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Dynamics Between Housing and Stock Markets: International Evidence over 1870 to 2015

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ABSTRACT
This research investigates the dynamic relationship between housing and stock markets across nine countries. Using total return indices from 1870 to 2015, empirical results around the globe consistently show that stock and housing markets are linearly segmented, with fractional integration found in Denmark and the US. A positive lead-lag relationship from stock to housing is observed for most countries, offering support for the wealth effect theory. The results have important implications for portfolio diversification strategy and government policy.

KEYWORDS
Housing markets; stock markets; integration; lead-lag relationship

Introduction

The impact of housing on stock markets during the 2007–2009 global financial crisis (GFC) has led to an increase in interest from economists keen to understand the relationship between the two markets. The importance of understanding this relationship cannot be overemphasized, as stocks and real estate comprise major assets in the portfolios of households and institutional investors. Understanding the interaction between the two markets can help governments propose better policies to promote economic growth and financial stability (Chiang et al., 2020).

Historically, the long-run relationship between stocks and housing primarily sits within two frameworks: integration/segmentation and the lead-lag relationship. Unlike stocks, housing is a real asset, traded in the private market. The unique differences between real and financial assets have made them potential risk diversifiers for portfolio management. Yet, if housing and stock markets are integrated, it indicates that two assets can substitute each other in portfolio allocation, suggesting limited diversification benefits.

Further understanding the lead-lag relationship within an economy is essential, as disturbances in one market might trigger contagion, driving the capital movements in the other market. Using the UK as an example, the country's economy is highly dependent on the cross-border cash flows of foreign investors. It was predicted that Brexit would lead to a reduced appetite for UK assets. In the worst-case scenario, the Bank of England warned that house prices might drop by around 30% after Brexit (Bissoondeeal, 2021). If

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strong links exist between housing and stock markets or if housing markets affect stock markets, then a housing crash could lead to crisis in the financial sector (Bissoondeeal, 2021). Therefore, a better understanding of the lead-lag relationship will help investors manage their portfolio risk, as well as assist policy makers in proposing policies that can stabilize the economy.

While the dynamic relationship between housing and stocks has been widely discussed, our present knowledge largely ignores that the inconclusive results documented in the literature might be due to data issues. This work differs from prior studies by applying more suitable data: total return indices from 1870 to 2015, across nine countries. First, due to data unavailability, a substantial volume of literature has used price indices rather than the total return indices. Yet, the economic rationale for applying total return indices is self-evident, as housing is a mixture of consumption and investment goods. The major return for holding housing assets is income return from a consumption perspective, not capital gain return from an investment perspective (Jordà et al., 2019; Lin, 2022). Our work is the first to apply total return index to investigate the dynamic relationship between housing and stock markets in an international context.

We believe an empirical investigation on housing using a long time series data is particularly needed, since a typical homeowner is exposed to housing markets for several decades. On average, homeowners normally reside in the same house for 12 years (Brounen et al., 2014). Moreover, mortgage terms can be up to four decades and home equity can function as an implicit pension insurance. All of these factors suggest long investment horizons for homeowners, justifying the proposed approach of applying long historical data for this study.

This work commences with stationarity testing of total return indices in stock and housing. The results of unit root testing show stationarity in their first differences and, therefore, conventional Engle–Granger cointegration tests are followed. Our integration analysis across nine countries consistently shows that stock and housing markets are segmented. While international evidence from Lin and Lin (2011) and Lin and Fuerst (2014) is mixed and inconclusive across countries, our results consistently show segmentation between housing and stocks. Therefore, this suggests there are diversification benefits of including these two assets together in portfolio allocations in the long run.

While Engle–Granger (Engle & Granger, 1987) integration testing assumes a linear assumption, it is possible that the integration is nonlinear (i.e., partial cointegration) between both markets (e.g., Mahmoudinia & Mostolizadeh, 2022; Tsai et al., 2012). Following the international literature of Lin and Lin (2011) and Lin and Fuerst (2014), we employ the nonlinear integration method developed by Okunev and Wilson (1997). Results show fractional integration in Denmark and the US. Interestingly, the differences in these results can be linked to the underlying structure of the economies. Denmark and the US are among the most competitive economies in the world. Potentially, this feature could explain a closer relationship between housing and stock markets.

The lead-lag relationship is next examined between housing and stocks by Granger (1969) causality testing. Conventionally, two main strands of economic theories are proposed to explain the relationship. The wealth effect argues that a gain in stock markets will encourage investors to shift their demand toward real estate markets and, thus, increase housing prices. In contrast, the credit price effect argues that an increase in real estate prices will raise the collateral value and reduce the cost of borrowing for firms and households. This expands investments and causes stock prices to rise. Yet, the empirical findings for the signs of the lead-lag relationship have been mixed and inconclusive in the literature. Thus, another explanation is the capital switching behavior, hypothesizing a negative lead-lag causal transmission, as investors switch their capital from a less profitable to a more profitable sector, occasionally.

Granger causality testing consistently shows a lead-lag relationship from stock to housing markets for most countries, including Denmark, France, the Netherlands, Norway, and Sweden. Further examination of the lead-lag relationship reveals that the sign is significantly positive for these countries. Overall, our results align with Irandoust (2020), indicating a strong wealth effect in most cases.

Similar to Liow et al. (2019), this research aims to shed light on why earlier research documents inconclusive results on the dynamics between housing and stock markets. However, in contrast to the existing literature, we are the first to focus on the application of a more appropriate dataset – total return index – rather than various types of time-series models. As highlighted in Sinai and Souleles (2005), hedging rent risk is the key motivation for homeownership. Without incorporating the income return component into modeling the dynamic relationship between housing and stock markets, the empirical results primarily capture the investment perspective on housing.

Our research also complements the work on interactions between regional housing prices and national equity prices. The empirical evidence from Chinese markets (e.g., Adcock et al., 2016) and UK markets (e.g., Bissoondeeal, 2021) shows that regional housing prices respond differently to the national stock market. We differ from these works, and present cross-nation analysis with the application of more appropriate datasets. Altogether, our research shows that as a consumption channel is incorporated into the modeling, via the use of the total return index, a closer relationship between housing and stocks across the nine countries is revealed: stock and housing markets are linearly segmented systematically, with a positive lead-lag relationship from stock to housing for most countries.

The remainder of the paper is organized as follows: we next discuss the literature review and research innovations, followed by a breakdown of our methods and data analysis. We move on to discuss our empirical results and further avenues for research. Finally, we outline our conclusions.

Literature Review

Stocks and real estate play an important role in households' capital distribution. In the US, households allocate approximately 50% of their wealth to real estate and stocks (Bodie et al., 2023). Hence, investigating their relationship is vital for effective portfolio management. The strands of literature on the dynamic linkage between housing and equities fall into two main areas: (1) integration versus segmentation, and (2) the lead-lag relationship. These are discussed below.

Integration/Segmentation

Substantial literature has underlined the importance of analyzing the integration/segmentation between real estate and stock markets to better understand how to construct a low-risk portfolio. If the stock and housing markets are integrated, the prices of the two investments move in the same direction, providing limited portfolio diversification benefits in the long run. In contrast, if the two markets are segmented, investors can hold both assets for portfolio diversification purposes, as real estate and equities would react differently to economic conditions. Understanding this relationship would enable investors to become more effective market participants.

Stocks and housing are crucial assets for investment strategies. Equities are regarded as a convenient investment opportunity due to high liquidity and transaction transparency (Dieci et al., 2018). Yet, real estate investment is lumpy, highly illiquid, and traded in a private market. Unlike financial assets, housing is known as a mixture of consumption and investment goods. Thus, it can be subject to local risk, as the preference for housing can depend on local amenities, employment, location, and so on (e.g., Han, 2013; Lin, 2022; Lin & Robberts, 2024). Given these fundamental differences, the real estate and stock markets can, arguably, be segmented. However, both asset classes are also subject to broader macroeconomic forces, including interest rates, inflation, and government policies. Moreover, a housing bubble can have a detrimental impact on the operation of banking systems and lead to a financial crash. Therefore, we can argue that housing and stock markets are integrated. During the 2007–2009 GFC, the US experienced a higher level of integration, following the delisting of Lehman Brothers (Luchtenberg & Seiler, 2014).

To illustrate, Lin and Lin (2011) empirically study the integration between the equity and housing markets through cointegration tests covering six Asian economies. Here they find that the two markets are closely integrated in Japan, fractionally integrated in China, Hong Kong, and Taiwan, and segmented in Singapore and South Korea. Their results suggest that Japan, as the most developed economy in Asia, has a closer relationship between stock and housing markets, leading to fewer diversification benefits of holding these two investments in a portfolio.

Similarly, Lin and Fuerst (2014) revisit this topic but with the application of more appropriate data for Asian markets; they find a linear cointegration between the equity and direct real estate markets in Taiwan, fractional integration in Hong Kong and Singapore, but segmentation in China, Japan, Thailand, Malaysia, Indonesia, and South Korea. Interestingly, the empirical findings show that integration typically takes place in more densely populated countries, implying that these geographic regions experience frequent transactions, making their property market more liquid and transparent due to lower transaction and information costs.

Looking into the West, Li et al. (2015) find co-movement between stock and housing markets in the US varies across frequencies and evolves over time from 1890 to 2012. Examining German markets, Gokmenoglu and Hesami (2020) find integration between stock and housing markets, suggesting similar price movements in the long run. Altogether, the integration/segmentation between real estate and equities can vary across countries and over time, due to the degree of macroeconomic influences, such as fiscal policy, taxation, etc. A summary of the relevant literature can be found in Table 1.

To continue this line of research, our work applies the cointegration method by Engle and Granger (1987) and nonlinear cointegration testing developed by Okunev and Wilson (1997). Before doing so, we first check if the total return indices of stock and

Table 1. Literature on cointegration between housing and stock markets.

Paper	Market	Sample period (frequency)	Index	Results
Adcock et al. (2016)	China	1999–2010 (Monthly)	Price index	Integration between housing and stock markets at the national level but differs across regional markets.
Bissoondeeal (2021)	UK	1975–2018 (Quarterly)	Price index	Segmentation between housing and stock markets, at both national and regional levels.
Gokmenoglu and Hesami (2020)	Germany	2005–2017 (Monthly)	Price index	Integration between housing and stock markets.
Lin and Lin (2011)	6 Asian countries	1995–2010 (Quarterly)	Price index	Integration in Japan, partial integration in China, Taiwan, and Hong Kong, and segmentation in Singapore and South Korea.
Lin and Fuerst (2014)	9 Asian countries	1980–2012 (Quarterly)	Price index	Integration in Taiwan, fractional cointegration in Singapore and Hong Kong, and segmentation in China, Japan, Thailand, Malaysia, Indonesia, and South Korea.
Liow et al. (2019)	US	1975–2018 (Monthly)	Price index	Moderate integration between housing and stock markets.
Su (2011)	8 European countries	2000–2008 (Monthly)	Price index	Integration between housing and stock markets.
Tsai et al. (2012)	US	1970–2009 (Quarterly)	Price index	Integration between housing and stock markets.
Yousaf and Ali (2020)	Pakistan	2011–2019 (Monthly)	Price index	Integration between housing and stock markets, at both national and regional levels.

housing are nonstationary and integrated of the same order. If so, these nonstationary variables may share a common trend in the long run. We next conduct the standard Engle and Granger residual-based test for cointegration by investigating the stationarity of the regression residuals between housing and stock markets. The null hypothesis of this approach is that the two markets are non-integrated. If the null hypothesis is rejected, the two markets are concluded to be integrated. As this method is based on a linear assumption, we further conduct the nonlinear integration testing (as detailed in Methods, below).

Lead-Lag Relationship

The lead-lag relationship between housing and stock markets is another key area of exploration in literature. Case and Shiller (2003) observe that housing price booms tend to peak following stock booms. The wealth effect theory suggests that price appreciation in equity prices induces households to invest or consume more in housing (e.g., Tsai et al., 2012). Hence, stock prices positively lead real estate prices. In contrast, the credit price effect theory suggests housing price appreciation allows households and firms to receive more loans at a lower cost. This can expand investments and stimulate the economy, subsequently causing stock prices to increase (e.g., Hui & Ng, 2012). Thus, in this scenario, the property market would lead the stock market positively.

Both wealth and credit price effects suggest a one-way positive lead-lag relationship. Nevertheless, researchers suggest that such a lead-lag relationship can be bidirectional and negative: the capital switching effect – when asset substitution opportunities are identified between housing and stock markets (Lizieri & Satchell, 1997). Investors display "flight to quality" phenomenon, investing in the markets of higher returns by switching capital from the other market of lower returns.

To test these theories, Liow et al. (2019) deploy a wavelet analysis to the US markets and find the equity market has a greater influence on the housing market in the long run, implying a strong wealth effect. Turning to the Asian literature, Lean (2012) shows that the wealth effect exists in more developed states of Malaysia. Similar results can be seen in European economies – France, Italy, Sweden, the UK and the Netherlands – where Granger's causality approach shows a unidirectional causality running from stock to housing prices, suggesting a prominent wealth effect (Irandoust, 2020).

However, a series of literature provides evidence to support the credit price effect. For instance, Lin and Lin (2011) find a lead-lag relationship from housing to stock markets in Singapore and Taiwan, suggesting that real estate prices may drive stock prices in these two countries. A non-parametric rank test by Su et al. (2013) reveals that in the long run, the credit price effect above the threshold value is observed in China, and concludes that the transmissions between housing and stock markets are nonlinear and asymmetric. To mitigate conflicting results, Lean (2012) argues for a mixed existence of credit price and wealth effect in Malaysia. Chen and Chiang (2022) conclude that the relationship can be time-varying and, overall, the credit price dominates the wealth effect in G7 countries.

Another strand of literature has also found bidirectional causation relationship between stock and housing markets. Motivated by the European sovereign debt crisis, quantile causality tests in Italy, Greece, and Spain reveal that instability in the housing market imposes volatility in the stock market, and vice versa (Lou, 2017). Chiang et al. (2020) find that in the US, in high volatility regimes, there exists a capital switching effect which triggers investment outflows from stocks into properties and negative correlation between the assets. Similarly, Lee et al. (2017) show a negative lead-lag price linkage between house and equity prices in Australia, validating the existence of a capital switching effect where investors rotate their capital out of underperforming assets to invest in outperforming ones. A summary of the relevant literature can be found in Table 2.

To continue this strand of literature, we employ the conventional Granger-causality testing to examine the lead-lag relationship. If we reject the null hypothesis that stocks do not Granger-cause housing, this supports the wealth effect. Conversely, if we reject the null hypothesis that housing does not Granger-cause stocks, this supports the credit-price effect. Yet, it is possible that the sign of the lead-lag relationship can be negative to support the capital switching theory. Thus, we next employ a conventional vector autoregressive (VAR) model to ascertain this.

Research Innovation

Considering the importance of housing and stocks in the economy, it is critical to investigate their dynamic relationship in the long run. Our research complements prior work in two areas.

Table 2. Literature on the lead-lag relationship between housing and stock markets.

Paper	Market	Sample period (frequency)	Index	Results
Chen and Chiang (2022)	G7 countries	1970–2021 (Quarterly)	Price index	Mixed results with no relationship in the UK, a bidirectional relationship in France and Germany before the launch of the euro, and time-varying unidirectional relationship in Canada, Italy, Japan and the US.
Chiang et al. (2020)	US	1987–2017 (Monthly)	Price index	Bidirectional relationship between housing and stock markets, depending on the volatility regimes.
Hui and Ng (2012)	Hong Kong	1984–2006 (Quarterly)	Price index	Over the sample period of 1990 to 1994, housing lead stocks. Yet, the correlation between the two markets had become weaker over time, even if the trend of the two market prices was similar.
Irandoust (2020)	7 European countries	1975–2017 (Quarterly)	Price index	A unidirectional causality running from stock to housing prices in most cases.
Kapopoulos and Siokis (2005)	Greece	1993–2003 (Quarterly)	Price index	Stock prices lead Athens' real estate prices, yet not for other urban real estate prices.
Lean (2012)	Malaysia	2000–2010 (Quarterly)	Price index	Mixed evidence of credit price and wealth effects, depending on the property types and regions.
Lee et al. (2017)	Australia	1993–2013 (Quarterly)	Price index	Two asset markets are bilaterally causally linked, though the results differ before and after the GFC.
Liow et al. (2019)	US	1975–2018 (Monthly)	Price index	Though two asset markets are bilaterally causally linked, there is a stronger effect from the stock to the housing market
Lin and Lin (2011)	6 Asian countries	1995–2010 (Quarterly)	Price index	Housing leads stock markets in Singapore and Taiwan.
Lou (2017)	4 European countries	1990–2014 (Monthly)	Price index	A bidirectional causation relationship between the two markets, especially in the tail quantile.
Su et al. (2013)	China	1998–2011 (Monthly)	Price index	Stocks lead housing in the short run. Yet, in the long run, a bidirectional causation relationship exists between the two markets.

First, while prior literature has ascertained the dynamics between stock and real estate markets (e.g., Ali & Zaman, 2017; Chen & Chiang, 2022; Chiang et al., 2020; Irandoust, 2020; Kakes & Van Den End, 2004; Lin & Fuerst, 2014; Lin & Lin, 2011; Liow, 2006; Liow et al., 2019), the price indices (rather than the total return indices) have been adopted due to the limited data availability in real estate markets. This approach is not ideal, as income return from rents of real estate and dividends of equities play a central role in determining the total return for the asset (Jordà et al., 2019). Hence, we argue that the full picture of the interconnections between stock and housing markets can be better understood using the total return index. Our research advances theory by using the total return indices incorporating property/stock capital gains combined with rental/dividend yields.

Second, a critical aspect of inspecting the relationship between housing and equity markets is the long-run outlook. Looking at the prior literature, the data used is mainly in the short span, after the 1970s. However, it is known that a typical household's presence in the housing market persists for decades, as people usually inhabit the same house for about 12 years (Brounen et al., 2014), and the mortgage term can be up to 40 years. Moreover, institutional investors, such as pension funds involving property investment, are reported to maintain, on average, an unexpired lease length of over 15 years (Mansley & Wang, 2021). These figures imply that real estate investment horizons are typically long, further validating the need for research in historical retrospect.

Indeed, the importance of using the long-run total returns in housing has been highlighted in the recent literature (e.g., Brounen et al., 2014; Chambers et al., 2021; Eichholtz et al., 2021; Jordà et al., 2019; Lin, 2022). To the best of our knowledge, our research is the first to examine the dynamics between stock and housing markets using the total return index, across nine countries over a historical period from 1870 to 2015.

Methods

The empirical methods we adopt for our research include conventional time-series methods[1] such as the unit root test by Dickey and Fuller (1981), the cointegration method by Engle and Granger (1987), and the causality test by Granger (1969). The only exception is the nonlinear cointegration testing developed Okunev and Wilson (1997). Thus, this section describes this method.

Okunev and Wilson (1997) argue that if real estate and stock markets are not linearly related, a nonlinear relationship might exist instead. Therefore, they propose a nonlinear model to measure this:

$$H(t) = S(t)^{\beta} e^{\{\alpha(t) - k\}} \tag{1}$$

where *H(t)* and *S(t)* denote the housing and stock indices at time *t*, respectively. This model can be further transformed into the following:

$$\log \frac{H(t+1)}{H(t)} = \delta_0 + \delta_1 \log \frac{S(t+1)}{S(t)} + \delta_2 logS(t) + \delta_3 logH(t) + e(t) \tag{2}$$

where δ_0 is the constant term; δ_1 investigates the fractional cointegration with the range of the value between 0 and 1. The higher value of δ_1 , the higher degree of integration. δ_2 indicates the change in the mean reversion features of the housing towards stock market, while δ_3 can be used to calculate the speed of adjustment of mean reversion towards the stock market. All the methods adopted are estimated by ordinary least squares.

Data Analysis

To conduct our empirical research, we employ a historical total return dataset from Jordà et al. (2019).[2] The total return on equities and real estate can be split into two major elements: capital increase arising from the change in the asset price, and a yield portion, reflecting gradual cash returns on the investment. The yield component for equities emerges from dividends, while real estate's yield comes from rental income.

According to Jordà et al. (2019), information about equity returns is obtained from multiple sources, including stock exchange listings, central banks, company reports, statistical offices and history journals. The construction of the stock indices mainly relies on a stock selection that represents the entire equity market weighted by market capitalization. In contrast, information about housing returns is obtained from the rent component in the cost of living of consumer price indices by national statistical offices and price indices from Knoll et al. (2017), along with other resources.

In line with previous studies, the dataset explores returns to the national aggregate holdings of real estate and equities. A benefit of this method is that it captures the likely returns for a hypothetical investor holding each country's portfolio. However, relying on a small sample may not represent the entire stock and housing returns. Our research overcomes this possible limitation as the dataset includes various geographic regions over a 145-year period – from 1870 to 2015.

Initially, the data covers annual total housing and equity returns for 16 countries from 1870 to 2015. Following Lin (2018), we define the long-run relationship over 100 years and, therefore, we require at least 100 years of uninterrupted data (i.e., without missing values) from an available sample period to 2015. This leads to nine surveyed countries in our analysis, with summary statistics of total annual housing and equity returns reported in Table 3. For most countries, stocks have higher returns than housing but are associated with higher risk. Therefore, it appears assets with higher risk are compensated with higher returns.

Further looking into the outliers and historical annual return per period, stocks were underperforming throughout World War II, followed by a sharp bounce in the postwar reconstruction period. Equities dropped again in the 1970s due to macro uncertainty, but once again recovered quickly in the 1980s as a result of a deregulation wave. In contrast, real estate returns did not experience the same massive swings during/following World War II and the 1970s, which demonstrates the stability of housing over periods of economic uncertainty and high inflation. Hence, stock and housing markets can react differently to the same macroeconomic shocks.

Empirical Results

Unit Root Testing

The empirical analysis commences by investigating the stationarity of the time series data using the conventional augmented Dickey–Fuller (ADF), developed by Dickey and Fuller (1981). The ADF results in Table 4 show that the null hypothesis of non-stationarity at the level series[3] cannot be rejected, while the results at the first difference series are rejected. The unit root testing shows that all indices of housing and stocks are first

Table 3. Summary statistics of total annual returns.

	Mean (%)	S.D. (%)	Min (%)	Max (%)	Obs
Panel A: Equity					
Australia (1870–2015)	11.41	15.86	−40.38	63.70	146
Denmark (1873–2015)	12.46	29.78	−88.41	137.76	143
France (1870–2015)	8.20	21.37	−40.89	115.86	146
Netherlands (1900–2015)	10.22	22.82	−49.46	130.07	116
Norway (1881–2015)	8.88	20.34	−54.06	92.80	135
Spain (1900–2015)	11.59	21.13	−36.95	113.26	116
Sweden (1871–2015)	10.96	19.95	−39.27	69.76	145
Switzerland (1900–2015)	8.69	18.51	−34.05	61.36	116
US (1872–2015)	10.45	18.04	−40.30	52.64	144
Panel B: Housing					
Australia (1901–2015)	10.57	13.69	−14.84	136.31	115
Denmark (1876–2015)	11.37	7.82	−9.30	35.12	140
France (1871–2015)	12.15	9.75	−5.13	54.74	145
Netherlands (1871–2015)	9.68	9.90	−19.98	43.10	145
Norway (1871–2015)	11.46	9.34	−10.27	58.41	145
Spain (1901–2015)	11.36	13.28	−26.09	54.29	115
Sweden (1883–2015)	11.47	7.83	−23.45	35.69	133
Switzerland (1902–2015)	7.97	5.75	−6.67	28.05	114
US (1891–2015)	8.87	8.40	−21.56	47.19	125

Note: The total annual returns of housing and equity are collected from Jordà et al. (2019). The annual returns are in nominal terms and period coverage differs across countries. The mean refers to arithmetic mean.

Table 4. Unit root testing.

	Level	First difference
Panel A: Equity		
Australia	−3.12	−13.33***
Denmark	−1.37	−10.82***
France	−2.54	−11.01***
Netherlands	−2.05	−10.19***
Norway	−1.72	−11.68***
Spain	−3.03	−6.42***
Sweden	−1.09	−10.64***
Switzerland	−2.87	−9.85***
US	−2.70	−11.33***
Panel B: Housing		
Australia	−1.94	−6.99***
Denmark	−1.60	−5.68***
France	−1.68	−4.15***
Netherlands	−2.04	−5.11***
Norway	−0.62	−11.74***
Spain	−2.29	−9.87***
Sweden	−2.39	−8.09***
Switzerland	−2.75	−6.59***
US	−1.85	−5.38***

Note: *** indicates significance at the 0.01 level.

difference stationary (i.e., I(1)). Therefore, standard integration testing by Engle and Granger (1987) can be conducted.

Integration Testing

Table 5 displays the results of the standard Engle–Granger residual-based test[4] for cointegration. The null hypothesis of no cointegration between housing and stock markets cannot be rejected in all the surveyed countries. This shows that stock and housing

Table 5. Engle–Granger testing for integration.

	Test statistics
Australia	−3.81
Denmark	−0.41
France	−2.44
Netherlands	−2.69
Norway	−2.76
Spain	−3.24
Sweden	−2.94
Switzerland	−3.06
US	−3.61

Table 6. Nonlinear cointegration.

	δ_0	δ_1	δ_2	δ_3
Australia	0.06	0.05	−0.00	0.01
	(0.08)	(0.06)	(0.02)	(0.02)
Denmark	0.13***	0.13***	−0.03***	0.02***
	(0.02)	(0.04)	(0.01)	(0.01)
France	0.05	−0.04	0.01	−0.00
	(0.04)	(0.04)	(0.01)	(0.01)
Netherlands	0.05	0.08	−0.00	0.01
	(0.03)	(0.04)	(0.02)	(0.02)
Norway	0.07	0.02	−0.03	0.02**
	(0.02)	(0.03)	(0.02)	(0.01)
Spain	0.12***	0.07	−0.07***	0.06***
	(0.03)	(0.06)	(0.03)	(0.02)
Sweden	0.07***	−0.04	−0.01	0.01**
	(0.02)	(0.03)	(0.01)	(0.01)
Switzerland	0.06***	−0.04	−0.02	0.02
	(0.02)	(0.03)	(0.01)	(0.01)
US	0.06**	0.12***	−0.03	0.04
	(0.02)	(0.03)	(0.02)	(0.02)

Note: *** and ** indicate significance at the 0.01 and 0.05 levels, respectively. Standard errors are in parentheses below the corresponding coefficient estimates. δ_1 measures the degree of the fractional cointegration with the range of the value between 0 and 1. See Equation (2) for detailed discussion.

markets are segmented. Thus, the two investment vehicles are good substitutes for each other, leading to fewer diversification benefits of holding them together in a portfolio.

The Engle–Granger (1987) integration testing is based on a linear assumption. However, it is possible that the integration is nonlinear (i.e., partial cointegration) between both markets (e.g., Mahmoudinia & Mostolizadeh, 2022; Tsai et al., 2012). Following the international literature (e.g., Lin & Fuerst, 2014; Lin & Lin, 2011), we apply the fractional cointegration tests developed by Okunev and Wilson (1997). The results of this testing can be seen in Table 6. The highest degree of fraction integration is in Denmark, followed by the US.

As highlighted in Lin and Fuerst (2014), the degree of integration varies across Asian countries and can reflect factors influencing the underlying economic structures. Interestingly, it shall be noted that the US had continuously been ranked as the most competitive economy (especially before the GFC), whereas recently, Denmark is ranked as the most competitive economy (according to the International Institute for Management Development (2023)). This suggests that Denmark and the US score an overall high performance for openness and social frameworks. According to Narayan et al. (2014), one of the key factors for integration is openness of domestic economy. In this setting, countries can display a relatively higher level of openness, attract foreign investment, improve efficiency, and reduce transaction costs, which lead to a higher degree of integration.

While earlier studies have shown evidence of segmentation between commercial real estate and stock markets in the US (e.g., Ling & Naranjo, 1999; Liu et al., 1990), international research on housing markets (e.g., Lin & Fuerst, 2014; Lin & Lin, 2011) presents mixed findings across different countries. Yet, recent work by Liow et al. (2019) and Yousaf and Ali (2020) shows support of integration between housing and stocks in the US and Pakistan, respectively. Our research extends theory by using a more appropriate suitable "total return" index and finds evidence of no linear integration systematically across all the countries, with fractional integration in Denmark and the US. Kyriakou et al. (2023) suggest that fractional integration reveals a long-term co-memory between housing and stock markets, implying that these two assets should not be held together in a portfolio for diversification purposes.

Causality Testing

Most studies have documented mixed evidence on the lead-lag relationship between housing and stock markets. In their empirical investigation across six Asian countries, Lin and Lin (2011) find that real estate Granger causes stock markets in Singapore and Taiwan. A recent work by Chen and Chiang (2022) looking at G7 countries, shows mixed results – there is a bidirectional relationship in France and Germany before the launch of the euro and a unidirectional relationship in Canada, Italy, Japan and the US.

One potential explanation for the inconsistent results across countries could be the use of a price index to investigate the dynamic relationship. To address this, we apply the 'total return' index in the Granger (1969) causality test to examine the lead-lag relationship between housing and stock markets. The results in Table 7 show that the null hypothesis of no unidirectional causality running from stocks to housing is rejected in Denmark, France, the Netherlands, Norway and Sweden. Interestingly, Denmark displays a unidirectional causality running from housing to stocks as well. As previously

Table 7. Granger causality test between stock and property markets.

	Null hypothesis	Wald test statistics
Australia	Housing does not Granger cause stocks	1.71
	Stocks do not Granger cause housing	0.85
Denmark	Housing does not Granger cause stocks	7.69***
	Stocks do not Granger cause housing	5.90**
France	Housing does not Granger cause stocks	3.16
	Stocks do not Granger cause housing	9.65***
Netherlands	Housing does not Granger cause stocks	0.32
	Stocks do not Granger cause housing	4.47**
Norway	Housing does not Granger cause stocks	0.34
	Stocks do not Granger cause housing	5.87**
Spain	Housing does not Granger cause stocks	0.17
	Stocks do not Granger cause housing	0.97
Sweden	Housing does not Granger cause stocks	0.26
	Stocks do not Granger cause housing	5.70**
Switzerland	Housing do not Granger cause stocks	1.03
	Stocks do not Granger cause housing	0.17
US	Housing does not Granger cause stocks	0.32
	Stocks do not Granger cause housing	0.54

Note: *** and ** indicate significance at the 0.01 and 0.05 level, respectively.

discussed, Denmark, the most competitive economy, shows the highest degree of integration between stock and housing among all the surveyed countries – this might explain a closer and bilateral causal relationship.

While the lead-lag relationship has been empirically examined in the literature, the signs of such a relationship (i.e., positive or negative) have not been meticulously examined. As adopted in Lee et al. (2017), one of the most fundamental approaches is to apply the conventional VAR model. Therefore, we focus on temporal influences and select the lag structure of each model via the Bayesian information criterion. Overall, the optimal lag suggested for each model is one year, which is similar to Chen and Chiang (2022) and Lee et al. (2017), whose studies show that the lead-lag effect tends to take place within a year.

See Table 8 for the results of our VAR (1) modeling. Results show a statistically significant and positive lead-lag relationship from stock to housing markets in Denmark, France, the Netherlands, Norway and Sweden, supporting the wealth effect theory. In contrast, the statically significant and negative lead-lag relationship from housing to equity markets is only found in Denmark, supporting the capital switching theory.

Further comparing the coefficient for each of the lead-lag relationships between housing and stock markets shows that most signs of the coefficient are significantly positive across countries and cannot support the capital switching hypothesis. One potential explanation for this is that most households consider housing to be a consumption, not an investment good. Thus, capital switching is less likely to occur for residential real estate. The capital switching theory would be more applicable to commercial real estate

Table 8. VAR modeling.

	Independent variable	Stock return	Housing return
Australia	Stock return$_{t-1}$	−0.12 (0.09)	0.15 (0.09)
	Housing return$_{t-1}$	−0.15 (0.11)	0.07 (0.07)
	Constant term	0.15*** (0.02)	0.08*** (0.02)
Denmark	Stock return$_{t-1}$	0.20** (0.08)	0.07** (0.03)
	Housing return$_{t-1}$	−0.53*** (0.19)	0.49*** (0.07)
	Constant term	0.15*** (0.02)	0.05*** (0.01)
France	Stock return$_{t-1}$	0.09 (0.08)	0.08*** (0.02)
	Housing return$_{t-1}$	−0.32 (0.18)	0.74*** (0.05)
	Constant term	0.11*** (0.02)	0.02*** (0.01)
Netherlands	Stock return$_{t-1}$	0.02 (0.09)	0.07** (0.03)
	Housing return$_{t-1}$	−0.12 (0.20)	0.55*** (0.07)
	Constant term	0.11*** (0.03)	0.04*** (0.01)
Norway	Stock return$_{t-1}$	0.02 (0.08)	0.08** (0.03)
	Housing return$_{t-1}$	0.12 (0.21)	0.18** (0.08)
	Constant term	0.07** (0.03)	0.08*** (0.01)
Spain	Stock return$_{t-1}$	0.27 (0.09)	0.06 (0.06)
	Housing return$_{t-1}$	−0.06 (0.14)	0.06 (0.09)
	Constant term	0.09*** (0.02)	0.10*** (0.02)
Sweden	Stock return$_{t-1}$	0.13 (0.09)	0.07** (0.03)
	Housing return$_{t-1}$	−0.11 (0.23)	0.33*** (0.08)
	Constant term	0.11*** (0.33)	0.07*** (0.01)
Switzerland	Stock return$_{t-1}$	0.06 (0.09)	−0.01 (0.03)
	Housing return$_{t-1}$	−0.31 (0.30)	0.42*** (0.09)
	Constant term	0.10*** (0.03)	0.05*** (0.01)
US	Stock return$_{t-1}$	0.02 (0.09)	0.03 (0.04)
	Housing return$_{t-1}$	−0.11 (0.20)	−0.04 (0.09)
	Constant term	0.12***(0.02)	0.09*** (0.01)

Note: *** and ** indicate significance at the 0.01 and 0.05 levels, respectively. Standard errors are in parentheses next to the corresponding coefficient estimates.

markets or residential real estate markets that are more subject to institutional influences.

Further Research Avenues

This work is the first attempt to apply the total return index over a long period – 1870–2015 – to explore the dynamic relationship between housing and stock markets around the world. Our work is fundamental but general in certain areas and future works can be extended as follows.

First, while we follow the prior literature to test the direction of capital switching theory, credit-price effect and wealth effect using the aggregate market data, we acknowledge that household-level data would be more ideal to ascertain the causality. This is important because housing is illiquid and its price discovery can be slow. It is possible that the observed lead-lag relationship from stocks to housing can be caused by the unique features of real estate markets rather than wealth effect.

Second, the market relationship can be time-varying as information and liquidity change. Following the delisting of Lehman Brothers, Luchtenberg and Seiler (2014) find strong levels of integration between listed real estate and stock markets. While our work focuses on the long-run outlook with low frequency data, it would be interesting to investigate the sub-sample period comparisons, using high frequency data. It is possible that the results of the dynamic relationship would potentially differ, subject to macroeconomic events (e.g., Brexit, COVID-19, and GFC). Since our subsample analysis does not have enough observations for an appropriate time series analysis, we leave this interesting topic for future research.

Conclusion

While the relationship between housing and stock markets has been extensively examined in the existing literature, our present knowledge largely ignores the possibility that the mixed and inconclusive findings may stem from an inadequate application of the price index. The main motivation for homeownership is to hedge rent risk, and the major source of return in housing is income return, not capital gain (Jordà et al., 2019; Lin, 2022). Therefore, modeling the interaction between housing and stock markets should be based on the total return index.

Our empirical investigation, spanning nine countries from 1870 to 2015 and using total return indices, aims to uncover a closer link to the underlying dynamics between housing and stock markets. International evidence consistently shows that housing and stock markets are linearly segmented, suggesting there are long-run diversification benefits of holding the two investments in a portfolio. Further investigation using the non-linear technique shows fractional integration in Denmark and the US. Our results align with Lin and Fuerst (2014) and suggest that the difference of integration may be a range of factors impacting upon the underlying economic structure for each country.

By further investigating the causality transmission, we find a positive lead-lag relationship from the equity to housing markets for most countries. Consistent with earlier research in advanced economies (e.g., Irandoust, 2020; Kapopoulos & Siokis, 2005;

Liow et al., 2019), we find support for the wealth effect theory which advocates that gains in stock prices prompt households to rebalance their portfolio by consuming or investing more in housing.

Interestingly, the two markets in Denmark are bilaterally causally linked, with the highest degree of integration. As the most competitive economy in the world, Denmark has more transparent and liquid real estate and financial markets, which might explain this closer relationship. Overall, we demonstrate the importance of using long-run historical data across nine countries to study the dynamics between housing and stock markets and our results will be able to shed light on investment strategy and government policy.

Notes

1. The lag selection for the models is based on Bayesian information criterion.
2. For detailed construction of the data for each country, refer to Jordà et al. (2019).
3. The level series are rebased using the total return data in Jordà et al. (2019).
4. The residual is obtained by running a linear regression between the log of the total housing return index and log of the total stock return index at the level series.

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