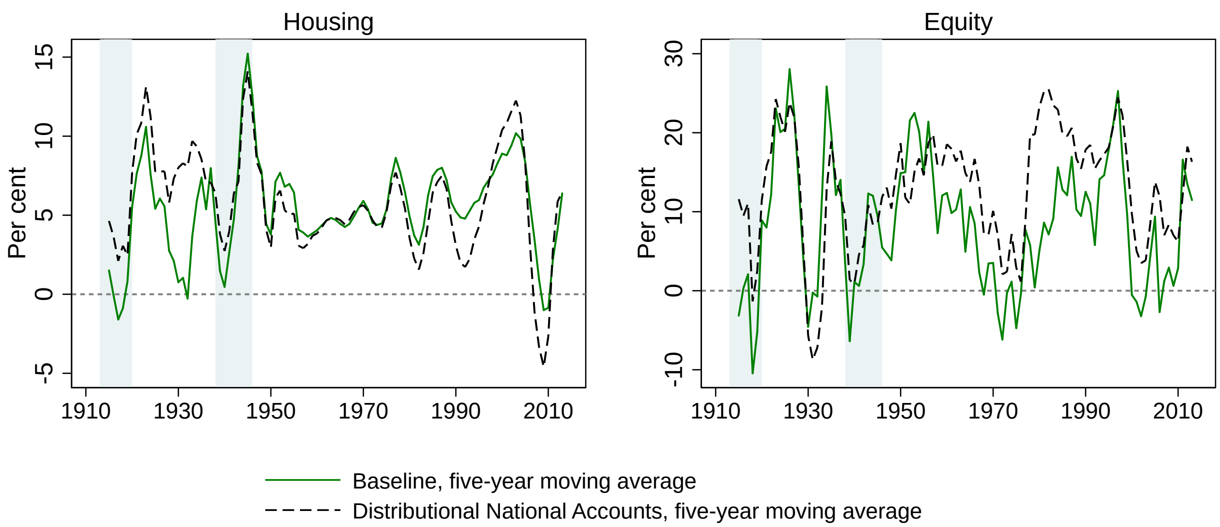
	1-year	5-year	10-year	20-year
Full sample:				
r-g, g	-0.35	-0.34	-0.23	-0.40
r, g	0.14	0.16	0.17	-0.02
r-g, r	0.88	0.87	0.92	0.93
Observations	1763	336	152	58
Post-1950:				
r-g, g	-0.08	-0.06	-0.31	-0.59
r, g	0.26	0.35	0.19	-0.21
r-g, r	0.94	0.91	0.88	0.91
Observations	1008	200	91	30

Note: Pairwise correlations of data averaged over 1-year, 5-year, 10-year and 20-year non-overlapping moving windows. 16 countries, equally weighted. r is the real return on capital, g is real GDP growth, and $r-g$ is the gap between the two.

Table A.26 presents the pairwise correlations between the real GDP growth, g, and the $r-g$ gap, as well as between the gap and r, and also between r and g. The $r-g$ gap and g show a negative correlation, although the size of the correlation coefficient is not overly large. The correlation generally becomes stronger and more robust at longer time horizons, in particular when looking at 20-year periods. Even though the correlation between r and g has become close to zero at short horizons after 1950, the longer-run correlation has remained negative. The negative correlation between the $r-g$ gap and g is explained by the fact that the rate of return r is relatively uncorrelated with the GDP growth rate g, or at least shows no robustly negative correlation. The $r-g$ gap is mainly driven by changes in the rate of return r, as the two show strongly positive comovement at short and long horizons, before and after 1950.

R. Comparison to balance sheet returns on housing and equity wealth

Figure A.9: *Our return estimates compared to Distributional National Accounts*



Note: Five-year moving average returns for the US. Baseline refers to estimates in this paper. Distributional National Accounts returns are from Piketty, Saez, and Zucman (2018).

The return on an asset from a national accounts perspective, or the "balance sheet approach" to returns, r_t^{BS} is calculated as follows:

$$\text{Balance sheet return:} \quad r_t^{BS} = \underbrace{\frac{\text{Capital Income}_t}{\text{Wealth}_t}}_{\text{Yield}} + \underbrace{\Delta\text{Wealth}_t - \text{Investment}_t}_{\text{Capital Gain}} \tag{13}$$

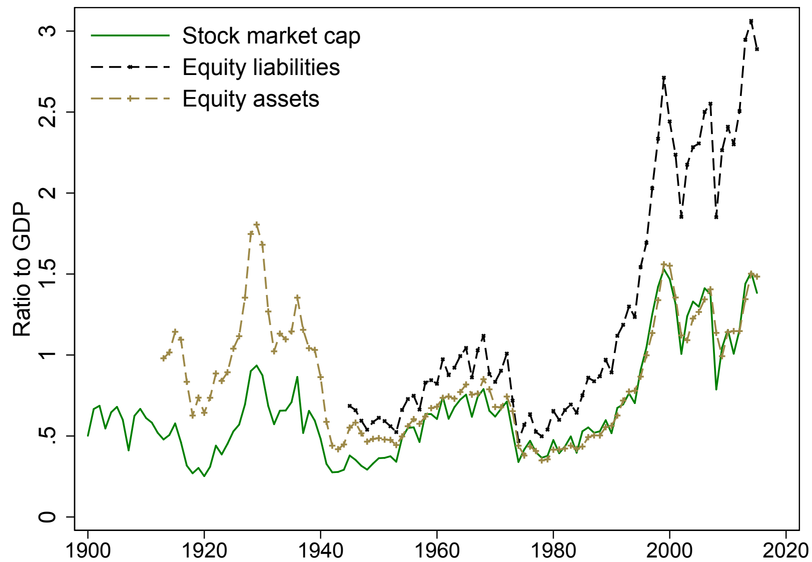
Similarly to the market return in equation (1), the balance sheet return can be divided into the yield—or capital income relative to the stock of wealth—and capital gain, which is the residual accumulated wealth, net of investment. These returns can be computed for aggregate wealth and national income, and for individual asset classes. The balance sheet returns on housing should be comparable to market returns, whereas corporate wealth returns should be somewhat higher than market data because they are computed gross of corporate taxes.

Figure A.9 compares the five-year moving average of the housing and equity returns in this paper (solid line) to those computed using the balance sheet approach for the US in Piketty, Saez, and Zucman (2018) (dashed line; further: PSZ). In terms of equation (13), the yield on housing is net rental income, and the yield on equities is total profits, gross of corporate taxes and net of depreciation. PSZ primarily rely on the Shiller (2000) index, rather than investment and wealth data, to estimate the capital gains on housing. Our housing returns are very similar to PSZ, both in level and trend (Figure A.9, left-hand side). The slight differences in the 1930s and 1990s arise because of differences between the Shiller (2000) house price index used by PSZ and the housing index in Knoll et al. (2017) used in this paper.[53]

Equity returns follow a similar trend, but the level of balance sheet return is higher than the market return in our data. Part of the difference is due to the fact that balance sheet returns are gross

[53] For further details on the differences in house price indices of Knoll et al. (2017) and Shiller (2000), see Appendix M.

Figure A.10: *US corporate equity assets and liabilities compared to capitalization of listed US firms*



Note: Equity wealth and equity liabilities include both listed and unlisted firms (data from Piketty, Saez, and Zucman, 2018). Stock market capitalization includes listed US firms on all US stock exchanges (data from Kuvshinov and Zimmermann, 2018).

of corporate taxes (see Section S and Table A.27). Adding back corporate taxes, however, still leaves our equity returns somewhat below those in Piketty et al. (2018). The remaining difference could either be explained by higher returns of unlisted relative to listed equities, or measurement error in one of the series. Even though it is difficult to precisely attribute the remaining difference, it is unlikely that the higher returns on unlisted equities play an important role: Moskowitz and Vissing-Jørgensen (2002) find that unlisted equities face a similar or worse risk-return tradeoff relative to listed equity, and the national accounts estimates of return on unlisted equity are themselves derived from listed equity data. It is also unlikely that there is much measurement error in the listed equity return data for the US, since these returns are directly observable, recorded in historical stock listings, and have been widely studied. It is somewhat more likely that there is some measurement error in the national accounts data—i.e., the figures either overstate the profits of corporations, understate equity wealth, or overstate the capital gains (i.e., overstate the growth in equity wealth or understate investment).

There is some tentative evidence that equity wealth in the US National Accounts may be somewhat underestimated during the mid-20th century. Figure A.10 shows that during the mid 20th century, US equity wealth was similar to the market capitalization of listed US firms, and equity liabilities were only slightly above the listed stock market cap. In principle, equity liabilities and assets should include the equity of unlisted as well as listed firms, and should be substantially higher than the market capitalization.[54] The closeness of the three series during the mid 20th century therefore suggests that the size of the US equity wealth in national accounts may be somewhat understated, which could account for some of the remaining return differential between our data and balance sheet approach estimates in Piketty et al. (2018). Alternatively, if we take the estimates in Figure A.10 at face value, they suggest that the share of unlisted firm equity wealth is small

[54] Equity liabilities are more comparable to stock market capitalization, since much of the US equity liabilities are held by foreigners and do not appear on the asset side of the (consolidated) household balance sheet.

relative to listed wealth, meaning that return differentials between listed and unlisted companies, even if large, cannot explain the remaining return differential.

S. Adjusting for corporate taxes and leverage

Throughout this paper, we calculate the return on equity from a household perspective, as the pre-tax cashflows and capital gains received by the equity holder, consistent with the literature on stock market returns (see, for example Shiller, 1981). The market return, however, differs from the return on the underlying asset—i.e., business wealth—in two ways. First, it is net of corporate profit taxes, which are paid out before distribution. Second, it is a levered return, in the sense that corporate equity is a levered claim on business wealth. Adjusting for corporate taxes and leverage would allow us to proxy the return on business wealth. Our housing returns already provide a proxy for the return on housing wealth (see also Section R.

We gross up the equity returns as follows. First, from Section II.C note that the real equity return $r_{eq,t}$ is the nominal capital gain CG_t plus dividend income Y_t, deflated by the inflation rate π_t:

$$r_{eq,t} = (CG_t + Y_t)/(1 + \pi_t) \tag{14}$$

To gross up for corporate taxes, we scale up Y_t to add back all profit taxes (both distributed dividends and retained earnings) attributable to equity wealth:

$$Y_t^{gross} = Y_t + Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t} * \frac{\tau}{1-\tau_t} * \frac{\text{Equity Wealth}_t}{\text{Total non-housing wealth}_t}, \tag{15}$$

where τ_t is the effective corporate tax rate. The second term on the right hand side is our proxy for the corporate tax payments of listed firms. We start with the dividends paid by listed firms Y_t, and scale them up to estimate the total post-corporate-tax profits of listed firms, $Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t}$.[55] We then scale the post-tax profits up by $1/(1-\tau_t)$ to proxy the pre-tax profits. The difference between pre- and post- tax profit—i.e., the corporate tax—is then $Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t} * \frac{\tau}{1-\tau_t}$.[56] In principle, corporate tax falls on both corporate equity and business wealth. We follow Piketty, Saez, and Zucman (2018) and assume that the share of corporate taxes attributable to equities is equal to the ratio of equity wealth to total non-housing wealth.[57] The real total return gross of corporate tax is then computed as follows:

$$r_{eq,t}^{gross} = (CG_t + Y_t^{gross})/(1 + \pi_t) \tag{16}$$

Finally, we also calculate the delevered pre-tax return on business wealth $r_{eq,t}^{delev,gross}$ as:

$$r_{eq,t}^{delev,gross} = ([CG_t + Y_t^{gross}] * (1-\alpha_t) + \alpha_t * r_{debt,t})/(1 + \pi_t), \tag{17}$$

where α_t is corporate leverage, and $r_{debt,t}$ is the interest paid on corporate debt liabilities.

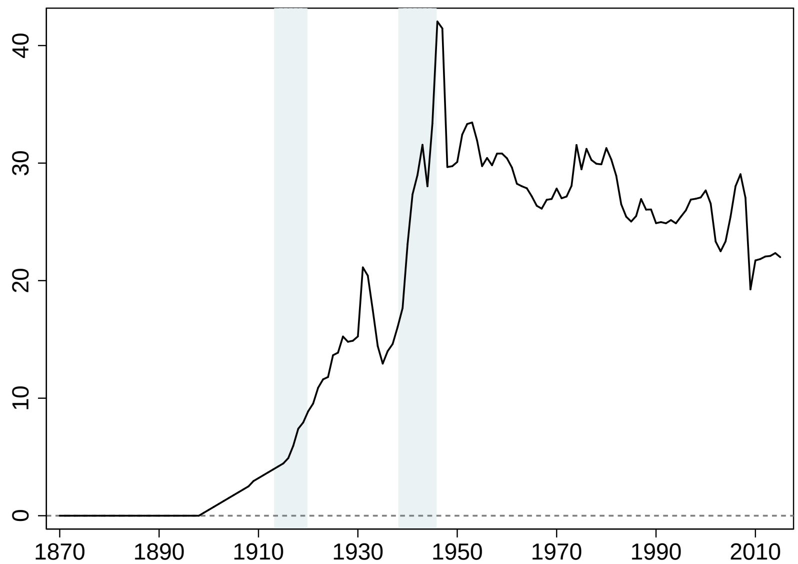
As an example, assume that in a given year the total return on equity is 10%, of which 5% are capital gains and 5% are dividends, and inflation is 3%, so the real return is 7%. Assume the corporate tax rate is 25%, half the profits are paid out as dividends, and the ratio of equities to total non-housing wealth is 1/3. The pre-tax nominal yield Y_t^{gross} is then $5\% + 5\% * 2 * 0.33 * 0.33 = 6.1\%$,

[55] This assumes that the payout ratios for listed firms are similar to those of unlisted firms.

[56] The corporate tax paid is pre-tax profits $Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t} * \frac{1}{1-\tau_t}$ less net profits $Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t}$, equals $Y_t * \frac{\text{Profit}_t}{\text{Dividends}_t} * \frac{\tau}{1-\tau_t}$.

[57] This ratio of around one-third is consistent, or slightly above the estimates in Graham et al. (2015), that is computed from firm balance sheet data.

Figure A.11: *Effective corporate tax rate, average of 5 countries*



Note: Average effective tax rate in Australia, France, Germany, Japan and US, equally weighted. Japanese tax rate interpolated between 1900 and 1930. Effective tax rate is total taxes paid / net corporate profits. Where effective data are not available, we extrapolate the series using statutory (top marginal) tax rates.

Table A.27: *Adjusting equity returns for corporate taxes and corporate leverage*

Country	Baseline	Gross of corporate tax	Gross of corporate tax, delevered
Australia	8.39	9.41	8.07
France	3.21	3.69	3.00
Germany	8.83	9.02	7.77
Japan	9.49	12.18	10.12
United States	8.40	10.20	8.74
Average	7.52	8.66	7.35

Note: Annual total real equity returns. Baseline returns are the raw data in this paper. Gross of corporate tax returns add back the share of corporate profit taxes attributable to business equity. Gross of corporate tax, delevered adds back corporate taxes and delevers the pre-tax equity return. Coverage differs across countries. Consistent coverage within countries. Average is the unweighted mean of all observations for which we have tax data, and is thus not exactly equal the average of the country-specific means.

and the pre-tax real total return $r^{gross}_{eq,t}$ is 8.1%. Now further assume that corporate leverage is 1/3, and the corporate financing rate is 5%. The delevered real pre-tax return is then roughly $11.1 * 0.67 + 5 * 0.33 - 3$, or 6.7%.

We use the following data to calculate the pre-tax and delevered return proxies. For τ_t, we use the effective corporate tax rate, or corporate taxes paid in proportion to gross (post-depreciation) corporate profits. We have collected annual corporate tax data for a subsample of five countries, four from 1870 (Australia, France, Germany, and US), and one from 1930 (Japan). For countries and years where effective tax data were not available, we have approximated the effective rate using changes in statutory rates. Figure A.11 shows the evolution of the effective corporate tax rate from 1870 to today. Taxes were near zero before the 1920s, before increasing and peaking at around 40% of profits after WW2, and declining slightly thereafter. The ratio of profits to dividends largely comes from national accounts and various historical statistics, and covers a slightly smaller sample of countries and years, with gaps filled using sample averages. The share of equity wealth to total non-financial assets, and corporate leverage data are only available for the US, from Piketty et al. (2018) and Graham, Leary, and Roberts (2015) respectively. US corporate leverage is measured as total debt relative to capital. We assume that the equity share in total wealth, and corporate leverage in other countries follow the US trend. We are grateful to Mark Leary for sharing the corporate leverage data with us. For the interest rate on corporate debt, we use the government bond yield plus a 1 percentage point spread (broadly indicative of corporate bond and business lending spreads).

Table A.27 shows the effect of adjusting equity returns for corporate taxes and leverage. Column 1 is the baseline average real total equity return equivalent to Table II, shown for the corporate tax data sample, separately for each country and in aggregate. Column 2 adds back corporate taxes using equations (15) and (16). Column 3 delevers the returns using equation (17). Adding back corporate taxes increases the average real equity return by +1.1 pps per year, with the country-specific impact ranging from +0.5 pps in France to +2.7 pps in Japan. Delevering reduces this pre-tax return by 1.3 pps per year, with the delevered pre-tax business equity return (Table A.27 column 3) close to our baseline average.

Data appendix

T. Data overview

Table A.28: *Overview of bill and bond data*

Country	Bills		Bonds	
	Period	Type of rate	Period	Type of bond
Australia	1870–1928	Deposit rate	1900–1968	Long maturity, central gov't
	1929–1944	Money market rate	1969–2015	Approx. 10y, central gov't
	1948–2015	Government bill rate		
Belgium	1870–1899	Central bank discount rate	1870–1913	Perpetual
	1900–1964	Deposit rate	1914–1940	Long maturity, central gov't
	1965–2015	Government bill rate	1941–1953	Perpetual
			1954–2015	Approx. 10y, central gov't
Denmark	1875–2015	Money market rate	1870–1923	Perpetual
			1924–1979	Long maturity, central gov't
			1980–2015	Approx. 10y, central gov't
Finland	1870–1977	Money market rate	1870–1925	Long maturity, central gov't
	1978–2015	Interbank rate	1926–1991	Approx. 5y, central gov't
			1992–2015	Approx. 10y, central gov't
France	1870–1998	Money market rate	1870–1969	Perpetual
	1999–2015	Government bill rate	1970–2015	Long maturity, central gov't
Germany	1870–1922	Money market rate	1870–1878	Long maturity, local gov't
	1924–1944	Interbank rate	1879–1943	Long maturity, central gov't
	1950–2015	Money market rate	1948–1955	Mortgage bond
			1956–2015	Long maturity, central gov't
Italy	1870–1977	Money market rate	1870–1913	Perpetual
	1978–2015	Government bill rate	1914–1954	Long maturity, central gov't
			1955–2015	Approx. 10y, central gov't
Japan	1876–1956	Deposit rate	1881–1970	Long maturity, central gov't
	1957–2015	Money market rate	1971–2015	Approx. 10y, central government
Netherlands	1870–1957	Money market rate	1870–1899	Perpetual
	1958–1964	Central bank discount rate	1900–1987	Long maturity, central gov't
	1965–2015	Money market rate	1988–2003	$\geq$ 8y, central government
			2004–2015	Approx. 10y, central government
Norway	1870–2015	Deposit rate	1870–1919	Long maturity, central gov't
			1920–2015	Approx. 10y, central gov't
Portugal	1880–1914	Money market rate	1870–1974	Long maturity, central gov't
	1915–1946	Central bank discount rate	1975–2015	Approx. 10y, central gov't
	1947–1977	Deposit rate		
	1978–2015	Money market rate		
Spain	1870–1921	Money market rate	1900–1994	Long maturity, central gov't
	1922–1974	Deposit rate	1995–2015	7–8y, central government
	1975–2015	Money market rate		
Sweden	1870–1998	Deposit rate	1874–1918	Long maturity, central gov't
	1999–2015	Government bill rate	1919–1949	Perpetual
			1950–2015	Approx. 10y, central gov't
Switzerland	1870–1968	Deposit rate	1900–2006	Long maturity, central gov't
	1969–2015	Money market rate	2007–2015	Approx. 10y, central gov't
United Kingdom	1870–2015	Money market rate	1870–1901	Perpetual
			1902–1989	Approx. 20y, central gov't
			1990–2015	Approx. 15y, central gov't
United States	1870–2013	Deposit rate	1870–1926	Approx. 10y, central gov't
	2014–2015	Money market rate	1927–2015	Long maturity, central gov't

Table A.29: *Overview of equity and housing data*

Country	Equity			Housing	
	Period	Coverage	Weighting	Period	Coverage
Australia	1870–1881	Listed abroad	Market cap	1901–2015	Urban
	1882–2015	Broad	Market cap		
Belgium	1870–2015	All share	Market cap	1890–1950	Urban
				1951–1961	Mixed
				1977–2015	Nationwide
Denmark	1873–1899	All share	Market cap	1876–1964	Mixed
	1900–1999	Broad	Market cap	1965–2015	Nationwide
	2000–2001	Blue chip	Market cap		
	2002–2015	All share	Market cap		
Finland	1896–1911	Broad	Book cap	1920–1964	Urban
	1912–1969	All share	Market cap	1965–1969	Mixed
	1970–1990	Broad	Market cap	1970–2015	Nationwide
	1991–2015	All share	Market cap		
France	1870–2015	Blue chip	Market cap	1871–1935	Urban
				1936–1948	Mixed
				1949–2015	Nationwide
Germany	1870–1889	Blue chip	Market cap	1871–1912	Mixed
	1890–1913	All share	Market cap	1913–1938	Urban
	1914–1959	Blue chip	Market cap	1939–1947	Mixed
	1960–2015	Broad	Market cap	1948–1970	Nationwide
				1971–2015	Mixed
Italy	1870–1887	Selected stocks	Book cap	1928–1998	Urban
	1888–2015	Broad	Market cap	1999–2015	Mixed
Japan	1882–1975	Broad	Transaction volume	1931–1946	Urban
	1976–2015	All share	Mix of equal and market cap	1947–2015	Mixed
Netherlands	1900–2003	Broad	Mostly market cap	1871–1969	Mixed
	2004–2015	All share	Market cap	1970–2015	Nationwide
Norway	1881–1920	All share	Market cap	1871–2015	Urban
	1921–1955	All share	Mix of equal and book cap		
	1956–2000	All share	Mix of book cap and company turnover		
	2001–2015	Most traded shares	Market cap		
Portugal	1871–2015	All share	Market cap	1948–2015	Mixed
Spain	1900–2015	All share	Market cap	1901–1957	Mixed
				1958–2015	Nationwide
Sweden	1871–2001	Broad	Market cap	1883-1959	Urban
	2002–2015	All share	Market cap	1960–2015	Mixed
Switzerland	1900–1925	All share	Market cap	1902–1930	Urban
	1926–1959	Broad	Equally weighted	1931–1940	Mixed
	1960–2015	Broad	Market cap	1941–2015	Nationwide
United Kingdom	1870–1928	All share	Market cap	1895–1899	Urban
	1929–1963	Blue chip	Market cap	1900–1913	Mixed
	1964–2015	All share	Market cap	1914–1929	Urban
				1930–1946	Mixed
				1947–2015	Nationwide
United States	1872–2015	Broad	Market cap	1891–1952	Urban
				1953–2015	Mixed

U. Housing returns

The total return on housing is a combination of the capital gain and rental income. The capital gain series are computed from the house price data in Knoll, Schularick, and Steger (2017). The rental indices are drawn from the unpublished PhD thesis of Knoll (2017), which also extended the dataset in Knoll et al. (2017) to cover three additional countries (Italy, Portugal and Spain). The sources for these new series are reproduced in Appendix W. This section starts by describing the construction of the rental yield series. Appendix V then describes the general methodology for constructing the rental indices, and Appendix W details the sources of the rent data.

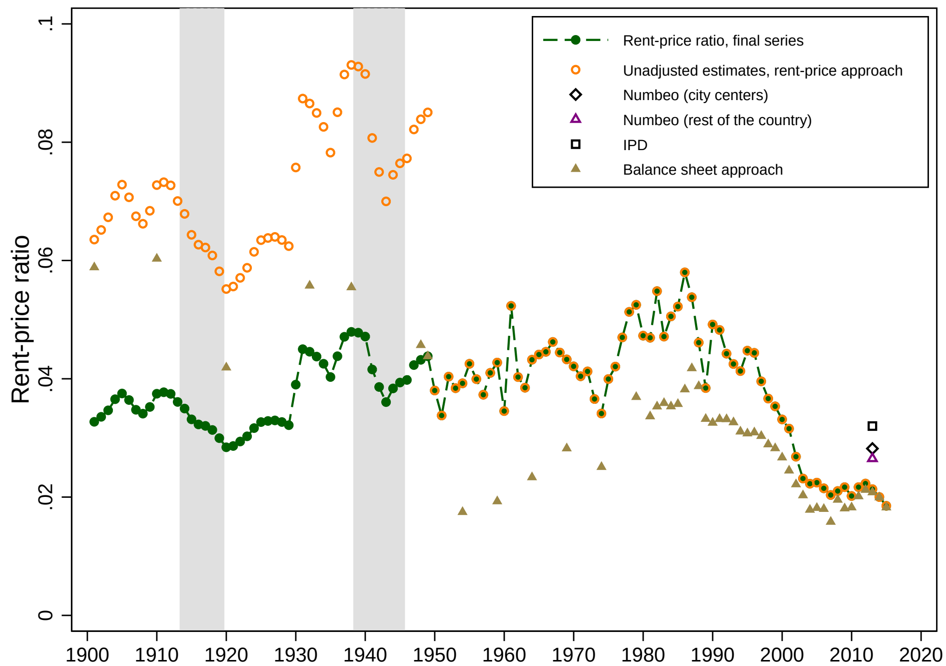
As described in Section II.C, the baseline housing return series is constructed using the rent-price approach. To do this, we take a benchmark net rent-price ratio—adjusted down for maintenance and other costs—in the year 2012, 2013 or 2014, and extrapolate it back using growth in the house price and rent indices. We further check the rent-price approach estimates against various alternative historical benchmarks. These include the balance sheet approach constructed from National Accounts data (see Section III.C for more detail on this method), and independent estimates from books, journal articles and historical newspapers.

If the rent-price approach estimate differs substantially from those in the alternative sources, we adjust it so that the estimates are in line with each other. We do not adjust the series when these differences are small, or we have good reasons to doubt the quality of the alternative estimates. When we do adjust, we either benchmark our series to historical net rent-price ratios from alternative sources, or adjust the growth in the rental index by a multiplicative factor, such that the different estimates of historical rent-price ratios are broadly in line with each other.

In each of the Appendix Figures A.12 to A.27, the series that we use in the paper are the "Rent-price ratio, final series" estimates denoted as green circles. These incorporate any adjustments made to bring the data into line with historical sources. Alongside these, we also present the raw unadjusted rent-price approach series—orange circles—and the alternative historical estimates themselves. We also show alternative benchmark estimates for the present day to help assess the reliability of our baseline IPD rent-price ratio. These are generally sourced from data on rental expenditure and property values on `Numbeo.com`, for one- and three-bedroom apartments i). within city-centres and ii). in the rest of the country, and are adjusted down by us to proxy the impact of running costs and depreciation. For cases where data on running costs and depreciation were not available, we estimate these to be about one-third of gross rent, in line with the recent and historical experience in most countries (see Figure III). For Australia and US, we additionally make use of benchmark rent-price ratio estimates based on detailed transaction-level data. In two countries—Australia and Belgium—we judge one of these alternative modern-day benchmarks to be more reliable than the IPD ratio, and use it to construct our final baseline net rent-price ratio series.

Australia

Figure A.12: *Australia: plausibility of rent-price ratio*



For 2014, Fox and Tulip (2014) report a gross rental yield of 4.2 per cent, running costs excluding taxes and utilities of 1.1 per cent, and depreciation rate of 1.1 per cent, using data covering almost all properties advertized for rent in major Australian cities. This gives us a benchmark net rent-price ratio of 0.02. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.12. We make one adjustment to these series to correct for possible mismeasurement of rental growth when lifting the wartime price controls in 1949/50 (see below for details). This gives us the adjusted final rent-price ratio series—the green-circled line in Figure A.12—used in this paper.

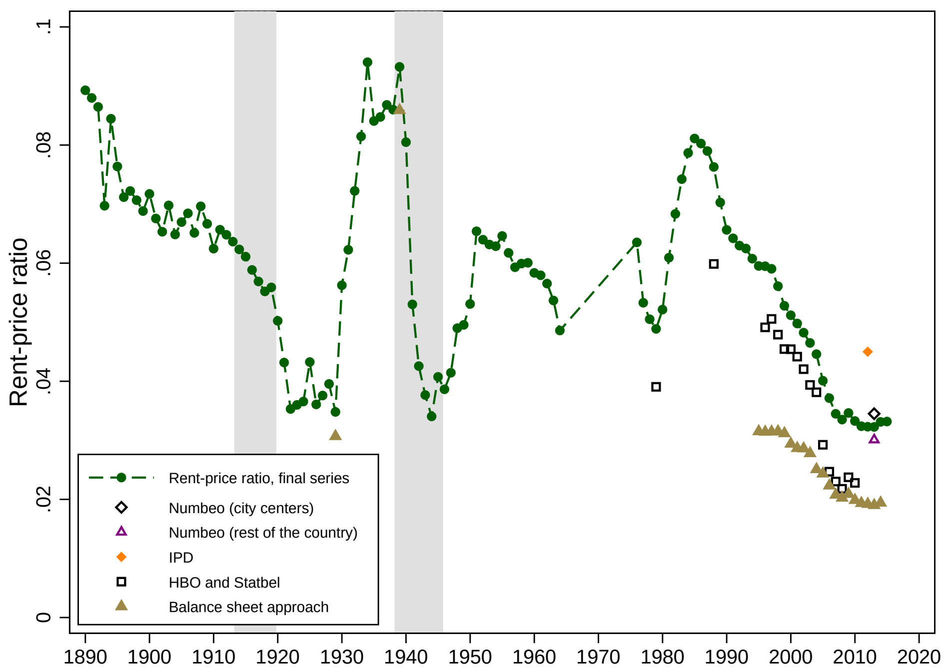
We obtain several scattered independent estimates of rent-price ratios in Australia. First, the IPD database (MSCI, 2016) reports a net rent-price ratio of 0.032 for the Australian residential real estate in 2013 (black square in Figure A.12). Balance sheet approach estimates (brown triangles) are obtained using a variety of sources. OECD (2016b), Stapledon (2007), Australian Bureau of Statistics (2014) and Butlin (1985) provide estimates of gross rental expenditure and various maintenance and running costs, as well as depreciation, for present-day and historical periods. As with the benchmark yield calculation, we subtract all non-tax and non-utilities related running costs, plus depreciation, to calculate total net rental expenditure. We then combine it with the housing wealth data from Stapledon (2007) and Piketty and Zucman (2014) to calculate the net rental yield.

The historical balance-sheet approach estimates are broadly in line with the unadjusted rent-price approach series (orange circles) over recent decades, but below it for the earlier years. Note that the long-run rent-price ratio shows a structural break in 1949/1950 stemming from a surge in house prices after the lifting of wartime price controls in 1949 (price controls for houses and land were introduced in 1942). While the abandonment of price controls undoubtedly had an effect on house prices, it is unclear whether it also resulted in a single sudden shift in the relationship between house prices and rents. To guard against measurement uncertainty, we benchmark our historical rent-price ratio to the balance sheet approach estimate in 1949. Figure A.12 shows that the adjusted long-run rent price ratio—the green circle line—generally concords with the balance-sheet approach estimates, being on average slightly lower during 1900–1940, and higher during 1950–1980.

Finally, modern-day gross rental yield estimates are available from `Numbeo.com` for one- and three-bedroom apartments i). within city-centres and ii). in the rest of the country. We adjust these down using the cost estimates from Fox and Tulip (2014) to obtain a proxy of net yield. The resulting estimates fall in-between those of the MSCI (2016), and the other approaches.

Belgium

Figure A.13: *Belgium: plausibility of rent-price ratio*



We construct the benchmark rent-price ratio using the rental yield data from `Numbeo.com`, taking the average of in- and out-of-city-centre apartments, and adjusting down one-third to account for running costs and depreciation. This gives us a benchmark net rent-price ratio of 0.033 for 2012. Applying the rent-price approach gives us the long-run net rent-price ratio series depicted as green circles in Figure A.13, which are the estimates used in this paper. Please note that the benchmark rent-price ratio from the IPD (MSCI, 2016)—0.045 for 2012—is substantially higher than the alternative approaches, which is why we rely on estimates from `Numbeo.com` instead.

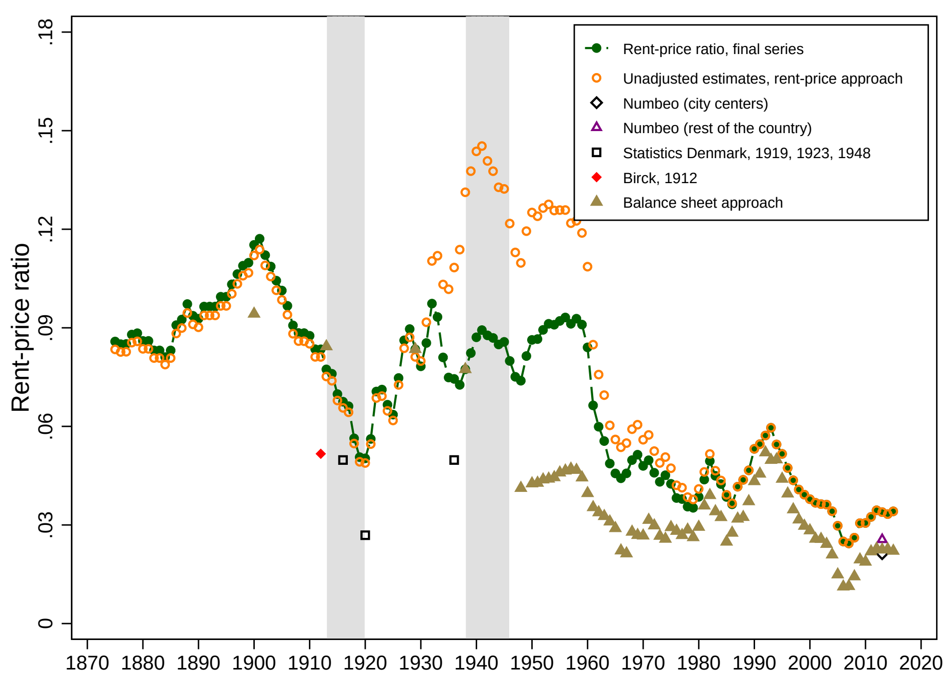
We construct four independent estimates of rent-price ratios. First, for 1978–2010, Statistics Belgium publish estimates of average rental expenditure and house prices (Statistics Belgium, 2013b, 2015). Assuming around one-third of gross rent is spent on maintenance, running costs and depreciation, this gives us a series of net rent-price ratios, depicted as square dots in Figure A.13. The resulting series are consistent with both the level and the time trend in our baseline series constructed using the rent-price approach.

Second, we construct estimates of gross rent-price ratios using the balance-sheet approach, based on data on rental expenditure and housing wealth, and scale these down one-third to obtain the net yield proxy. For the modern period, Poullet (2013) provides estimates of housing wealth, and Statistics Belgium (2013a) and OECD (2016b) of rental expenditure. For historical series, Peeters, Goossens, and Buyst (2005) reports estimates of total gross and net rents on all dwellings, which we scale down to obtain an estimate of net rental expenditure on residential real estate. Goldsmith and Frijdal (1975) report estimates of housing wealth for 1948–1971, which we extend back to 1929 using data in Goldsmith (1985), and assuming a constant share of land to residential property value. The resulting net rental yield estimates are somewhat below our baseline rent-price ratio for the modern period, and broadly in line with its historical levels, falling within a reasonable margin of error given the substantial uncertainty in the Belgian housing wealth estimates.

We would like to thank Stijn Van Nieuwerburgh for sharing historical rent and house price data for Belgium.

Denmark

Figure A.14: *Denmark: plausibility of rent-price ratio*



For 2013, the MSCI (2016) reports the rent-price ratio for Danish residential real estate of 0.034. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.14. We make one adjustment to these series to correct for possible mismeasurement of rental growth around WW2 (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.14—used in this paper.

We obtain several additional estimates of rent-price ratios in Denmark throughout the past century and a half. First, we construct estimates using the balance sheet approach using data on total rental expenditure (Hansen, 1976; OECD, 2016b; Statistics Denmark, 2017b) and housing wealth

(Abildgren, 2016). We estimate housing running costs and depreciation as fixed proportions of dwelling intermediate consumption, and depreciation of all buildings (Statistics Denmark, 2017a), and subtract these from gross rental expenditure to produce net rental yield estimates. The balance sheet approach yields are similar to the rent-price approach for the recent decades and in the early 20th century, but diverge somewhat in the 1940s and 50s. Both estimates are subject to measurement error, but the large difference suggests that some of the high levels of the rent-price approach ratio may be a result of the rental index underestimating the rent growth during this period. To guard against accumulation of errors in the rent-price approach, we benchmark the historical yield to the balance sheet approach estimates in 1938 and 1929, and adjust the rent-price ratio growth for the in-between years, with the final series (green circles) being somewhere in-between the balance-sheet and rent-price approaches. For earlier the historical period, the rent-price and balance-sheet approaches display similar levels and time trend.

Our baseline rent-price ratio estimates are also in line with two further historical sources. First, according to Birck (1912), at the time of his writing, housing values in Copenhagen typically amounted to 13 times the annual rental income. Second, in line with this estimate, Statistics Denmark (1919) reports that housing values in urban areas in 1916 were about 13.5 times the annual rental income (note that housing values reported in Statistics Denmark (1919, 1923, 1948, 1954) relate to valuation for tax purposes). These data imply a gross rent-price ratio of about 0.06–0.07, and a net rent-price ratio of around 0.04–0.05. For 1920, Statistics Denmark (1923) states that housing values in urban areas were about 25 times the annual rental income implying a gross rent-price ratio of roughly 0.04 (roughly 0.03 net). In 1936, rent-price ratios in urban areas had returned to pre-WW1 levels (Statistics Denmark, 1948). Finally, estimates of net rent-price ratios based on data from `www.Numbeo.com` are similar to the modern-day values for the balance-sheet and rent-price approaches.

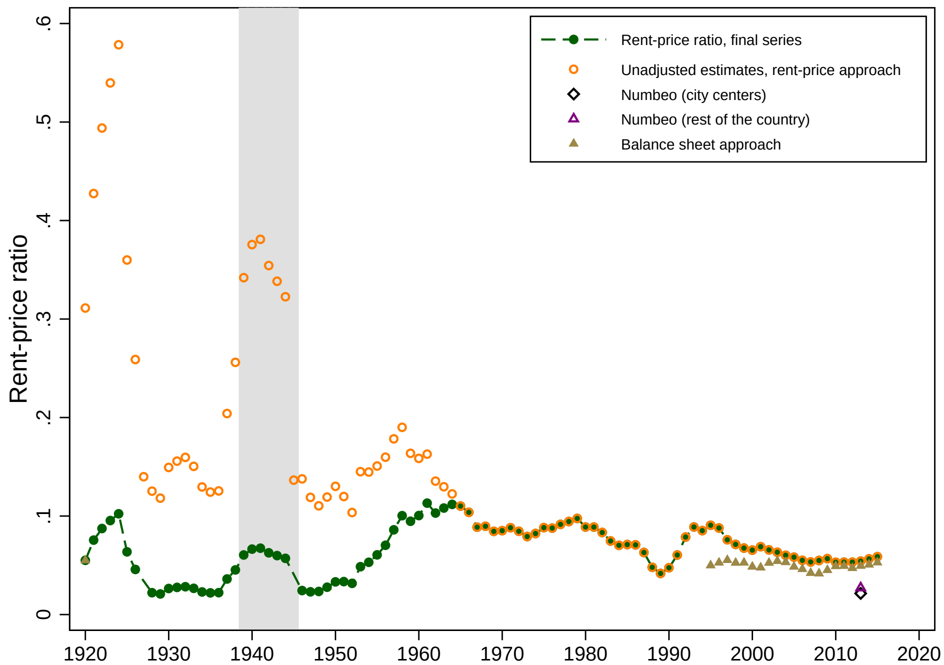
Finland

For 2013, the MSCI (2016) reports the rent-price ratio for Finnish residential real estate of 0.054. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.15. We make one adjustment to these series to correct for possible mismeasurement of rental growth during the rent controls imposed in the early-to-mid 20th century (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.15—used in this paper.

We obtain two alternative estimates of the net rent-price ratio for the modern period. First, we construct proxies of gross rental expenditure, running costs and depreciation, and total housing wealth back to 1995 using data from Statistics Finland and OECD. These are roughly the same as our benchmark rent-price ratio for the benchmark year, but are slightly lower in the late 1990s. Note, however, that data from Statistics Finland imply a housing depreciation rate of 3.5%, and running and maintenance costs of around 2%, which corresponds to an expected duration of the structure of less than 20 years. Therefore, the cost estimates are almost certainly too high, and adjusting these to more reasonable levels would leave the rent-price ratios on par, or above our baseline values. For 2013, we also obtain estimates of rent-price ratios for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country from `www.Numbeo.com`. Once adjusted for costs, these are somewhat lower than both the estimates using the rent-price and balance sheet approach.

We also construct an independent estimate of the rent-price ratio in Finland in 1920 using data on total housing value (Statistics Finland, 1920) and total expenditure on rents (Hjerppe, 1989), adjusted down by one-third to account for running costs and depreciation. Figure A.15 shows that this estimate is significantly below the long-run rent price ratio in 1920. Similarly to the case of Spain,

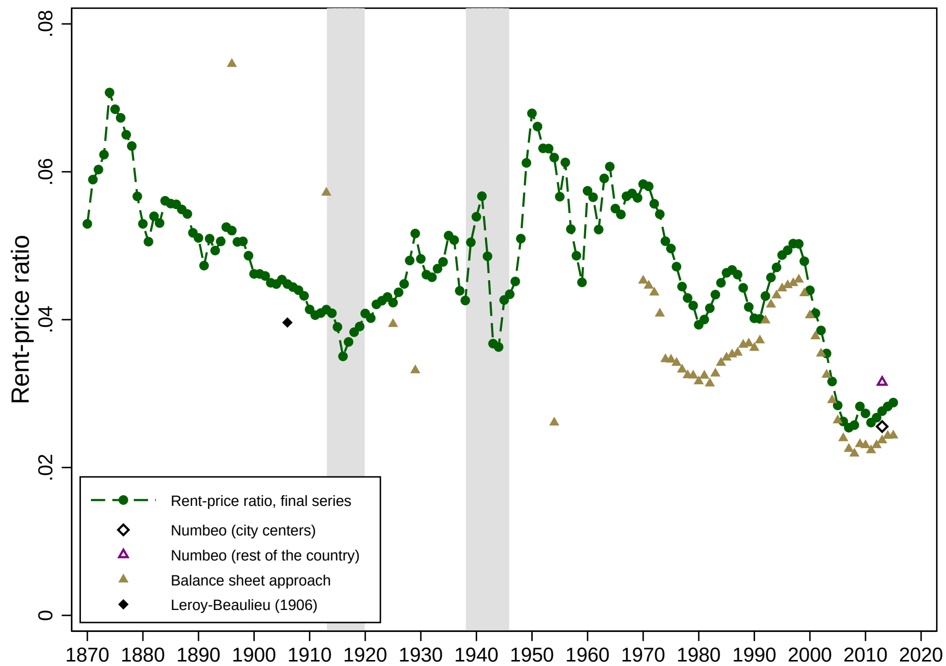
Figure A.15: *Finland: plausibility of rent-price ratio*



the discrepancy between the rent-price approach and alternative estimates may reflect difficulties of the Finnish statistical office to construct a rent index after the introduction of wartime rent controls. Rent controls were introduced during WW2 and were only abolished under the *Tenancy Act* of 1961 (Whitehead, 2012). While this period of deregulation was rather short-lived—rent regulation was re-introduced in 1968 and parts of the private rental market were subject to rent regulation until the mid-1990s—the downward trend of the long-run rent-price ratio appears particularly remarkable. In other words, the data suggest that rents during the period of deregulation increased significantly less than house prices. To the best of our knowledge, no quantitative or qualitative evidence exists supporting such a pronounced fall in the rent-price ratio during the first half of the 1960s. We therefore conjecture that the rent index suffers from a downward bias during the period of wartime rent regulation and immediately thereafter. To mitigate this bias, we adjust the gross growth rate in rents between WW2 and 1965 up by a constant factor calibrated so that the adjusted long-run rent-price ratio concords with the independent estimate in 1920, which is a factor of 1.1. Figure A.15 displays the resulting adjusted long-run rent-price ratio.

France

Figure A.16: *France: plausibility of rent-price ratio*



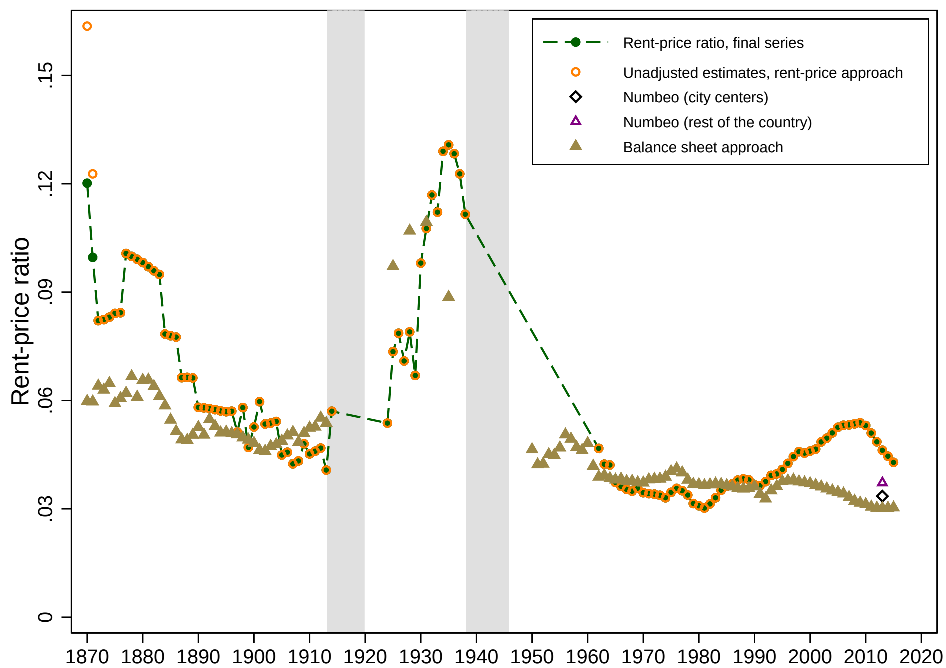
For 2013, the MSCI (2016) reports the rent-price ratio for French residential real estate of 0.028. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.16, which are the estimates used in this paper.

We obtain several scattered independent estimates of rent-price ratios in France since 1870. First, we calculate rent-price ratios using the balance-sheet approach, based on the data on total housing value (Piketty and Zucman, 2014) and total expenditure on rents (Statistics France, 2016b; Villa, 1994) net of running costs and depreciation (Piketty and Zucman, 2014; Statistics France, 2016a,b). These estimates are in line with those using the rent-price approach, even though the balance-sheet approach rental yield estimates for 1900–1920 are somewhat higher, and for 1920–1960 somewhat lower. Second, `Numbeo.com` estimates of modern-day rent-price ratios are in line with the IPD benchmark.

A few additional scattered estimates on housing returns for the pre-WW2 period are available. For 1903, Haynie (1903) reports an average gross rental yield for Paris of about 4 percent. For 1906, Leroy-Beaulieu (1906) estimates a gross rental yield for Paris of 6.36 percent, ranging from 5.13 percent in the 16th arrondissement to 7.76 percent in the 20th arrondissement. Simonnet, Gallais-Hamonno, and Arbulu (1998) state that the gross rent of residential properties purchased by the property investment fund *La Fourmi Immobiliere* amounted to about 6 to 7 percent of property value between 1899 and 1913. These estimates are generally comparable with an average annual net rental yield of about 5 percent for 1914–1938 for the final series used in this paper.

Germany

Figure A.17: *Germany: plausibility of rent-price ratio*



For 2013, the MSCI (2016) reports the rent-price ratio for German residential real estate of 0.047. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.17. We make one adjustment to these series to correct for possible mismeasurement of rental growth in the early 1870s (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.17—used in this paper.

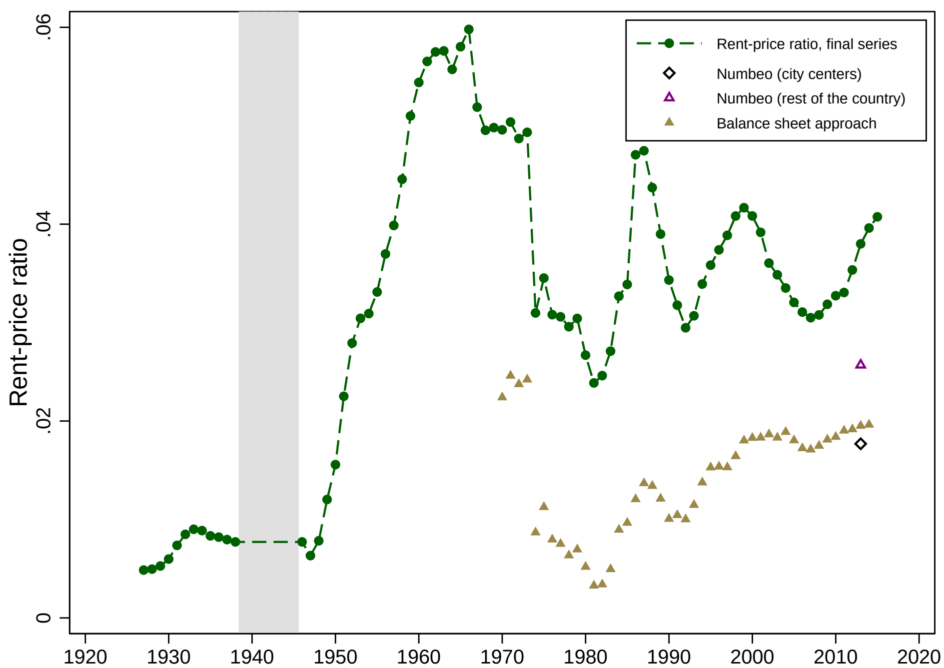
We obtain three independent estimates of historical rent-price ratios in Germany. First, `Numbeo.com` estimates of modern-day rent-price ratios are broadly in line with the rent-price approach. Second, we calculate the balance sheet approach estimates for benchmark years based on data on total housing value and total expenditure on rents. The housing wealth series combines the data in Piketty and Zucman (2014), and various issues of *Statistik der Einheitswerte*. For the pre-WW1 period, we scale up the value of structures reported in Piketty and Zucman (2014) to obtain a proxy for total housing wealth. The rental expenditure data are from OECD (2016b) and Statistics Germany (2013) for the modern period, and (Hoffmann, 1965) for the period before WW2. Throughout we assume around one-third of gross rent is spent on costs and depreciation to obtain a proxy for net rental expenditure.

Figure A.17 shows that the balance sheet approach estimates confirm the general level and historical time trend of the rent-price ratio: rents were high in the interwar period, and comparatively lower before WW1 and after WW2. The modern-day balance sheet approach estimates are somewhat below those in our final series, but within a reasonable margin of error, given the uncertainty in estimating housing wealth, imputed rents, running costs and depreciation. For the years 1870–1871, however, the balance sheet approach estimates of rental yield are relatively stable, whereas those using the rent-price approach are markedly high. It is likely that the rental index underestimated the rental growth during years 1870–1871, when house prices grew sharply. However, the balance sheet approach net yield estimate is in itself highly uncertain, as housing wealth data may have been smoothed over time, and there is little data on the value of land underlying dwellings. We therefore adjust the rental yield down to the average of the rent-price figures, and an alternative rental yield series that extrapolates the growth of rents back using the balance sheet approach. This results in the green dots, our final series for 1870–1871, that suggests that rental yields fell during those years, but probably by less than suggested by the raw unadjusted series.

Finally, one additional series on housing returns is available for the pre-WW2 period. For 1870–1913, Tilly (1986) reports housing returns for Germany and Berlin. Average annual real net returns according to Tilly (1986) amount to about 8 percent—a figure similar to the circa 10 percent p.a. average annual real return calculated using the adjusted rent and house price data.

Italy

Figure A.18: *Italy: plausibility of rent-price ratio*

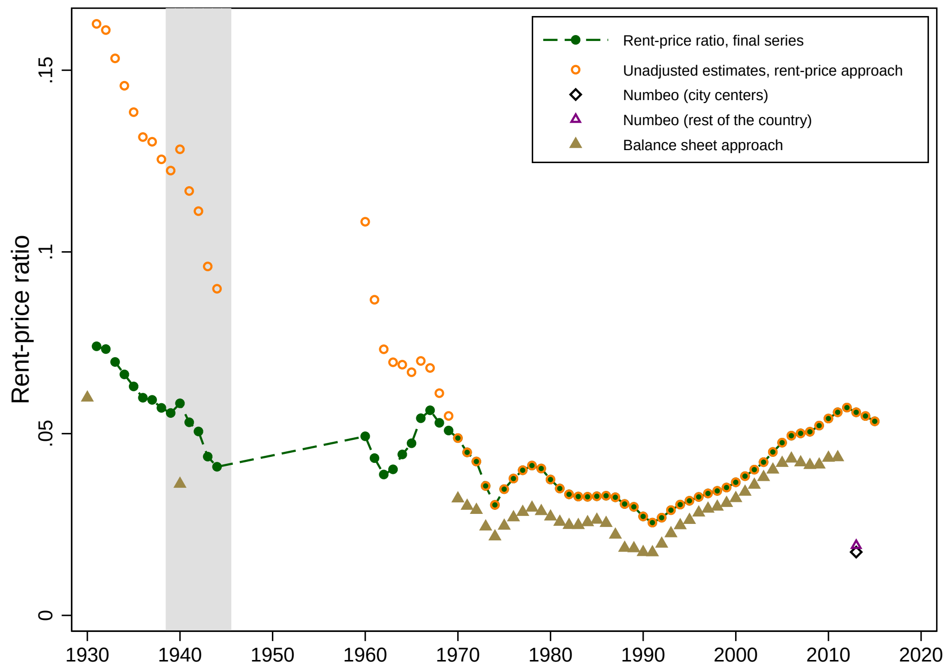


For 2013, the MSCI (2016) reports the rent-price ratio for Italian residential real estate of 0.038. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.18, which are the estimates used in this paper.

To gauge the plausibility of historical rent-price ratios, we construct the balance-sheet approach rental yields as total rental expenditure net or running costs and depreciation, in proportion to total housing wealth (Istat, 2016; Piketty and Zucman, 2014). These are somewhat lower than the rent-price approach estimate, but confirm the general trend in the rent-price ratio from the 1970s onwards. Finally, `Numbeo.com` estimates of modern-day rent-price ratios are similar to the rent-price and balance sheet approach.

Japan

Figure A.19: *Japan: plausibility of rent-price ratio*



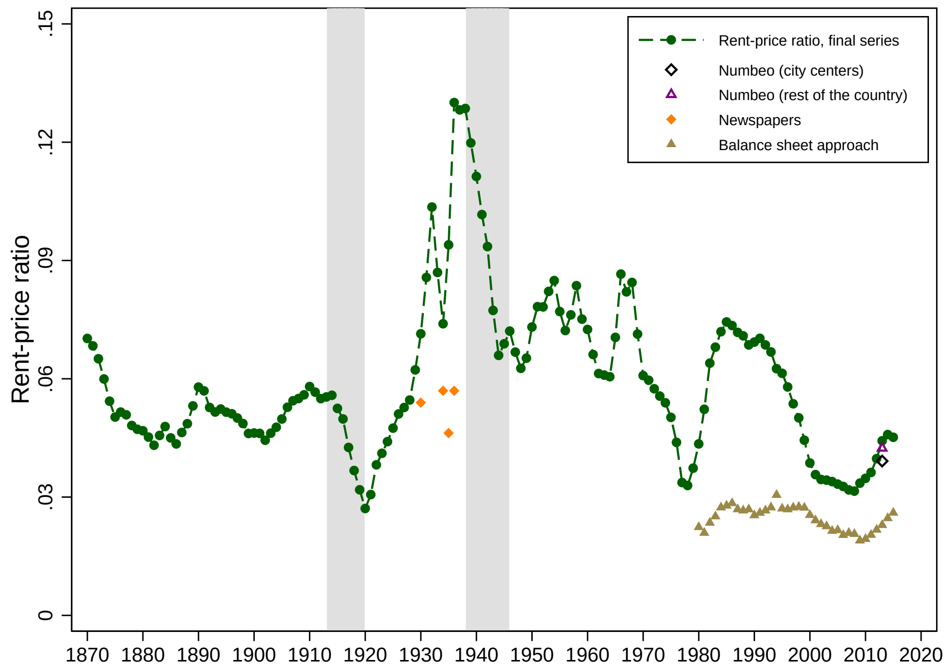
For 2013, the MSCI (2016) reports the rent-price ratio for Japanese residential real estate of 0.056. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.19. We make one adjustment to these series to correct for possible mismeasurement of rental growth in the 1960s (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.19—used in this paper.

We obtain two independent estimates for rent-price ratios in Japan. First, we calculate rent-price ratios for benchmark years (1930, 1940, 1970–2011) based on data on total housing value (Goldsmith, 1985; Piketty and Zucman, 2014) and total expenditure on rents (Cabinet Office. Government of Japan, 2012; Shinohara, 1967). To proxy the net rent-price ratio, we assume around one-third of gross rent is spent on running costs and depreciation. The resulting estimates are consistent with the long-run rent-price ratio for the period 1970–2011 (Figure A.19). Yet, for 1930 and 1940 the estimates are much lower than those using the rent-price approach. This suggests that the rent index may have underestimated rent growth between 1940 and 1970, thus inflating the historical rental yield estimates. Indeed, the unadjusted series imply that the rent-price ratio fell dramatically during the 1970s, a trend not mirrored in any subsequent period, or in the balance-sheet approach data. To this end, we conjecture that the rental index understated the growth in rents by a factor of two during the 1960s. The resulting adjusted rent-price ratio (green circles) is then consistent with the historical estimates using the balance sheet approach.

Second, estimates of modern-day rent-price ratios from `Numbeo.com` are are somewhat below both the rent-price approach and balance-sheet approach estimates for the 2010s.

Netherlands

Figure A.20: *Netherlands: plausibility of rent-price ratio*



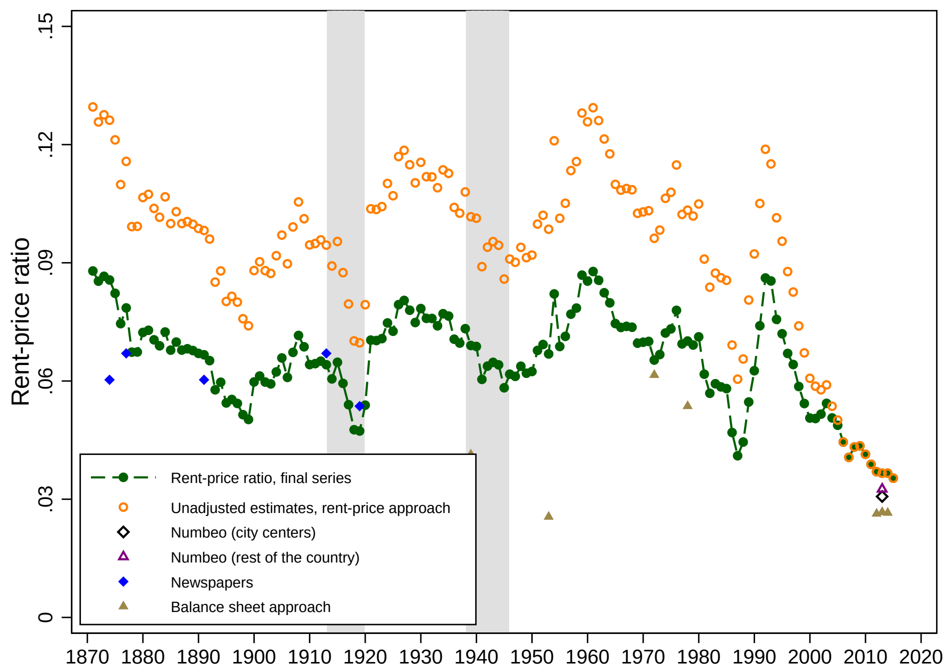
For 2013, the MSCI (2016) reports the rent-price ratio for Dutch residential real estate of 0.044. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.20, which are the estimates used in this paper.

We obtain two independent estimates for rent-price ratios in the Netherlands. First, we calculate the rent-price ratio using the balance sheet approach, based on estimates of rental expenditure from OECD (2016b), and housing wealth estimated from non-financial balance sheet data in OECD (2016c) and Groote, Albers, and De Jong (1996) (brown trianges in Figure A.20). We assume one-third of gross rental is spent on running costs and depreciation. The yields confirm the general trend in our benchmark series, although their levels are somewhat lower. It is worth noting that the estimates of housing wealth and running costs for the Netherlands are highly uncertain, hence we do not put too much weight on the level of the balance-sheet approach yields.

Second, a number of newspaper advertisements and articles in the mid-1930s report rent-price ratio levels of 0.07–0.09, which we conjecture are around 0.05 - 0.06 in net terms, once running costs and depreciation are taken out (Limburgsch Dagblaad, 1935; Nieuwe Tilburgsche Courant, 1934, 1936). These are somewhat lower than our baseline series, but similar to the levels observed in the early 1930s, with the remaining margin of error easily attributed to location specificity (the advertisements are for city-center properties, with the correspondingly lower yiedls). More generally, residential real estate was perceived as a highly profitable investment throughout the decade (De Telegraaf, 1939). Finally, estimates of the rent-price ratio based on data from `Numbeo.com` are almost identical to our baseline IPD benchmark (MSCI, 2016).

Norway

Figure A.21: *Norway: plausibility of rent-price ratio*



For 2013, the MSCI (2016) reports the rent-price ratio for Norwegian residential real estate of 0.037. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.21. We make one adjustment to these series to bring the estimates in line with alternative historical sources (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.21—used in this paper.

We obtain several scattered independent estimates of rent-price ratios in Norway since 1871. First, we calculate rent-price ratios for benchmark years using the balance-sheet approach, based on data on total housing value (Goldsmith, 1985; OECD, 2016c) and total expenditure on rents (OECD, 2016b; Statistics Norway, 1954, 2014), and assuming one-third of gross rent is consumed by running costs and depreciation expenses to estimate the net rental yield. Note that for the historical expenditure series, we estimate rents as 80% of total housing expenditure, a proportion consistent with modern-day Norwegian data, and historical data for the US. We also collect scattered data from advertisements for Oslo residential real estate in *Aftenposten*, one of Norway's largest newspapers, with the gross advertised yield again adjusted down by one-third to proxy the net figure.

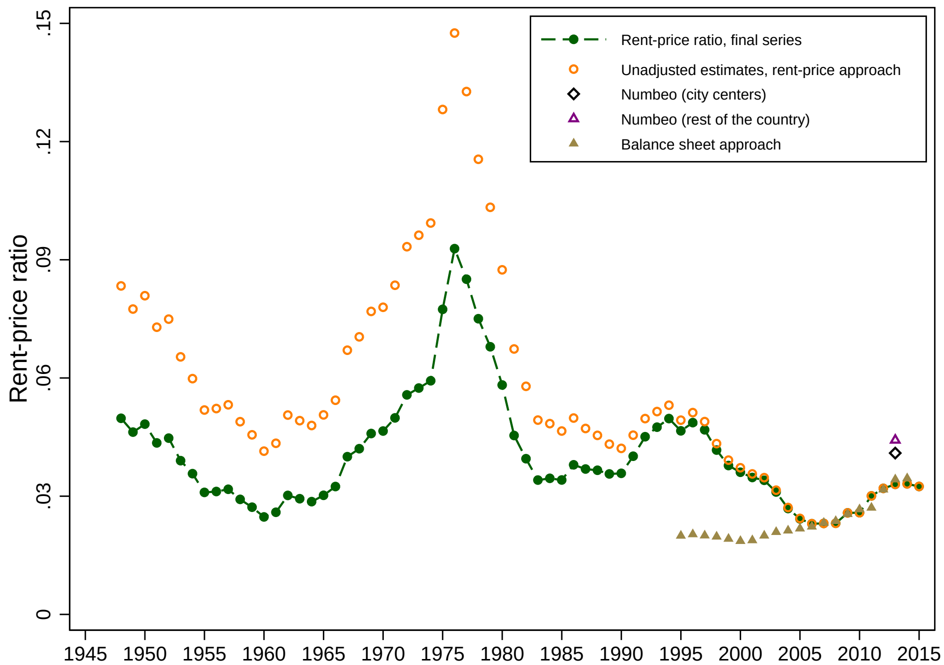
Both these sets of estimates confirm the general long-run trend in the rent-price ratio. The long-run rent-price ratio was essentially stable up until the early 2000s, with increases in early 20th century and late 1960s reversed by falls in WW1 and the 1980s, and is currently at a historical low. However the long-run level of the ratio is generally lower than the estimates using the rent-price approach (orange diamonds): around 6%–8% rather than 8%–12%, and this divergence is already apparent in the late 1970s. Based on this, we stipulate that the rental index during late 1990s and early 2000s—a period when house prices increased substantially—understated the growth of rents relative to prices, leading the rent-price approach to overstate the historical rental yields. To correct for this presumed bias, we adjust the growth in rents up by a factor of 1.5 for the years 1990 to 2005.

The resulting adjusted rent-price ratio (green circles) is in line with the historical estimates both in terms of levels and trend.

Lastly, estimates of the rent-price ratio based on data from www.Numbeo.com are in line with our baseline IPD benchmark (MSCI, 2016).

Portugal

Figure A.22: *Portugal: plausibility of rent-price ratio*



For 2013, the MSCI (2016) reports the rent-price ratio for Portuguese residential real estate of 0.033. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.22. We make one adjustment to these series to correct for potential biases arising from rent mismeasurement during the prolonged period of rent controls in the last quarter of the 20th century (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.22—used in this paper.

We obtain several scattered independent estimates of rent-price ratios in Portugal. First, estimates of the rent-price ratio based on data from www.Numbeo.com are slightly above, but broadly in line with our baseline IPD benchmark (MSCI, 2016). Second, we compute the rental yield using the balance-sheet approach, based on data on total rental expenditure (OECD, 2016b) and total housing wealth (Cardoso, Farinha, and Lameira, 2008), scaled down one-third to adjust for running costs and depreciation. These are almost identical to the rent-price approach for the recent years, but diverge somewhat in the late 1990s. More generally, the historical growth in rents relative to house prices in Portugal may have been understated due to the imposition of rent controls in 1974, which remained in place in various forms until well into the 2000s. This seems likely given the high levels of the unadjusted rent-price approach yields in the 1970s and early 1980s (orange circles in Figure A.22). Unfortunately, no alternative historical estimates of the rent-price ratio before 1995 are available for Portugal. Instead, we stipulate that the rent-price ratio in the 1940s and 50s, before the reported high rent inflation of the 1960s (Cardoso, 1983) and the subsequent rent controls, was at levels similar to the 1980s and 1990s. To achieve that, we adjust rental growth up by a factor of 1.2 for years 1974–2005; the period for which rent controls were in place.

The resulting adjusted long-run rent-price ratio (green circles in Figure A.22) concords with the narrative evidence on house prices and rent developments in Portugal. Real house prices in Portugal rose after the end of WW2 until the Carnation Revolution in 1974. After a brief but substantial house price recession after the revolution, real house prices embarked on a steep incline (Azevedo, 2016). By contrast, real rents remained broadly stable between 1948 and the mid-1960s as well as after 1990 but exhibit a pronounced boom and bust pattern between the mid-1960s and the mid-1980s. According to Cardoso (1983), the rapid growth of inflation-adjusted rents between the mid-1960s and the mid-1970s was the result of both rising construction costs and high inflation expectations. In 1974, new rent legislation provided for a rent freeze on existing contracts. Rent increases were also regulated between tenancies but unregulated for new construction. These regulations resulted in lower rent growth rates and rents considerably lagging behind inflation (Cardoso, 1983), and a consequent fall in the rent-price ratio.

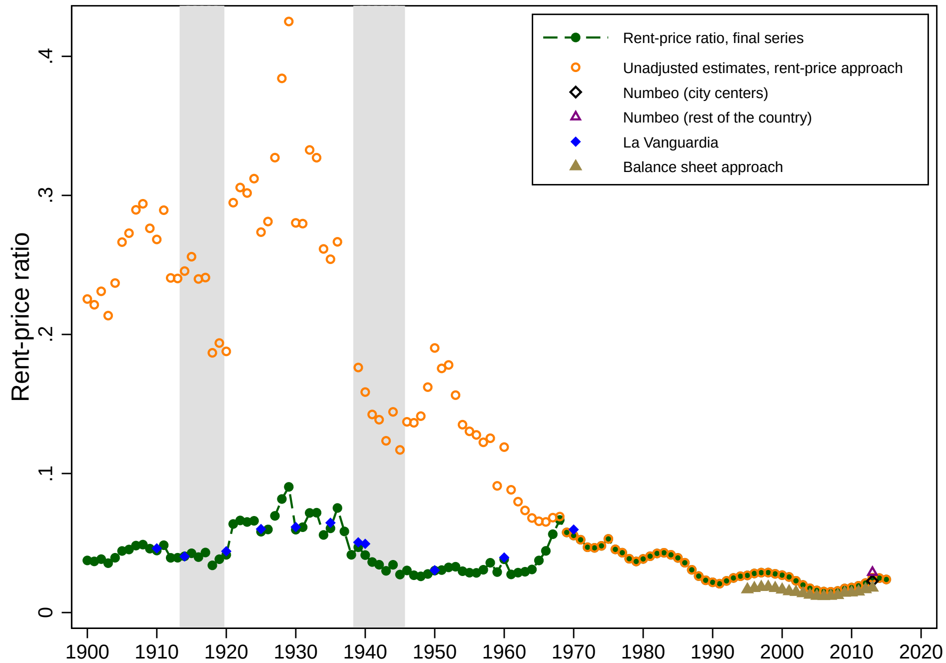
Spain

For 2013, the MSCI (2016) reports the rent-price ratio for Spanish residential real estate of 0.025. Applying the rent-price approach to this benchmark gives us the unadjusted long-run net rent-price ratio series depicted as orange circles in in Figure A.23. We make one adjustment to these series to correct for possible mismeasurement of rental growth during the rent controls imposed in the early-to-mid 20th century (see below for details). This gives us the final adjusted rent-price ratio series—the green-circled line in Figure A.23—used in this paper.

We obtain several scattered independent estimates of rent-price ratios in Spain. First, estimates of the rent-price ratio based on data from `www.Numbeo.com` are almost identical to our baseline IPD benchmark (MSCI, 2016). Second, we construct net rent-price ratios using the balance sheet approach, as total rental expenditure (OECD, 2016b) less running costs and depreciation (assumed to be one-third of gross rent), in relation to housing wealth (Artola Blanco, Bauluz, and Martínez-Toledano, 2017). These are slightly below but broadly in line with the rent-price approach for the overlapping years.

Finally, we collected scattered data on rent-price ratios from advertisements for Barcelona residential real estate in *La Vanguardia* for benchmark years (1910, 1914, 1920, 1925, 1930, 1935, 1940, 1950, 1960, 1970). For each of the benchmark years, we construct an average rent-price ratio based on between 25 and 46 advertisements. The gross ratios in the advertisements are adjusted down to exclude running costs and depreciation, calibrated at 2% p.a., around one-third of the advertized yields. Figure A.23 shows that the newspaper estimates are significantly below the rent-price ratio for the benchmark years between 1910 and 1960. Yet it also suggests that rent-price ratios were generally higher before the mid-1950s. Similarly to Finland, this trajectory may reflect difficulties of the Spanish statistical office to construct a rent index after the introduction of rent freezes in the 1930s and during the years of strong rent regulation after WW2. While the rent freeze was lifted in 1945, these regulations remained effective until the mid-1960s. Specifically, the data suggest that rents between the end of WW2 and the mid-1960s increased substantially less than house prices. To the best of our knowledge, no quantitative or qualitative evidence exists supporting such a pronounced fall in the rent-price ratio in the immediate post-WW2 years or a generally higher level of rental yields prior to the 1960s. To mitigate this bias, we adjust the growth rate in rents between 1910 and 1960 so that the adjusted long-run rent-price ratio concords with the independent estimates obtained from *La Vanguardia*. Figure A.23 displays the resulting adjusted long-run rent-price ratio

Figure A.23: *Spain: plausibility of rent-price ratio*



(green circles), which is the final series we use in this paper.

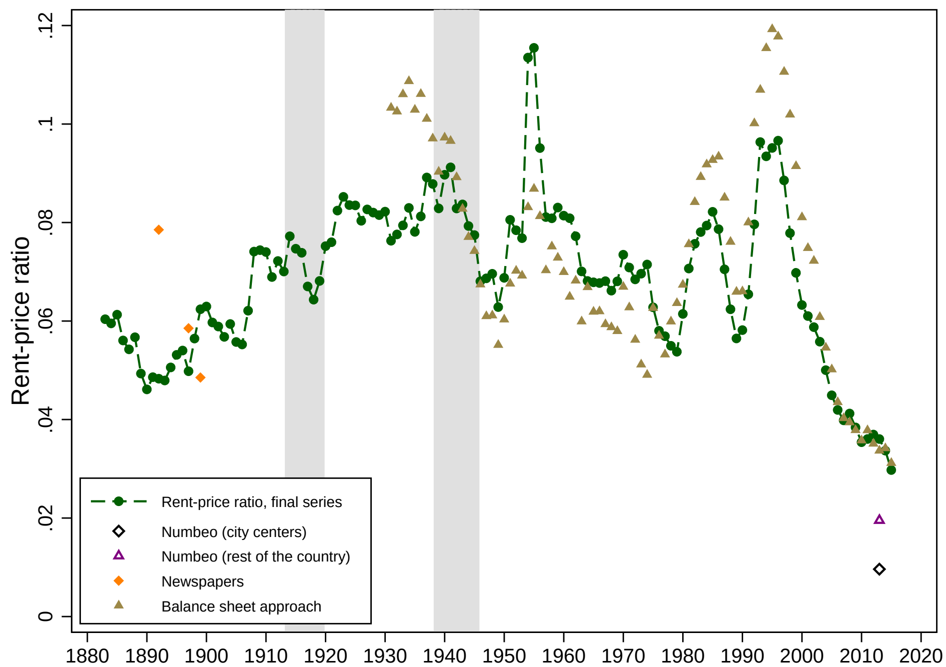
Sweden

For 2013, the MSCI (2016) reports the rent-price ratio for Swedish residential real estate of 0.036. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.24, which are the estimates used in this paper.

We obtain three independent estimates of rent-price ratios for Sweden. First, we compute net rental yields based on the balance-sheet approach as total rental expenditure less running costs and depreciation, as a share of housing wealth, drawing on a variety of sources. The modern-day rental expenditure data are obtained from OECD (2016b), and further data back to 1969 were provided by Birgitta Magnusson Wärmark at Statistics Sweden. These are extrapolated back to 1931 using data on total housing expenditure from Dahlman and Klevmarken (1971). The data on running costs are a weighted average of total repairs of dwellings (data provided by Jonas Zeed at Statistics Sweden), and maintenance costs on rentals reported by (OECD, 2016b) scaled up to capture owner-occupied dwellings. Data on depreciation were provided by Jonas Zeed at Statistics Sweden, and were extrapolated back using dwellings depreciation in Edvinsson (2016). Before 1995, running costs are assumed to have evolved in line with depreciation. The long-run housing wealth data are sourced from Waldenström (2017). Both the level and the time trend in the resulting long-run rent-price ratio are in line with the historical balance-sheet approach estimates.

Second, the rent-price ratio in the late 19th / early 20th century is in line with those reported in several newspaper advertisements and articles. According to these sources, gross rent-price ratios were in the range of 0.07 to 0.1, and residential real estate was perceived as highly profitable investment (Dagens Nyheter, 1892, 1897, 1899). Given that running costs and depreciation amounted to around 2% p.a. of property value in Sweden during the period 1930–2015, this leads us to

Figure A.24: *Sweden: plausibility of rent-price ratio*

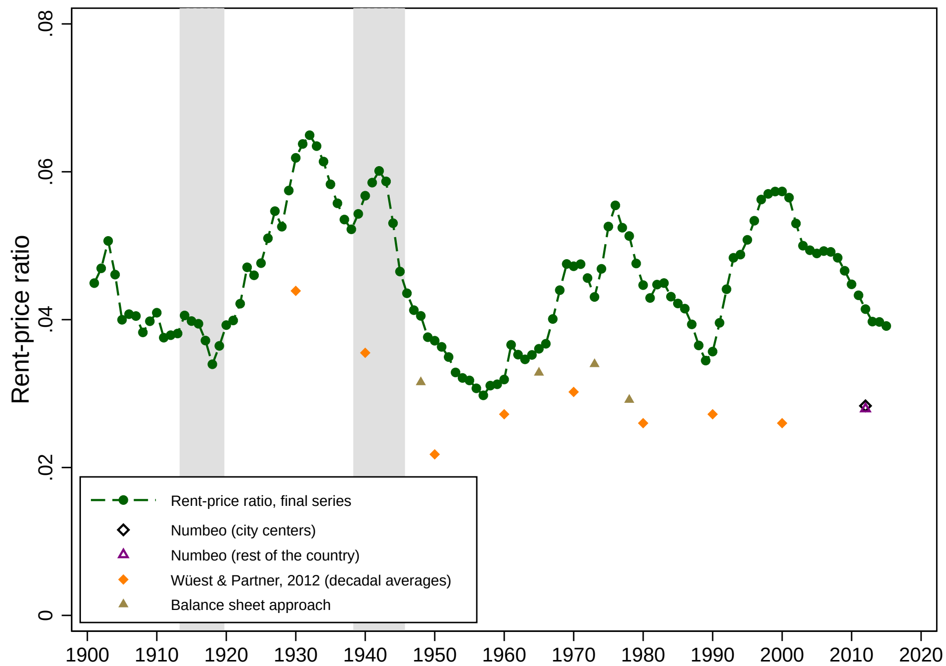


conjecture that net rent-price ratios were around 0.05–0.08, in line with our estimates.

Finally, estimates of modern-day rent-price ratios from Numbeo.com are somewhat below both our benchmark ratio and the balance sheet approach. However these are not based on a representative or matched sample of properties for sale and for rent, and are therefore less reliable than the alternative estimates.

Switzerland

Figure A.25: *Switzerland: plausibility of rent-price ratio*



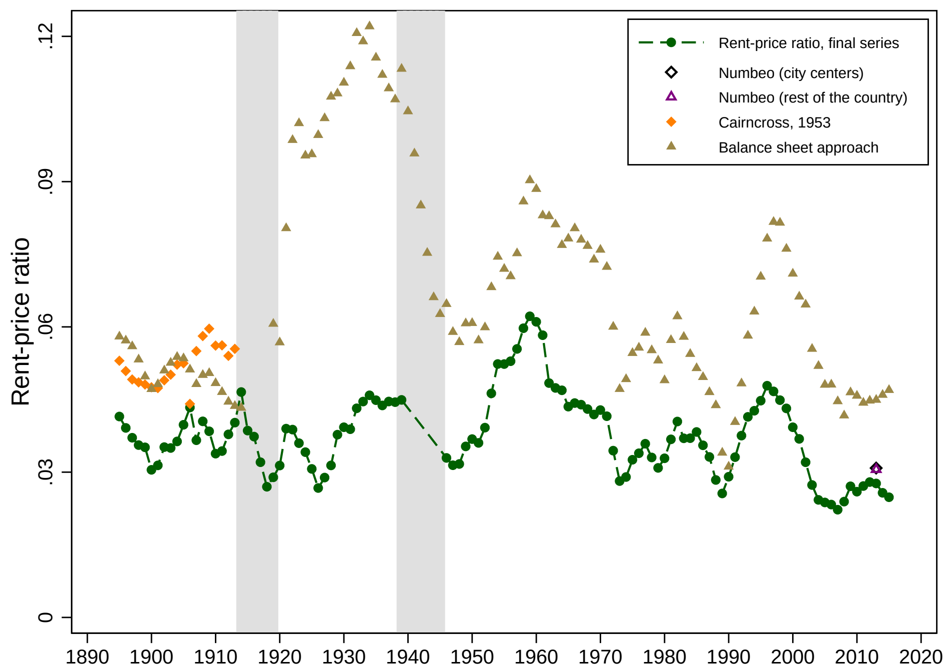
For 2013, the MSCI (2016) reports the rent-price ratio for Swiss residential real estate of 0.040. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.25, which are the estimates used in this paper.

To check the plausibility of the long-run rent-price ratio, we obtain four independent estimates. First, Real (1950) reports real returns on residential real estate in Zurich of 6 percent in 1927 and 7.3 percent in 1933. These data are—by and large—in line with the estimates of housing returns constructed by merging the indices of house prices and rents. Second, Wüest and Partner (2012) estimate 10-year averages of real rental yields in Switzerland for 1920–2000. Assuming around one-third of gross rent goes to running costs and depreciation, the resulting net rental yield estiamtes are broadly consistent with the long-run rent-price ratio (Figure A.25), taking into account the various estimation uncertainties. For the post-WW2 period, we calculate rent-price ratios using the balance sheet approach for benchmark years (1948, 1965, 1973, 1978) drawing on data on housing wealth from Goldsmith (1985), rental expenditure from Statistics Switzerland (2014), and assuming one-third of gross rent is taken up by runnign costs and depreciation. Again, the resulting estimates are broadly consistent with the long-run rent-price ratio (Figure A.25).

Finally, estimates of rent-price ratios based on data from `Numbeo.com` are somewhat below, but within a reasonable error margin of the MSCI (2016) benchmark ratio.

United Kingdom

Figure A.26: *United Kingdom: plausibility of rent-price ratio*



For 2013, the MSCI (2016) reports the rent-price ratio for U.K. residential real estate of 0.032. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.26, which are the estimates used in this paper. Please note that for years 1947–1955, no rental index data were available, and we extrapolated the rent-price ratio series using the growth in the "balance sheet approach" measure, benchmarking against rental index values in 1946 and 1956.[58]

We construct several alternative estimates of the rent-price ratio for the period going back to 1900. First, we construct the net rental yield based on the balance-sheet approach using data on total rental expenditure less running costs and depreciation, in proportion to housing wealth, based on a variety of sources. For rents, we rely on historical series of housing and rental expenditure from Mitchell (1988), Sefton and Weale (1995) and Piketty and Zucman (2014), combined with recent Office for National Statistics (ONS) data, and historical data from the ONS shared with us by Amanda Bell. Estimates of costs and depreciation are available from the UK National Accounts, and housing wealth is taken from Piketty and Zucman (2014). It is worth noting that the estimates of rental expenditure for the UK are subject to large uncertainty: the ONS updated the methodology for rent imputation in 2016, resulting in large upward revisions to historical imputed rent estimates (by as large as a factor of three). It is possible that some of the historical data are subject to similar uncertainties, which helps explain why the rental yield levels using the balance sheet approach are so much higher than the extrapolated rent-price ratio, even though the time trend is similar.

[58] We assume that the 1956 index value is correct, but correct the 1946 rental index value for possible biases arising from the wartime rent controls, such that the trend in the rent-price ratios matches that in the balance sheet approach measure, and the 1956 rent-price approach estimate.

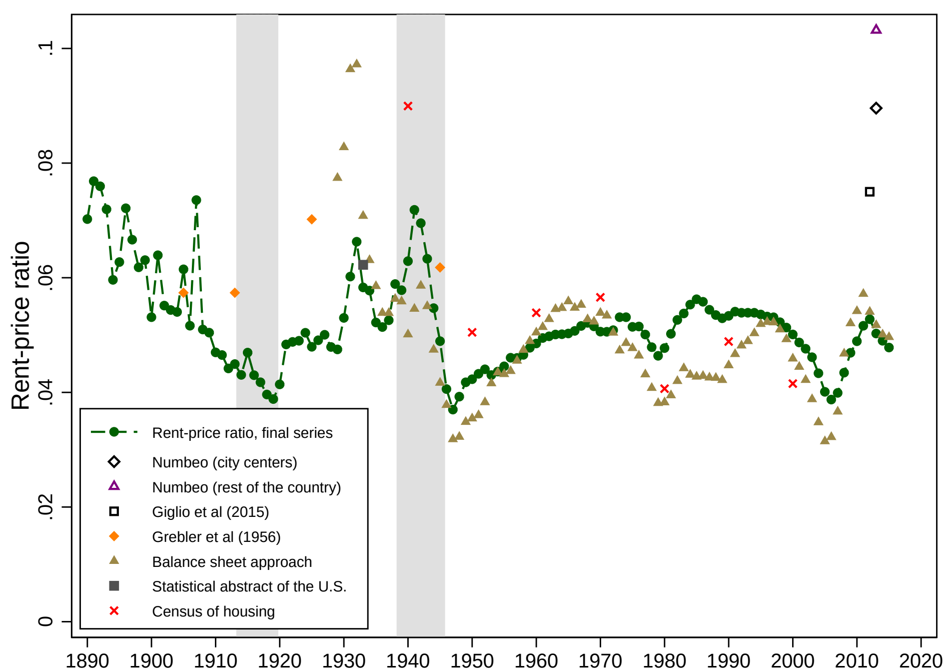
Some additional scattered data on rent-price ratios are available for the pre-WW2 period. For England, Cairncross (1975) reports an average gross rent-price ratio of 0.068 between 1895 and 1913, or around 0.05 in net terms. Offer (1981) estimates slightly higher rent-price ratios for selected years between 1892 and 1913 for occupied leasehold dwellings in London. As Figure A.26 shows, these data are slightly higher, but broadly consistent with the our long-run rent-price ratio estimates (an average of 0.037 during 1900–1913). Tarbuck (1938) states that high-quality freehold houses were valued at 25 to 16 years purchase and lower quality freehold houses at 14 to 11 years purchase in the 1930s, again broadly consistent with our estimates.

Overall, these estimates suggest that our rental yields for the UK are somewhat conservative, but fit the time pattern and broad levels found in the alternative historical sources.

Concerning the modern period, estimates of the rent-price ratio based on data from `www.Numbeo.com` are very similar to the MSCI (2016) benchmark. Additionally, Bracke (2015) estimates a gross rental yield of 0.05 on central London properties over the period 2006–2012, based on a matched micro-level dataset of around 2000 properties. Again, these estimates are consistent with our data.

United States

Figure A.27: *United States: plausibility of rent-price ratio*



For 2014, the MSCI (2016) reports the rent-price ratio for U.S. residential real estate of 0.049. Applying the rent-price approach to this benchmark gives us the long-run net rent-price ratio series depicted as green circles in in Figure A.27, which are the estimates used in this paper.

We obtain independent estimates of U.S. rent-price ratios from five additional sources. First, decadal averages of gross price-rent ratios are available for 1899–1938 from Grebler, Blank, and Winnick (1956) ranging between 10.4 and 12.6. Second, estimates of gross rents paid and home values are available from various issues of the U.S. Census and Statistical Abstract, published by U.S. Census Bureau (1942, 2013). Once adjusted for estimates of running costs and depreciation, the estimates from these sources are similar to the price-rent ratios resulting from merging the indices of house prices and rents (see Figure A.27). Third, we calculate the rent-price ratio using the balance sheet approach, as total rental expenditure less housing running costs—estimated as 2/3 of total housing intermediate consumption—in proportion to total housing value, using expenditure data from Bureau of Economic Analysis (2014) and housing wealth estimates in Saez and Zucman (2016). Reassuringly, the resulting estimates are very close to the long-run rent-price ratio. Estimates of the rent-price ratio for 2012 are also available from the real estate portal Trulia, as used by Giglio, Maggiori, and Stroebel (2015). The resulting net rent-price ratio of 0.075 is higher than the figures from MSCI (2016) and the balance sheet approach. This may be because the Trulia ratios are not market cap weighted, and may overweigh the high-yield low-housing-wealth areas outside of cities. Alternatively, the MSCI (2016) IPD ratio could understate the rental yield because investor portfolios tend to be concentrated in cities. To be consistent with the balance sheet approach and to remain conservative, we use the IPD ratio as our benchmark.

Finally, estimates of the rent-price ratio based on data from `www.Numbeo.com` are higher than our benchmark estimate and similar to the Trulia transaction-level data. As with the Trulia data, these are not market-capitalization weighted, which may bias the rental yield estimates upwards. Given the similarity to the balance-sheet approach yields and the historical estimates from Grebler, Blank, and Winnick (1956), the rent-price approach estimates stemming from the MSCI (2016) benchmark should provide the most accurate picture of the historical rental returns on housing in the US. Still, given the higher alternative benchmark yield estimates of Trulia and `Numbeo.com`, our housing return series for the US should be viewed as conservative compared to other possible alternatives.

V. Rent indices: methodology

Rent indices measure the change in 'pure' rents for primary residences, i.e., net of house furnishings, maintenance costs, and utilities. For modern rent indices included in CPIs, data are usually collected by statistical offices through surveys of housing authorities, landlords, households, or real estate agents (International Labour Organization et al., 2004).

Rental units are heterogeneous goods.[59] Consequently, there are several main challenges involved when constructing consistent long-run rent indices. First, rent indices may be national or cover several cities or regions. Second, rent indices may cover different housing types ranging from high to low value housing, from new to existing dwellings. Third, rental leases are normally agreed to over longer periods of time. Hence, current rental payments may not reflect the current *market rent* but the *contract rent*, i.e., the rent paid by the renter in the first period after the rental contract has been negotiated.[60] Fourth, if the quality of rental units improve over time, a simple mean or median of observed rents can be upwardly biased. These issues are similar to those when constructing house price indices and the same standard approaches can be applied to adjust for quality and composition changes. For a survey of the different approaches, the reader is referred Knoll et al. (2017). Yet, as can be seen from the data description that follows, these index construction methods commonly used for house price indices have less often been applied to rents.

Another important question when it comes to rent indices is the treatment of subsidized and controlled rents. Rental units may be private or government owned and hence be subject to different levels of rent controls or subsidies. Since these regulations may apply to a substantial share of the rental market, rent indices typically cover also subsidized and controlled rents (International Labour Organization et al., 2004).[61] It is worth noting that not properly controlling for substantial changes in rent regulation may result in a mis-measurement of rent growth rates. More specifically, if the share of the rental market subject to these regulations suddenly increases—e.g., during wars and in the immediate post-war years—the rent index can be downwardly biased.[62]

An additional challenge when constructing rent indices is the treatment of owner-occupied housing. Since a significant share of households in advanced economies are owner-occupants, rent indices typically cover changes in the cost of shelter for both renters and owner-occupiers.[63] The cost for owner-occupied shelter is an estimate of the implicit rent that owner-occupants would have to pay if they were renting their dwellings. Different approaches to estimate the change in implicit rents exist, each with advantages and disadvantages. Most statistical offices rely on the *rental equivalent approach*.[64] The resulting rent index is based on an estimate of how much owner-occupiers would have to pay to rent their dwellings or would earn from renting their home

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[59]Compared to owner-occupied houses, Gordon and van Goethem (2007) argue that rental units are, however, less heterogeneous in size at any given time and more homogenous over time. The authors provide also scattered evidence for the U.S. that rental units experience quality change along fewer dimensions than owner-occupied units.

[60]Typically, in times of low or moderate general inflation, the market rent will be higher than the contract rent. Yet, the introduction of rent controls or a temporary strong increase in the supply of rental units may result in the market rent being lower than the contract rent (Shimizu et al., 2015).

[61]Exceptions include, for example, the Canadian rent index where subsidized dwellings are excluded (Statistics Canada, 2015).

[62]For example, this has been the case for the Australia CPI rent index after WW2 (see Section W).

[63]Imputed rents of owner-occupied housing are excluded in Belgium and France. In some countries, two rent indices are reported, one for renter-occupied and one for owner-occupied dwellings (International Labour Organization et al., 2004; OECD, 2002).

[64]The *rental equivalent approach* is currently used in the U.S., Japan, Denmark, Germany, the Netherlands, Norway, and Switzerland (OECD, 2002).

in a competitive market. Data either come from surveys asking owner-occupiers to estimate the units' potential rent or are based on matching owner-occupied units with rented units with similar characteristics.[65] The *user cost approach* assumes that a landlord would charge a rent that at least covers repairs and maintenance, taxes, insurance, and the cost of ownership (i.e., depreciation, mortgage interest, opportunity costs of owning a house). The resulting rent index is a weighted average of the change in the price of these components.[66] The user cost approach is important in its own right (i.e., when the size of the rental market is relatively small, it is not possible to value the services of owner-occupied housing using the *rental equivalence approach*). Nevertheless, the user-cost and rental equivalence approach should, in principle, yield similar results given that capital market theory implies that the price of an asset should equal the discounted value of the flow of income or services (e.g., rents) that it provides over the lifetime of the asset. The *net acquisitions approach* measures the costs associated with the purchase and ongoing ownership of dwellings for own use. Hence it covers the costs of repair and maintenance, taxes, insurances and the change in the cost of the net acquisition of the dwelling, i.e., the change in the total market value (Diewert, 2009; International Labour Organization et al., 2004; OECD, 2002).[67] If rents of owner-occupants are included in rent indices, the combined rent index is a weighted average of rents for rented and owner-occupied dwellings. Weights are based on the share of owner-occupants and tenants in the respective housing market.

[65]This approach may result in a bias of unknown size and direction if i) owners' assessment of the rental value of their dwelling is unreliable, ii) if the rental market is small and the rental housing stock is not comparable to the owner-occupied housing stock, and ii) if rents set in rental markets are significantly affected by government regulation since subsidized and controlled rents should not be used in calculating an owners' equivalent rent index (Diewert, 2009; International Labour Organization et al., 2004; OECD, 2002).

[66]A (partial) *user cost approach* is currently used in Canada, Finland, Sweden, and the United Kingdom (OECD, 2002).

[67]Hence, a basic requirement of this method is the existence of a constant- quality house price index. The *net acquisitions approach* is currently used in Australia (OECD, 2002).

W. Data sources for the rental indices

To construct rent indices reaching back to the late 19th century, we rely on two main sources. First, we use the rent components of the cost of living or consumer price indices published by regional or national statistical offices such as Statistics Sweden (1961) and Statistics Norway (2015). The cost of shelter is a major component of household expenditure. Cost of living (COLIs) or consumer price indices (CPIs) therefore typically include a component for housing. In many advanced economies, the construction of COLIs/CPIs was initiated by governments during WW1 to calculate necessary wage adjustments in times of strongly rising price levels. Hence, most countries' statistical offices started to collect data on rents and calculate rent indices in the early 20th century.[68] The Yearbook of Labor Statistics (International Labour Organization, various years) serves as main repository for these data from national statistical offices. Second, to extend these indices back to the late 19th century, we draw on previous work of economic historians, such as Rees (1961) for the U.S., Lewis and Weber (1965) for the U.K., or Curti (1981) for Switzerland.

Australia

Rent data Historical data on rents in Australia are available for 1901–2015.

For Australia, there are two principal sources for historical rent data. First, the CPI rent component constructed by the Australian Bureau of Statistics covers the period 1901–2015. This rent index is based on data for urban areas and has historically been published in two versions, the *A* and the *C series*.[69]. For the years the two series overlap, the difference appears negligible (Stapledon, 2012). Since 1961, the CPI rent index is based on rent data for 8 capital cities. The sample of dwellings included is stratified according to location, dwelling type and dwelling size based on data from the most recent *Census of Population and Housing* (Australian Bureau of Statistics, 2011). Rent data are collected from real estate agents and state and territory housing authorities (Australian Bureau of Statistics, 2011).

The second source is Stapledon (2007) who presents an index of average rents per dwelling based on census estimates for 1901–2005. The author observes substantial differences between his series and the CPI rent index described above. While for the years prior to WW2, the rent index based on census data and the CPI rent index are highly correlated,[70] the CPI rent index increases much less than the index based on census data during the immediate post-WW2 decades (see Figure A.28). Stapledon (2007) hypothesizes that this may reflect difficulties of the Australian statistical office to construct a rent index after the introduction of wartime rent controls.

Given this potential bias in the CPI rent index in the post-WW2 period, we rely on the series constructed by Stapledon (2007) for the years 1940–1989 and the CPI rent component before and after.[71]. For the pre-WW2 period, we rely on the *C series* whenever possible as it is based on a more homogeneous dwelling sample and may thus be less affected by shifts in the composition of the sample. The available series are spliced as shown in Table A.30.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts before 1990. As noted above, the latter aspect may be less of a problem for the years 1921–1939 since the index is confined to a specific market segment, i.e., 4-

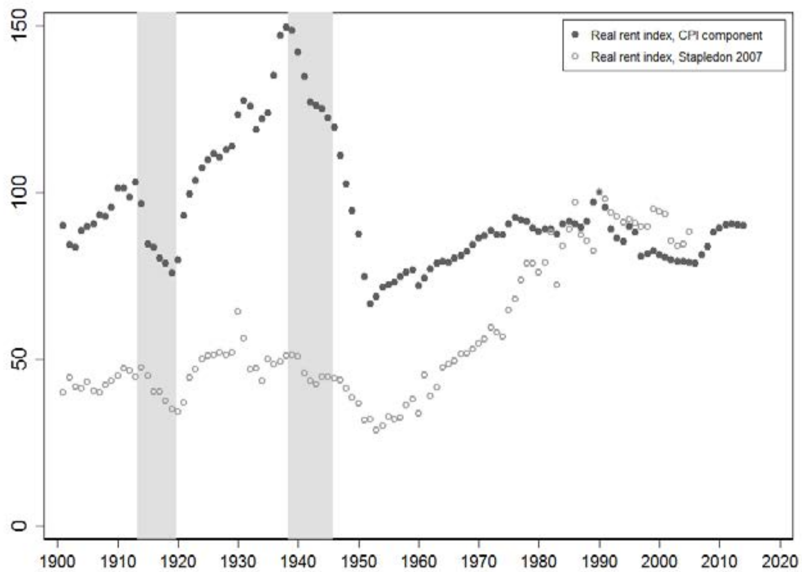
[68] One exception is Belgium where house rents were only added to the CPI basket in 1989.

[69] The *A series* starts in 1901 and refers to average rents of all kinds of dwellings in the 6 capital cities. The series was discontinued in 1938. The *C series* starts in 1920, covers 30 towns (including the 6 capital cities) and is based on rent data for 4- and 5-room houses (Australian Bureau of Statistics, 2011).

[70] Correlation coefficient of 0.75.

[71] Rent controls were introduced in 1939 and gradually lifted after 1949. According to Stapledon (2007), rent controls affected rent levels well into the 1960s.

Figure A.28: *Australia: comparison of real rent indices*



Note: Indices, 1990=100

Table A.30: *Data sources: rent index, Australia*

Period	Source	Details
1901–1920	Australian Bureau of Statistics, CPI A series as published in Stapledon (2012)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1921–1939	Australian Bureau of Statistics, CPI C series as published in Stapledon (2012)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Houses with 4-5 rooms; *Method*: Average rents.
1940–1989	Stapledon (2007)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1990–2015	Australian Bureau of Statistics, CPI series	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification.

and 5-room dwellings. Note that matching the Australian house price and rent series in terms of geographical coverage has been—by and large—possible. Both series are based on data for capital cities since 1901. Yet, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

Belgium

Rent data Historical data on rents in Belgium are available for 1890–2015.

The long-run rent index relies on five different sources. First, for the years since 1984, we rely on the CPI rent index constructed by Statistics Belgium.[72] The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded. Second, for 1977–1983, we use the rent index published by the International Labour Organization (2014) which, in turn, is based on data provided by Statistics Belgium. The main characteristics of these two series are summarized in Table A.31.

For earlier periods, data has been drawn from two major historical studies (Buyst, 1994; Segers, 1999) and an unpublished database by Anne Henau.[73] The rent index for seven cities[74] constructed by Segers (1999) for 1890–1920 is based on data from two public institutions for social welfare, the *Burelen van Weldadigheid* and the *Burgerlijke Godshuizen*. The individual city series are constructed as chain indices so as to at least partially account for changes in the underlying sample. The combined index is an unweighted average of the seven city indices. The rent index reported in Buyst (1994) for 1921–1938 is an unweighted average of five city indices[75] combining data drawn from studies by Leeman (1955) and Henau (1991) (see below). The unpublished index constructed by Henau for 1939–1961 covers four cities[76] using records of local Public Welfare Committees (OCMWs).

Three alternative series for the pre-WW2 period are available. Van den Eeckhout and Scholliers (1979) present a rent index for dwellings let by the OCMW in Brussels for 1800–1940. Henau (1991), also using records of local OCMWs, constructs rent indices for Leuven, Luik, Ghent, and Antwerp for 1910–1940. Leeman (1955) calculates city indices for a small sample of houses for Brussels, Gent, and Hoei for 1914–1939. As these series, however, are less comprehensive in terms of geographic coverage, we rely on the indices by Segers (1999) and Buyst (1994). The rent indices constructed by Van den Eeckhout and Scholliers (1979), Leeman (1955), Buyst (1994), and Segers (1999) follow a joint, almost identical path for the years they overlap.

The available series are spliced as shown in Table A.31. Since no time series of rents is available for 1961–1977, the two sub-indices (1870–1961 and 1977–2013) are linked using scattered data on rent increases between 1963 and 1982 reported by Van Fulpen (1984).

The resulting index suffers from two weaknesses. The first relates to the lack of correction for quality changes and sample composition shifts. Second, for 1939–161, the series relies on dwellings let by Public Welfare Committees only. It is of course possible that this particular market segment does not perfectly mirror fluctuations in prices of other residential property types. Note further that the matching of the Belgian house price and rent series is imperfect for two reasons. First, the house price index is based on data for the Brussels area prior to 1950. Since the available rent data for the pre-1950 period relies on a rather mall sample, we opted for the indices with broader geographic coverage. Second, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

[72]Only in 1989, house rents were added to the CPI basket. Series sent by email, contact person is Erik Vloeberghs, Statistics Belgium.

[73]Series sent by email, contact person is Erik Buyst, KU Leuven.

[74]These are Antwerp, Brugge, Brussels, Gent, Kortrijk, Leuven, Luik.

[75]These are Brussels, Antwerp, Ghent, Leuven, and Luik.

[76]These are Leuven, Luik, Ghent, and Antwerp.

Table A.31: *Data sources: rent index, Belgium*

Period	Source	Details
1870–1920	Segers (1999)	*Geographic Coverage*: 7 cities ; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1921–1938	Buyst (1994)	*Geographic Coverage*: 5 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1939–1961	Unpublished database by Anne Henau.	*Geographic Coverage*: 4 cities; *Type(s) of Dwellings*: All kinds of dwellings let by Public Welfare Committees; *Method*: Average rents.
1977–1983	International Labour Organization (2014)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Non-public housing; representative sample of 1,521 apartments and houses of various sizes; *Method*: Average rents.
1984–2013	Statistics Belgium	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Non-public housing; representative sample of 1,521 apartments and houses of various sizes; *Method*: Average rents.

Denmark

Rent data Historical data on rents in Denmark are available for 1870–2015.

For 1870–1926, no rent series for Denmark as a whole exists. We therefore combine three series on rents in Copenhagen to proxy for development of rents in Denmark as a whole. First, for 1870–1911, we rely on an index of average rents for 3 room apartments—which can generally be considered working class or lower middle class dwellings—in Copenhagen (Pedersen, 1930). Second, for 1914–1917, the long-rent index is based on the increase in average rents of 1–8 room houses in Copenhagen as reported in Statistics Copenhagen (1906–1966). Third, for 1918–1926, we rely on the rent component of the cost of living index reported in Statistics Denmark (1925) and Statistics Copenhagen (1906–1966) referring to average rents of 1-5 room houses in Copenhagen.

For 1927–1955, we use the CPI rent index as reported in the Yearbook of Labor Statistics (International Labour Organization, various years) which for the years prior to 1947 is based on average rents in 100 towns and in 200 towns for the years thereafter.

For 1955–1964, to the best of our knowledge, no data on rents for Denmark as a whole are available. we therefore use the increase in average rents of 1–5 room houses in Copenhagen as reported in Statistics Copenhagen (1906–1966) as a proxy for rent increases in Denmark.

For 1965–2015, we rely on the CPI rent index as reported in Statistics Denmark (2003), Statistics Denmark (2015), and the yearbooks of the International Labour Organization (various years). The available series are spliced as shown in Table A.32.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts. To some extent, the latter aspect may be less problematic for 1870–1913 since the index for these years is confined to a specific market segment, i.e., 3-room apartments. It is important to note that the matching of the Danish house price and rent series is imperfect. While the house price index relies on data for dwellings in rural areas prior to 1938, the rent index mostly covers urban areas. Moreover, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence

Table A.32: *Data sources: rent index, Denmark*

Period	Source	Details
1870–1913	Pedersen (1930)	*Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 3 room apartments; *Method*: Average rents.
1914–1917	Statistics Copenhagen (1906–1966)	*Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-8 room houses; *Method*: Average rents.
1918–1926	Statistics Copenhagen (1906–1966); Statistics Denmark (1925)	*Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-5 room houses; *Method*: Average rents.
1927–1954	International Labour Organization (various years)	*Geographic Coverage*: Danish towns; *Type(s) of Dwellings*: New and existing dwellings; *Method*: Average rents.
1955–1964	Statistics Copenhagen (1906–1966)	*Geographic Coverage*: Copenhagen; *Type(s) of Dwellings*: 1-5 room houses; *Method*: Average rents.
1965–2015	International Labour Organization (various years); Statistics Denmark (2003, 2015)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing dwellings; *Method*: Average rents.

be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Finland

Rent data Historical data on rents in Finland are available for 1920–2015.

The long-run rent index relies on the rent component of the consumer price index as published by the Ministry for Social Affairs (1920–1929), the International Labour Organization (various years), and Statistics Finland (2009). The main characteristics of the rent series are summarized in Table A.33.

The main weakness of the long-run rent series relates to the lack of correction for quality changes and sample composition shifts. These aspects may be somewhat less problematic for the post-1964 period since the index is adjusted for the size of the dwelling. Unfortunately, due to data limitations, the matching of the Finnish house price and rent series is imperfect. While the house price index relies on data for Helskinki prior to 1969, the rent index also covers more urban areas but is based on a larger city sample. In addition, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Table A.33: *Data sources: rent index, Finland*

Period	Source	Details
1920–1926	Ministry for Social Affairs (1920–1929)	*Geographic Coverage*: 21 towns; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1927–1965	International Labour Organization (various years)	*Geographic Coverage*: 21 towns (1927–1936), 36 towns (1937–1965); *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1964–2015	Statistics Finland (2009)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per sqm.

France

Rent data Historical data on rents in France are available for 1870–2015.

The long-run rent index relies on two main sources. For 1870–1948, we use an average rent index for Paris constructed by Marnata (1961). The index is based on a sample of more than 10,000 dwellings. Data come from lease management books from residential neighbourhoods in Paris and mostly refer to dwellings of relatively high quality. After 1949, we rely on national estimates, measured by the rent component of the CPI from the Statistics France (2015). The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded.

For the years prior to 1949, data on rents are also available for Paris (1914–1962) from the yearbooks of the International Labour Organization (various years). Reassuringly, the series by Marnata (1961) and the series published by the International Labour Organization (various years) are highly correlated for the years the overlap.[77] In addition, the International Labour Organization (various years) also presents a series for 45 departments for 1930–1937. For the years the series for Paris and the series for 45 departments overlap, they show similar rent increases. Note, however, that the house price index also relies on data for Paris only prior to 1936. For this reason, we use the Paris series throughout for the years prior to 1949 (Marnata, 1961). The available series are spliced as shown in Table A.34.

Table A.34: *Data sources: rent index, France*

Period	Source	Details
1870–1948	Marnata (1961)	*Geographic Coverage*: Paris; *Type(s) of Dwellings*: High-quality existing dwellings; *Method*: Average rents.
1949–2015	Statistics France (2015) as published in Conseil General de l'Environnement et du Developpement Durable (2013)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.

The most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Both aspects may be less problematic for the pre-WW2 years since the rent index is confined to a specific market segment, i.e., high-quality existing dwellings in Paris. Note further that the matching of the French house price and rent series

[77] Correlation coefficient of 0.98.

in terms of geographical coverage has been generally possible. Both series are based on data for Paris prior to WW2 and on data for France as a whole for the second half of the 20th century. Yet, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

Germany

Rent data Historical data on rents in Germany are available for 1870–2015.

The earliest data on rents in Germany comes from Hoffmann (1965). Hoffmann (1965) presents a rent index for 1850–1959. For 1850–1913, Hoffmann (1965) calculates a rent index using data on long-term interest rates and the replacement value of residential buildings, hence assuming that rents only depend on replacement costs and interest rates.

There are two additional sources on rents prior to WW1, both providing data on average rents in (parts of) Berlin. Bernhardt (1997) presents data on average rents for 1- and 2-room apartments between 1890 and 1910, and for 1-6 room apartments (separately for each size) in Berlin-Wilmersdorf between 1906–1913. Kuczynski (1947) provides an average rent based on scattered data for a number of larger German cities[78] for 1820–1913. Both sources, however, only report data for some years, not for the full period. For the 1895–1913 period, Kuczynski (1947) suggests a substantially stronger rise in nominal rents (42 percent) when compared to the index constructed by Hoffmann (1965) (22 percent). According to Hoffmann (1965), this can be explained by the fact that the index by Kuczynski (1947) does not account for quality improvements and may hence be upwardly biased. To be precise, the same bias should be present in Bernhardt (1997) as the data also refers to average rents. Yet, during the period they overlap (1890–1910), the series by Hoffmann (1965) and Bernhardt (1997) show about the same increase in rents while Kuczynski (1947) again suggests a significantly steeper rise.

For the years after 1913, Hoffmann (1965) relies on the rent component of the consumer price index as published by the Statistics Germany (1924–1935) (for 1913–1934) and Statistics Germany (various years) (for 1934–1959). The CPI rent index is a weighted average of rents in 72 municipalities (with population used as weights) including small, medium, and large cities. It is based on data for working class family dwellings, typically 2 rooms with a kitchen. The index refers to existing dwellings, i.e., built prior to WW1, throughout. This, however, should not underestimate increases in rents given that dwellings built after WW1 only accounted for about 15 percent of all rental dwellings in 1934 (Statistics Germany, 1925, 1934).

Statistics Germany (various years) reports the CPI rent index for the years since 1948. The index relies on a survey of households and landlords and covers 3-4 room apartments in more than 100 German municipalities. Subsidized apartments are included. The index is calculated as a matched-models index and adjusts for major renovations (Angermann, 1985; Kurz and Hofmann, 2004).[79]

The long-run index is constructed as shown in the Table A.35. For 1870–1912, we use the rent index constructed by Hoffmann (1965). For the years since 1913, we rely on the rent component of the consumer price index as published in Statistics Germany (1924–1935) and Statistics Germany

[78] These include Berlin, Halle, Hamburg, Leipzig, Breslau, Dresden, Magdeburg, Barmen, Chemnitz, Jena, Lbeck, Magdeburg, Strassburg, and Stuttgart.

[79] The matched models method aims to control for quality changes by matching rents collected for a sample of models (or varieties of selected apartments) in a baseline period with rents of these same matched models in subsequent periods (Kurz and Hofmann, 2004).

Table A.35: *Data sources: rent index, Germany*

Period	Source	Details
1870–1912	Hoffmann (1965)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Imputed rent based on long-term rates and replacement values of residential buildings.
1913–1947	Statistics Germany (1924–1935, various years)	*Geographic Coverage*: 72 municipalities; *Type(s) of Dwellings*: Working class dwellings; *Method*: Weighted average rents.
1948–2015	Statistics Germany (various years)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: 3-4 room apartments; *Method*: Matched models index.

(various years).

The long-run rent index has two main weaknesses. First, for the years prior to WW2, the index neither controls for quality changes nor for sample composition shifts. The latter aspect may be less of a problem for the interwar period ince the index is confined to a specific and presumably relatively homogeneous market segment, i.e., working class dwellings. Second, data prior to WW1 are not based on actual observed rents but have been estimated using data in replacement values and long-term interest rates.

Matching the German house price and rent series in terms of geographical coverage has been largely possible for the post-WW2 period. In both cases, data refers to Germany as a whole or at least covers a substantial share of the German housing market. This is unfortunately not the case for the pre-WW2 period. House price data for the pre-WW1 years only reflects trends in Berlin and Hamburg but the rent index covers all of Germany. For the interwar period, the house price index refers to urban real estate while the rent index provides a somewhat broader coverage. Moreover, no information on differences between the characteristics of the dwellings in the house price and the dwellings included in the rent index exist. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

Italy

House price data Historical data on house prices in Italy are available for 1927–2015.

We rely on the long-run house price index constructed by Cannari and D'Alessio (2016) throughout. For 1927–1941, Cannari and D'Alessio (2016) rely on a series published in Statistics Italy's statistical yearbooks which, in turn, are based on house price indices constructed by the *Federazione Nazionale Fascista di Proprietari di Fabbricati*. The series is based on data for existing dwellings and reflects average transaction prices per room. For the years since 1966, the index relies on average transaction prices per square meter of new and existing dwellings in provincial capitals before 1997 and average transaction prices per square meter of new and existing dwellings in municipal districts after 1998. Data are drawn from publications of the *Consulente Immobiliare*.

Unfortunately, no price data are available for the period 1941–1961. To obtain a long-run index, Cannari and D'Alessio (2016) link average prices per room in eight cities (Turin, Genoa, Milan, Trieste, Bologna, Rome, Naples and Palermo) in 1941 with average transaction prices per room in these cities in 1966 assuming an average room size of 18 square meters. To obtain an annual house price series for 1941–1966, Cannari and D'Alessio (2016) interpolate using data on year-to-year

Table A.36: *Data sources: rent index, Italy*

Period	Source	Details
1927–1937	International Labour Organization (various years)	*Geographic Coverage*: Milan; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1938–1955	International Labour Organization (various years)	*Geographic Coverage*: 62 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1956–2015	International Labour Organization (various years)	*Geographic Coverage*: 92 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.

increases in construction costs.

Rent data Historical data on rents in Italy are available for 1927–2015. The long-run index relies on the CPI rent component throughout and spliced as shown in Table A.36. Data are drawn from International Labour Organization (various years) and reflect average rents. The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded. Due to data availability, geographic coverage varies over time. The series reflects average rents in Milan (pre-1938), in 62 cities (1938–1955), and 92 cities (post-1955). The series has a gap between 1939 and 1945. Since, to the best of the author's knowledge, no data on rents are available for this period, we link the pre-1939 and post-1945 series assuming that rents increased in lockstep with house prices, i.e., by a factor of about 1.6 adjusted for inflation.

The single most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Italian house price and rent series is unfortunately imperfect. While the rent index is only based on data for Milan before 1937 and for urban areas more generally thereafter, the house price index offers a more comprehensive geographic coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Japan

Rent data Historical data on rents in Japan are available for 1931–2015.

The long-run rent index relies on the rent component of the consumer price index throughout. For 1931–1946, the CPI rent index is reported in the yearbooks of the International Labour Organization

Table A.37: *Data sources: rent index, Japan*

Period	Source	Details
1931–1946	International Labour Organization (various years)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Wooden houses; *Method*: Average rents.
1947–2015	Statistics Japan (2012)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: Small and medium-sized wooden houses, non-wooden houses; *Method*: Average rents per sqm.

(various years). The index covers 13 cities through 1936 and 24 cities thereafter and refers to average rents of wooden houses.

For the years since 1947, the rent component of the CPI is published by Statistics Japan (2012). Data are collected as part of the *Retail Price Survey* in more than 1200 districts. The rent index covers small and medium-sized wooden houses as well as non-wooden houses and refers to the average rent per sqm. Subsidized dwellings are included. Imputed rents for owner-occupiers are included since 1970 (International Labour Organization, 2013; Shiratsuka, 1999). The available series are spliced as shown in Table A.37.

The most important limitation of the long-run rent index is the lack of correction for quality improvements and sample composition shifts. Particularly the latter aspect may be somewhat less problematic for the post-WW2 years since the series controls for the size of the dwelling. Matching the Japanese house price and rent series in terms of geographical coverage has been partly possible. For the pre-WW2 years both series are based on data for urban dwellings only. Yet for the second half of the 20th century, the rent index offers a somewhat broader coverage. In addition, the house price index reflects residential land prices inly whereas the rent index naturally is based on rents for dwellings.

Netherlands

Rent data Historical data on rents in the Netherlands are available for 1870–2015.

We rely on the long-run rent index constructed by Ambrose et al. (2013) throughout. The series is based on two main sources. For 1870–1913, it uses the rent component of the cost of living index calculated by Van Riel (2006). This pre-WW1 series refers to imputed rents of owner-occupied houses. Data comes from tax authorities and are estimated relying on average rents of comparable renter-occupied dwellings in the vicinity. For the post-WW1 period, Ambrose et al. (2013) draw data from various publications of Statistics Netherlands. Statistics Netherlands collects data through annual rent surveys and covers more than two thirds of Dutch municipalities. The nationwide index is a weighted average of rent changes by region. It is adjusted for the effect of major renovations (Statistics Netherlands, 2010, 2014). The main characteristics of the series are summarized in A.38.

Table A.38: *Data sources: rent index, Netherlands*

Period	Source	Details
1870–1913	Van Riel (2006) as published in Ambrose et al. (2013)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1914–2015	Statistics Netherlands as published in Ambrose et al. (2013)	*Geographic Coverage*: Nationwide ; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents.

One alternative series for the pre-WW2 period is available which can be used as comparative to the index presented by Ambrose et al. (2013). For 1909–1944, Statistics Amsterdam (1916–1944) reports average rents of working class in Amsterdam that have not undergone significant alteration or renovation.[80] Both series, i.e., the index constructed by Ambrose et al. (2013) and the series published

[80]For 1909 to 1928, Statistics Amsterdam (1916–1944) provides only scattered evidence, i.e., data on 1909, 1912, 1918. The series are continuous after 1928. Statistics Amsterdam (1916–1944) also presents data on average rents of middle class dwellings. Yet, this series is based on a significantly smaller sample compared to the one for working class dwellings. According to the 1936–37 yearbook, for example, the data covers 1719 working class dwellings but only 110 middle class dwellings.

Table A.39: *Data sources: rent index, Norway*

Period	Source	Details
1871–1978	Rent index underlying by the price to rent ratio reported in Jurgilas and Lansing (2012)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents.
1979–2013	Statistics Norway (2015)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents.

in the Statistics Amsterdam (1916–1944) are strongly correlated for the years they overlap.[81] This is reassuring since the long-run house price index only relies on data for Amsterdam prior to 1970 (Knoll et al., 2017).

The main weakness of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, it is important to note that the matching of the Dutch rent and house price series is unfortunately imperfect. This is mainly for two reasons. First, while the house price index relies on data for Amsterdam only prior to 1970, the rent index offers a broader geographical coverage. Yet, the evidence suggests that at least during the first half of the 20th century, rents in Amsterdam and the rest of the country moved closely together. Second, no information exists on the extent to which characteristics of the dwellings included in the house price index differ from those included in the rent index. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Norway

Rent data Historical data on rents in Norway are available for 1871–2015.

For the period 1871–1978, the long-run index relies on a rent index presented by Jurgilas and Lansing (2012).[82] The series uses the rent component of the consumer price index since 1914[83] which for the years since 1920 is based on data for 26 towns and 5 industrial centers across Norway and on data for Oslo only for 1914–1919. For the pre-WW1 period, the index is constructed as a weighted average of average rents in 32 cities and towns.[84] Data comes from consumption surveys conducted by Statistics Norway.

For the years prior to WW1, an additional series is available in Statistics Oslo (1915) covering average expenditures for rents of a family of four in Oslo for 1901–1914. Both series, i.e., the rent index by Jurgilas and Lansing (2012) and the data published in Statistics Oslo (1915), depict a similar trend for the years they overlap. For 1979–2015, the long-run rent index relies on the rent component of the consumer price index as published by Statistics Norway (2015). The series is based on a sample of about 2000 rented dwellings that are classified according to their age. The aggregate index is calculated as a weighted average rent index (Statistics Norway, 1991). The available series are spliced as shown in Table A.39.

[81] Correlation coefficient of 0.92 for 1909–1940.

[82] The series were constructed by Ola Grytten, Norwegian School of Economics, and sent by email. Contact person is Marius Jurgilas, Norges Bank.

[83] See for example the rent index for 1914–1948 as reported in Statistics Norway (1949, Table 185) and for 1924–1959 as reported in Statistics Norway (1978, Table 287) for comparison.

[84] Population is used as weights.

The main weakness of the long-run rent series is the lack of adjustment for quality changes and sample composition shifts. On the upside, the matching of the Norwegian house price and rent series in terms of geographic coverage has been generally possible. Both series rely on data for urban areas. Yet the coverage of the rent series is relatively more comprehensive. Unfortunately, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

Portugal

House price data Historical data on house prices in Portugal are available for 1931–2015.

We rely on the long-run house price index constructed by Azevedo (2016). The author relies on the total number and value of transactions of new and existing real estate as reported to the land registry and collected by the Ministry of Justice to construct a weighted average house price index.[85] The number of transactions is used as weights. The data cover Portugal as a whole and are published in yearbooks and monthly bulletins by Statistics Portugal.[86]

Rent data Historical data on rents in Portugal are available for 1948–2015.

The long-run rent index is based on the rent component of the consumer price index as published in International Labour Organization (various years). Data are collected by personal or phone interviews. The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded. The main characteristics of the series are summarized in Table A.40.

The main weakness of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Portuguese house price and rent series is unfortunately imperfect. While the rent index is only based on data for urban areas throughout, the house price index consistently offers a more comprehensive geographic coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Table A.40: *Data sources: rent index, Portugal*

Period	Source	Details
1948–2015	International Labour Organization (various years)	*Geographic Coverage*: 1948–1950: Lisbon, 1951–1953: Lisbon and Porto, 1954–1961: 5 cities, 1962–1976: 6 cities, 1976–2015: 41 cities; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.

[85]While the data also includes commercial real estate, Azevedo (2016) argues based on evidence presented by Evangelista and Teixeira (2014) that commercial property transactions only account for a small share of all transactions recorded.

[86]Sources are the various issues of the *Annurio estatstico de Portugal*, the *Estatsticas Monetrias e Financeiras*, and the *Boletins Mensais de Eststica*.

Spain

House price data Historical data on house prices in Spain are available for 1900–2015.

We rely on the long-run house price index constructed by Amaral (2016) throughout. The author combines data from various sources to arrive at a long-run index. For 1900–1904, the series are based on average transaction prices of new and existing dwellings in Madrid and Barcelona. Data are collected from newspaper advertisements.[87] For 1905–1933, Amaral (2016) uses an average transaction price index constructed by Carmona et al. (2017) based on data for all kinds of existing dwellings drawn from the *Registrars Yearbooks*. For 1934–1975, Amaral (2016) uses transaction price data for new and existing dwellings collected from the *Registrars Yearbooks* to construct a weighted average house price index covering Spain as a whole. For 1976–1986, the authors relies on a series of average transaction prices per square meter of new dwellings in Madrid constructed by the real estate agency *Tecnigrama*. For 1987–1994, the series is based on weighted average transaction prices per square meter of new and existing dwellings collected by the Spanish Ministry of Housing covering Spain as a whole. For the years after 1995, he relies on a nationwide index published by the Spanish Ministry of Public Works and Transports which reflects average transaction prices per square meter for new and existing dwellings.

Rent data Historical data on rents in Spain are available for 1870–2015.

The earliest source for data on rents in Spain is Maluquer de Motes (2013) covering average rents of all kinds of dwellings in Catalunya between 1870 and 1933. Data are drawn from archival records and from the *Registrars Yearbooks*. For the years since 1935, the long-run rent index is based on the CPI rent index as published in the yearbooks of the International Labour Organization (various years) and Statistics Spain (2016). The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded. The available series are spliced as shown in Table A.41.

The single most important drawback of the long-run rent series is again the lack of correction for quality changes and sample composition shifts. Moreover, the matching of the Spanish house price and rent series is unfortunately imperfect. While the rent index is only based on data for urban areas before 1976, the house price data covers the whole of Spain. The opposite is true for the years between 1987 and 1994. After 1994, both series provide nationwide coverage. Second, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be inaccurate and we need to assume that changes in rents of different types of houses are strongly correlated.

Table A.41: *Data sources: rent index, Spain*

Period	Source	Details
1870–1936	Maluquer de Motes (2013)	*Geographic Coverage*: Catalunya; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1937–1976	International Labour Organization (various years)	*Geographic Coverage*: 1937–1956: 50 cities; 1957–1976: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents.
1977–2015	Statistics Spain (2016)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Weighted average rents.

[87] On average, more than 120 observations per year were collected.

Table A.42: *Data sources: rent index, Sweden*

Period	Source	Details
1882–1913	Myrdal (1933)	*Geographic Coverage*: Stockholm; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per room.
1914–1931	Myrdal (1933)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents per room.
1932–1959	Statistics Sweden (1933, 1961)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1960–2015	International Labour Organization (various years)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.

Sweden

Rent data Historical data on rents in Sweden are available for 1883–2015.

The earliest source for data on rents in Sweden is Myrdal (1933). For 1883–1913, Myrdal (1933) reports an index of average rents per room in Stockholm based on data published in the *Stockholm list of houses to let (Stockholms hyreslista)*, a publication advertising dwellings to let edited by the *Stockholms Intecknings Garanti Aktiebolag*. For 1913/14–1931, Myrdal (1933) reports the rent component of the cost of living index of the Social Board based on housing surveys and covering working or lower middle class dwellings in more than 40, predominantly urban, municipalities (Statistics Sweden, 1933).

For the years since 1932, the long-run rent index is based on the rent component of the consumer price index as published in International Labour Organization (various years); Statistics Sweden (1961) and Statistics Sweden (1933). The main characteristics of this series are summarized in Table A.42. The available series are spliced as shown in Table A.42.

The most important drawback of the long-run rent series is again the imperfect of correction for quality changes and sample composition shifts. Both aspects may be less problematic for years prior to 1931 since the rent index reflects average rents per room. Note further that the matching of the Swedish house price and rent series in terms of geographical coverage has been largely possible. For the years prior to 1960, both series are based on for urban areas. For the years after 1960, however, the rent index provides a more comprehensive geographical coverage compared to the house price series. Moreover, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

Switzerland

Rent data Historical data on rents in Switzerland are available for 1890–2015.

The earliest source for rent data in Switzerland is Curti (1981). Curti (1981) separately calculates indices of rents for 3-room apartments for five cities (Zurich, Winterthur, Bern, Biel, and Basel) and the Zurich highlands for 1890–1910. Data are collected from newspaper advertisements.[88]

[88] The author collects about 30 advertisements per year from *Tagblatt der Stadt Zürich*.

Table A.43: *Data sources: rent index, Switzerland*

Period	Source	Details
1890–1919	Curti (1981)	*Geographic Coverage*: Zurich; *Type(s) of Dwellings*: 3 room apartment; *Method*: Average rent.
1920–1939	Statistics Zurich (1946–1962)	*Geographic Coverage*: Zurich; *Type(s) of Dwellings*: 3 room apartment; *Method*: Average rent.
1940–2015	Statistics Switzerland (2015)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: New and existing 1-5 room apartments; *Method*: Weighted average rent, adjusted for quality changes.

For 1908–1920, Curti (1981) relies on data from the city of Zurich housing authority (as collected by Statistics Zurich). Curti (1981) adjusts the 3-year moving average of the spliced series so as to conform with the average rents of 3 room apartments according to the housing censuses of 1896, 1910 and 1920. Since for the years prior to 1930 the house price index for Switzerland is based on data for Zurich only (Knoll et al., 2017), we use the city index for Zurich for 1890–1910 to construct a long-run rent index.

For 1920–1939, we rely on the index of average rents for 3 room apartments in six working class neighborhoods as published by Statistics Zurich (1946–1962).[89]

For 1940–2015, the long-run index is based on the rent component of the consumer price index as published by Statistics Switzerland (2015). The series refers to new and existing 1-5 room apartments in 89 municipalities. Data are collected through surveys of households and the index is calculated as a weighted average.[90] The index is adjusted for major quality changes. The index covers tenants' rents only, i.e., imputed rents of owner-occupiers are excluded. The available series are spliced as shown in Table A.43.

The main weakness of the long-run rent series is the lack of adjustment for quality changes for the pre-WW2 period. Sample composition shifts are unlikely to affect the index since data reflects the rent of 3-room apartments only. Note further, that matching the rent and the house price series with respect to geographic coverage has been largely possible. Both series before the 1930s are based on data for Zurich and for the whole of Switzerland after 1940. Yet, no additional information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

United Kingdom

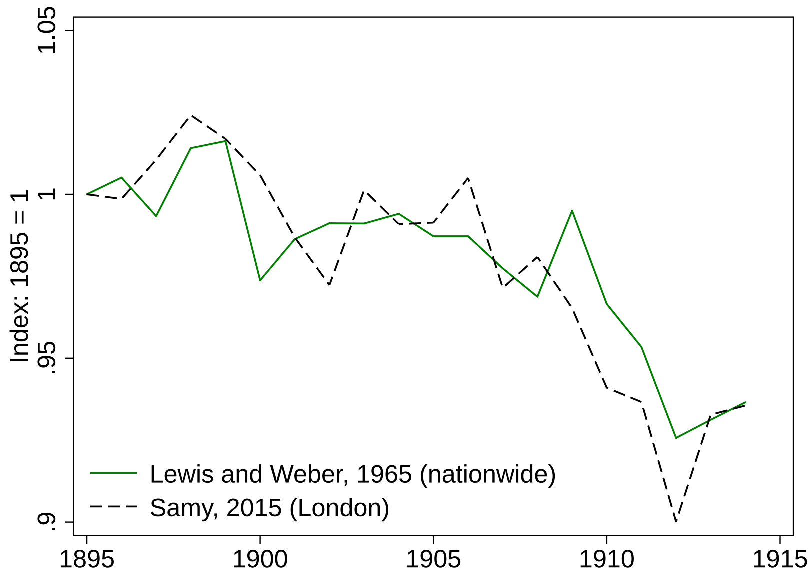
House price data We extend the historical house price series in Knoll et al. (2017) back to 1895 using the new house price index for London constructed by Samy (2015). The index is based on transaction-level data from the London Auction Mart, and constructed using a hedonic regression controlling for quality changes over time.

Rent data Historical data on rents in the United Kingdom are available for 1895–2015. For 1895–1899, we rely on the rental index from the London Auction Mart data constructed by Samy

[89] These are Aussersihl, Industriequartier, Wiedikon, Wipkingen, and Unter- and Oberstrass.

[90] The number of the different kinds of apartments (new and existing) is used as weights.

Figure A.29: *Comparison of pre-WW1 rental indices for the UK*



Note: Real rental indices. The index in Lewis and Weber (1965) has nationwide coverage, but potentially does not control for quality adjustments. The index in Samy (2015) is for London only, but controls for quality changes.

(2015), to be consistent with the house price series. For 1900–1914, we rely on an index of average rents by Lewis and Weber (1965).[91] The series is based on property valuations for the *Inhabited House Duty*, a tax applied to residential houses with an annual rental value of 20 GBP or more. The index may hence include an element of quality increase as well as a true increase in rents, but comparison with the Samy (2015) quality-adjusted index for London, shown in Figure A.29 suggests that the differences are very small.

For 1914–1938, the long-run rent index is based on the rent component of the official cost of living index compiled by the Ministry of Labor (as reported by Holmans (2005) and International Labour Organization (various years)). The series refers to average rents of working class dwellings in more than 500 towns. It is worth noting that the index reflects not only increases in rent proper but also in domestic rates.[92] The index lacks annual rental data during WW1, so we interpolate the annual rental changes during WW1 using the London-only index in Samy (2015), for years 1915–1919.

For the post-WW2 period, we use the rent component of the consumer price index as published in the yearbooks of the International Labour Organization (various years). Data are collected through surveys and cover also subsidized dwellings. For the years since 1956, the series includes expenditures on maintenance and repair. To the best of our knowledge, no data on rents exist between 1946 and 1954. To link the pre- and post-WW2 series, we use scattered data on average rents of houses and flats let by local authorities 1936–1957 presented by Holmans (2005). The available

[91] In principle, the Lewis and Weber (1965) series is available back to 1874, and closely tracks the London index assembled by Samy (2015) from the Auction Mart data.

[92] According to Holmans (2005), in the housing market for working class families, dwellings were generally let at a rent that included domestic rates. Landlords recouped the rates they paid to local authorities through the rents they charged. While the dwellings may have thus been subject to rent controls according to the Rent Restriction Acts, increases in total rents to recoup increases in domestic rates were not limited according to these acts.

Table A.44: *Data sources: rent index, United Kingdom*

Period	Source	Details
1895–1899	Samy (2015)	*Geographic Coverage*: London; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Hedonic regression.
1900–1913	Lewis and Weber (1965)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Average rents.
1914–1946	Rent component of official consumer price index as published in Holmans (2005) and International Labour Organization (various years)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Working class dwellings; *Method*: Average rents. *Note:* We interpolate annual changes during 1915–1919 using the London index in Samy (2015).
1954–2013	Rent component of official consumer price index as published in International Labour Organization (various years)	*Geographic Coverage*: Nationwide; *Type(s) of Dwellings*: All kinds of dwellings; *Method*:

series are spliced as shown in Table A.44.

The most important limitation of the long-run rent series is the lack of correction for quality changes and sample composition shifts. As noted above, the latter aspect may be less of a problem for the years 1914–1946 since the index is confined to a specific and presumably relatively homogeneous market segment, i.e., working class dwellings. The matching of the U.K. house price and rent series in terms of geographical coverage has been largely possible. Both series are based on data for the whole of the U.K. after WW2. The house price series reflects urban developments prior to 1930 as does the rent index during the interwar period. Yet, the rent series provides a more comprehensive coverage prior to WW1 compared to the house price series. Moreover, to the best of our knowledge, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

United States

Rent data Historical data on rents in the United States are available for 1890–2015.

For the 1890–1914, the long-run rent index relies on the rent component of the NBER cost of living index for manufacturing wage earners constructed by Rees (1961). The index is based on newspaper advertisements in six cities[93] and is confined to working class dwellings. The aggregate series is a simple average of the city indices. The index controls for differences in size but not for other potential sources of quality differences.

Data for 1915–1940 is available from U.S. Bureau of Labor Statistics (2015) which, in turn, are based on the Bureau of Labor Statistics' rental survey of landlords. The index is based on data on average rents for working class dwellings in 32 shipbuilding and other industrial centers for 1915–1935 and 42 cities with population over 50,000 thereafter. The series is based on comparisons of average rents for identical housing units (Bureau of Labor Statistics, 1966). Yet, several authors made the case for a downward bias of the historical U.S. Bureau of Labor Statistics (2015) rent series

[93]These are New York, Chicago, Philadelphia, Boston, Cincinnati, St. Louis.

Table A.45: *Data sources: rent index, United States*

Period	Source	Details
1890–1914	Rees (1961)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of working class dwellings; *Method*: Stratification.
1915–1940	U.S. Bureau of Labor Statistics (2015), adjusted using estimates by Gordon and van Goethem (2007)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: Working class dwellings; *Method*: Average rents.
1941–1995	Crone et al. (2010)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification.
1996–2015	U.S. Bureau of Labor Statistics (2015)	*Geographic Coverage*: Urban areas; *Type(s) of Dwellings*: All kinds of dwellings; *Method*: Stratification.

(Crone, Nakamura, and Voith, 2010; Gordon and van Goethem, 2007), e.g., due to aging bias or omission of new units. To adjust for the downward bias for 1915–1940, we use estimates by Gordon and van Goethem (2007).[94]

For 1941–1995, the long-run index relies on the revised CPI for tenant rents constructed by Crone et al. (2010). Crone et al. (2010) argue that for the post-1995 period, tenant rents should be correctly calculated in the original U.S. Bureau of Labor Statistics (2015) series. For the post-1995 years, we therefore use the CPI rent index as published by U.S. Bureau of Labor Statistics (2015). The available series are spliced as shown in Table A.45.

Compared to data for other countries, the U.S. rent series is relatively well adjusted for quality changes and sample composition shifts. Also, matching the house price and rent series with respect to geographical coverage has been largely possible. Both series rely on data for urban areas prior to WW2. Yet, while this is still true for the post-WW2 rent series, the house price index provides a more comprehensive coverage during that period. Apart from that, to the best of our knowledge, no information exists on the quality differences that may exist between the dwellings included in the house price and the dwellings included in the rent series. The matching of the series with respect to the exact type of dwelling covered may hence be imperfect and we need to assume that changes in rents of different types of houses are strongly correlated.

[94] Gordon and van Goethem (2007) estimate a CPI bias of -0.86 percent per year for 1914–1935 and of -1.04 percent for 1935–1960.

X. Equity and bond returns

This section details the sources used to construct the total equity and bond return series in this paper.

Australia

Table A.46: *Data sources: equity and bond returns, Australia*

Year	Data source
Equity returns:	
1870–1881	Sum of capital gains, dividends and gains or losses from stock operations for Australian shares listed in London, weighted by market capitalization. Constructed from *Investor Monthly Manual* (IMM) data, various issues (`http://som.yale.edu/imm-issues`).
1882–2008	With-dividend return from Brailsford, Handley, and Maheswaran (2012). Note: we use these series rather than the alternative from NERA Economic Consulting (2015) due to greater consistency with the IMM historical series.
2009–2013	Total equity return from NERA Economic Consulting (2015).
2014–2015	ASX 200 total return index, from RBA Statistics Table F7.
Bond returns:	
1900–1925	Total return on Australian government bonds listed in Sydney from Moore (2010b). Converted from pound sterling to Australian Dollar.
1926–1968	Total return on Australian bonds listed in London. Data for 1926–1929 are from Meyer, Reinhart, and Trebesch (2015), shared by Josefin Meyer. Data for 1930–1968 were constructed by the authors.
1969–1987	Implied capital gain + yield from the 10-year government bond yield series published by the Reserve Bank of Australia. Capital gain estimated from movements in yields, using monthly yield data. Spliced with London listings data over 1968–1969.
1988–2015	Average of total returns on individual Australian government bonds, targeting 10-year maturity.

We are grateful to Josefin Meyer and Christoph Trebesch for sharing historical bond return data for Australia.

Belgium

Table A.47: *Data sources: equity and bond returns, Belgium*

Year	Data source
Equity returns:	
1870–2015	Total return on all common stocks of Belgian companies listed on the Brussels stock exchange, provided by Frans Buelens. Market capitalization weighted. See Annaert, Buelens, Cuyvers, De Ceuster, Deloof, and De Schepper (2011) for further details.
Bond returns:	
1870–1913	Total return on the 3% rente; price and yield data from Drappier (1937), Table II.
1914–1937	Data from the SCOB database shared by Frans Buelens; total return on long-term government bonds, aggregated from individual bond data.
1938–1995	Total return on long-term government bonds, from various issues of National Bank of Belgium *Economic Summaries* and Ten-year Statistics, calculated from monthly data. 1938–1953: 4% perpetual bonds. Spliced with the SCOB data over the period 1938–1940. 1954–1963: 5-20 year 4.5% bond issued before 1962; price changes estimated using movements in yields. 1963–1970: Weighted average of 5-20 year bonds issued before 1962 and 5+ year bonds issued after 1962. 1971–1989: 5+ year maturity bonds, price changes estimated from movements in yields. 1989–1995: basket of 6+ maturity bonds, mean maturity approximately 10 years, price changes estimated from movements in yields.
1996–2015	Total return on 10-year government bonds, National Bank of Belgium online database, price changes estimated from movements in yields.

We are grateful to Frans Buelens for sharing the historical equity and bond return series from the SCOB database of the Brussels stock exchange.

Denmark

Table A.48: *Data sources: equity and bond returns, Denmark*

Year	Data source
Equity returns:	
1873–1900	Total return on all shares of Danish firms listed on Danish stock exchanges, market cap weighted. Computed from microdata in *Green's Dankse Fonds og Aktier*, various years.
1901–1922	Total return on a broad selection of Danish shares, market cap weighted. We take all shares listed in the statistical yearbooks (Statistisk aarbog, years 1896–1927). For years 1914–1922, we combine the all-share price index in the statistical yearbook with the market cap weighted dividend series based on the smaller selection of stocks.
1923–1999	Combination of dividend yields from Nielsen and Risager (2001) (market-cap weighted, circa 100 companies), and the share price index from Jordà, Schularick, and Taylor (2017), which is compiled from League of Nations, UN and IMF data.
2000–2001	Returns on the MSCI total return index.
2002–2015	Total return on the OMXCGI index.
Bond returns:	
1870–1990	Total return on long-term government bonds from Statistics Denmark (1969) and various issues of the Danmarks Nationalbank's *Monetary Review*. Perpetuals up to 1923, 10-40 year bonds for 1924–1980, 10-year maturity bonds from 1980 onwards.
1991–2015	Statistics Denmark, total return on the 10-year bullet loan

We are grateful to Kim Abildgren for helpful advice about the historical Danish stock return series.

Finland

Table A.49: *Data sources: equity and bond returns, Finland*

Year	Data source
Equity returns:	
1895–1912	Total return index from Poutvaara (1996), based on several banks.
1913–1990	Total return index from Nyberg and Vaihekoski (2014), from the data shared with us by Mika Vaihekoski.
1991–2015	OMX Helsinki all-share total return index
Bond returns:	
1870–1925	Total return on long-term Finnish government bonds listed abroad, constructed from individual bond data in Arola (2006) (data from the online appendix of Nyberg and Vaihekoski (2011)).
1926–1991	Total return on approximately 5-year maturity government bonds from Nyberg and Vaihekoski (2011), using price movements implied by changes in market yield.
1992–2016	Average of total returns on individual Finnish government bonds, targeting 10-year maturity.

We are grateful to Mika Vaihekoski for sharing data and assisting with numerous queries regarding the Finnish stock and bond return series.

France

Table A.50: *Data sources: equity and bond returns, France*

Year	Data source
Equity returns:	
1870–2010	Total return index from Le Bris and Hautcoeur (2010). Index constructed to mirror the methodology of the CAC-40: returns on largest 40 listed French firms weighted by market cap, with a continuously updated sample, market cap weighted.
2011–2015	Total return on the CAC-40 index.
Bond returns:	
1870–1969	Total return on 4% and 5% rente (perpetual bonds). Data provided by David LeBris, from Le Bris and Hautcoeur (2010).
1970–2015	Total return on a representative basket of long-term government bonds. Assume 10-year maturity before 1990 and 30-year after; as in Le Bris and Hautcoeur (2010). Price movements estimated from changes in yields at monthly frequency. Data provided by David LeBris, from Le Bris and Hautcoeur (2010).

We are grateful to David Le Bris for sharing data, assisting with numerous queries and providing helpful comments on the paper.

Germany

Table A.51: *Data sources: equity and bond returns, Germany*

Year	Data source
Equity returns:	
1870–1889	Total return on the value-weighted top-30 blue-chip index from Ronge (2002)
1890–1913	All-share value-weighted performance index from Eube (1998).
1914–1959	Total return on the value-weighted top-30 blue-chip index from Ronge (2002).
1960–1990	Total return index from Gielen (1994), value-weighted, broad coverage. We use the "net" performance index, which excludes the adjustment for dividend income tax credit.
1991–1995	Total return on the DAX index.
1996–2016	Total return on the CDAX index.
Bond returns:	
1870–1903	Total return on listed long-term government bonds, arithmetic average of returns on individual bonds, with price and yield data collected from Homburger (1905) For early years we use regional bonds to fill gaps.
1904–1930	Total return on listed government bonds from the *Berliner Börsenzeitung*. Arithmetic average of individual bond returns. Average maturity generally 5-15 years. No data for the hyperinflation period of 1923–25.
1931–1943	total return on 4.5–6% government bonds (6% until 1935, then converted to 4.5%), aggregated using individual bond data from Papadia and Schioppa (2016), Deutsche Bundesbank (1976) and *Statistisches Jahrbuch für das Deutsche Reich*, various issues. Spliced with the *Berliner Börsenzeitung* series over 1928–1930.
1948–1955	Total return on mortgage bonds (Pfandbriefe, 4% and 5% coupons, from Deutsche Bundesbank (1976) and *Statistisches Jahrbuch für die Bundesrepublik Deutschland*, various issues.
1956–1967	Total return on public bonds from Deutsche Bundesbank (1976), using an average of bond returns for different issue yields. For years where the sample composition changes we use the return implied by yield movements, otherwise we use actual price changes.
1969–2015	REX government bond total return index, Bundesbank database series BBK01.WU046A.

We are grateful to Ulrich Ronge for sharing data and assisting with a number of queries, and to Carsten Burhop for helpful advice. We would also like to thank Andrea Papadia for sharing data.

Italy

Table A.52: *Data sources: equity and bond returns, Italy*

Year	Data source
Equity returns:	
1870–1887	Capital gain + dividend return on stocks listed on the Genova stock exchange. Caclu-ated using indices in Da Pozzo and Felloni (1964), which are a book capital weighted average of returns on individual shares.
1888–1912	Total return on shares listed at the Milan Stock Exchange from Baia Curioni (2001). Market cap weighted.
1913–1954	Capital gain + dividend return on a broad index of Italian shares from Rosania (1954). Market cap weighted.
1955–1969	Capital gain on a broad index of Italian shares from Mondani (1978) (capitalization-weighted), plus dividend returns computed using total dividends paid and market capitalization data (as total dividends in lira / market cap), covering the vast majority Italian listed firms. Data sourced from *Mediobanca: indici e dati*, various years.
1970–2015	Total return on the main *Mediobanca* index, from Mediobanca (2013) and Mediobanca (2016).
Bond returns:	
1870–1913	Sum of lagged current yield and capital gain on the 5% perpetual bond (Rendita), computed from data in Bianchi (1979).
1913–1954	Sum of lagged current yield and capital gain on a representative basket of long-term government bonds, computed from data in Rosania (1954).
1955–1987	Total return on listed government bonds using data in various years of *Mediobanca: indici e dati*, targeting a maturity of 10 years. For the 1980s, only data on 3-5 year maturity bonds were used since longer dated government bonds were not typically listed on the stock exchange.
1988–2015	Average of total returns on individual Italian government bonds, targeting 10-year maturity. For 1988–1991, maturity is generally shorter than 10 years since almost all the bonds traded had relatively short maturities.

We are grateful to Stefano Battilossi for helpful advice about the historical series, and Giovanni Pellegrino for help with translating historical sources. We are also grateful to Massimo Caruso, Giuseppe Conte and Roberto Violi at Banca d'Italia for helpful advice and help in accessing historical publications.

Japan

Table A.53: *Data sources: equity and bond returns, Japan*

Year	Data source
Equity returns:	
1882–1940	Sum of capital gain (Laspeyres index, base 1934–36), dividend return and gain/loss from stock operations, weighted by clearing transaction volumes, from Fujino and Akiyama (1977).
1941–1945	Capital gain from Bank of Japan (1966) + dividend return estimated using 1940 dividend yield, growth in nominal dividends paid by Japanese businesses from Bank of Japan (1966), and share price growth from Bank of Japan (1966) (chain linked).
1946–1947	Stock exchange closed; no data.
1948	Capital gain from Unted Nations' *Monthly Bulletin of Statistics* + dividend return estimated using growth in nominal dividends paid by Japanese businesses, as above.
1949–1951	Capital gain from *Bureau of Statistics Japan*, Table 14-25-a "Transactions and Yields of Listed Stocks, Tokyo Stock Exchange 1st Section" + dividend return from Fujino and Akiyama (1977) + gain/loss from stock operations from Fujino and Akiyama (1977).
1952–2015	Capital gain and dividend return from *Bureau of Statistics Japan* Tables 14-25-a and Table 14-25-b, covering Tokyo Stock Exchange 1st and 2nd section, + gain/loss from stock operations from Fujino and Akiyama (1977) (note: the Fujino and Akiyama (1977) series stop in 1975).
Bond returns:	
1880–1940	Lagged current yield + capital gain on central government bonds, from Fujino and Akiyama (1977). Price index used: Laspeyres, base 1934–36.
1941–1965	Secondary markets for government debt were shut down for a prolonged time after WW2, hence we use government bond yield data (not total returns) for this period. Sources are Homer and Sylla (2005) for 1941–1963 (long-term government bond yield), and IMF's IFS database for 1964–65 (Section "Interest rates", Series "Government Bonds").
1966–1970	Lagged current yield + capital gain on central government bonds, from Fujino and Akiyama (1977). Price index used: Laspeyres, base 1969–71.
1971–1987	Total return on long-term government bonds; 9-10 year maturity, from Hamao (1991).
1988–2015	Average of total returns on individual Japanese government bonds, targeting 10-year maturity.

We are grateful to Ryoji Koike for helpful advice, and to Yuzuru Kumon and Kaspar Zimmermann for assisting with collecting and interpreting the data.

Netherlands

Table A.54: *Data sources: equity and bond returns, Netherlands*

Year	Data source
Equity returns:	
1900–1995	Total stock return index from Eichholtz, Koedijk, and Otten (2000), based on a selection of Dutch stocks, using data kindly shared with us by Roger Otten. The stock exchange was closed from from August 1944 to April 1946, so the 1945 return covers the period August 1944–April 1946.
1996–2003	CBS total equity return reinvestment index, from *CBS Statline*.
2004–2015	AEX all-share index.
Bond returns:	
1870–1900	Total return on the 2.5% perpetual bond, using data in Albers (2002).
1901–1987	Total return on long-term government bonds from Eichholtz, Koedijk, and Otten (2000), using data kindly shared with us by Roger Otten.
1988–2003	CBS total bond return reinvestment index, bonds of 8 years and above maturity, from *CBS Statline*.
2004–2015	Average of total returns on individual Dutch government bonds, targeting 10-year maturity.

We are grateful to Roger Otten for sharing the data on historical stock and bond returns in the Netherlands.

Norway

Table A.55: *Data sources: equity and bond returns, Norway*

Year	Data source
Equity returns:	
1881–1920	Total return on all stocks listed on the Oslo stock exchange, market cap weighted. Constructed from share-level microdata collected from the following publications: *Kurslisten over Vaerdipapier* (the stock listing), *Farmand* magazine, and *Kierulfs haandbok over aktier og obligationer*, various years.
1921–1969	Capital gain from Klovland (2004b) plus dividend return from various issues of Norway's historical statistics and statistical yearbooks (*Historisk Statistikk*, *Statistisk Årbok*).
1970–1983	Capital gain from Klovland (2004b) plus dividend return constructed using the MSCI Norway total return and price return indices.
1984–2000	Capital gain from Klovland (2004b) plus dividend return constructed as total dividends paid by listed firms in proportion to total market capitalization.
2001–2015	Total return on the OSEBX index.
Bond returns:	
1870–1919	Total return on long-term government bonds listed on the Oslo Stock Exchange and major foreign exchanges. We use Oslo data unless there are few bonds being traded, in which case we rely on foreign exchanges. Oslo data come from *Kurslisten over Vaerdipapier*, *Farmand* magazine, and *Kierulfs haandbok over aktier og obligationer*. London data are from the *Investor Monthly Manual* (`http://som.yale.edu/imm-issues`), various issues. Other major markets' data are from Klovland (2004a), with price movements estimated from changes in yields.
1920–1992	Total return on 10-year government bonds, with price changes estimated from movements in monthly yields in Klovland (2004a).
1993–2015	Average of total returns on individual Norwegian government bonds, targeting 10-year maturity.

We are grateful to Jan Tore Klovland for answering numerous queries and helpful advice, and to the staff at the Oslo Nasjonalbiblioteket for help in locating the historical data sources.

Portugal

Table A.56: *Data sources: equity and bond returns, Portugal*

Year	Data source
Equity returns:	
1870–1987	Total return on all shares listed on the Lisbon stock exchange, market capitalization weighted. Own calculations using share price, dividend and balance sheet information in the following publications: *Diario do Governo*, *Boletim da Bolsa* and annual reports of public companies, various years. For years 1900–1925, capital for a large number of companies had to be estimated using the trend in capital of a small number of firms. For year 1975, the stock exchange was closed because of the Carnation Revolution. We assumed no dividends were paid, and interpolated the stock prices of firms listed both before and after the closure to compute returns.
1988–2015	Total return on the PSI all-share index.
Bond returns:	
1870–1993	Total return on central government bonds listed on the Lisbon stock exchange. Average maturity around 15–30 years. Computed from bond listings data in *Diario do Governo* and *Boletim da Bolsa*. Weighted by the capitalization of individual bonds. During 1975 the stock exchange was closed, and we used yield data from the Bank of Portugal Statistics, series "Yield on fixed rate treasury bonds—10 years (monthly average)", and estimated price movements from changes in yields.
1994–2015	Average of total returns on individual Portuguese government bonds, targeting 10-year maturity.

We are grateful to Jose Rodrigues da Costa and Maria Eugenia Mata for help and advice in finding and interpreting the data sources for the historical Portuguese data. We are also grateful to staff at the Banco do Portugal archive for helpful advice and sharing data.

Spain

Table A.57: *Data sources: equity and bond returns, Spain*

Year	Data source
Equity returns:	
1900–1940	Total return on all Spanish ordinary shares listed at the Madrid Stock Exchange, weighted by market capitalization. Data for 1900–1926 were kindly shared with us by Lyndon Moore (see Moore, 2010a,b). Data for 1926–1936 were collected at the archive of the Banco de España, using stock exchange listings in various issues of the *Boletin de Cotization Oficial* of the Madrid stock exchange. The stock exchange was closed during the Spanish Civil war years 1937–1939. For these years, we calculated the returns using the average return on shares listed both before and after the exchange was closed, and assumed no dividends were paid (this seems reasonable since even in 1940, very few companies paid our dividends).
1940–2015	IGBM and Historical IGBM total return index for the Madrid stock exchange. Sources: López, Carreras, and Tafunell (2005), Chapter 10, "Empresa y Bolsa", Table 10.33; Fernandez, Carabias, and Miguel (2007), European Federation of Exchanges. All shares, market capitalization weighted.
Bond returns:	
1900–1936	Total return on long-term government bonds listed on the Madrid Stock Exchange, market capitalization weighted, average maturity around 25 years. Data for 1900–1926 were kindly shared with us by Lyndon Moore (see Moore, 2010a,b).
1940– 1972	Total return on long-term government bonds from various issues of statistical bulletins, *Anuario Estadístico da España* (`http://www.ine.es/inebaseweb/25687.do`).
1973–1990	Total return on government bonds traded on the Barcelona stock exchange, from the *La Vanguardia* newspaper, various issues. Spliced with the series from statistical bulletins over years 1973–1975.
1989–2015	Total return on medium- and long-term government bonds from various issues of the *Banco de España Statistical Bulletin*. 1988–1994: maturity of less than 5 years; 1995–2015: maturity of 7–8 years.

We are grateful to Lyndon Moore for sharing data and providing helpful advice. We would also like to thank Stefano Battilossi for help with locating the historical data sources, and staff at the Banco de España archive for assisting with our queries.

Sweden

Table A.58: *Data sources: equity and bond returns, Sweden*

Year	Data source
Equity returns:	
1871–2002	Total equity return index from Waldenström (2014).
2003–2015	OMXSGI total return index.
Bond returns:	
1870–1874	Total return on 4% and 5% perpetuals, using individual bond data in the online appendix of Waldenström (2014).
1874–2015	Holding period return on long-term government bonds from Waldenström (2014), generally targeting 10-year maturity. Extended to 2015 using own data.

We are grateful to Daniel Waldenström for helpful advice regarding the historical Swedish returns data.

Switzerland

Table A.59: *Data sources: equity and bond returns, Switzerland*

Year	Data source
Equity returns:	
1900–1925	Total return on all Swiss stocks listed in Zurich, capitalization-weighted. Calculated using individual stock price and dividend data kindly shared with us by Lyndon Moore (see Moore, 2010a,b). The stock exchange closed from mid-1914 to mid-1916, and the 1915 return covers the period July 1914 to July 1916.
1926–1959	Total return on Swiss equities from Pictet and Cie (1998).
1960–1983	SBC total return index from Pictet and Cie (1998) and Swiss National Bank's *Kapitalmarkt* statistics.
1984–2015	SPI total return index from Pictet and Cie (1998), Swiss National Bank's *Kapitalmarkt* statistics and the SIX stock exchange statistics (six-group.com).
Bond returns:	
1899–1926	Total return on all Swiss government bonds listed on the Zurich stock exchange, capitalization-weighted. Calculated using individual bond price and yield data kindly shared with us by Lyndon Moore (see Moore, 2010a,b).
1927–1995	Total return on Swiss bonds from Pictet and Cie (1998).
1996–2015	SBI total bond return index from the SIX stock exchange statistics (six-group.com). 7+ year maturity before 2007 and 7–10 year maturity afterwards.

We are grateful to Lyndon Moore for sharing data and providing helpful advice, and to Rebekka Schefer for hepling us locate the historical sources.

United Kingdom

Table A.60: *Data sources: equity and bond returns, United Kingdom*

Year	Data source
Equity returns:	
1870–1907	Total return on all UK stocks listed on the London stock exchange, capitalization weighted, from Grossman (2002).
1908–1963	Blue-chip market capitalization weighted index based on the largest 30 stocks listed on the London stock exchange, from Barclays (2016).
1964–2015	FTSE Actuaries all-share index, from Barclays (2016).
Bond returns:	
1870–1901	Total return on 3% and 2.75% consols from the *Statistical abstract for the UK*, various issues.
1902–2015	Total return on gilts (price change + lagged yield) from Barclays (2016). Targetting 20-year maturity before 1990 and 15-year maturity afterwards.

We are grateful to Richard Grossman and John Turner for helpful advice regarding historical UK stock and bond return data.

United States

Table A.61: *Data sources: equity and bond returns, United States*

Year	Data source
Equity returns:	
1870–2015	Capital gain + dividend return from Shiller (2000) (up-to-date data from http://www.econ.yale.edu/~shiller/data.htm)
Bond returns:	
1870–1926	Total return on a basket of central government bonds around 10-year maturity. Calculated from prices of individual bonds in the *Commercial and Financial Chronicle*, various issues.
1927–1928	Total return on 10-year government bonds, price changes imputed from yields. Source: Aswath Damodaran database (http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html).
1929–2015	Total return on US long-term government bonds, from Barclays (2016).

We are grateful to Josefin Meyer for helpful advice concerning the historical bond return data for the US.

Y. Taxes on real estate

Although the extent of real estate taxation varies widely across countries, real estate is taxed nearly everywhere in the developed world. International comparisons of housing taxation levels are, however, difficult since tax laws, tax rates, assessment rules vary over time and within countries. Typically, real estate is subject to four different kinds of taxes. First, in most countries, transfer taxes or stamp duties are levied when real estate is purchased. Second, in some cases capital gains from property sales are taxed. Often, the tax rates depend on the holding period. Third, income taxes typically also apply to rental income. Fourth, owners' of real estate may be subject to property taxes and/or wealth taxes where the tax is based upon the (assessed) value of the property.

This section briefly describes the current property tax regimes by country and provides estimates of the tax impact on real estate returns. With few exceptions, the tax impact on real estate returns can be considered to be less than 1 percentage point per annum.

Australia

Two kinds of property taxes exist. First, all but one Australian states/territories levy a land tax (no land tax is imposed in the Northern Territory). Typically, land tax is calculated by reference to the site value of the land (i.e., excluding buildings). Tax rates vary depending on the property value between 0.1% and 3.7%. Yet, the land tax is a narrow-based tax, i.e., many states apply substantial minimum thresholds and several land uses—such as owner-occupied housing—are exempt. Consequently, I will not consider any tax impact of land taxes on housing returns. Second, council rates are levied by local governments. Rates vary across localities rates and are set based on local budgetary requirements. Some councils base the tax on the assessed value of the land, others base it on the assessed value of the property as a whole (i.e., land and buildings) (Commonwealth of Australia, 2010). While all these specific make it difficult to determine an average or exemplary tax impact on returns, it can generally be considered to be well below 1%. Capital gains taxes apply only to investment properties, not to primary residences. Rates are higher the shorter the holding period. All Australian states levy stamp duties on property transfers. Rates vary across states and different types of property and may amount up to 6% of the property value (Commonwealth of Australia, 2010).

Belgium

Property taxes (*Onroerende voorheffing*) are levied on the cadastral value, i.e., the notional rental value, of the property. Rates range between 1.25% in Wallonia and Brussels and 2.5% in Flanders (Deloitte, 2016a). Using a tax rate 2.5% and a rent-price ratio of 0.045 (2012) the implied tax impact is $0.025 \times 0.045 \times 100 = 0.11\%$. Capital gains taxes of 16.5% are levied if the property has been owned for less than five years. Property transfer taxes amount to 12.5% of the property value in Wallonia and Brussels and 10% in Flanders (Deloitte, 2016a).

Denmark

Two kinds of property taxes exist. First, the national property tax (*Ejendomsvrdiskat*). The tax rate is 1% of the assessed property value if the property value is below DKK 3,040,000 and 3% above. The tax is not based on current assessed property values but on 2002 values. Second, a municipal land tax (*Grundskyld* or *Daekningsafgifter*) is levied on the land value. Rates vary across municipalities and range between 1.6% and 3.4% (Skatteministeriet, 2016). According to Pedersen and Isaksen (2015) the national property tax amounted to a little below 0.6% of property values in 2014 and municipal land taxes to about 0.07% giving us a combined tax impact of about 1.35% (Pedersen and Isaksen, 2015). No capital gains tax is payable if the property was the owners' principal residence. Stamp duties are levied on property transfers and amount to 0.6% of the purchase prices plus DKK 1,660.

Finland

Property taxes (*Kiinteistövero*) are levied by municipalities. Tax rates for permanent residences range between 0.37% and 0.8% of the taxable value where the taxable value is about 70% of the property's market value (KTI, 2015). The implied tax impact is therefore $0.8 \times 0.7 = 0.56\%$. Capital gains from property sales are taxed at progressive rates, from 30% to 33%. There is a 4% property transfer tax for property. First-time homebuyers are exempt from transfer taxes (KTI, 2015).

France

Property taxes (*taxe foncière sur les propriétés bâties*) are levied by municipalities. The tax base is the cadastral income, equal to 50% of the notional rental value (Public Finances Directorate General, 2015). Tax rates in 2014 ranged between 0.84% and 3.34% (OECD, 2016a). Using the rent-price ratio of 0.045 in 2012 and assuming a tax rate of 3.34%, the implied tax impact therefore is $0.045 \times 0.5 \times 0.034 \times 100 = 0.08\%$. Capital gains from property sales are taxed at 19%. Property transfer taxes amount to about 5% of the property value (Deloitte, 2015a).

Germany

Property laxes (*Grundsteuer*) are levied by federal states. Tax rates vary between 0.26% and 0.1% of the assessed value (*Einheitswert*) of the property and are multiplied by a municipal factor (*Hebesatz*). Since assessed values are based on historic values, they are significantly below market values. In 2010, assessed values were about 5% of market values (Wissenschaftlicher Beirat beim Bundesministerium der Finanzen, 2010). Municipal factors in 2015 ranged between 260% and 855% (median value of 470%) (Deutscher Industrie- und Handelskammertag, 2016). Using a tax rate of 0.5%, the implied tax impact is $0.05 \times 0.005 \times 4.7 = 0.12\%$. Capital gains from property sales are taxed if the property has been owned for less than 10 years (*Abgeltungssteuer*). Property transfer taxes are levied on the state level and range between 3.5% and 6.5% of the property value.

Japan

Two kinds of property taxes exist. First, a fixed assets tax is levied at the municipal level with rates ranging from 1.4 to 2.1 of the assessed taxable property value. The taxable property value is 33% of the total assessed property value for residential properties and 16% if the land plot is smaller than 200 sqm. Second, the city planning tax amounts to 0.3% of the assessed taxable property value. The taxable property value is 66% of the total assessed property value for residential properties and 33% if the land plot is smaller than 200 sqm (Ministry of Land, Infrastructure, Transport, and Tourism, 2016b). The implied tax impact is therefore $0.33 \times 2.1 + 0.66 \times 0.3 = 0.89\%$. Capital gains from property sales are taxed at 20% if the property has been owned for more than five years and at 39% if the property has been owned for less than five years. Owner-occupiers are given a deduction of JPY 30 mio. There is a national stamp duty (*Registered Licence Tax*) of 1% of the assessed property value and a prefectural real estate acquisition tax of 3% of the property value (Ministry of Land, Infrastructure, Transport, and Tourism, 2016a).

Netherlands

Property taxes (*Onroerendezaakbelasting*) are levied at the municipal level. Tax rates range between 0.0453% and 0.2636% (average of 0.1259%) of the assessed property value (*Waardering Onroerende Zaak (WOZ) value*) (Centrum voor Onderzoek van de Economie van de Lagere Overheden, 2016; Deloitte, 2016c). The tax impact on returns therefore ranges between about 0.05% and 0.26%. No capital gains tax is payable if the property was the owners' principal residence. Property transfer taxes amount to 2% of the property value (Deloitte, 2016c).

Norway

Property taxes are levied at the municipal level. Tax rates range between 0.2% and 0.7% of the tax value of the property. Typically, the tax value of a dwelling is about 25% of its assessed market value if the dwelling is the primary residence. Higher values apply for secondary residences. In addition, wealth taxes are levied at a rate of 0.85% (tax-free threshold is NOK 1.2 mio) on the tax value of the property (Norwegian Tax Administration, 2016). The implied tax impact therefore is $0.25 \times 0.7 + 0.25 \times 0.85 = 0.39\%$. Capital gains from the sale of real estate property are taxed as ordinary income at 27%. A stamp duty of 2.5% applies to the transfer of real property (Deloitte, 2016b).

Sweden

Property taxes (*kommunal fastighetsavgift*) are levied at the municipal level. For residential properties, the tax rate is 0.75% of the taxable property value with taxable values amounting to about 75% of the property's market value. Fees are reduced for newly built dwellings (Swedish Tax Agency, 2012). The implied tax impact is therefore $0.75 \times 0.75 = 0.56\%$. Capital gains from sales of private dwellings are taxed at a rate of 22%. Stamp duties amount to 1.5% of the property value (Swedish Tax Agency, 2012).

Switzerland

Most Swiss municipalities and some cantons levy property taxes (*Liegenschaftssteuer*) with rates varying across cantons between 0.2% and 3% (property taxes are not levied in the cantons Zurich, Schwyz, Glarus, Zug, Solothurn, Basel-Landschaft, and Aargau). The tax is levied on the estimated market value of the property (Deloitte, 2015b). The tax impact on returns therefore ranges between 0.2% and 3%. Capital gains from property sales are taxed in all Swiss cantons (*Grundstückgewinnsteuer*). Tax rates depend on the holding period and range from 30% (if the property is sold within 1 year) and 1% (if the property has been owned for more than 25 years) of the property value. In addition, almost all cantons levy property transfer taxes (*Handänderungssteuer*). Tax rates vary between 10% and 33% (ch.ch, 2016; Eidgenössische Steuerverwaltung, 2013).

United Kingdom

Property taxes (*Council tax*) are levied by local authorities. Each property is allocated to one of eight valuation bands based on its assessed capital value (as of 1 April 1991 in England and Scotland, 1 April 2003 in Wales). Taxes on properties in Band D (properties valued between GBP 68,001 and GBP 88,000 in 1991) amounted to GBP 1484 in 2015 (Department for Communities and Local Government, 2016). Since 1991, nominal house prices have increased by a factor of about 2.5. The implied tax impact in 2015 for a property valued at GBP 68,001 in 1991 is $1484/(68,001 \times 2.5) \times 100 = 0.87\%$.

No capital gains tax is payable if the property was the owners' principal residence. Property transfer tax rates (*Stamp Duty Land Tax*) depend on the value of the property sold and range between 0% (less than GBP 125,000) and 12.5% (more than GBP 1.5 m.) (Deloitte, 2016d).

United States

Property taxes in the U.S. are levied at the state level and are deductible from federal income taxes. Generally, tax rates are about 1% of real estate values, with rates varying across states. Giglio, Maggiori, and Stroebel (2015) assume the deductibility reflects a marginal federal income tax rate of 33%. The tax impact is thus $(1 - 0.33) \times 0.01 = 0.67\%$. Property transfer taxes are levied at the state level and range between 0.01% and 3% of property value (Federation of Tax Administrators, 2006).

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