The Rate of Return on Everything, 1870–2015*

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PRELIMINARY

Abstract

This paper answers fundamental questions that have preoccupied modern economic thought since the 18th century. 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 covering total returns for all important assets classes—equity, housing, bonds, and bills—across 16 advanced economies from 1870 to 2015.

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1. Introduction

What is the rate of return in an economy? At a fundamental level, the real, risk-adjusted returns on different asset classes must reflect equilibrium resource allocations that ensure a society's optimal consumption choices over time. Yet there is much more to this simple observation. Current debates about secular stagnation, inequality, and monetary policy at the nominal effective lower bound, to name a few, are all informed by medium-run cyclical behavior that requires long spans of data to contrast competing hypotheses. Our paper introduces, for the first time, a large dataset on the rates of return on all major asset classes in advanced economies, annually since 1870. Our data provide new empirical foundations of long-run macro-financial research. Along the way, we uncover new and somewhat unexpected stylized facts.

The accumulation of capital, the expansion of the capital's share in income, and the growth rate of the economy relative to the rate of return to capital play a central role in the current debate sparked by Piketty (2014) on the accumulation of wealth, growth, and inequality. The origins of this debate are as old as the profession itself. David Ricardo and John Stuart Mill devoted much of their time to the study of profit rates. Karl Marx famously built his political economy on the idea of the tendency of the profit rate to fall, which he introduced in chapter 3 of *Das Kapital*.

Another strand of research, triggered by the financial crisis and with roots in Alvin Hansen's (1939) AEA Presidential Address, seeks to revive the secular stagnation hypothesis (Summers, 2014). Demographic trends are pushing the world's economies into uncharted territory. Population growth has stalled in much of the advanced world, with developing economies following closely behind. Meanwhile, we are living longer and healthier lives and spending more time in retirement. 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.

In a third major strand of financial research, preferences over current versus future consumption, and attitudes toward risk, manifest themselves in the premiums that the rates of return on risky assets carry over safe assets. Trying to account for such premiums spawned a voluminous literature following the seminal work of Mehra and Prescott (1985). Returns on different asset classes, each of their volatilities, and each of their correlations with consumption, and with each other, sit at the core of the canonical consumption-Euler equation that drives so much of how we think about not just asset pricing, but the demand side of an aggregate economy in all standard macro models.

Debates on the monetary policy framework have taken on new life too. Holston, Laubach, and Williams (2016) 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. As a result, the probability that the nominal policy interest rate may be constrained by the effective lower bound has increased, in turn raising questions about the prevailing policy framework. But viewed from a long run perspective how surprised should we be by this recent decline in the natural rate?

The common thread running through each of these broad 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 to measure it? The risky rate is a measure of profitability of private investment. The safe rate plays an important role in benchmarking compensation for risk, and is often tied to discussion of monetary policy settings and the notion of the natural rate. Yet as we will see, rates of return on risky investment have remained relatively constant over the last four decades while safe rates have continued to decline.

Outline and Context We begin by documenting our new and extensive data collection. We have painstakingly compiled asset return data for 16 advanced countries, over nearly 150 years. We construct three types of returns: investment income, capital gains, and hence total returns. This calculation is done for four major asset classes, two of them risky—equities and housing—and two of them relatively safe—government bonds and bills.

Our work goes far beyond prior work in terms of both coverage and accuracy. Notably, housing wealth is on average roughly one half of national wealth in a typical economy, and can fluctuate significantly over time (Piketty, 2014). But there is no previous rate of return database which contains any information on housing returns. Here we build on prior work on housing prices (Knoll, Schularick, and Steger, 2016) and new data on rents (Knoll, 2016) to offer an augmented database which can track returns on this important component of national wealth.

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., gaps around wars and political instability), and in a number of cases we accessed new and previously unused raw data sources. As a result, we have extended the coverage of the dataset to even more countries and years.

Next, we present basic stylized facts of these new data on returns. Over the long run of nearly 150 years, we find that advanced economy risky assets have performed strongly. The average total real rate of return is approximately 7% per year for *equities* and 8% for *housing*. The average total real rate of return for safe assets has been much lower, 2.5% for *bonds* and 1% for *bills*. These average rates of return are strikingly consistent over different subsamples, and they hold true whether or not one calculates these averages using GDP-weighted portfolios. Housing returns exceed or match equity returns, but with considerably lower volatility—a challenge to the conventional wisdom of investing in equities for the long-run.

In the final part of the paper we focus on two broad questions: (1) What has happened to the risk-premium, that is, the difference in total returns between risky and safe assets? And (2), what has happened to "$r - g$," the difference between the real rate of return on assets and the growth rate of real per capita GDP in the economy? This is the concept that Piketty (2014) put at the center of his analysis of the long-run dynamics of inequality and wealth accumulation.

Both risky and safe rates of return were relatively high in the pre-WW2 era, with an obvious dip for WW1. The risk premium between risky and safe rates grew large with the Great Depression and through the Bretton Woods era. Safe real rates were especially low in WW2 up to the late 1970s. After spiking in the 1980s, the safe return has gradually declined, yet risky returns have remained relatively close to their historical average level, and the risk premium is approaching post-1980s highs.

Turning to $r - g$, we find that this difference was quite large in the pre-WW2 period, on average about 5% per annum, with the obvious exception of WW1. The post-WW2 period has been one in which the difference has averaged about 3%–4%, narrowing to about 2% with the oil crises, before recovering and declining again with the Global Financial Crisis. The broad strokes are consistent with evidence reported in Piketty (2014) even though we use data from different sources and different methods.

Our data consist of actual asset returns taken from market data. In that regard, our data are therefore more detailed than returns inferred from wealth estimates in discrete benchmark years as in Piketty (2014). Either way, $r - g$ appears to be quite stable in the long run, always greater than zero over the full sample, and rising to its heights during the late 19th and late 20th century gilded ages of rising inequality and slowing growth. Over shorter time frames, however, we judge the correlation of $r - g$ and g to be far from clear and consistent, a relationship worthy of deeper investigation that stands at a crux of the inequality-growth nexus (Rognlie, 2015).

This paper follows a long and venerable tradition of economic thinking about fundamental returns on capital that includes, among others, Adam Smith, Knut Wicksell, and John Maynard Keynes. More specifically, our paper is closely related, and effectively aims to bridge the gap, between two literatures.

The first is rooted in finance and is concerned with long-run returns on different assets. The literature on historical asset price returns and financial markets is too large to discuss in detail, but important contributions have been made with recent digitization of historical financial time series, such as the project led by William Goetzmann and Geert Rouwenhorst at Yale University. The book *Triumph of the Optimists* by 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. Another key contribution to add is the pioneering and multi-decade project to document the history of interest rates by Homer and Sylla (2005).

The second related strand of literature is the analysis of comparative national balance sheets over time, as in Goldsmith (1985). More recently, Piketty and Zucman (2014) have brought together data 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 the aggregate capital income from the national accounts by the aggregate value of capital, equally taken from the 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 quadruple the number of countries for which we calculate real rates of return.

Major findings We summarize our four main findings as follows.

1. **On the risky rate,** r_{risky} Until this paper, we have had no way to know rates of return on all risky assets in the long run. Research could only focus on the available data on equity markets (Campbell, 2003; Mehra and Prescott, 1985).

   This was because of the shortage of data on residential real estate. Our work for the first time presents continuous time series of total housing returns from 1870 to the present for advanced economies. We uncover several new stylized facts.

   In terms of total returns, residential real estate and equities have shown very similar and high real total gains, on average about 7.5% per year. Housing outperformed equity before WW1. Since WW2, equities have slightly outperformed housing on average, but only at the cost of much higher volatility and cyclicality. The observation that housing returns are similar or greater than equity returns yet considerably less volatile is puzzling. Diversification with real estate is admittedly harder than with equities. Aggregate numbers do obscure this fact although accounting for variability in house prices at the local level still appears to leave a great deal of this housing puzzle unresolved.

   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 significant aggregate diversification gains from holding the two asset classes. Absent the data introduced in this paper, economists had been unable to quantify these gains.

2. **On the safe rate,** r_{safe} We find that the real safe rate has been very volatile over the long-run, more so than one might expect, at times even more volatile than real risky returns. Both world wars saw moments of very low safe rates, well below zero. So did the 1970s inflation and growth crises. 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 decline that took place from 1870 to WW1. Viewed from a long-run perspective, it may be fair to characterize the real safe rate as normally fluctuating around the levels that we see today. The puzzle may well be why was the safe rate so high in the mid-1980s rather than why has it declined ever since.

   How do the trends we expose inform current debates on secular stagnation and economic policy more generally? International evidence in Holston, Laubach, and Williams (2016) on the decline of the natural rate of interest since the mid-1980s is consistent with our richer cross-country sample. This observation is compatible with the secular stagnation hypothesis, whereby the economy can fall into low investment traps (see, for example Summers, 2014) and Eggertsson and Mehrotra (2014). Demographic shifts all over the world are re-shaping the economic landscape in ways that may put pressure on real interest rates going forward.

More immediately, the possibility that advanced economies are entering an era of low real rates calls into question standard monetary policy frameworks based on an inflation target. Monetary policy based on inflation targeting had been credited for the Great Moderation, until the Global Financial Crisis. Since that turbulent period, the prospect of long stretches constrained by the effective lower bound have commentators wondering whether inflation targeting regimes are the still the right approach for central banks (Williams, 2016).

3. **On the risk premium,** $r_{risky} - r_{safe}$ Over the very long run, the risk premium has been volatile. A vast literature in finance has typically focused on business-cycle comovements in short span data (see, for example Cochrane, 2009, 2011). Yet 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, despite the return to peacetime. However, there is no visible long-run trend, and mean reversion appears strong. The bursts of the risk premium in the wartime and interwar years were mostly a phenomena of collapsing safe rates rather than dramatic spikes in risky rates.

   In fact, the risky rate has often been smoother and more stable than safe rates, averaging about $7\% - 8\%$ across all eras. Recently, with safe rates low and falling, the risk premium has been held down by a parallel but smaller decline in risky rates. 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 rates seem to absorb almost all of these adjustments seems like a puzzle in need of further exploration and explanation.

   In addition, one could add yet another layer to this discussion, this time by considering international diversification. It is not just that housing returns seem to be higher on a rough, risk-adjusted basis. It is that, while equity returns have become increasingly correlated across countries over time (specially since WW2), housing returns have always been largely uncorrelated. Again, international diversification may be even harder to achieve than at the national level. But the thought experiment suggests that the ideal investor would like to hold an internationally diversified portfolio of real estate holdings, even more so than equities.

4. **On returns minus growth,** $r_{capital} - g$ Turning to real returns on all investable wealth, Piketty (2014) argued that if the return to capital exceeded the rate of economic growth, rentiers would accumulate wealth at a faster rate and thus worsen wealth inequality. Comparing returns to growth, or "r minus g" in Piketty's notation, we uncover a striking finding. Even calculated from more granular asset price returns data, the same facts reported in Piketty (2014) hold true for more countries and more years—namely $r \gg g$. In fact the only exceptions to that rule happen in very special periods—the years in or right around wartime. In peacetime, r has always been much greater than g. As of today, this gap is still quite large, although if

anything a little smaller than that seen by late 19th century gilded age investors.

However, 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). 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.

2. A new historical global returns database

The dataset unveiled in this study covers nominal and real returns on bills, bonds, equities, and residential real estate in 16 countries from 1870 to 2015. The countries covered are Australia, Belgium, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Table 1 summarizes the data coverage by country and asset class.

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 is known about long-run returns on housing.

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

2.1. The composition of wealth

Figure 1 and Table 2 show the decomposition of economy-wide investable asset holdings and capital stock average shares across five major economies at the end of 2015: France, Germany, Japan, UK and USA. Investable assets, displayed on the left panel of Figure 1, 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. That leaves housing, other non-financial assets—mainly other buildings, machinery, and equipment—equity, bonds, bills, deposits and other financial assets, which mainly include private debt securities (corporate bonds and asset-backed securities). The right panel of Figure 1 shows the decomposition of the capital stock into housing and various other non-financial assets. The decomposition of investable assets into individual classes for each country, is further shown in Table 2.

Housing, equity, bonds, and bills comprise over half of all investable assets in the advanced economies today (nearly two-thirds whenever deposit rates are added). The housing returns data also allow us to assess returns on around half of the outstanding total capital stock, using our new

Table 1: *Data coverage*

Country	Bills	Bonds	Equities	Housing
Australia	1870–2015	1900–2015	1870–2015	1901–2015
Belgium	1870–2015	1870–2015	1870–2015	1890–2015
Denmark	1875–2015	1870–2015	1893–2015	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	1914–2015	1871–2015
Portugal	1880–2015	1871–2015	1871–2015	1948–2015
Spain	1880–2015	1900–2015	1900–2015	1901–2015
Sweden	1870–2015	1875–2015	1871–2015	1883–2015
Switzerland	1870–2015	1900–2015	1900–2015	1902–2015
UK	1870–2015	1870–2015	1870–2015	1900–2015
USA	1870–2015	1871–2015	1872–2015	1891–2015

total return series as a proxy for aggregate housing returns. Our improved and extended equity return data for publicly-traded equities will then be used, as is standard, as a proxy for aggregate business equity returns.[1]

2.2. Historical return data

Our measure of the risk-free rate is 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 macrohistory database (Jordà, Schularick, and Taylor, 2016b).[2] For periods when data on Treasury bill returns were unavailable, we relied on either money market rates or deposit rates of banks from Zimmermann (2017).

The bond return series refer to the total return on long-term government bonds. Unlike a number of preceding cross-country studies, we focus on the bonds listed and traded on local exchanges, and denominated in local currency. The focus on local-exchange bonds makes the bond return estimates more comparable to those of equities, housing and bills. Further, this results in a larger sample of bonds, and focuses our attention on those bonds that are more likely to be held by the representative

[1] For example, to proxy the market value of unlisted equities, the US Financial Accounts apply industry-specific stock market valuations to the net worth and revenue of unlisted companies.

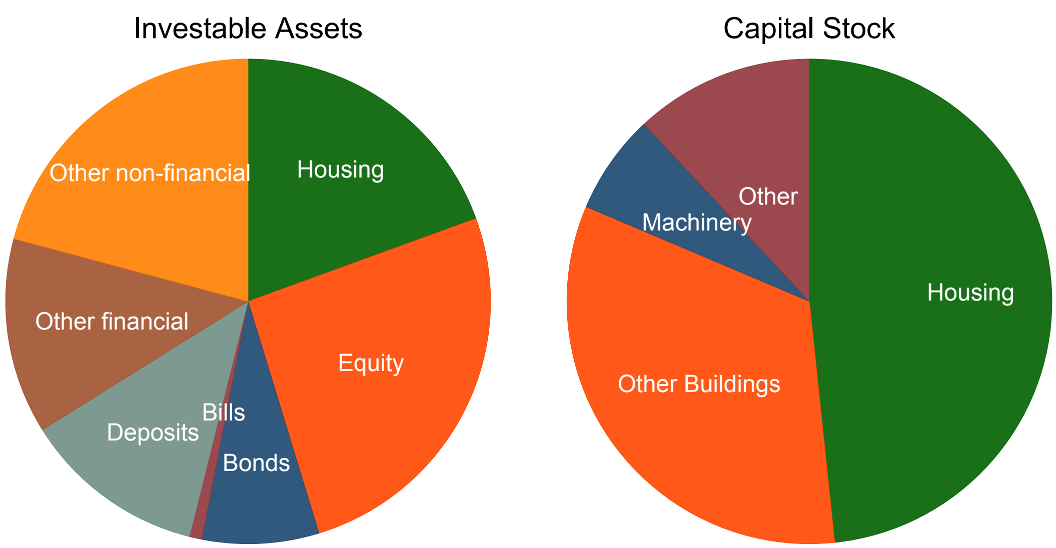
[2] www.macrohistory.net/data

Table 2: *Composition of investable assets by country*

Country	Housing	Equity	Bonds	Bills	Deposits	Other Fin.	Other Non-Fin.
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	13.3	39.1	8.6	0.8	7.3	11.2	19.8
Average share	19.4	25.9	7.7	0.9	12.3	13.2	20.7

Note: Ratios to total investable assets, percentage points. End-2015. Data sourced from national accounts and national wealth estimates published by the countries' central banks and statistical offices.

Figure 1: *Composition of investable assets and capital stock in the major economies*



Note: Composition of total investable assets and capital stock. Average of the individual asset shares of France, Germany, Japan, UK and US, end-2015. Investable assets are defined as the gross total of economy-wide assets excluding loans, derivatives, financial institutions' deposits, insurance, and pension claims. The capital stock is business capital plus housing. Data sourced from national accounts and national wealth estimates published by the countries' central banks and statistical offices.

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 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).

Our dataset also tracks the development of returns on equity and housing. The new data on total returns on equity 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 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.

To the best of the authors' knowledge, this study is the first to present long-run returns on residential real estate. We combine the long-run house price series presented by Knoll, Schularick, and Steger (2016) with a novel dataset on rents from Knoll (2016). For most countries, the rent series rely on the rent components of the cost of living of consumer price indices as constructed by national statistical offices and combines them with information from other sources to create long-run series reaching back to the late 19th century.

We also study a number of "composite" asset returns, as well as those on the individual asset classes—bills, bonds, equities and housing—described above. More precisely, we compute the rate of return on safe assets, risky assets, and overall capital, 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 a proportion of total asset stock, as weights. To this end, we construct measures of equity market capitalization and housing wealth for each country and period in our sample, and combine 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 Section D.

Tables A.13 and A.14 present an overview of our four asset return series by country, their main characteristics and coverage. The paper comes with an extensive data appendix (see the Data Appendix) that specifies the sources we consulted and discusses the construction of the series in greater detail.

2.3. 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 i in country j at time t is calculated as:

$$\text{Total return:} \quad R_{i,j,t} = \frac{P_{i,j,t} - P_{i,j,t-1}}{P_{i,j,t-1}} + Y_{i,j,t}\,. \tag{1}$$

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

$$\text{Real return:} \quad r_{i,j,t} = R_{i,j,t} - \pi_{j,t}\,. \tag{2}$$

These returns will be summarized in period average form, by country, or for all countries.[3]

Investors must be compensated for risk to invest in risky assets. A measure of this "risk premium" can be calculated by comparing the real total return on the risky asset with the return on a risk-free asset. Call the real return on the benchmark risk-free asset $r_{safe,j,t}$, which we define in more detail momentarily. We therefore calculate the risk premium (return in excess of the risk-free rate) RP for the risky asset i in country j as

$$\text{Risk premium:} \quad RP_{i,j,t} = r_{i,j,t} - r_{safe,j,t}\,. \tag{3}$$

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 capital." Appendix D 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 to proxy the bond and bill stocks, since we have no data yet on the market weights (only total public debt weight) over our full sample. The safe asset return is then computed as an average of the real returns on bonds and bills as follows:

$$\text{Safe return:} \quad r_{safe,j,t} = \frac{r_{bill,j,t} + r_{bond,j,t}}{2}. \tag{4}$$

For risky assets, the weights w here are the asset holdings of equity and housing stocks in the respective country j and year t, scaled to add to 1. We use stock market capitalization and housing wealth as weights for equity and housing. The risky asset return is a weighted average of returns on equity and housing:

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

[3] 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. These are calculated as $\left(\prod_{i \in T}(1 + r_{i,j,t})\right)^{\frac{1}{T}} - 1$. 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.

The "return on capital" 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 j and year t, scaled to add to 1.

$$\text{Return on capital:} \quad r_{capital,j,t} = r_{risky,j,t} \times w_{risky,j,t} + r_{safe,t} \times w_{safe,j,t}. \tag{6}$$

For comparison, Appendix Section E also provides information on the equally-weighted risky return, and the equally-weighted rate of return on capital, that are simple averages of housing and equity, and housing, equity and bonds respectively.

Finally, we also consider returns from a global investor perspective in Appendix Section F. These measure the returns from investing in local markets in US dollars. This measure effectively subtracts the depreciation of the local exchange rate vis-a-vis the dollar from the nominal return:

$$\text{USD return:} \quad R^{USD}_{i,j,t} = R_{i,j,t} - \Delta s_{j,t}, \tag{7}$$

where $\Delta s_{j,t}$ is the exchange rate depreciation of the local exchange rate vis-a-vis the US dollar in year t (i.e. if the local currency loses value in year t, the USD return is smaller than the local-currency nominal return). The real USD returns are net of US inflation:

$$\text{Real USD return:} \quad r^{USD}_{i,j,t} = R^{USD}_{i,j,t} - \pi_{USA,t}, \tag{8}$$

where $\pi_{USA,t}$ is US inflation in year t.

2.4. Constructing housing returns using the rent-price approach

This section briefly describes our methodology to calculate total housing returns and we provide further details as needed later in the paper (Section 5.1 and Appendix Section J). 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 rental yields from Trulia and the Investment Property Database (IPD).[4] We can then construct a time series of returns by 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, 2016) and new data on rents (Knoll, 2016). This method assumes that the indices cover a representative portfolio of houses. If so, there is no need to correct for changes in the housing stock, and only information about the growth rates in prices and rents are necessary. A time series of the rent-to-price ratio can be derived iteratively as

$$\frac{RI_{t+1}}{HPI_{t+1}} = \left[\frac{(RI_{t+1}/RI_t)}{(HPI_{t+1}/HPI_t)}\right]\frac{RI_t}{HPI_t}. \tag{9}$$

[4]For the U.S. we use Trulia instead of IPD, as suggested by Giglio et al. (2015).

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

$$R_{house,t+1} = \frac{RI_{t+1}}{HPI_t} + \frac{HPI_{t+1} - HPI_t}{HPI_t}. \quad (10)$$

As this approach is sensitive to the choice of rent-price-ratio at benchmark dates, we corroborate the plausibility of the historical rent-price ratios with additional primary sources as well as economic and financial history books and articles, and examine the sensitivity of aggregate return estimates to varying benchmark ratio assumptions. For further details, see Section 5.1 and Appendix Section J.

3. Rates of return: Aggregate trends

We begin with the first key finding—one that was completely unknown until now, due to lack of evidence. The data summary in Table 3 and Figure 2 show that residential real estate, not equity, has been the best long-run investment over the course of modern history. The full sample summary return data are shown in the upper panel of Table 3, and the post-1950 sample in the bottom panel. Data are pooled and equally-weighted, i.e., they are raw rather than portfolio returns. We include wars so that results are not polluted by omitted disasters. We do, however, exclude hyperinflations in order to focus on the underlying trends in returns, rather than inflation.

Although returns on housing and equities are similar, the volatility of housing returns is substantially lower, as Table 3 shows. Returns on the two asset classes are in the same ballpark (7.9% for housing and 7.0% for equities), 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—7.5% for housing versus 4.7% for equities. This finding appears to contradict one of the basic assumptions 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 our long historical sample. The bottom half of Table 3 makes this point. Compared to the full sample period (1870–2015) reported in the upper half of the table, the same clear pattern emerges: stocks and real estate dominate in terms of returns. Moreover, average returns post–1950 are similar to the full sample, even though the later period excludes the devastating effects of the two world wars.

Other robustness checks are reported in the Appendix in Figures A.1, A.2, and A.3. Briefly, we find that the observed patterns are not driven by the smaller European countries in our sample. Figure A.1 shows average real returns weighted by country-level real GDP, both for the full sample and post–1950 period. The magnitude of returns is more or less the same as that of the unweighted series shown in Table 3.

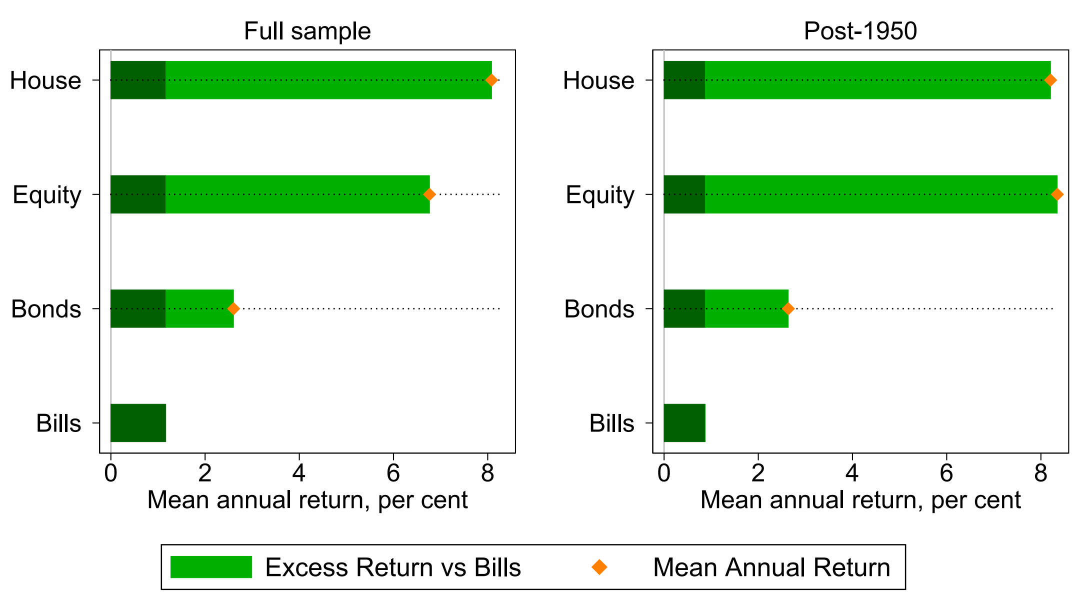
The results could be biased because different countries enter the sample at different dates due to data availability. Figure A.2 plots the average returns for sample-consistent country groups, starting at benchmark years—the later the benchmark year, the more countries we can include. Again, the broad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

Table 3: *Global real returns*

	Real returns				Nominal Returns			
	Bills	Bonds	Equities	Houses	Bills	Bonds	Equities	Houses
Full sample:								
Mean return p.a.	1.01	2.52	7.01	7.89	4.62	6.13	10.88	11.93
Std.dev.	5.96	10.21	22.34	9.86	3.36	8.54	23.25	10.55
Geometric mean	0.82	2.01	4.73	7.46	4.57	5.80	8.62	11.46
Mean excess return p.a.	.	1.51	6.00	6.88	.			
Std.dev.	.	7.97	21.88	9.73	.			
Geometric mean	.	1.21	3.84	6.45	.			
Observations	1705	1705	1705	1705	1705	1705	1705	1705
Post-1950:								
Mean return p.a.	0.92	2.72	8.28	8.17	5.40	7.22	12.95	13.01
Std.dev.	3.33	9.17	24.44	8.31	4.02	9.27	25.41	9.59
Geometric mean	0.87	2.32	5.56	7.85	5.32	6.84	10.23	12.62
Mean excess return p.a.	.	1.80	7.36	7.24	.			
Std.dev.	.	8.60	24.09	8.61	.			
Geometric mean	.	1.45	4.72	6.90	.			
Observations	1023	1023	1023	1023	1023	1023	1023	1023

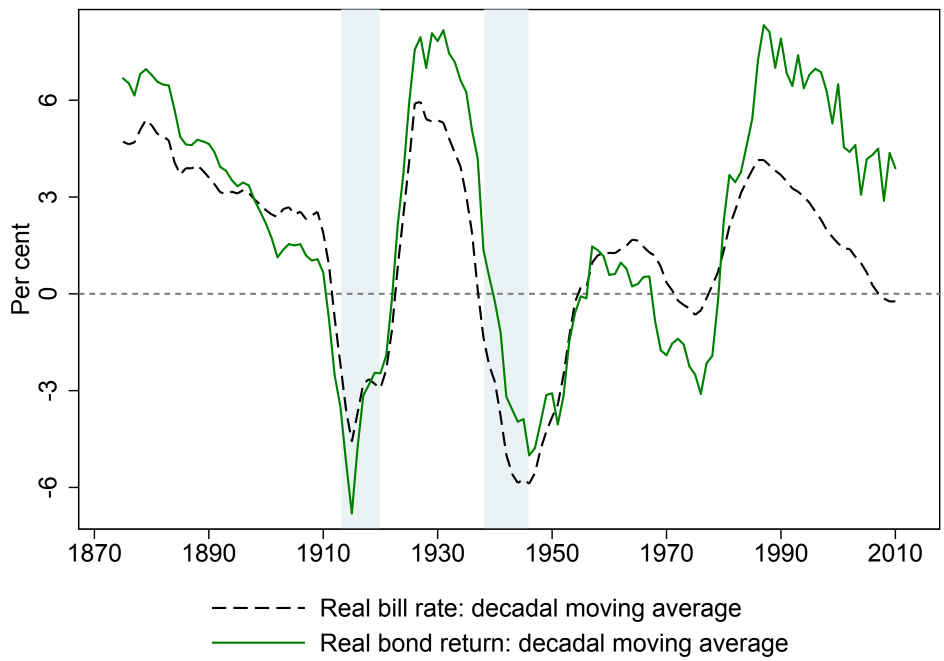
Note: Annual global returns in 16 countries, equally weighted. Period coverage differs across countries. Consistent coverage within countries. Excess returns are computed relative to bills.

Figure 2: *Global real rates of return*



Notes: Arithmetic avg. real returns p.a., unweighted, 16 countries. Consistent coverage within each country.

Figure 3: *Trends in real returns on bonds and bills*



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

Lastly, we investigate the possibility that the results are biased because of wartime experiences. We recompute average returns, but now dropping the two world wars from the sample. Figure A.3 plots the average returns in this case, and alas the main result remains largely unchanged.

4. Safe rates of return

Figure 3 shows the trends in real returns on government bonds (solid line) and bills (dashed line) since 1870. 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 quite similar. We smooth the data using a decadal moving average—for example, the observation reported in 1900 is the average of data from 1895 to 1905.

Two striking features of Figure 3 deserve comment. First, low real rates, and in fact negative real rates have been relatively common during modern financial history. Second, long and short-term returns have tracked each other closely—with a premium of about 1% that has widened considerably since the well-documented decline of the mid-1980s (Holston, Laubach, and Williams, 2016).

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 (or even more volatile) than real risky rates, a topic we return to in the next subsection. Considerable variation in the risk premium often comes from sharp changes in safe real rates, not from the 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. 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 "secular stagnation" (see, for example Summers, 2014).

However, in contrast to 1870 and the late 1930s, the more recent decline is characterized by a much higher term premium—a feature with few precedents in our sample. 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 dip dramatically during both world wars. It is perhaps to be expected: demand for safe assets spikes during disasters although the dip may also reflect periods of financial repression 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, during the late 19th and 20th 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 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.

Figure 4 explores additional key moments of the data. The top-left panel plots the correlation between real bond and 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.

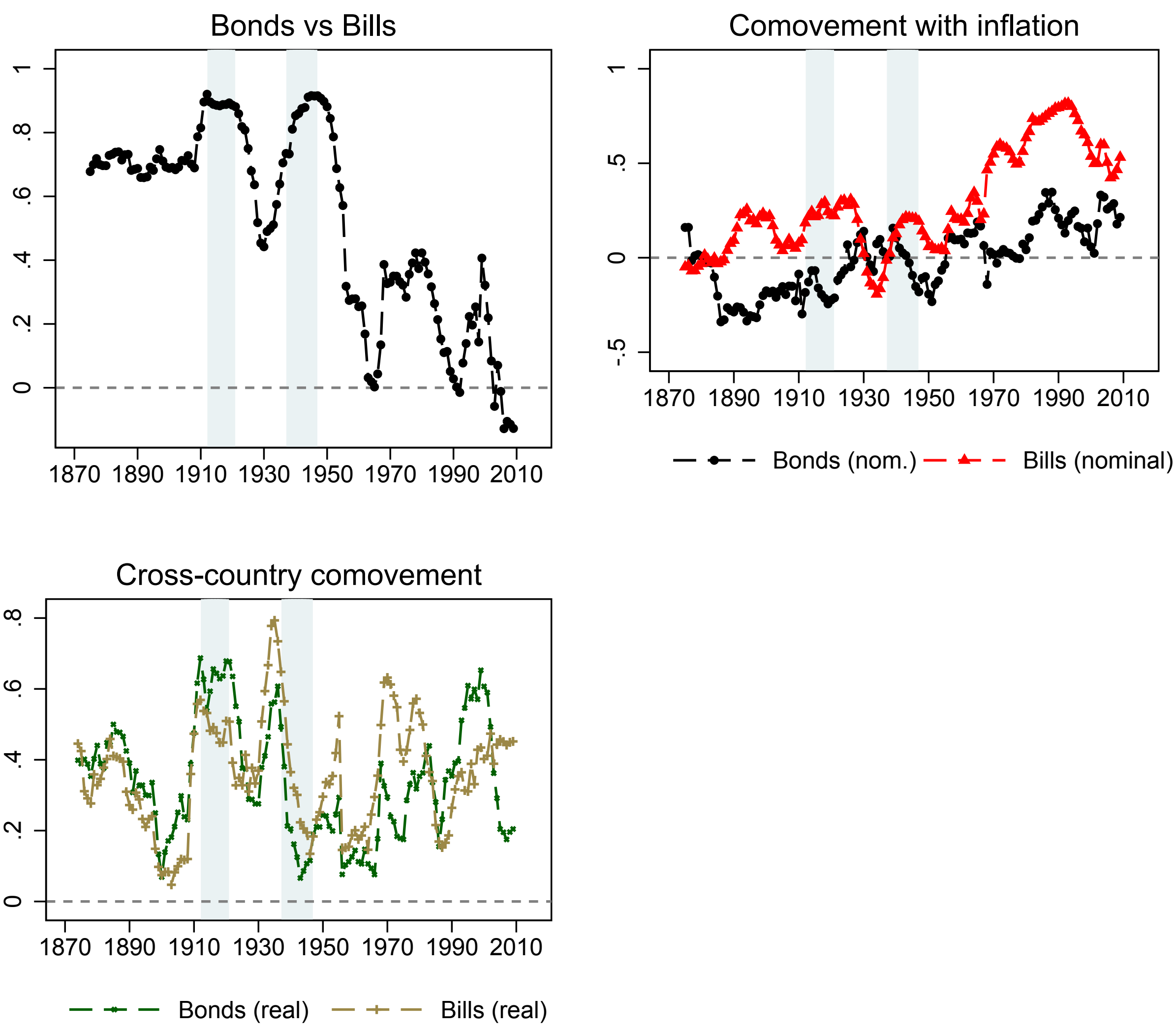
The top right panel of Figure 4 displays the correlation between nominal safe asset returns and inflation. The figure shows that safe assets provided more of an inflation hedge starting in the 1970s, around the start of the era of modern central banking. However, as Figure 3 showed, both bonds and bills have experienced prolonged periods of negative real returns—both during wartime inflation, and 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 4 displays the cross correlation of safe returns over rolling decadal windows to examine how much inflation risk can be diversified with debt instruments. This correlation coefficient is the average of all country-pair combinations for a given window, and is 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: bonds or bills), and time window $T = (t-5, t+5)$. Here j and k denote the country pairs, and r – real returns, constructed as described in Section 2.3.

Figure 4: *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.

Turning to cross-sectional features, Table 4 shows country-specific safe asset returns for three 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, and approximately zero for Portugal. For Spain and 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 $1\% - 3\%$.

Cross-country real safe returns have exhibited positive comovement throughout history. The degree of comovement shows a few marked increases associated with WW1 and the 1930s. The effect of these major global shocks on individual countries seems to have resulted in a higher correlation

Table 4: *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	1.16	3.01	1.50	3.86	2.30	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	0.95	2.96	2.22	6.94
Germany	1.51	3.15	1.86	3.69	1.96	4.22
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	2.35	1.04	1.35	2.08	4.15
Norway	1.10	2.28	-0.26	1.52	1.50	3.10
Portugal	0.12	2.75	-0.40	2.66	0.65	6.25
Spain	0.32	1.00	-0.32	0.31	2.20	3.29
Sweden	1.81	3.32	0.82	2.71	1.51	6.60
Switzerland	0.80	1.93	0.12	1.56	0.33	1.93
UK	1.16	2.29	1.14	2.63	2.70	6.67
USA	2.17	2.79	1.30	2.64	1.71	5.71
Average, unweighted	1.14	2.53	0.90	2.64	1.98	5.26
Average, weighted	1.31	2.46	1.17	2.60	1.89	5.41

Note: Average annual real 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.

of cross-country asset returns. This was less true of WW2 and its aftermath, perhaps because the evolving machinery of financial repression was better able to manage the yield curve.

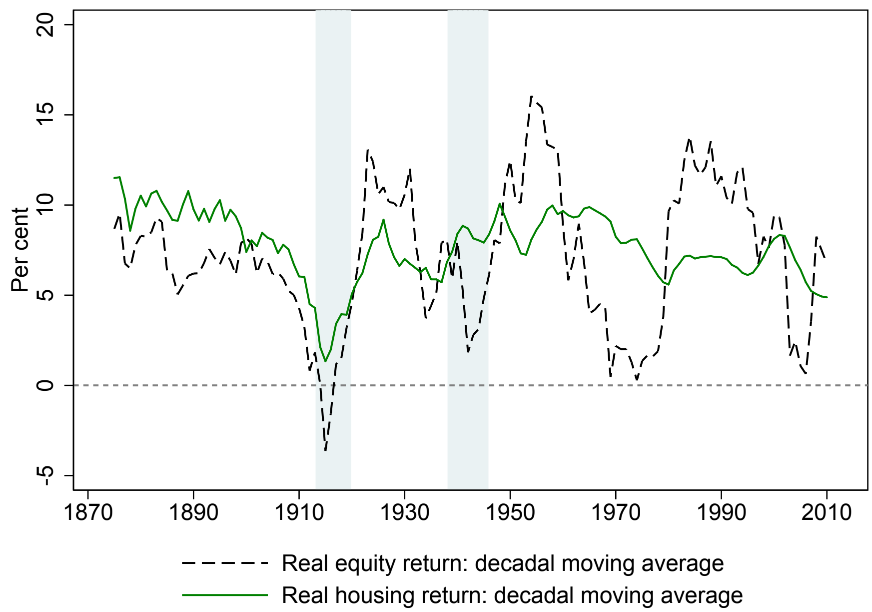
In sum, real returns on safe assets, even adjusted for risk, have been quite low across the advanced countries and throughout the last 150 years. In fact, for some countries, these returns have been persistently negative. Periods of unexpected inflation, in war and peace, have often diluted returns, and flights to safety have arguably depressed returns in the asset class even further in the more turbulent periods of global financial history.

5. Risky rates of return

We next shift our focus to the risky assets in our portfolio, i.e., housing and equities. Figure 5 shows the trends in real returns on housing (solid line) and equity (dashed line) for our entire sample, again presented as decadal moving averages. In addition, Figure 6 displays the correlation of risky returns between asset classes, across countries, and with inflation, in a manner similar to Figure 4.

A major stylized fact leaps out. Prior to WW2, real returns on housing, safe assets and equities followed remarkably similar trajectories. After WW2 this was no longer the case. Risky returns were

Figure 5: *Trends in real returns on equity and housing*



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

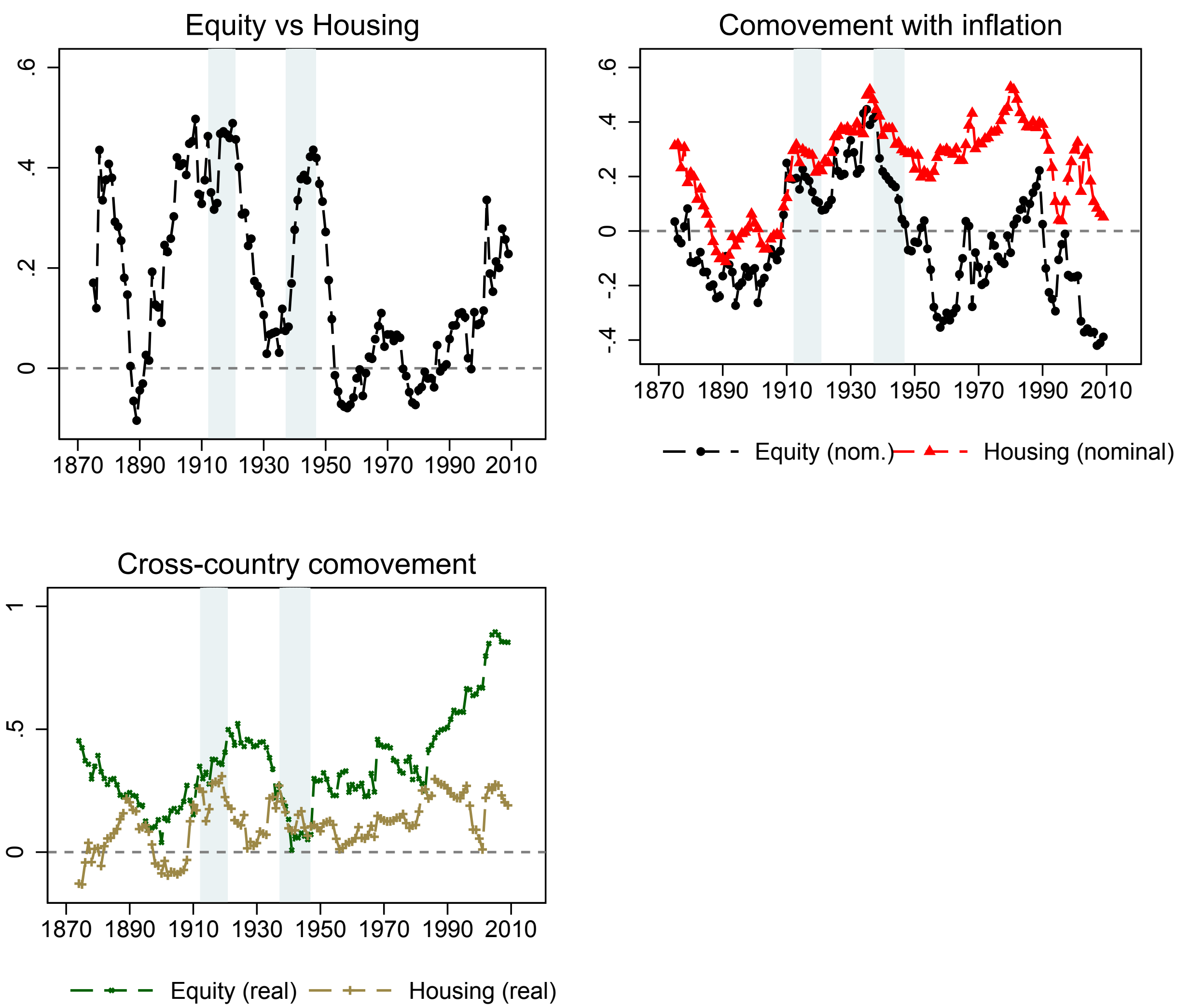
high and stable in the 19th century, but fell sharply around WW1, with the decade-average real equity returns turning negative. Returns recovered quickly during the 1920s, before experiencing a reasonably modest drop in the aftermath the Great Depression. Most strikingly though, from the onset of WW2 onwards the trajectories of the two risky asset classes diverged markedly from each other, and also from those of safe assets.

Equity returns have experienced many pronounced global boom-bust cycles, much more so than housing returns, with real returns as high as 16% and as low as −4% over the course of entire decades. Equity returns fell in WW2, boomed sharply during the post-war reconstruction, and fell off again in the climate of general macroeconomic instability in the late 1970s. Equity returns bounced back following a wave of deregulation and privatization of the1980s. The next major event to consider was the Global Financial Crisis, which extracted its toll on equities and to some extent housing, as we shall see.

Housing returns, on the other hand, have remained remarkably stable over the entire post-WW2 period. As a consequence, the correlation between equity and housing returns, depicted in the top panel of Figure 6, 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 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, housing persistently outperformed equity up until the end of WW1, even though the returns followed a broadly similar temporal pattern. In recent decades, equities have slightly outperformed housing on average, but only at the cost of much higher volatility and

Figure 6: *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.

cyclicality. Furthermore, the upswings in equity prices have generally not coincided with times of low growth or high inflation, when standard theory would say high returns would have been particularly valuable.

The top-right panel of Figure 6 shows that equity co-moved negatively with inflation in the 1970s, while housing provided a more robust hedge against rising consumer prices. In fact, apart from the interwar period when the world was gripped by a general deflationary bias, 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 comovement in the bottom-left panel of Figure 6. A well-diversified global equity portfolio has become less of a hedge against country-specific risk (Quinn and Voth, 2008). As is a matter of debate, this may reflect the greater trading 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 are exposed more to idiosyncratic country-level shocks.

Next we explore long-run risky returns in individual countries. Table 5 shows the 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.

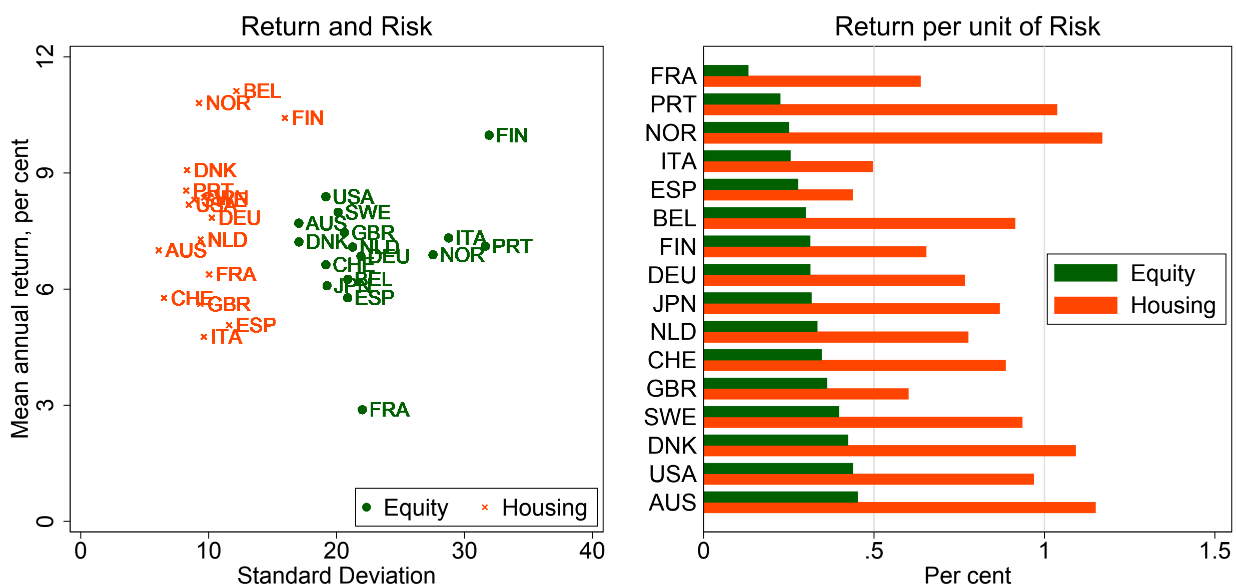
Still, the figures also show an important degree of heterogeneity among individual countries. Many of the countries that have been particularly negatively affected by the two world wars—for example, France, Belgium, and Japan—show lower equity returns. Political shocks also play a role: for example, equity returns are particularly low in France, to a large degree because of the

Table 5: *Real rates of return on equity and housing*

Country	Full Sample		Post 1950		Post 1980	
	Equity	Housing	Equity	Housing	Equity	Housing
Australia	7.70	7.00	7.38	8.60	8.78	9.00
Belgium	6.25	11.12	8.20	10.70	11.49	9.35
Denmark	7.22	9.07	9.33	7.86	12.57	5.17
Finland	9.98	10.42	12.81	11.49	16.17	9.47
France	2.88	6.38	5.29	9.67	8.29	5.76
Germany	6.85	7.85	7.52	5.29	10.06	4.12
Italy	7.32	4.77	6.18	5.55	9.45	4.57
Japan	6.09	8.36	6.32	7.25	5.79	3.58
Netherlands	7.09	7.28	9.41	8.53	11.90	6.41
Norway	6.89	10.81	7.57	11.53	9.77	11.34
Portugal	7.11	8.54	7.54	8.18	8.34	7.70
Spain	5.77	5.07	7.11	5.83	11.00	4.62
Sweden	7.98	8.30	11.30	8.94	15.74	9.00
Switzerland	6.63	5.77	8.28	5.64	9.12	6.19
UK	7.46	5.61	9.02	7.21	9.34	6.81
USA	8.39	8.18	8.75	7.58	9.09	7.68
Average, unweighted	6.72	8.00	8.35	8.21	10.43	6.92
Average, weighted	7.11	7.76	8.22	7.44	8.89	6.36

Note: Average annual real 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.

Figure 7: *Risk and return of equity and housing*



Note: Left panel: average real return p.a. and standard deviation. Right panel: ratio of return to standard deviation. 16 countries. Consistent coverage within each country.

wave of nationalizations in the aftermath of WW2, and the fallout from an oil crisis in the 1960s. This coincided with a time when equity returns for many other countries were booming (for more detail, see Blancheton et al., 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 Norway, Belgium and Finland, but low in Italy and Spain. 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 absolute terms in 6 countries, and equities outperformed housing in 2. Returns on the two assets were about the same (i.e. less than 1 percentage point difference) in the remaining 8 countries. After WW2, housing was the best-performing asset class in 5 countries, and equities in 9.

However, although aggregate returns on equities exceed aggregate returns on housing for certain countries and time periods, equities do not outperform housing in simple risk-adjusted terms. Figure 7 compares the riskiness and returns of housing and equities for each country. The left panel plots average annual real returns on housing (orange crosses) and equities (green circles) against their standard deviation. The right panel shows returns per unit of risk for equities (in dark green) and housing (in orange) for each country in the sample. Housing provides a higher return per unit of risk in each of the 16 countries in our sample, and almost double that of equities.

5.1. Accuracy and comparability of risky returns

This section provides consistency and robustness checks by examining (1) the accuracy of equity returns, (2) the accuracy of housing returns, and (3) the comparability of housing and equity returns.

Accuracy of equity returns The potential biases in constructing equity returns fall into two main categories: survivorship bias and weighting issues. Survivorship bias arises when poorly performing firms, or firms that eventually go bankrupt are excluded from the sample. This can happen if the selection of index constituents is chosen at the end of the sample period and the index is calculated retrospectively, or if failed firms are wrongly excluded as outliers. This can be a particular problem when trying to link equity indices across wartime breaks.

The best practice in weighting equity indices is to use market-capitalization weights of individual stocks. This approach most closely mirrors the composition of a hypothetical representative investor's portfolio. Equally-weighted indices are therefore likely to overweight smaller firms, which tend to have higher returns on average, and potentially carry a higher risk. Finally, some equity indices are based on a subsample of the companies traded on the exchange, and a small sample may not be representative of overall stock market movements.

To guard against these biases, our equity return series is based on market-capitalization weighted returns across a broad and inclusive sample of firms, for almost every country and period. Where market-capitalization weighting is not available, we try to use close alternatives such as weighting individual stock returns by the book capital of the company rather than using equally-weighted averages. Where all-share indices were not available, we have generally made use of "blue-chip" indices, that consist of a value-weighted rotating sample of high-capitalization firms. Using such indices with a rotating sample selection generally helps avoid survivorship biases (Le Bris and Hautcoeur, 2010). Further, even though blue-chip indices only capture a proportion of the market, Annaert, Buelens, Cuyvers, De Ceuster, Deloof, and De Schepper (2011) show that they tend to match the overall stock market movements very well. Table A.14 in the Appendix provides a more detailed description of the weighting and coverage of the equity return series for each country and sub-period.

Note that both survivorship bias and equal weighting act to increase equity returns—either by biasing the sample towards successful companies, or by overweighting smaller high-return shares. Correcting for these two biases would therefore only strengthen our main conclusion that housing has outperformed equity in risk-adjusted return terms.

Also note that, even if biases exist, their impact on our series is likely to be small. Research suggests that survivorship bias is likely to push average equity returns upwards by about 0.5%–1% per year (see Annaert et al., 2012; Nielsen and Risager, 2001), even though the magnitude could potentially be larger for some cases (see Le Bris and Hautcoeur, 2010). The bias from equal-weighting is likely to be somewhat smaller. Moreover, this bias should be minimal given that we mainly use market-capitalization weighting for the vast majority of countries and periods. In light of all the above, the potential upward bias to our equity return series is likely to be small, and well below 0.5 percentage points per year on average for the entire sample.

Accuracy of housing returns A number of additional issues have to be considered when constructing returns on housing. First, 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, in the Investment Property Database (IPD) the rental yields reflect net income (i.e., net of property management costs, ground rent, and other irrecoverable expenditure) received for residential real estate as percentage of the capital employed.

Assuming that maintenance costs are stable over many years, rental yields calculated using the rent-price approach detailed above are net yields.[5] We also note that rental yields drawn from the IPD database are based on asset-level data from a wide variety of professional investors in real estate covering a substantial share of the total institutional investment market in each country. Hence, the rent-price ratios do not suffer from the typical problem of comparing two different sets of properties: those for sale and those for rent.[6]

Second, using the rent-price approach naturally implies that the level of returns is sensitive to the choice of rent-price-ratio benchmark value. Wherever possible, we corroborate the resulting long-run rent-price ratios using a wide range of primary sources, and economic and financial history books and articles. We also construct additional estimates of rent-price ratios for benchmark years following a procedure related to the *balance-sheet approach* use to calculate time series of housing returns.[7]. It is important to note that these independent estimates, i.e. the data collected from historical materials as well as the estimates derived using the balance-sheet approach, are unlikely to be identical to the long-run rent-price ratios constructed by applying the rent-price approach in any given year. Discrepancies may stem from differences in geographical coverage and in the types of dwellings covered. Moreover, the extent to which the independent estimates do not account for maintenance and depreciation but reflect gross rent-price ratios, they may be somewhat higher than our long-run net rent-price ratio. The estimates therefore serve to confirm the general level and trajectory of the long-run rent-price ratios rather than their exact value. We discuss the rent-price series for each country in great detail in Appendix J. Figure 8 shows how this approach works for the U.K. and Switzerland. Reassuringly, the independent scattered estimates we gathered are, by and large, consistent with the long-run rent-price ratios constructed using the rent-price approach.

However, rent-price ratios within a country may differ across regions and property types at any given point in time. Data drawn from the IPD database in most cases reflect rental yields in

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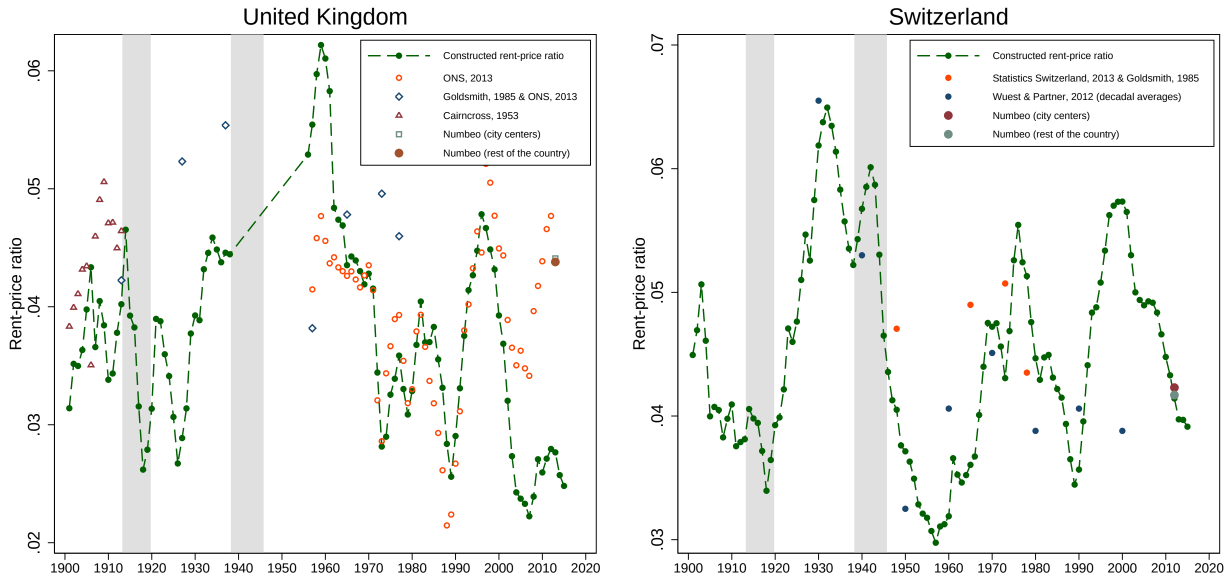
[5] In the case of the U.S., to compute net returns, we subtract maintenance costs and depreciation calibrating their impact at 2.5 percent p.a.

[6] Also the rent-price ratio drawn from Trulia for the U.S. relies on asset-level data.

[7] The balance-sheet approach combines information from national accounts on the value of the stock of residential estate and total rental income—or household expenditure on housing—controlling for changes in the housing stock. Let HW denote total housing wealth, RIC total rental income, and S be a measure of the housing stock. The one-period gross return on housing H is then given by $H_{t+1} = \frac{HW_{t+1}+RIC_t}{HW_t} \times \frac{S_t}{S_t+1}$

Figure 8: *Historical plausibility of rent-price ratios*



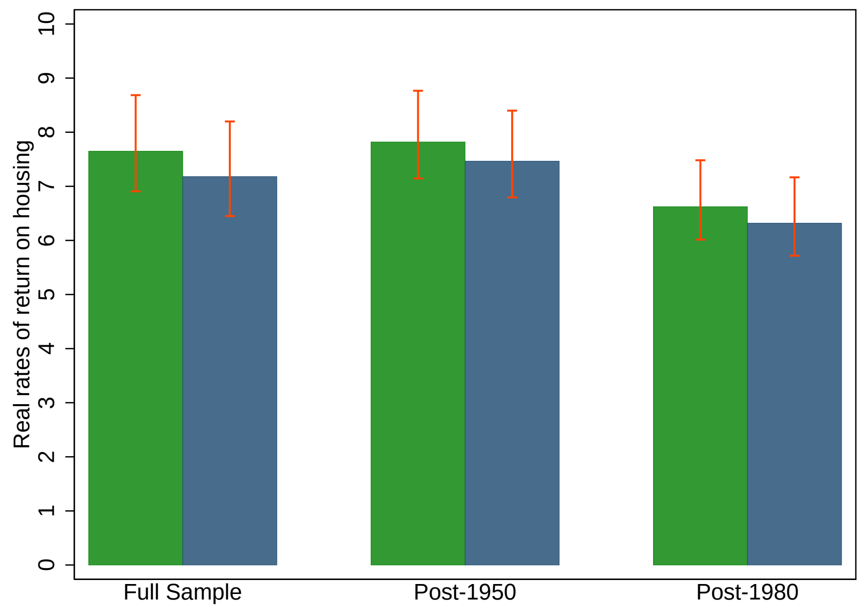
Note: Historical estimates of the rent-price ratio in this paper compared to alternative historical sources.

large cities, which tend to be lower compared to, say, rural areas. What is the effect of adjusting the benchmark rent-price ratios within reasonable limits? Note that the inverse of the rent-price ratio intuitively can be interpreted as the number of years of annual rent that would be required to purchase the property. In 2013, according to data reported by `www.Numbeo.com`, the difference between price-rent ratios in city centers and out of city centers for the countries in the sample in 2013 amounts to a little less than 3 times the annual rent. 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 long-run housing returns. Figure 9 shows that this approach results in a difference of about ± 1 percentage point relative to the baseline estimates, which we think is reassuringly small.

Finally, since our sample is dominated by European countries, our data may underestimate the riskiness of an investment in residential real estate during the years of the two world wars. Particularly in European cities, a substantial part of the housing stock was destroyed during the war years. Incorporating the physical loss of (part of) the asset would lower the return to a representative housing investment beyond the mere fall in price. Put differently, our data may suffer from a survivorship bias.[8] But as Figure 7 shows, the main facts the data allow us to establish are similar in countries that experienced major war destruction on their own territory and countries that did not (i.e., Australia, Canada, Denmark, and the U.S). Further, Appendix Table A.4 shows that housing offers a slightly higher return relative to equity on average even after wars are excluded.

[8] See Jorion and Goetzmann (1999) for a discussion of the survivorship bias in equity markets.

Figure 9: *Sensitivity of housing returns: Varying benchmark rent-price ratios*



Note: Error bars show the impact of increasing or reducing the benchmark price/rent ratio by ± 3 on historical returns. Green bars (left column) denote arithmetic average returns, and blue bars (right column) – geometric averages.

Comparability of housing and equity returns A key challenge when comparing returns on housing and equities is accounting for differences in liquidity, taxation, and leverage. 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. It also takes a relatively long time to sell a house, and if the house is owner-occupied, additional costs are incurred with changes in residence. Equities are much more liquid than houses. However, housing transactions typical occur much less frequently than transactions of financial assets such as equities for reasons somewhat unrelated to these costs.

We provide a rough estimate of how transaction costs affect our return estimates for housing. To do this, we perform a simple back-of the envelope calculation using current data on average holding periods of residential real estate and average transaction costs incurred by the buyer. According to the (OECD, 2012), average roundtrip transaction costs across 13 of the 16 countries in our sample amount to about 7.7 percent of the property's value.[9] 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. Accounting for transaction costs would thus lower the average annual return to housing by less than 1 percentage point.

[9]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.

For the equity market, typical transaction costs values used applied to the U.S. are 1.5 bps and 75 bps for the Treasury bill and value-weighted equity returns, respectively. Jones (2002) finds a one-way fee (half-spread) plus commission of 100 bps from the 1930s to the 1970s, implying a round-trip or two-way transaction cost of 200 bps. For less frequently traded stocks, the spreads could be as high or higher, and they could well be higher in overseas markets and in more distant historical epochs.

However, these simple cost ratios need to be adjusted for the typical trading frequency of each asset. Jones (2002) also shows the turnover, at least post-WW2, has been at a minimum of 25% annually on the NYSE, rising rapidly in recent years. Over a longer horizon NYSE turnover has been at least 50% on average implying annualized round-trip transaction costs of at least 100 bps (200% times 50%) over a century or so. Thus, based on observed average investor holding periods and average investor transaction costs it is not at all clear that the transaction costs on an annualized basis have been that different for equities and housing over the long run.

Next, when calculating equity and housing returns, we do not account for taxes. From an investor's perspective accounting for taxes is clearly important. Equity capital gains and, for some countries and periods, dividend income, are typically subject to a capital gains tax. When dividends are not taxed as capital gains, they are typically taxed as income. In some countries, housing capital gains are subject to capital gains taxes, but particularly owner-occupied houses have been granted exemptions in many cases. Additionally, housing tends to be subject to further asset-specific levies in the form of property taxes, documented extensively in Appendix K. For both equities and housing, the level and applicability of taxes has varied over time. For housing, this variation in treatment also extends to the assessment rules, valuations, and tax band specifications. As a ballpark estimate, the impact of property taxes would lower the real estate returns by less than one percentage point per year relative to equity (see Appendix K for further detail). The various exemptions for homeowners make the impact of capital gains taxes on real estate returns even harder to quantify but also imply that differential tax treatment is unlikely to play an important role in explaining the return differentials between equities and housing. Since quantifying the time- and country-varying effect of taxes on returns with precision is beyond the scope of this study, we focus on pre-tax returns throughout the paper.

Further to this, Jordà, Schularick, and Taylor (2016a) show that advanced economies in the second half of the 20th century experienced a boom in mortgage lending and borrowing. It is important to note that this surge in household borrowing did not only reflect rising house prices, but also reflected substantially increased household debt levels relative to asset values. Hence, 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 return associated with the investment. And today, unlike in the early 20th century, houses can be levered much more than equities, in the U.S. and in most other countries. 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.

Finally, we follow the standard approach and focus on aggregate returns for a representative agent. At the disaggregated level, both individual housing returns and those of individual equities show a higher volatility than the aggregate indices. For example, we found that in the U.S., local (ZIP5) housing return volatility is about twice as large as aggregate volatility, which would about equalize risk-adjusted returns to equity and housing if investors owned one undiversified house. And it is much more difficult to invest in a diversified housing portfolio than a well-diversified equity portfolio. Such constraints on the set of investment opportunities might help to understand why investors have historically been willing to hold their wealth in equities as well as housing.

5.2. Decomposition of returns

What explains the superior risk-adjusted performance of housing relative to equities? To gain insights into this question, we separately analyze movements in capital gains and income yield as shown in Table 6. The table shows both arithmetic and geometric average world returns over the entire sample and since 1950. Capital gain measures the return from price appreciation only. Depending on the asset, other components of total returns measure income from either dividends or rents received by the investor. Both capital gain and dividend or rental income are expressed as a proportion of the previous period's price. The small residual 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 6: *Total nominal return components for equity and housing.*

		Full Sample		Post 1950	
		Arithmetic	Geometric	Arithmetic	Geometric
Housing	Capital gain	5.86 (11.21)	5.34	7.27 (9.78)	6.87
	Rental income	6.45 (2.80)	6.41	6.11 (2.60)	6.08
	Total return	12.31 (11.85)	11.75	13.38 (10.52)	12.94
	Capital gain share	48%	45%	54%	53%
Equity	Capital gain	6.79 (22.95)	4.53	9.27 (24.98)	6.56
	Dividend income	4.24 (1.86)	4.22	3.83 (1.88)	3.82
	Total return	11.03 (23.43)	8.75	13.08 (25.61)	10.32
	Capital gain share	62%	52%	71%	64%
	Observations	1670	1670	987	987

Note: Average annual nominal returns across 16 countries, unweighted. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries.

Table 6 shows that the main reason risk-adjusted housing returns are higher is the lower volatility of house prices. Both rental yields and dividend income are relatively stable for all years and countries throughout the sample. However, the standard deviation of equity prices is double that of housing prices over the full sample, and around 2.5 times that of housing prices after 1950.

Equity prices have experienced large swings and high-amplitude cycles throughout the course of modern history. Moreover, capital gains—the more volatile component—are responsible for a larger share of equity total returns than they are for housing. These two factors have become even more relevant during the post-WW2 decades.

A similar pattern is visible at the country level. The higher volatility of equity prices is a persistent feature of all countries and all periods in our sample. Table 7 illustrates this point. Capital gains account for a relatively larger share of equity returns, compared to housing returns, in 13 countries, and a similar share in 3 countries.

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 contrary, are more stable because swings in national 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.

6. 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 10 depicts the trends in global safe and risky asset returns, again using decadal moving averages of the GDP-weighted global return series. The risky return in each country is a weighted average of housing and equity returns, with the weights corresponding to the equity market capitalization and housing wealth in each respective country. The safe return is a simple unweighted average of bonds and bills.[10] The left panel of Figure 10 shows the risky and safe asset returns, and the right panel depicts the risk premium, calculated as the difference between the two series.

Both risky and safe rates were high during the 19th century but had been gradually declining in the lead to WW1, after which they declined sharply, as is to be expected. After the war, returns recovering during the 1920s. From 1930 onwards, the risky rate has stayed high and relatively stable, whereas the safe rate 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

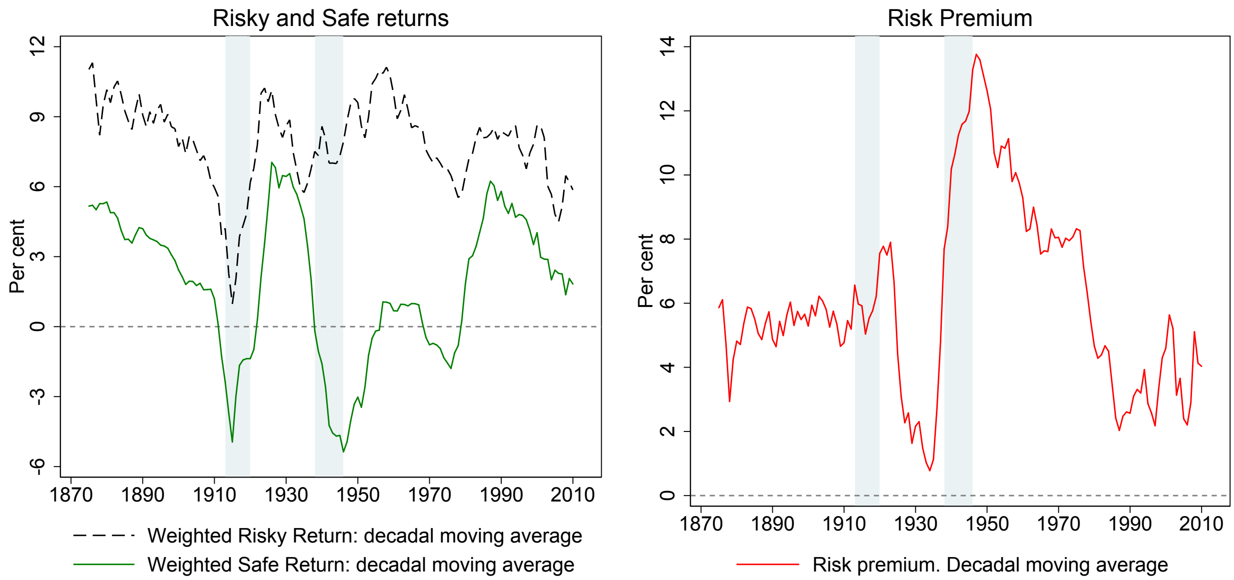
[10] For details on the construction of the weighted returns and the asset weights, see Section 2.3 and Appendix Section D. Appendix Section E further compares the portfolio-weighted returns to equally-weighted returns, i.e. a simple average of housing and equity.

Table 7: *Total nominal return components for equity and housing by country.*

	Housing				Equity				N
	Cap. Gain	Rental Inc.	Total Rtn	Cgain share	Cap. Gain	Div. Inc.	Total Rtn	Cgain share	
Australia	6.53	5.78	12.31	53.05%	7.09	4.92	12.01	59.04%	113
	(13.72)	(1.61)	(14.61)		(16.70)	(1.08)	(17.36)		
Belgium	5.95	8.79	14.74	40.34%	6.43	3.89	10.32	62.27%	126
	(9.89)	(2.16)	(9.87)		(23.19)	(1.61)	(23.81)		
Denmark	4.95	7.92	12.87	38.48%	6.15	4.85	11.01	55.91%	123
	(7.93)	(3.55)	(8.71)		(18.04)	(2.24)	(18.50)		
Finland	11.13	8.10	19.23	57.87%	11.86	5.12	16.97	69.87%	93
	(22.16)	(3.10)	(23.07)		(32.74)	(2.01)	(33.36)		
France	7.49	5.25	12.73	58.80%	4.86	3.74	8.60	56.54%	136
	(9.28)	(0.99)	(9.73)		(20.93)	(1.34)	(21.27)		
Germany	3.50	6.05	9.55	36.62%	4.33	3.88	8.45	51.31%	111
	(10.20)	(2.70)	(10.95)		(21.32)	(1.60)	(21.97)		
Italy	7.29	3.49	10.77	67.63%	9.28	3.61	12.89	71.99%	81
	(14.74)	(1.59)	(15.03)		(31.23)	(1.30)	(31.48)		
Japan	5.89	6.62	12.51	47.09%	6.82	2.68	9.88	69.05%	70
	(9.60)	(4.07)	(11.25)		(18.51)	(1.76)	(18.88)		
Netherlands	4.26	6.33	10.59	40.21%	5.44	4.90	10.34	52.59%	116
	(10.02)	(2.20)	(10.54)		(22.60)	(1.36)	(22.64)		
Norway	5.55	9.61	15.15	36.60%	6.63	4.46	11.10	59.78%	102
	(8.30)	(2.46)	(8.66)		(27.85)	(2.43)	(28.91)		
Portugal	9.49	5.91	15.40	61.62%	10.93	2.66	13.60	80.36%	65
	(10.05)	(2.62)	(11.47)		(34.96)	(1.27)	(35.18)		
Spain	6.80	4.11	10.91	62.36%	6.69	4.93	11.34	58.99%	111
	(12.47)	(1.59)	(12.72)		(20.22)	(2.85)	(21.03)		
Sweden	4.23	7.20	11.43	36.98%	6.95	4.12	11.07	62.81%	130
	(7.52)	(1.54)	(7.90)		(20.11)	(1.03)	(20.71)		
Switzerland	3.92	4.65	8.57	45.70%	4.99	3.61	8.23	60.61%	69
	(6.19)	(0.58)	(6.24)		(19.28)	(1.96)	(18.58)		
UK	5.55	3.92	9.46	58.60%	6.56	4.71	11.35	57.81%	99
	(10.12)	(0.89)	(10.29)		(21.99)	(1.39)	(22.86)		
USA	3.54	7.59	11.13	31.80%	6.70	4.38	11.08	60.45%	125
	(8.24)	(1.41)	(8.60)		(18.22)	(1.57)	(18.45)		

Note: Arithmetic average of annual nominal returns, full sample. Standard deviation in parentheses. Period coverage differs across countries. Consistent coverage within countries.

Figure 10: *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.

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 rate 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 rate has been falling again since the mid-1980s as many have noted. 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 rates, risky rates 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 in safe asset returns, even though the safe rate 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.

Next we examine the long-run developments in the risk premium, i.e. the spread between safe and risky returns (right panel of Figure 10). This spread was low and stable at around 5 percentage points before WW1. It rose slightly after the WW1, before falling to an all-time low of near zero

Table 8: *Real risky and safe asset returns across countries and time*

Country	Full Sample		1950–1980		Post 1980	
	Risky rate	Safe rate	Risky rate	Safe rate	Risky rate	Safe rate
Australia	7.34	1.84	8.26	-1.34	9.14	4.54
Belgium	10.28	1.62	11.24	0.64	9.81	4.27
Denmark	8.99	2.94	10.04	0.49	6.89	4.97
Finland	11.55	2.16	13.99	1.28	12.92	4.18
France	6.43	0.53	12.33	-1.15	6.30	4.58
Germany	7.88	3.34	7.00	1.77	5.18	3.09
Italy	5.23	2.28	6.98	-0.83	5.13	4.14
Japan	8.32	1.29	11.77	0.05	4.81	3.00
Netherlands	7.23	1.09	10.26	-0.89	7.44	3.11
Norway	10.56	0.96	11.13	-1.34	11.59	2.30
Portugal	8.50	1.50	9.36	-1.16	7.67	3.45
Spain	5.67	0.80	7.19	-3.09	5.42	2.74
Sweden	8.54	2.35	8.67	-1.12	11.12	4.06
Switzerland	6.24	1.39	5.45	0.25	7.66	1.13
UK	6.63	2.22	8.88	-0.70	7.73	4.69
USA	8.44	1.85	7.52	-0.44	8.31	3.71
Average, unweighted	8.04	1.89	9.49	-0.51	7.95	3.62
Average, weighted	7.93	1.89	8.70	-0.48	7.13	3.65

Note: Average annual real returns. Real risky return is a weighted average of equities 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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

by around 1930. The decades following the onset of the 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 a remarkably low frequency of 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 be relatively more frequent when risk premiums are low. This finding speaks to the recent literature on the mispricing of risk around financial crises. Among others, Krishnamurthy and Muir (2016) argue that when risk is underpriced, i.e. risk premiums are excessively low, severe financial crises become more likely. The long-run trends in risk premiums presented here seem to confirm this hypothesis.

Table 8 zooms into the evolution of safe and risky asset returns across different countries and time periods. To enable a comparison with the aggregate trends in Figure 10, we split the post–WW2 period into two subperiods: 1950–1980, when global risk premiums were high and global safe rates low, and post-1980, which saw an initial recovery, and subsequent decline in global safe rates.

The vast majority of the countries in our sample follow similar patterns. The risky rate is largely stable across time, even though it varies somewhat across countries: from around 5.5% in Italy and Spain to $11-12\%$ in Norway and Finland. Risk premiums were at or near their highest level in almost every country during the period 1950–1980, largely due to low returns on safe assets. The real safe rate of return was close zero or negative for the majority of the countries in the sample, with the lowest level of -3% observed in Spain, and only Finland and Germany experiencing robustly positive real returns. Meanwhile, risky rates 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 rates across the board, with the recent downward trend not yet apparent in these longer-run period averages. Risky rates, 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.

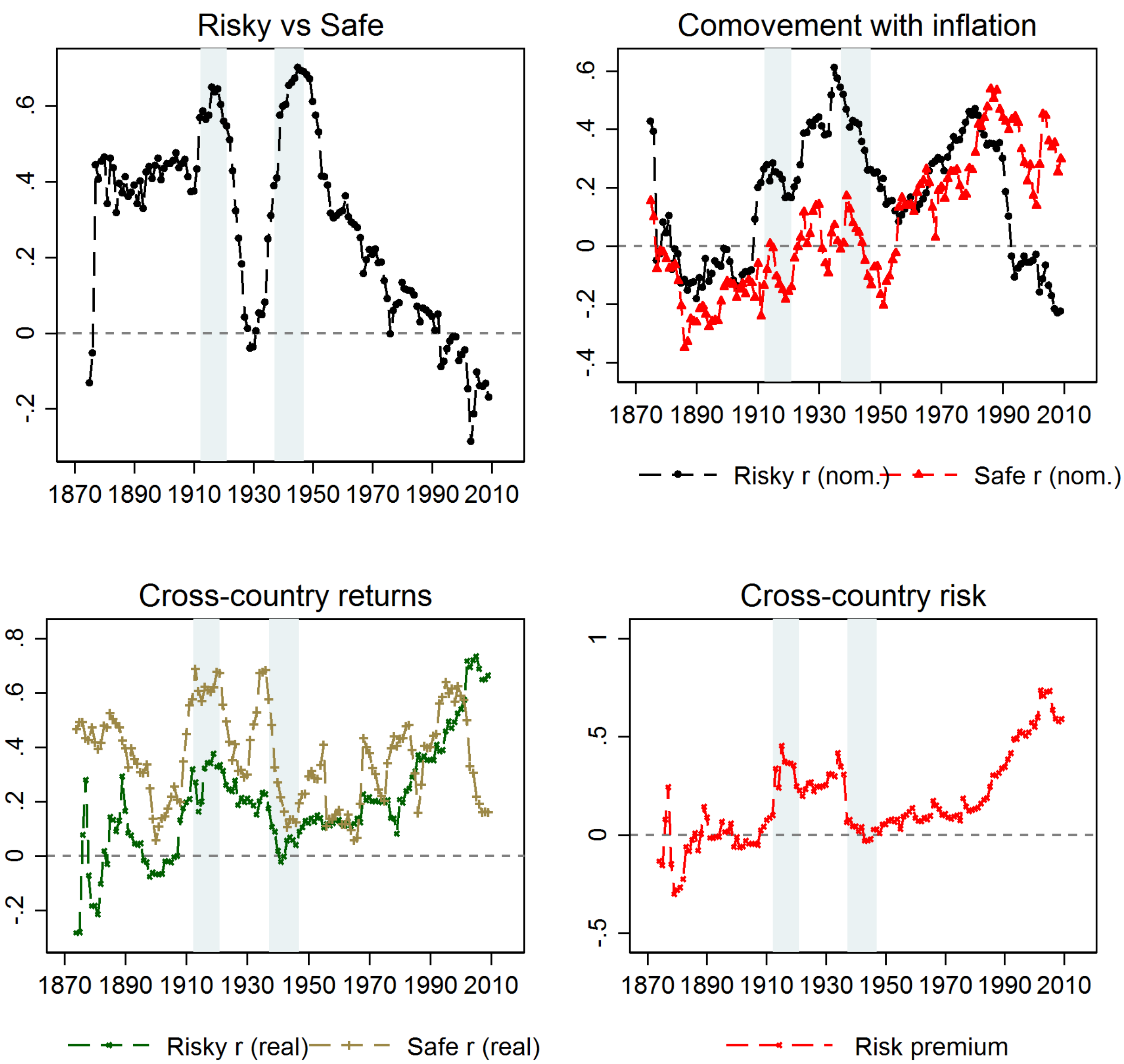
We now turn to examine the correlations between risky and safe returns, which are displayed in Figure 11. The top-left panel of this figure shows the rolling decadal correlation between the risky and safe returns, calculated as the average of rolling correlations in individual countries in a similar fashion to the calculations in Figure 6. 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 11 shows the comovement of risky and safe nominal returns with inflation. Mirroring the findings presented in the preceding Sections, safe rates 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 11, historically safe rates 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 11. 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, 2016b).

7. r versus g

Our data provide insights into the debate on inequality and wealth accummulation. Piketty and Zucman (2014) and Piketty (2014) argue that wealth-to-income ratios in advanced economies have followed a U-shaped pattern over the past century and a half. They further hypothesize that capital-to-income ratios may continue to rise in the future, along with a predicted decline in GDP growth g.

Figure 11: *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.

The main theoretical argument for why wealth will continue to rise relative to income comes about from a simple relation: $r > g$. Simply put, if the rate of return on capital r consistently exceeds GDP growth g, wealth accumulation outpaces income growth and the equilibrium wealth-to-income ratio will increase as a result.

To examine these propositions against our data, we construct a measure of the world's return on capital as a weighted average of returns on bonds, equities and housing. Similarly to the risky returns in Section 6, we weigh 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).[11] Figure 12 displays the long-run trends in the global return on capital and the global GDP growth rate since the late 19th century, again using decadal averages of GDP-weighted data.

Our data show that the trend long-run rate of return on capital has consistently been higher than the GDP growth rate. Over the past 150 years, the return on capital has substantially exceeded GDP growth in 13 decades, and has only been below GDP growth in the two decades corresponding to two World Wars. The gap between r and g has been persistently large. Since 1870, the weighted average return on capital (r) has been about 6.5%, compared to a weighted average real GDP growth rate (g) of 3.1%, with the average $r - g$ gap of 3.4 percentage points – about the same magnitude as the real GDP growth rate itself. The peacetime gap between r and g has been around 4 percentage points.

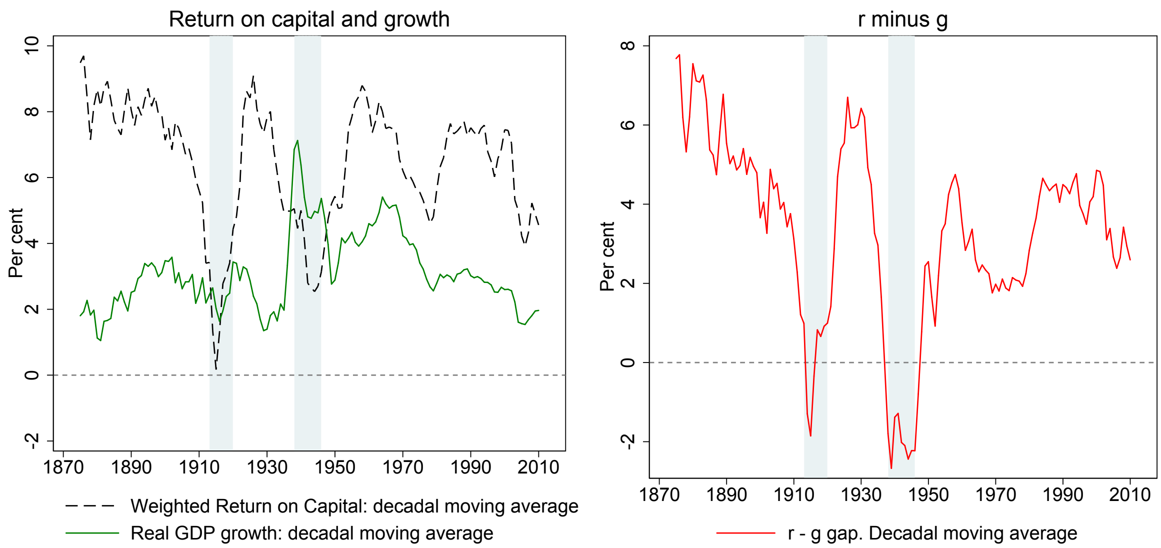
Returns were high before WW1, collapsed during the war and picked up again during the interwar years. Over the following decades, return on capital fell somewhat during the crisis times of WW2, the macroeconomic instability of 1970s, and the Global Financial Crisis. By contrast, real GDP growth rates have remained relatively stable throughout the 20th century, with modest falls during war time, and a reasonably prolonged elevated level during the post-WW2 reconstruction decades. Consequently, the initial difference between r and g of about 5–6 percentage points disappeared around WW1, and after reappearing briefly in the late 1920s, remained modest until the 1980s. After 1980, returns picked up again while growth slowed, and the gap between r and g widened, only to be moderated somewhat by the Global Financial crisis. The recent decades of the widening gap between r and g have also seen increases in inequality and wealth-to-income ratios (Piketty, 2014; Piketty and Zucman, 2014).

Table 9 shows how the rate of return on capital 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 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 12.

One feature of the data that stands out is that there is no clear and stable relationship between $r - g$ and g, however. This is a crucial moment relating to elasticity of substitution in the debate between Piketty (2014) and Rognlie (2015). The level of $r - g$ was very high during the late 19th century, which was historically a slower growth era in our sample. In the postwar period of fast growth $r - g$ took on a lower average value and remained fairly flat. Over these eras advanced economy growth trends g were subject to a long rise and fall. We find that at an annual frequency correlation of $r - g$ and g is -0.4 in the pre-WW2 and the 1946–1970 peacetime years, but the correlation has fallen to zero in the post-1970 era.

[11] For details on the construction of the weighted returns and the asset weights, see Section 2.3 and Appendix Section D. Appendix Section E further compares the portfolio-weighted returns to equally-weighted returns, with the equally-weighted return on capital a simple average of equity, housing and bonds.

Figure 12: *Real return on capital 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 capital 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.

Table 9: *Return on capital and GDP growth across countries and time*

Country	Full Sample		Post 1950		Post 1980	
	Return on Capital	GDP Growth	Return on Capital	GDP Growth	Return on Capital	GDP Growth
Australia	6.49	3.55	7.83	3.81	8.77	3.41
Belgium	7.80	2.48	8.15	2.89	7.41	2.12
Denmark	8.05	2.70	7.70	2.59	6.33	1.76
Finland	11.90	3.73	11.80	3.29	11.33	2.40
France	4.63	2.55	7.51	3.17	5.67	1.91
Germany	6.92	2.84	5.18	2.86	4.57	2.49
Italy	4.71	3.81	4.73	3.29	4.49	1.35
Japan	6.45	4.15	6.43	4.17	3.85	2.04
Netherlands	5.29	3.16	6.76	3.20	6.50	2.28
Norway	8.75	3.33	9.30	3.45	9.90	2.79
Portugal	7.59	3.42	7.29	3.51	6.69	2.12
Spain	4.84	3.30	5.33	4.03	5.08	2.55
Sweden	7.49	2.88	8.62	2.86	9.46	2.35
Switzerland	5.33	2.33	5.61	2.68	6.83	1.94
UK	5.25	2.03	6.59	2.51	6.99	2.45
USA	7.15	3.38	6.75	3.32	7.10	2.80
Average, unweighted	6.76	2.90	7.28	3.26	6.93	2.30
Average, weighted	6.49	3.08	6.58	3.36	6.16	2.48

Note: Average annual real returns. Real return on capital 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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

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, 2016a; Knoll, Schularick, and Steger, 2016). This much is evident from Table 7.

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 of housing have remained pretty stable, as we have discussed. Equities display a similar pattern, with post-WW2 increases in total returns coming from capital gains relative to dividends, but with total returns remaining pretty stable. Much of the recent divergence between r and g seems to be coming from a prolonged period of low productivity that started before the Global Financial Crisis (Fernald, Hall, Stock, and Watson, 2017).

8. Conclusion

This paper, perhaps for the first time, investigates the long history of asset returns for all the major categories of an economy's investable wealth portfolio. Our investigation has confirmed many of the broad patterns that have occupied much research in economics and finance. The returns to risky assets, and risk premiums, have been high and stable over the past 150 years, and 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 figure prominently in the current debate on inequality. A 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.

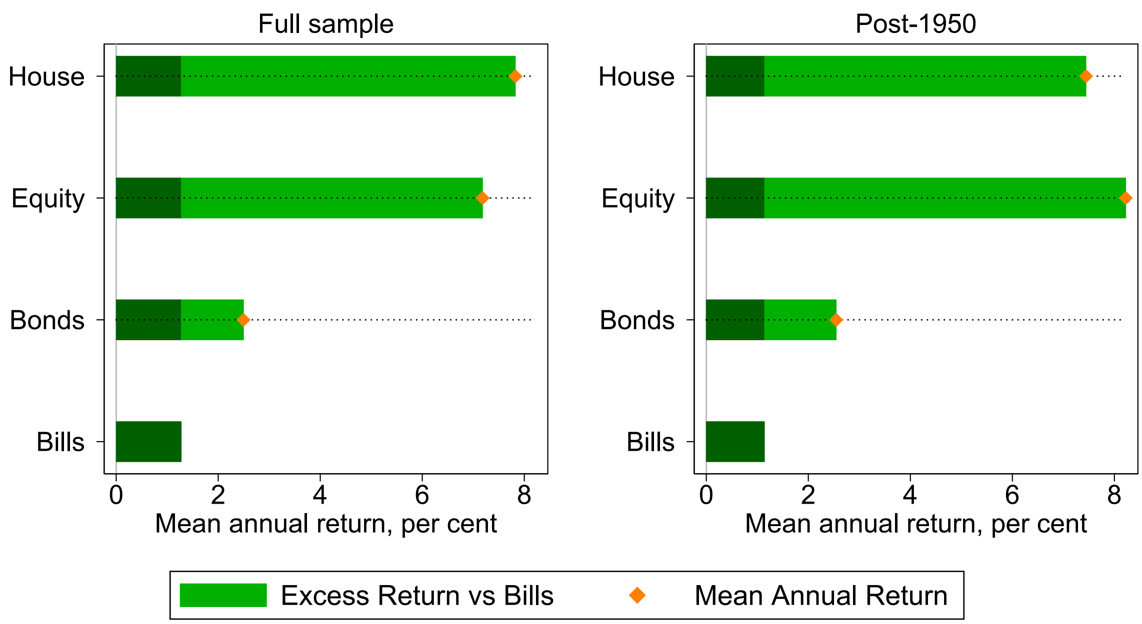
These and other discoveries set out a rich agenda for future research, by us and by others. Many issues remain to be explored, among them determining the particular fundamentals that drive the returns on each of the asset classes in typical economies. For now, we hope our introduction of this new universe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

Appendix

Aggregate rates of return: Robustness checks

A. The effect of GDP weighting

Figure A.1: *GDP-weighted returns*



Notes: Arithmetic avg. real returns p.a., weighted by real GDP. Consistent coverage within each country.

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. For comparison, Table A.2 shows returns for a sample that is consistent within each country, across all four asset classes. Comparison of the two tables shows that 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	Equities	Housing
Australia	2.02	2.17	8.41	7.00
Belgium	1.62	3.01	5.89	11.12
Denmark	2.98	3.59	7.22	9.05
Finland	0.64	3.22	9.37	10.42
France	-0.47	0.83	2.88	6.38
Germany	1.49	3.12	8.62	7.85
Italy	1.20	2.11	6.13	4.77
Japan	0.63	2.54	9.25	8.36
Netherlands	1.37	2.35	7.09	7.22
Norway	1.10	2.28	6.89	11.19
Portugal	-0.01	3.25	5.23	7.98
Spain	0.85	0.50	5.69	4.82
Sweden	1.77	3.32	7.96	8.30
Switzerland	1.64	1.93	6.62	5.63
UK	1.16	2.29	7.10	5.61
USA	2.17	2.79	8.34	8.18
Average, unweighted	1.17	2.54	7.08	8.03
Average, weighted	1.32	2.43	7.34	7.72

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.

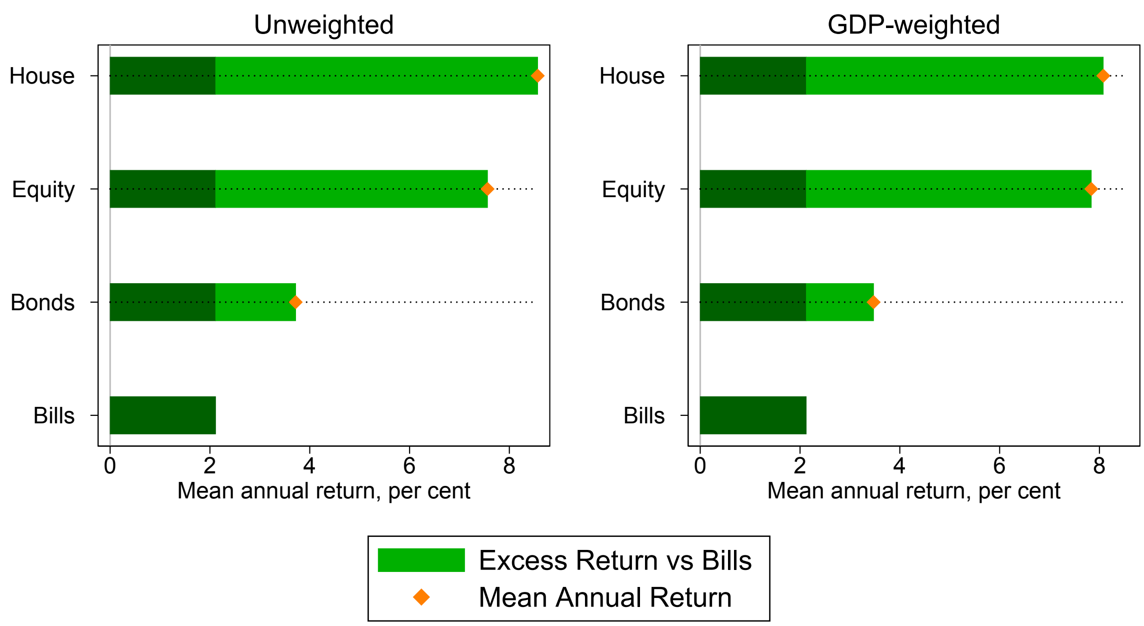
Table A.2: *Returns using the full within-country-consistent sample*

Country	Bills	Bonds	Equities	Housing
Australia	1.36	2.31	7.64	7.16
Belgium	0.66	2.57	6.25	11.12
Denmark	2.64	3.24	7.20	9.16
Finland	0.08	4.25	9.98	10.42
France	-0.47	1.54	3.64	7.14
Germany	2.65	4.03	6.85	7.85
Italy	1.37	3.19	7.32	4.77
Japan	0.39	2.18	6.09	8.36
Netherlands	0.78	1.40	7.09	7.28
Norway	0.14	1.79	6.89	10.81
Portugal	0.01	3.00	7.11	8.54
Spain	0.46	1.13	6.45	5.41
Sweden	1.56	3.15	7.98	8.30
Switzerland	0.81	1.97	6.63	5.77
UK	1.62	2.81	7.46	5.61
USA	1.45	2.26	8.39	8.18
Average, unweighted	1.17	2.61	6.77	8.08
Average, weighted	1.28	2.50	7.18	7.83

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 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.

Table A.3: *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	1.16	3.01	1.77	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	3.11
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	2.35	2.22	3.30
Norway	1.10	2.28	1.91	3.09
Portugal	0.12	2.75	1.11	3.90
Spain	0.32	1.00	1.17	1.81
Sweden	1.81	3.32	2.66	4.50
Switzerland	0.80	1.93	1.67	2.87
UK	1.16	2.29	2.03	3.22
USA	2.17	2.79	2.93	3.54
Average, unweighted	1.14	2.53	2.19	3.74
Average, weighted	1.31	2.46	2.25	3.46

Note: Average annual real returns. Returns excluding wars omit periods 1914 - 1919 and 1939 - 1947. 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.

Table A.4: *Real returns on equity and housing, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Equity	Housing	Equity	Housing
Australia	7.70	7.00	8.38	7.52
Belgium	6.25	11.12	6.82	11.24
Denmark	7.22	9.07	7.71	8.61
Finland	9.98	10.42	11.66	12.04
France	2.88	6.38	4.39	7.75
Germany	6.85	7.85	7.01	8.16
Italy	7.32	4.77	6.67	4.51
Japan	6.09	8.36	6.85	8.22
Netherlands	7.09	7.28	7.53	7.22
Norway	6.89	10.81	7.46	11.95
Portugal	7.11	8.54	7.11	8.54
Spain	5.77	5.07	6.64	5.98
Sweden	7.98	8.30	9.48	8.97
Switzerland	6.63	5.77	7.94	6.44
UK	7.46	5.61	8.20	6.02
USA	8.39	8.18	9.20	8.31
Average, unweighted	6.72	8.00	7.54	8.55
Average, weighted	7.11	7.76	7.82	8.06

Note: Average annual real returns. Returns excluding wars omit periods 1914 - 1919 and 1939 - 1947. 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.

Table A.5: *Real risky and safe asset returns, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Risky rate	Safe rate	Risky rate	Safe rate
Australia	7.34	1.84	7.77	2.28
Belgium	10.28	1.62	10.58	2.31
Denmark	8.99	2.94	8.62	3.78
Finland	11.55	2.16	13.27	3.55
France	6.43	0.53	7.28	2.00
Germany	7.88	3.34	8.16	3.36
Italy	5.23	2.28	4.91	2.94
Japan	8.32	1.29	8.27	2.08
Netherlands	7.23	1.09	7.31	2.13
Norway	10.56	0.96	11.65	2.05
Portugal	8.50	1.50	8.50	1.50
Spain	5.67	0.80	6.20	1.51
Sweden	8.54	2.35	9.46	3.41
Switzerland	6.24	1.39	7.07	2.21
UK	6.63	2.22	7.15	3.06
USA	8.44	1.85	8.76	2.65
Average, unweighted	8.04	1.89	8.62	2.92
Average, weighted	7.93	1.89	8.30	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 equities 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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

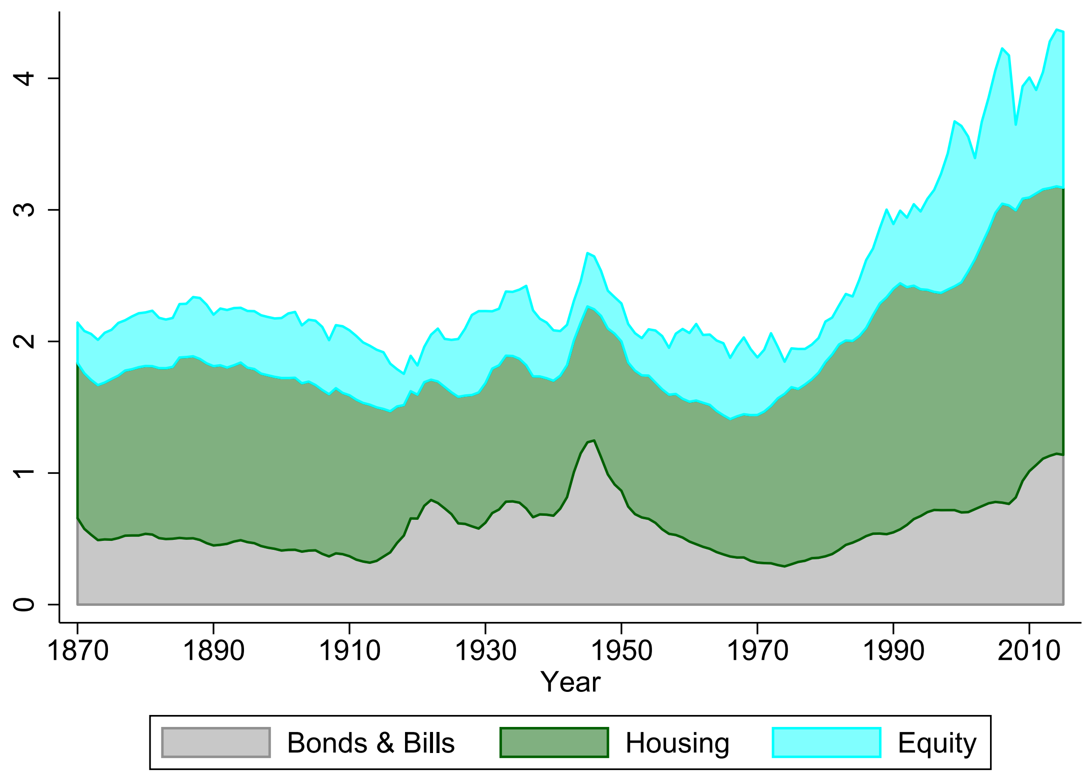
Table A.6: *Return on capital and GDP growth, including and excluding world wars*

Country	Full Sample		Excluding wars	
	Return on Capital	GDP Growth	Return on Capital	GDP Growth
Australia	6.49	3.55	7.01	3.69
Belgium	7.80	2.48	8.19	2.66
Denmark	8.05	2.70	7.84	2.84
Finland	11.90	3.73	11.90	3.73
France	4.63	2.55	5.73	2.75
Germany	6.92	2.84	7.15	3.00
Italy	4.71	3.81	4.56	3.22
Japan	6.45	4.15	6.96	4.28
Netherlands	5.29	3.16	5.81	3.16
Norway	8.75	3.33	9.77	3.47
Portugal	7.59	3.42	7.59	3.42
Spain	4.84	3.30	5.50	3.44
Sweden	7.49	2.88	8.44	2.96
Switzerland	5.33	2.33	6.22	2.54
UK	5.25	2.03	5.90	2.14
USA	7.15	3.38	7.72	3.18
Average, unweighted	6.76	2.90	7.43	2.97
Average, weighted	6.49	3.08	7.10	2.99

Note: Average annual real returns. Returns excluding wars omit periods 1914 - 1919 and 1939 - 1947. Real return on capital 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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

D. The global asset portfolio

Figure A.4: *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.

This section briefly presents the asset portfolio data used to calculate the weighted risky and safe asset returns, and the overall rate of return on capital. As outlined in Section 2.3, we weigh the individual asset returns within each country according to the shares of the respective assets in the country's wealth portfolio, to arrive at these composite return measures.

We measure equity wealth as the stock market capitalization of the specific country. These newly collected data strive to measure 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, e.g. the national wealth estimates for Sweden constructed by Waldenstrom (2017). 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, 2016b) the as a proxy for the stock of bonds and bills, and divide public debt equally between these two financial instruments.

The broad patterns in the asset holdings show that housing has been the dominant asset in the countries' portfolios throughout the sample. Public debt, and returns on bonds and bills, have 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.

E. Equally-weighted portfolio returns

Table A.7 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 stylised 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.

Table A.7: *Equally-weighted portfolio returns*

Country	Portfolio weights		Equal weights	
	Risky rate	Return on capital	Risky rate	Return on capital
Australia	7.34	6.49	7.40	5.69
Belgium	10.28	7.80	8.68	6.44
Denmark	8.99	8.05	8.18	6.34
Finland	11.55	11.90	10.20	9.19
France	6.43	4.63	5.39	3.84
Germany	7.88	6.92	7.35	6.13
Italy	5.23	4.71	6.04	4.90
Japan	8.32	6.45	7.23	5.28
Netherlands	7.23	5.29	7.18	5.41
Norway	10.56	8.75	8.85	6.49
Portugal	8.50	7.59	7.83	5.74
Spain	5.67	4.84	5.93	4.33
Sweden	8.54	7.49	8.14	6.21
Switzerland	6.24	5.33	6.20	4.71
UK	6.63	5.25	6.54	5.17
USA	8.44	7.15	8.29	6.20
Average, unweighted	8.04	6.76	7.43	5.69
Average, weighted	7.93	6.49	7.50	5.69

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 capital 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 capital is an unweighted average of housing, equity and bonds. 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.

F. US Dollar returns

Table A.8: *Global real returns for a US investor*

	Real returns				Nominal Returns			
	Bills	Bonds	Equities	Houses	Bills	Bonds	Equities	Houses
Full sample:								
Mean return p.a.	1.89	3.44	7.95	8.94	4.49	6.02	10.68	11.81
Std.dev.	12.18	15.32	25.45	15.83	11.79	14.68	25.80	16.22
Geometric mean	1.09	2.28	5.00	7.74	3.75	4.97	7.77	10.58
Mean excess return p.a.	0.25	1.80	6.31	7.30				
Std.dev.	11.37	14.45	25.11	15.82				
Geometric mean	-0.45	0.77	3.42	6.10	.			
Observations	1705	1705	1705	1705	1705	1705	1705	1705
Post-1950:								
Mean return p.a.	2.16	3.92	9.42	9.62	5.79	7.57	13.21	13.52
Std.dev.	10.54	13.38	26.32	14.48	10.95	13.56	26.97	15.04
Geometric mean	1.63	3.10	6.36	8.67	5.24	6.76	10.14	12.53
Mean excess return p.a.	0.83	2.59	8.09	8.29				
Std.dev.	10.55	13.42	26.12	14.61				
Geometric mean	0.28	1.74	5.04	7.30	.			
Observations	1023	1023	1023	1023	1023	1023	1023	1023

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.

Table A.9: *USD returns by country*

Country	Bills	Bonds	Equities	Housing
Australia	1.68	2.48	8.26	7.62
Belgium	1.02	3.11	6.93	11.61
Denmark	3.41	4.00	7.87	9.93
Finland	1.83	6.39	11.93	12.77
France	0.99	3.04	4.77	8.81
Germany	4.25	5.74	8.41	9.64
Italy	2.74	4.70	8.64	6.26
Japan	2.25	4.03	7.84	10.45
Netherlands	1.79	2.43	7.94	8.60
Norway	0.91	2.59	8.22	11.75
Portugal	0.67	3.68	8.54	9.28
Spain	0.92	1.58	6.91	6.13
Sweden	2.02	3.58	8.56	8.81
Switzerland	1.97	3.16	7.49	7.06
UK	2.24	3.42	8.15	6.40
USA	1.45	2.26	8.39	8.18
Average, unweighted	1.99	3.48	7.67	9.07
Average, weighted	1.98	3.23	7.89	8.64

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.

G. Risky returns ranked by country

Table A.10: *Risky returns ranked by country*

Country	Full sample	Post-1950	Post-1980
Finland	11.55	13.29	12.92
Norway	10.56	11.37	11.59
Belgium	10.28	10.58	9.81
Denmark	8.93	8.59	6.89
Sweden	8.54	10.07	11.12
Portugal	8.50	8.19	7.67
USA	8.44	8.12	8.31
Japan	8.32	7.38	4.81
Average, unweighted	8.04	8.62	7.95
Germany	7.88	5.81	5.18
Australia	7.34	8.58	9.14
Netherlands	7.23	8.78	7.44
UK	6.63	8.16	7.73
France	6.43	8.93	6.30
Switzerland	6.24	6.70	7.66
Spain	5.67	6.10	5.42
Italy	5.23	5.73	5.13

Note: Average annual real risky returns. Real risky return is a weighted average of equities and housing. 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. The figure is the unweighted arithmetic average of individual country returns.

H. Returns before the Global Financial Crisis

Table A.11: *Asset returns before the Global Financial Crisis*

Country	Bills	Bonds	Equities	Housing
Australia	1.30	1.95	8.16	7.10
Belgium	1.32	2.86	6.10	11.58
Denmark	3.31	3.56	6.81	9.71
Finland	0.76	3.10	10.64	10.88
France	-0.46	1.17	3.12	6.69
Germany	1.64	3.13	6.94	7.83
Italy	1.30	2.24	8.26	5.32
Japan	0.74	2.51	6.20	8.94
Netherlands	1.48	2.43	7.11	7.77
Norway	1.14	2.39	7.19	11.20
Portugal	0.14	2.19	8.90	9.78
Spain	0.39	0.87	6.19	5.77
Sweden	1.92	3.15	7.87	8.32
Switzerland	0.89	1.99	6.72	5.55
UK	1.32	2.16	7.83	5.98
USA	2.36	2.65	8.47	8.39
Average, unweighted	1.23	2.41	6.87	8.27
Average, weighted	1.43	2.32	7.23	7.98

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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Table A.12: *Risky and safe returns, including and exluding the GFC*

Country	Full Sample		Excluding the GFC	
	Risky rate	Safe rate	Risky rate	Safe rate
Australia	7.34	1.84	7.53	1.70
Belgium	10.28	1.62	10.58	1.59
Denmark	8.99	2.94	9.29	3.04
Finland	11.55	2.16	12.19	2.19
France	6.43	0.53	6.76	0.36
Germany	7.88	3.34	7.88	3.49
Italy	5.23	2.28	5.83	2.18
Japan	8.32	1.29	8.74	1.28
Netherlands	7.23	1.09	7.58	1.15
Norway	10.56	0.96	10.95	1.01
Portugal	8.50	1.50	9.77	0.91
Spain	5.67	0.80	6.38	0.78
Sweden	8.54	2.35	8.49	2.30
Switzerland	6.24	1.39	6.16	1.48
UK	6.63	2.22	7.01	2.29
USA	8.44	1.85	8.58	1.84
Average, unweighted	8.04	1.89	8.27	1.88
Average, weighted	7.93	1.89	8.10	1.88

Note: Average annual real returns excluding the Global Financial Crisis (i.e. sample ends in 2007). Real risky return is a weighted average of equities 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. The Average, unweighted and Average, weighted figures are respectively the unweighted and real-GDP-weighted arithmetic averages of individual country returns.

Data appendix

I. Data overview

Table A.13: *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	1885–1977	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	1900–2015	Long maturity, central gov't
	1965–2015	Money market rate		
Norway	1870–2015	Deposit rate	1870–2015	Long maturity, central gov't
Portugal	1880–1914	Money market rate	1870–1974	Long maturity, central gov't
	1915–1946	Central bank discount rate	1976–2015	Approx. 10y, central gov't
	1947–1977	Deposit rate		
	1978–2015	Money market rate		
Spain	1883–1914	Money market rate	1900–1913	Long maturity, central gov't
	1922–1974	Deposit rate	1914–1971	Perpetual
	1975–2015	Money market rate	1972–2015	Long maturity, central gov't
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	1900–1912	Perpetual
	1969–2015	Money market rate	1913–2015	Long maturity, central gov't
United Kingdom	1870–2015	Money market rate	1870–1901	Perpetual
			1902–1979	Long maturity, central gov't
			1980–2015	Approx. 10y, 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

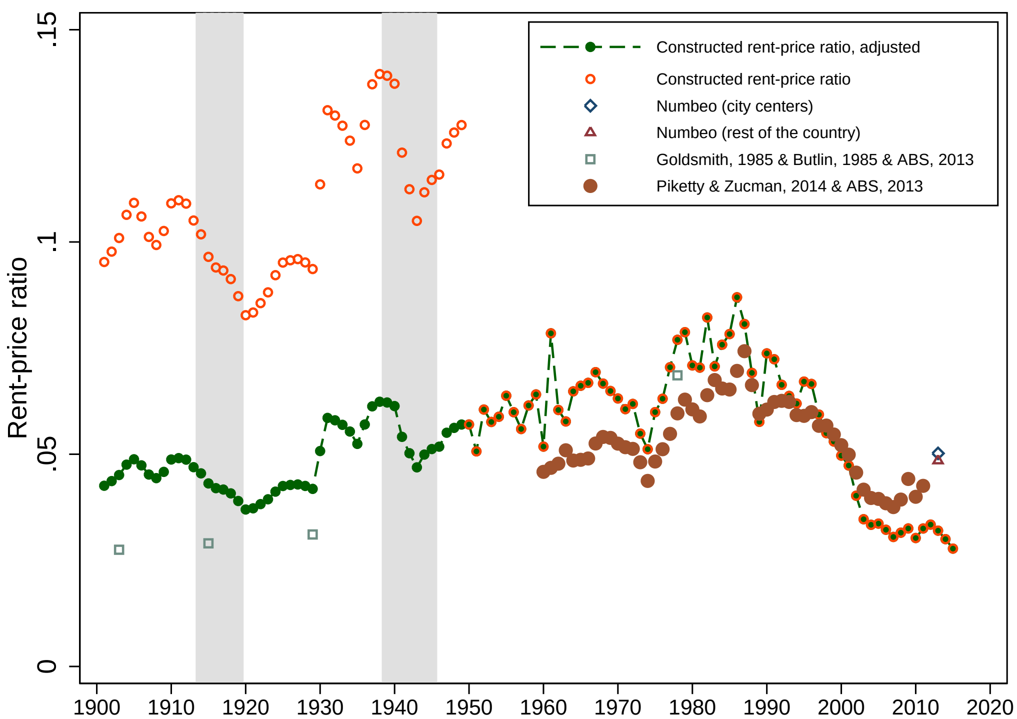
Table A.14: *Overview of equity and housing data*

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	1893–1914	Broad	Book cap	1876–1964	Mixed
	1915–1999	Broad	Market cap	1965–2015	Nationwide
	2000–2015	Blue chip	Market cap	1965–2015	Nationwide
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	1870–1913	All share	Market cap	1871–1912	Mixed
	1914–1959	Blue chip	Market cap	1913–1938	Urban
	1960–2015	Broad	Market cap	1939–1947	Mixed
				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
	1976–2004	All share	Mix of equal and market cap	1947–2015	Mixed
	2005–2015	Broad	Market cap		
Netherlands	1900–2015	Broad	Mostly market cap	1871–1969	Mixed
Norway	1914–1954	All share	Equally weighted	1871–2015	Urban
	1955–1974	All share	Company turnover		
	1975–2015	Blue chip	Market cap		
Portugal	1871–1987	All share	Market cap	1948–2015	Mixed
	1988–2015	Blue chip	Market cap		
Spain	1900–1969	All share	Market cap	1901–1957	Mixed
	1970–1987	Blue chip	Market cap	1958–2015	Nationwide
	1988–2015	All share	Market cap		
Sweden	1871–2015	Broad	Market cap	1883-1959	Urban
				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	1900–1913	Mixed
	1929–1963	Blue chip	Market cap	1914–1929	Urban
	1964–2015	All share	Market cap	1930–1946	Mixed
				1947–2015	Nationwide
United States	1872–2015	Broad	Market cap	1891–1952	Urban
				1953–2015	Mixed

J. Housing returns

Australia

Figure A.5: *Australia: plausibility of rent-price ratio*

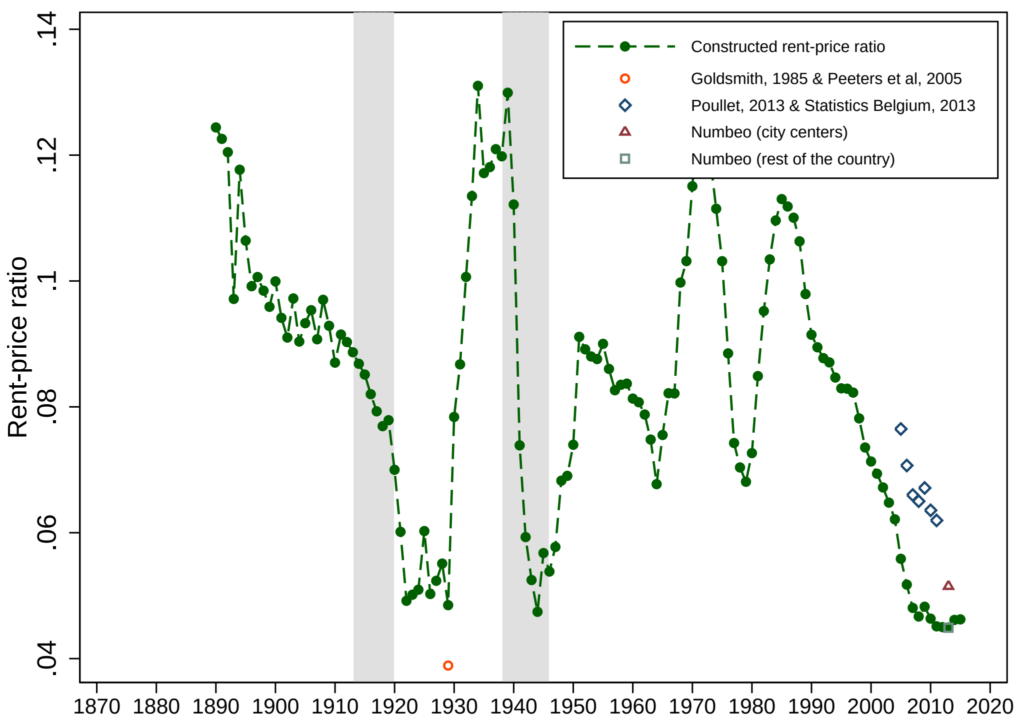


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Australian residential real estate of 0.032. Figure A.5 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain several scattered independent estimates of rent-price ratios in Australia. First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure A.5). Second, we construct rent-price ratios for benchmark years (1903, 1915, 1929, 1978) combining data on total housing value presented by Goldsmith (1985) and total expenditure on rents (Australian Bureau of Statistics, 2014; Butlin, 1985) as well as for 1959–2011 based on housing wealth data from Piketty and Zucman (2014) and total expenditure on rents (Australian Bureau of Statistics, 2014). For the post-WW2 period, these scattered estimates are consistent with the long-run rent-price ratio (see Figure A.5). Yet, for the pre-WW2 period, they are significantly lower. 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 appears unlikely that it also resulted in single sudden shift in the relationship between house prices and rents. The structural break in the long-run rent-price ratio may thus be interpreted as an artifact of the historical data. We therefore adjust the growth rate in rents between 1949 and 1950 to mirror the growth rate in the house price index. Figure A.5 shows that the adjusted long-run rent price ratio generally concords with the independent estimates of rent-price ratios for the pre-WW2 period.

Belgium

Figure A.6: *Belgium: plausibility of rent-price ratio*

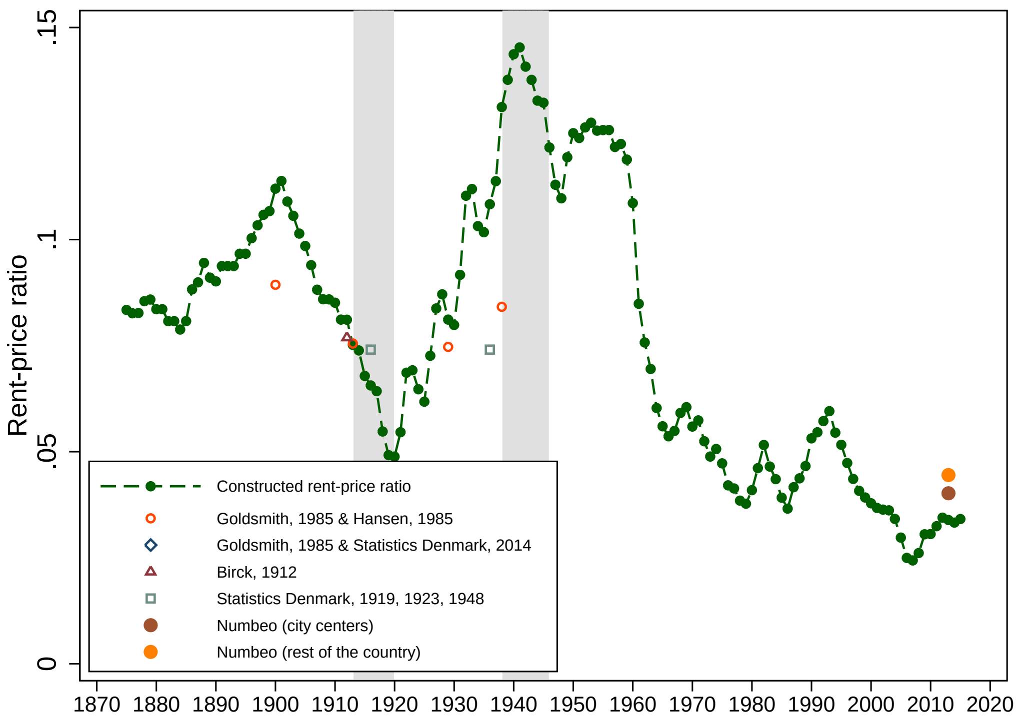


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Belgian residential real estate of 0.045. Figure A.6 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain three independent estimates of rent-price ratios. First, for 1929, we calculate a rent-price ratio of 0.025 based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Peeters et al., 2005). Second, for 2005–2011, we calculate a rent-price ratio based on data on total housing value (Poullet, 2013) and total expenditure on rents (Statistics Belgium, 2013). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. Reassuringly, all estimates appear, by and large, consistent with the long-run rent-price ratio (see Figure A.6).

Denmark

Figure A.7: *Denmark: plausibility of rent-price ratio*

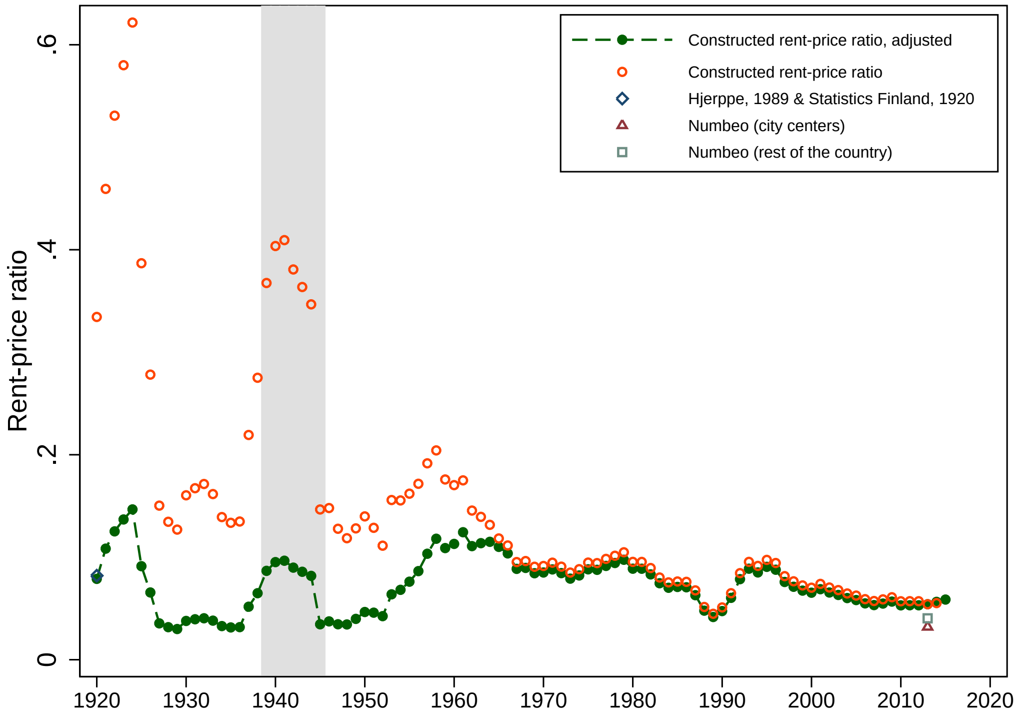


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for Danish residential real estate of 0.034. Figure A.7 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain several additional estimates of rent-price ratios in Denmark throughout the past century and a half. Overall, the long-run rent-price ratio in line with these scattered data from various accounts. 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 rent-price ratio of about 0.06–0.07. For 1920, Statistics Denmark (1923) states that housing values in urban areas were about 25 times the annual rental income implying a rent-price ratio of roughly 0.04. In 1936, rent-price ratios in urban areas had returned to pre-World War 1 levels (Statistics Denmark, 1948). Third, we calculate a rent-price ratio for benchmark years (1900, 1913, 1929, 1938) using data on total housing value (Goldsmith, 1985) and total expenditure on rents (Statistics Denmark, 2014). Reassuringly, all of these estimates appear consistent with the long-run rent-price ratio (see Figure A.7). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure A.7).

Finland

Figure A.8: *Finland: plausibility of rent-price ratio*

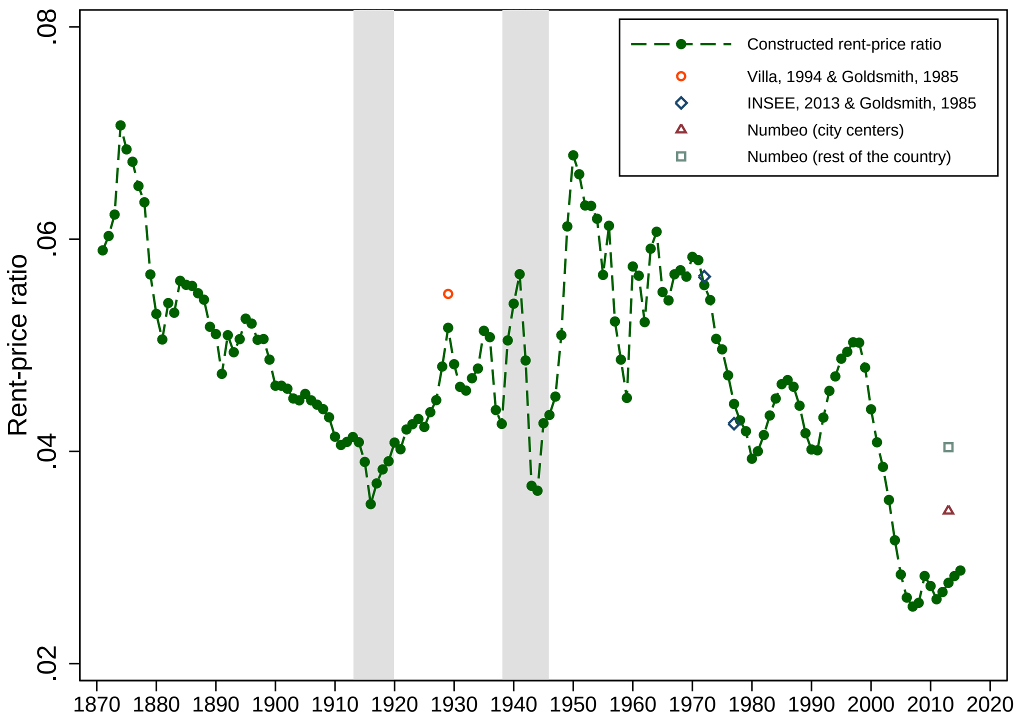


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for Finnish residential real estate of 0.054. Figure A.7 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain two independent estimates of rent-price ratios in Finland since 1920. First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are similar to the data reported by MSCI (2016) (see Figure A.8). Second, we calculate a rent-price ratio for 1920 based on data on total housing value (Statistics Finland, 1920) and total expenditure on rents (Hjerppe, 1989). Figure A.8 shows that this estimate is significantly below the long-run rent price ratio in 1920. Yet it also suggests that rent-price ratios were generally higher before 1960, decreased during the first half of the 1960s and remain within a relatively tight range thereafter. Similar to the case of Australia, this trajectory 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 growth rate in rents between WW2 and 1961 by a constant factor calibrated so the adjusted long-run rent-price ratio concords with the independent estimate in 1920—factor of 1.07. Figure A.8 displays the resulting adjusted long-run rent-price ratio.

France

Figure A.9: *France: plausibility of rent-price ratio*



To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for French residential real estate of 0.028. Figure A.9 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

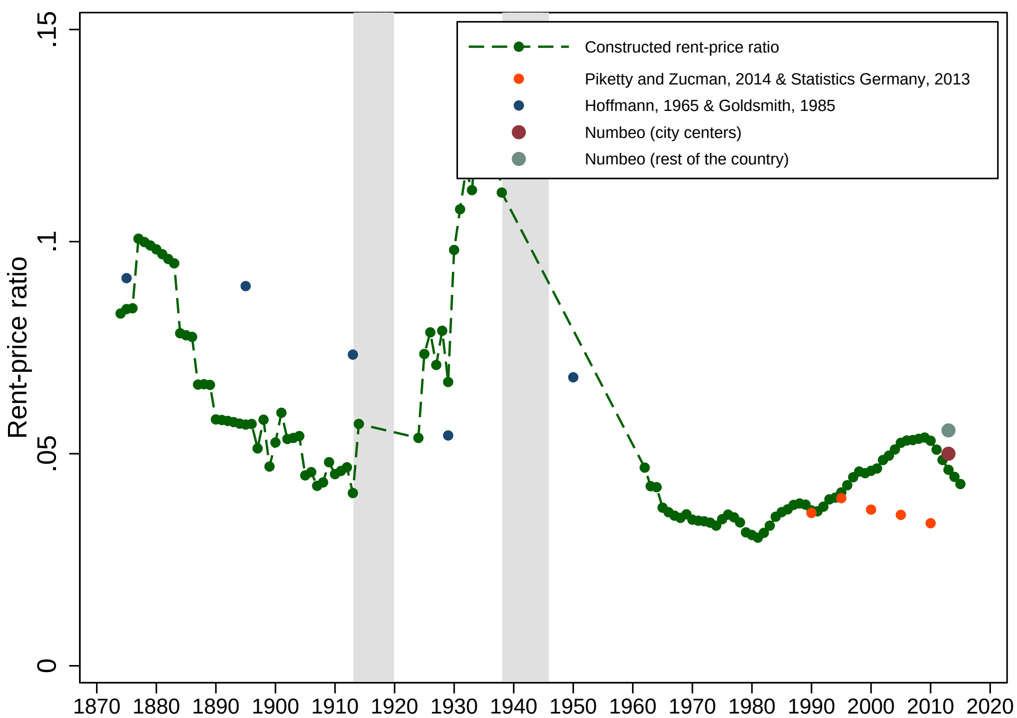
We obtain several scattered independent estimates of rent-price ratios in France since 1870. First, we calculate rent-price ratios for benchmark years (1929, 1960, 1972, 1977) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Statistics France, 2013; Villa, 1994). Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. All of these estimates are, by and large, consistent with the long-run rent-price ratio (see Figure A.9).

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. Friggit (2002) states that the gross rent of residential properties purchased by the real estate agency *La Fourmi Immobiliere* amounted to about 6 to 7 percent of the properties' value between 1899 and 1913. These estimates are generally comparable with an average annual real rental yield of about 5 percent for 1914–1938 calculated by merging the indices of house prices and rents and relying on the benchmark rent-price ratio in 2013.

Germany

Figure A.10: *Germany: plausibility of rent-price ratio*



To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for German residential real estate of 0.047. Figure A.10 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

To corroborate the plausibility of the long-run rent-price ratio, we obtain four independent estimates. First, we calculate rent-price ratios for benchmark years based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Hoffmann, 1965). Figure A.10 shows that the resulting estimates confirm a downward trend of the rent-price ratio prior to WW2. Yet, they tend to be somewhat higher compared to the long-run rent-price ratio. Second, 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. This estimate is about 1 percentage point lower compared to average annual real returns of a little less than 9 percent calculated by merging the house price and rent indices. As third plausibility check, for 1992–2011, we calculate rent price ratios for benchmark years combining data on total housing value (Piketty and Zucman, 2014) and total expenditure on rents (Statistics Germany, 2013). Again, the resulting estimates appear to be broadly consistent with the long-run rent-price ratio (Figure A.10). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are similar to the data reported by MSCI (2016) (Figure A.10).

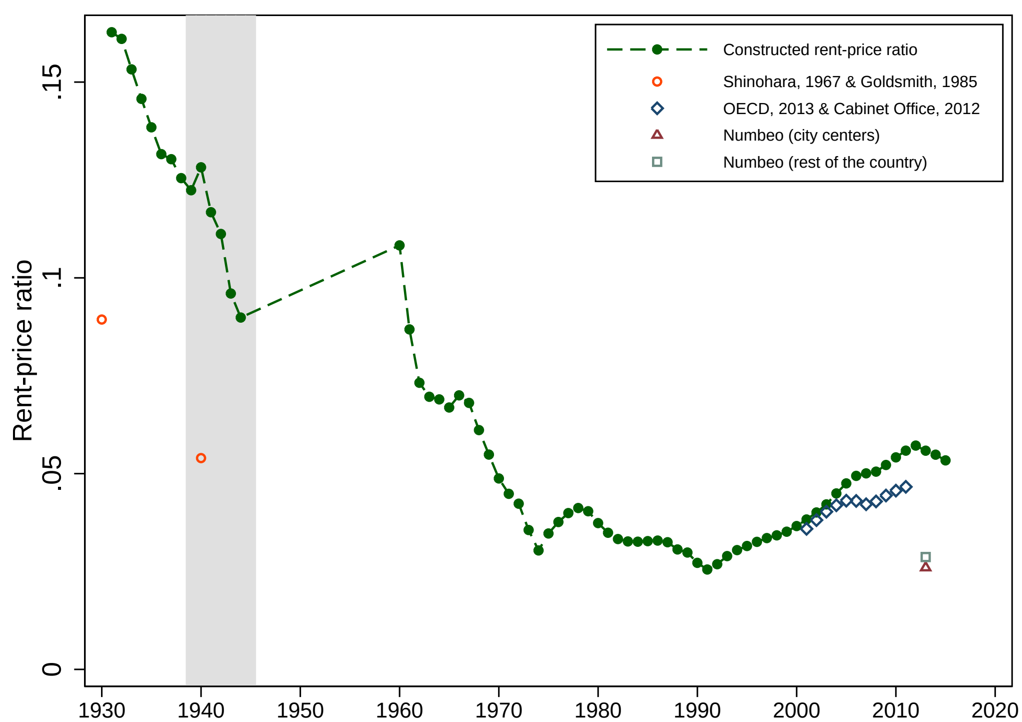
Italy

To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Italian residential real estate of 0.038.

Estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates range between 0.03 (within city centers) and 0.038 (rest of the country) and are thus consistent with the data reported by MSCI (2016). Unfortunately, to the best of the authors' knowledge, no additional independent estimates of rent-price ratios in Italy are available.

Japan

Figure A.11: *Japan: plausibility of rent-price ratio*

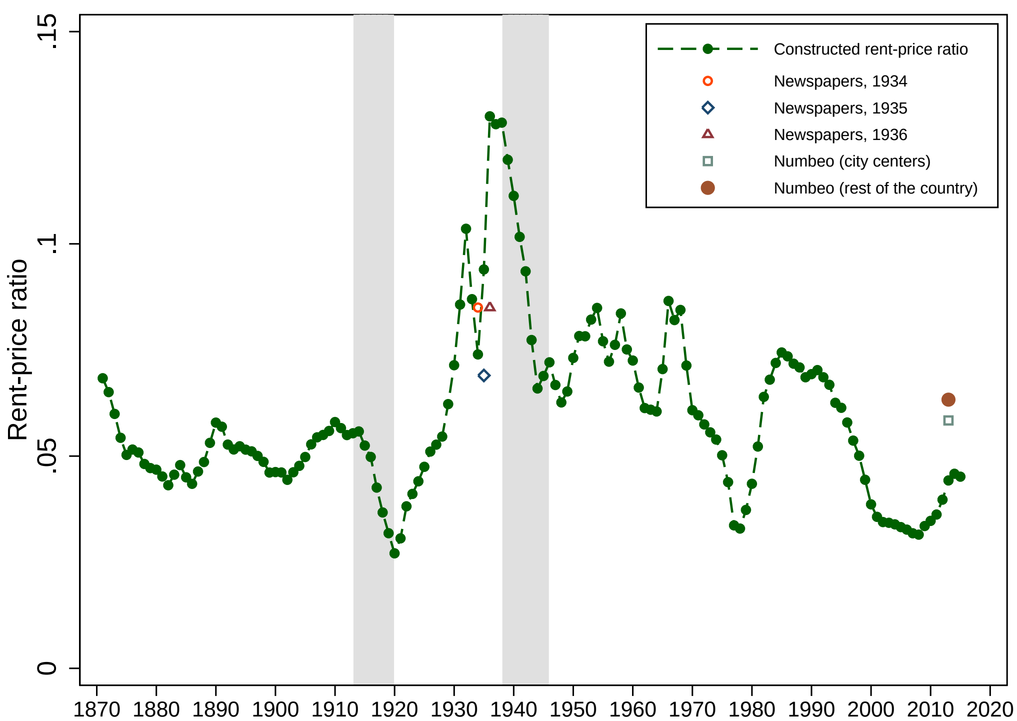


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Japanese residential real estate of 0.056.

We obtain two independent estimates for rent-price ratios in Japan. First, we calculate rent-price ratios for benchmark years (1930, 1940, 2000–2011) based on data on total housing value (Goldsmith, 1985; OECD, 2013) and total expenditure on rents (Cabinet Office. Government of Japan, 2012; Shinohara, 1967). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio for 2000–2011 (Figure A.11). Yet, for 1930 and 1940 the estimates are somewhat lower compared to the long-run rent price ratios suggesting that the rent index may underestimate rent growth between 1945 and 1960 which would mechanically result in overestimating the level of the rent-price ratio before 1945. To the best of the authors' knowledge, no rent data are available for 1945–1960 limiting our ability to corroborate the plausibility of the long-run rent-price index for the pre-WW2 period. Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are somewhat lower compared to the data reported by MSCI (2016) but are within a reasonable range of the long-run rent-price ratio.

Netherlands

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



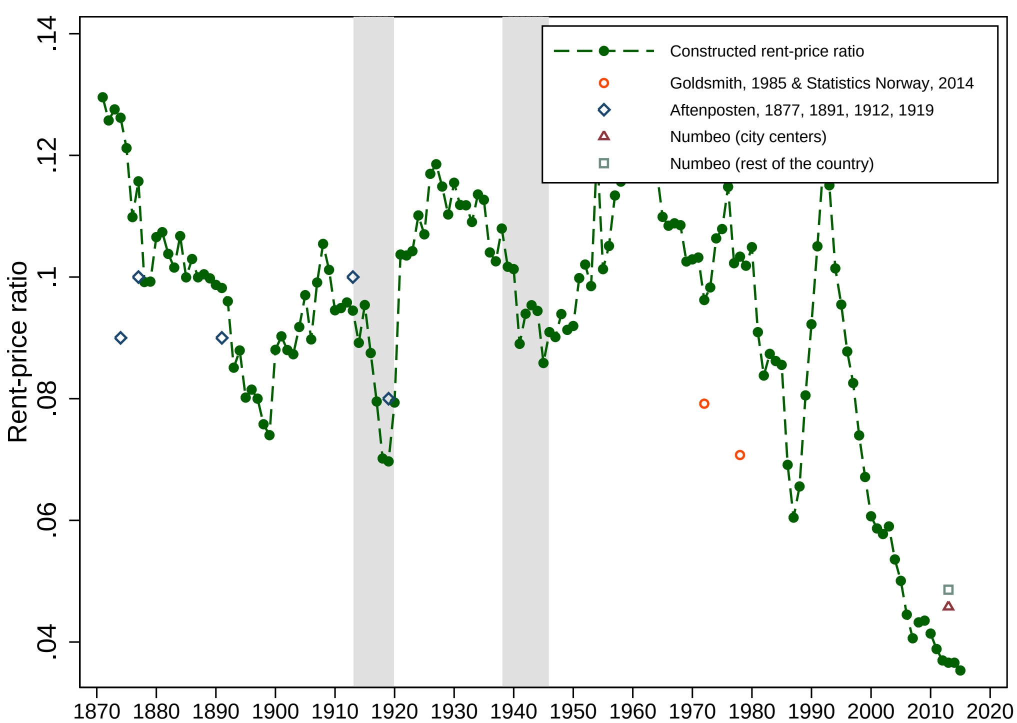
To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Dutch residential real estate of 0.044.

The resulting long-run rent-price ratio appears to be, by and large, in line with rent-price ratios reported in several newspaper advertisements and articles. According to these sources, rent-price ratios were in the range of 0.07-0.09 in the first half of the 1930s (Limburgsch Dagblaad, 1935; Nieuwe Tilburgsche Courant, 1934, 1936) and residential real estate was perceived as highly profitable investment throughout the decade (De Telegraaf, 1939). By comparison, the rent-price ratio constructed by merging the indices of house prices and rents was on average about 0.011 during the first half of the 1930s (Figure A.12).

Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are consistent with the data reported by MSCI (2016) (Figure A.12).

Norway

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



To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for Norwegian residential real estate of 0.037. Figure A.13 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain several scattered independent estimates of rent-price ratios in Norway since 1871. First, we calculate rent-price ratios for benchmark years (1972, 1978) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Statistics Norway, 2014; **?**). Second, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure A.13). Third, we collected scattered data from advertisements for Oslo residential real estate in *Aftenposten*, one of Norway's largest newspapers. According to these advertisements, rent-price ratios for apartment houses in different parts of Oslo ranged between 0.08 and 0.10 prior to World War 1 and reached similar levels in the interwar period (Aftenposten, 1874, 1877, 1891, 1912, 1919). All estimates are, by and large, consistent with the long-run rent-price ratio (see Figure A.13).

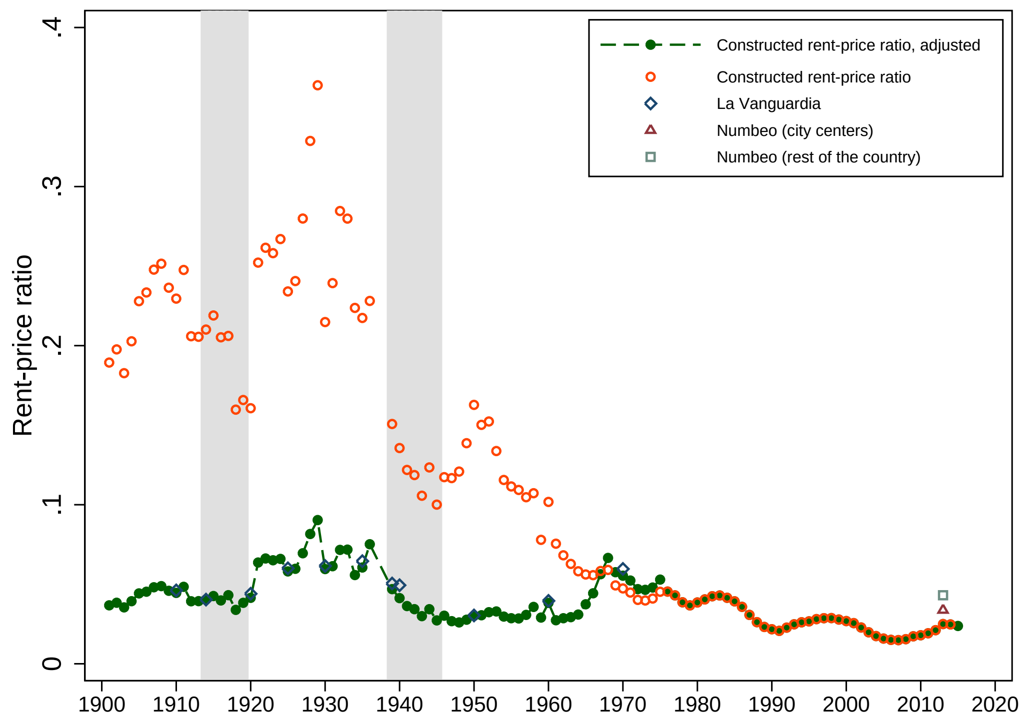
Portugal

To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports a rent-price ratio for Portuguese residential real estate of 0.037.

Estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are consistent with the data reported by MSCI (2016). Unfortunately, to the best of the author's knowledge, no additional independent estimates of rent-price ratios in Portugal are available. Yet, the trajectory of the long-run rent-price ratio is broadly in line with narrative evidence on house price and rent developments—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).

Spain

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

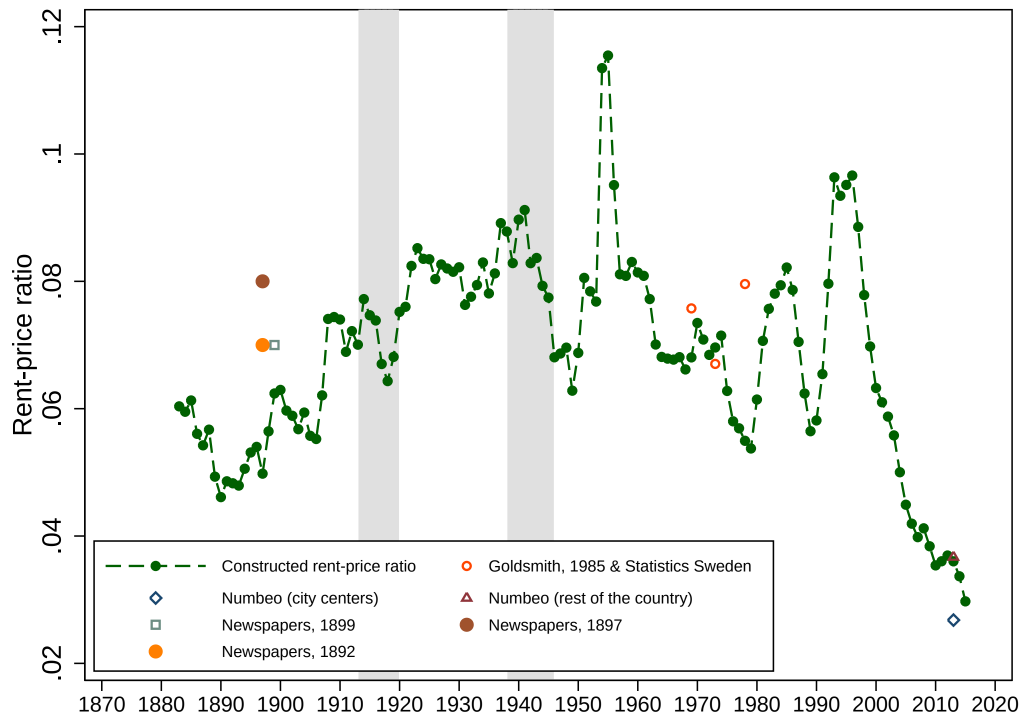


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for Spanish residential real estate of 0.025. Figure A.14 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain several scattered independent estimates of rent-price ratios in Spain. First, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure A.14). Second, 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. Figure A.14 shows that these estimate 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. Similar to Australia, 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 the adjusted long-run rent-price ratio concords with the independent estimates obtained from *La Vanguardia*. Figure A.14 displays the resulting adjusted long-run rent-price ratio.

Sweden

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

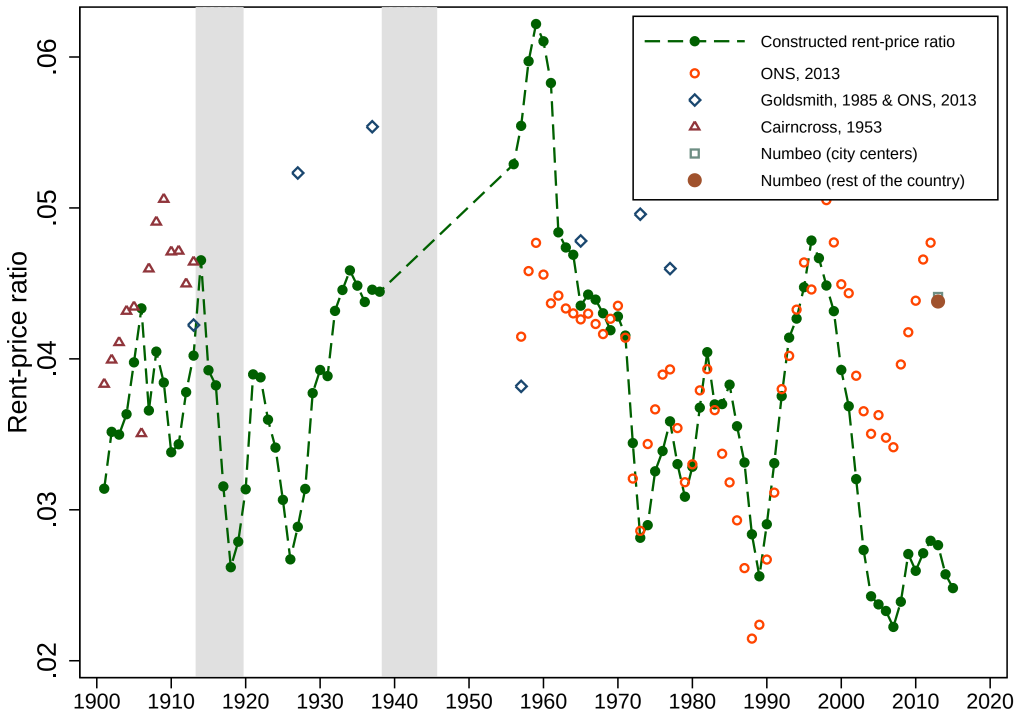


To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for Swedish residential real estate of 0.036. Figure A.15 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

We obtain three independent estimates of rent-price ratios. First, the resulting long-run rent-price ratio appears to be in line with rent-price ratios reported in several newspaper advertisements and articles. According to these sources, rent-price ratios were in the range of 0.07 to 0.08 in the late 19th century (Dagens Nyheter, 1892, 1897, 1899) and residential real estate was perceived as highly profitable investment at the time. By comparison, the rent-price ratio constructed by merging the indices of house prices and rents was on average about 0.053 during the last years of the 19th century (see Figure A.15). Second, we calculate a rent-price ratio for benchmark years (1969, 1973, 1979) using data on total housing value (Goldsmith, 1985) and total expenditure on rents (data drawn from Statistics Sweden. The series sent by email, contact person is Birgitta Magnusson Wärmark, Statistics Sweden). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio (see Figure A.15). Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from www.Numbeo.com for one- and three-bedroom apartments within city-centers and in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (see Figure A.15).

United Kingdom

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



To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio for 2013, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). For 2013, the MSCI (2016) reports the rent-price ratio for U.K. residential real estate of 0.032. Figure A.16 displays the resulting long-run rent-price ratio along with independent estimates as detailed below.

Some scattered data on rent-price ratios are available for the pre-WW2 period. For England, Cairncross (1975) reports an average rent-price ratio of 0.043 between 1895 and 1913. Offer (1981) estimates a little higher rent-price ratios for selected years between 1892 and 1913 for occupied leasehold dwellings in London. As Figure A.16 shows, these data are broadly consistent with the long-run rent-price ratios. Average rent-price ratio of 0.037 percent for 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, these estimates are consistent with the long-run rent-price ratio.

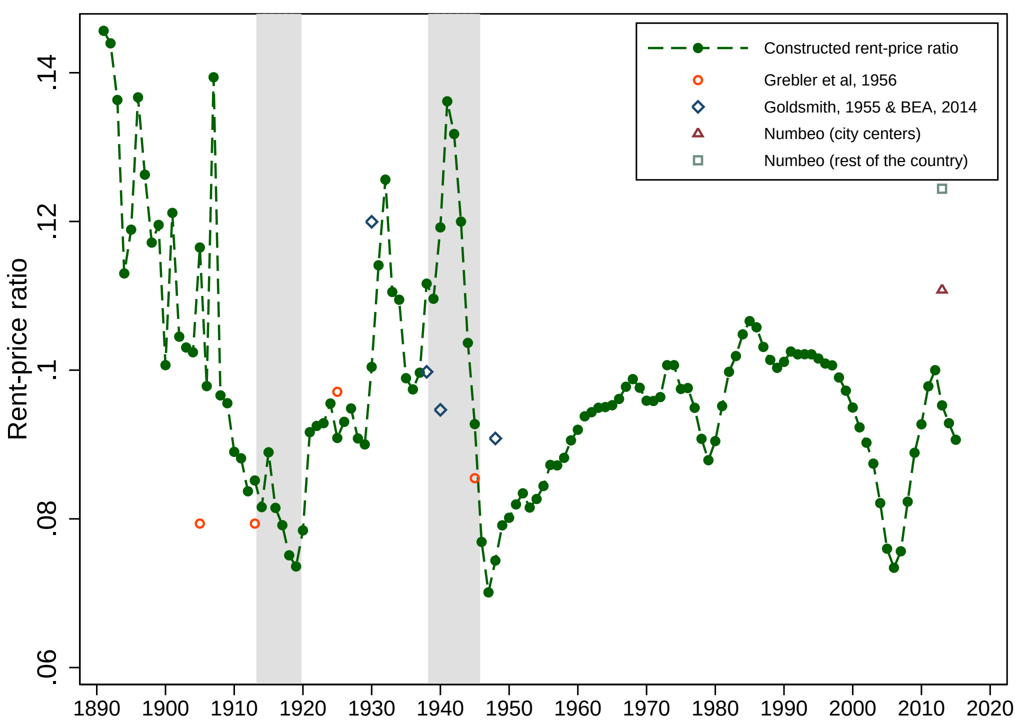
We also calculate rent-price ratios for benchmark years (1913, 1927, 1937, 1948, 1957, 1965, 1973, 1977) based on data on total housing value (Goldsmith, 1985) and total expenditure on rents (Mitchell, 1988). Reassuringly, the resulting estimates appear consistent with the long-run rent-price ratio (Figure A.16).

As additional plausibility check for the post-WW2 period, we calculate a rent-price ratio combining data on total housing value from the Office of National Statistics and total expenditure on rents (**?**). The series from the Office of National Statistics was sent by email, contact person is Amanda Bell. Even though the series includes data for the whole 1957-2012 period, a number of definitional changes occurred during the transition from the European System of Accounts (ESA) ESA1979 to ESA1995 in 1998. At the time, these series were not joined together and this is likely to indicate a definitional difference. Again, the resulting estimates of average annual real housing returns are consistent with the series summarized in Table 5.

Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. For 2013, these estimates are comparable to the data reported by MSCI (2016) (Figure A.16).

United States

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



To construct a long-run rent-price ratio and compute a time-series of housing returns, we follow the rent-price approach (see Section 2.4) using a benchmark rent-price ratio, the house price index presented by Knoll et al. (2016) and the rent index introduced in Knoll (2016). We rely on a rent-price ratio of 0.1 from the real estate portal Trulia for 2012 as suggested by Giglio et al. (2015) as benchmark. Figure A.17 displays the resulting long-run rent-price ratio along with independent estimates as detailed below. We obtain independent estimates of U.S. rent-price ratios from three additional sources. First, decadal averages of price-rent ratios are available for 1899–1938 from Grebler et al. (1956) ranging between 10.4 and 12.6. Overall, these data are very similar to the price-rent ratios resulting from merging the indices of house prices and rents (see Figure A.17). As additional plausibility check, we calculate a rent-price ratio for benchmark years (1930, 1938, 1940, 1948) using the data drawn Goldsmith (1955) and Bureau of Economic Analysis (2014). Reassuringly, the resulting estimates are comparable to the long-run rent-price ratio. Finally, estimates of gross rent-price ratios (i.e. not accounting for maintenance and depreciation) since 2009 are also available from `www.Numbeo.com` for one- and three-bedroom apartments i) within city-centers and ii) in the rest of the country. Given that the data from `www.Numbeo.com` is not adjusted for maintenance and depreciation, it is unsurprising that these estimates are somewhat higher compared to the long-run rent-price ratio (see Figure A.17).

K. 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, 2016). 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 with rates varying across states and are deductible from federal income taxes. Generally, tax rates are about 1% of real estate values. Since property taxes are deductible from : and, while there is variation across states. Giglio et al. (2015) assume that the deductibility reflects a marginal U.S. federal income tax rate of 33%. The tax impact is therefore $(1 - 0.33) \times 0.01 = 0.67\%$. Property transfer taxes are levied at the state level and range between 0.01% and 3% of the property value (Federation of Tax Administrators, 2006).

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