Journal of Property Research

ISSN: 0959-9916 (Print) 1466-4453 (Online) Journal homepage: http://www.tandfonline.com/loi/rjpr20

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To cite this article: Arvydas Jadevicius, Simon Huston, Andrew Baum & Allan Butler (2018) Two centuries of farmland prices in England, Journal of Property Research, 35:1, 72-94, DOI: 10.1080/09599916.2017.1393450

To link to this article: https://doi.org/10.1080/09599916.2017.1393450

Published online: 10 Nov 2017.

JOURNAL OF PROPERTY RESEARCH, 2018
VOL. 35, NO. 1, 72–94
https://doi.org/10.1080/09599916.2017.1393450

Two centuries of farmland prices in England

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ABSTRACT
The dissemination of robust asset price data can help improve market efficiency, resource allocation and investment analysis. Land prices influence housing affordability, food security and the carbon infrastructure. Yet price and return histories for farmland in England are fragmented. To provide perspective, a long farmland price series is needed to improve transparency and bring the asset class into line with commercial and residential real estate. After reviewing the historical backdrop and considering methodology, this research uses a chain-linking approach to construct a long-term farmland price series for England. It then adjusts the series for inflation to examine real land prices. The resulting two-century English farmland prices series contributes to farmland market analysis. Notwithstanding some concerns with long-run chain component heterogeneity, the combined series helps us to understand English average farmland price dynamics. As measured by the geometric mean, English land price real capital returns have been positive over more than two centuries. Farmland real price growth was 0.33 per cent annually from 1781 to 2013 and 0.71 per cent from 1801 to 2013. The series contributes to an understanding of land price dynamics.

ARTICLE HISTORY
Received 7 February 2016
Accepted 12 October 2017

KEYWORDS
Chain-linking; farmland; prices; returns; England

> Sir, – In these times, when the rental and marketable value of land are in such an unsatisfactory and uncertain state that the savings of the community run riot on the Stock Exchange, it is interesting to those who are connected with the land to bring to light all facts bearing on the question. (Norton & Gilbert, 1889, p. 128)

Introduction

History demonstrates the importance and complexity of land markets, and the link to food security and power. For farmers, investors and policy-makers, good-quality land price data are vital. This research set out to generate a long-term farmland price series for England.

The research illustrates the fluctuation of English farmland prices influenced by policy, social and economic forces. Broadly, over the past couple of centuries, Western European farming divides into five distinct periods of agricultural protection: the era of laissez-faire; the great depression; the protectionist revival; the interwar years; and the post-war years

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(Federico, 2005; Swinnen, 2009; Tracy, 1982). Most European countries followed this pattern, although the UK charted a slightly different course. Following the 1846 repeal of the Corn Laws, which had imposed import tariffs on grain since the fifteenth century (Hill & Ingersent, 1982), the UK entered an extended era of laissez-faire that effectively ended in 1932. This period began with a 'golden age' of farming, which was relatively short-lived. Between 1870 and 1896, a 'great agricultural depression' led to the impoverishment of many UK farmers and some landlords (Hill & Ingersent, 1982). In contrast, many European countries revived protectionist policies during the great agricultural depression but the UK continued its laissez-faire approach. It was only in response to food shortages, in the latter stages of the First World War, that policy changed temporarily. The introduction of the 1917 Corn Production Act afforded limited protection to agriculture through guaranteed prices for wheat and oats (Whetham, 1974). With repeal of the Act in 1921, the UK returned to its laissez-faire approach to agriculture. As the 'interwar years' continued, the first substantial agricultural market intervention, which signalled the end of the laissez-faire period, was the Wheat Act of 1932. Introduced to counteract a fall in world grain prices and above normal imports (Tracy, 1982), this act became the forerunner of modern farm support programmes (Mollett, 1960). This period also heralded a change in the relationship between UK Government and the land since agricultural depression deepened and the likelihood of war with Germany increased (Smith, 1989). The Second World War solidified agriculture's strategic importance to the UK, which formed the basis of the watershed 1947 Agriculture Act (Bowers, 1985). Following this Act, agricultural protection became the norm in the 'post-war period'. However, it was not until the UK joined the EEC and the Common Agricultural Policy (CAP) that the benefits of agricultural intervention were questioned (Bowers, 1985; Smith, 1989).

Different factors interact to affect government intervention in agriculture including farm incomes; proportion of consumer spending on food; farm structure; political organisation of farmers; and food shortages (Swinnen, 2009). Both theoretical modelling and empirical evidence support the notion that agricultural policy support payments become capitalised in farmland prices (Latruffe & Le Mouël, 2009; Swinnen, Ciaian, & Kancs, 2008). Floyd (1965) theorised that US farm price support improves returns to land as long as output is not controlled and government compensates operators for land removed from production. In addition, the theoretical analysis of Courleux, Guyomard, Levert, and Piet (2008) concluded that the Single Farm Payment (SFP) scheme, introduced as part of CAP reform in 2003, led to the capitalisation of this payment into farmland prices. The most important factor driving this was the ratio of SFP entitlements to eligible hectares, but others included the quantum of previous payments, the price elasticity of land supply and the rate of mandatory set aside. Empirical evidence tends to support theoretical underpinnings (Kilian, Antón, Salhofer, & Röder, 2012). Although agricultural policies, particularly price support, are clear determinants of farmland prices, others factors may be significant (Goodwin, Mishra, & Ortalo-Magné, 2003). Within the farm environment, agricultural commodity prices, farm expansion and farm size tend to drive farmland prices in many countries (Swinnen et al., 2008). Other land price influences include GDP, house prices, share prices and local growth or decline (Feichtinger & Salhofer, 2011; Livanis, Moss, Breneman, & Nehring, 2006).

The importance of good long-term economic and real estate data for market analysis is obvious and well documented (Devaney, 2010; Hand, Mannila, & Smyth, 2001; Mitchell, Solomou, & Weale, 2011; Wheaton, Baranski, & Templeton, 2009; Wooldridge, 2009). Data on the relative performance of various sectors and long-term time-series analysis can help improve market efficiency (Makridakis, Wheelwright, & Hyndman, 1998; Solomou, 1998). It also underpins investment modelling for, *inter alia*, food security, sustainable development and low carbon infrastructure (Granoff, Hogarth, & Miller, 2016). In addition to an appreciation of market changes, long time series are necessary for most types of statistical analysis. Following Yaffee and McGee (2000), a properly estimated and parameterised model should contain 'enough observations'. Although Yaffee and McGee did not suggest what constituted 'enough observations', the recommendation is that if a series is cyclical or seasonal, then it should be long enough to cover several waves.

UK data on commercial and residential property markets are plentiful. London is considered the best documented property market in Europe (Ball & Tsolacos, 2002; Devaney, 2010; Lizieri, 2009; McGough & Tsolacos, 2002). As McGough and Tsolacos (2002, p. 35) remark, 'in some senses, researchers seem spoilt for choice' since UK property data are available at national and local levels, in various frequencies, regularities and length which allows for detailed and robust property market analytics. However, land value is distinct from site or property values with the latter including the former. Effectively, property is a composite good with appreciating land and depreciating buildings (Rambaldi, McAllister, & Fletcher, 2015). There is a growing interest from the property investment community in rural land market conditions and prospects (Jadevicius & Martin, 2014). Naturally, 'informed', as opposed to 'noisy' (Black, 1986) developers and investors would welcome well-established land price data series. Land values are the bedrock for urban economics. They are central in understanding property market price changes, the impact of land-use policies and taxes levied on property, costs of urban agglomeration and even calibrating optimal settlement size (Albouy & Ehrlich, 2013). Aside from investors, farmers themselves need robust land price benchmarks (Walsh, 2001).

Curiously, despite the importance of land values, UK long-term farmland series are fragmented as compared to residential or commercial series. Typically, data on land are available only for a single area or for limited time periods (Albouy & Ehrlich, 2013).

Main contribution

The main contribution of this research is to redress the farmland price series information deficit. It generates a long-term land price series for England to inform landowners, investors, farmers, developers and policy-makers.

Table 1. Nominal and real growth for farmland and gold prices and stock market index.

	Mean(G)	Std. Dev.	Min.	Max	Count
Nominal price growth (1800–2013)					
Farmland	2.76	25.72	−84.00	200.00	213
FTSE AS	2.50	17.70	−55.34	136.33	213
Price of Gold	2.03	13.33	−24.96	99.21	213
Real price growth (1800–2013)					
Farmland	0.71	26.17	−82.95	194.06	213
FTSE AS	0.45	16.71	−61.51	90.22	213
Price of Gold	0.00	12.99	−33.41%	68.84%	213

Notes:*Growth is a geometric mean returns over the sample period.

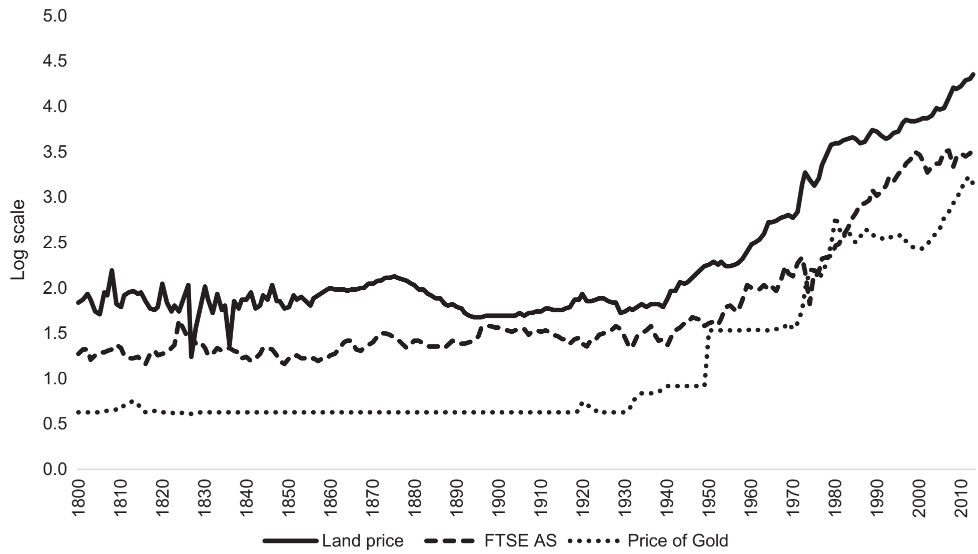

Figure 1. Nominal values of agricultural land (£/ha), FTSE all share index and gold ($/ounce) (1800–2013). Source: FTSE All Share series come from GFD (2015) and LSE (2015); Gold series are derived from Officer and Williamson (2015).

Notes: *Land prices in £/ha. **FTSE All Share series is a closing index value for the last trading day of the year. ***Gold series is New York Market Price (U.S. dollars per fine ounce).

As Table 1 and Figure 1 below illustrate, land appreciated in aggregate over the long term. Farmland real price growth was 0.33% annually over extended 1781–2013 period. Gold and stock prices behaved in a similar way. Over the nineteenth and mid-twentieth centuries, despite fluctuations, the three asset classes saw little real net appreciation until the early 1970s when inflation drove all three series significantly upwards, though with some periods of negative correction.

Figure 1 illustrates that land prices between 1850 and 1920 did not vary much year on year. Over the period 1800–2013, the range of returns to land was huge but the real geometric mean (see methodology section) of annual price changes was 0.71% for land, 0.45% for the FTSE index and 0.00% for gold.

Literature review

In order the evaluate the relative performance of land compared to other asset classes and gain insights into the land price dynamics, the research reviews a range of economic, real estate and industry literature. The diverse literature facilitates a long-term view for land price analysis (Ambachtsheer, Pollice, Waitzer, & Vanderpol, 2013; Generation, 2011, 2012; Makridakis et al., 1998; Solomou, 1998).

Stocks and bonds

In this section, we refer to previous work reporting returns on asset types. In doing so, we will use the term 'return' to mean the total return – income plus capital appreciation measured annually. We will also discuss real returns (returns net of inflation).

To measure total return, we need evidence of annual income (dividends for stocks, coupons or interest payments for bonds and rent for real estate). The absence of this evidence limits us to a study of capital appreciation or a price series. It is important to bear in mind this distinction between series of total returns and prices.

We begin our discussion with evidence of long-term stock and bond returns, which is reasonably plentiful. For example, beyond property, Smith (1928) examined the performance of stocks and bonds over the 1866–1922 period. Smith produced a series of scenarios comparing diversified common stock portfolios with bond portfolios. His empirical analysis suggested that stocks outperformed bonds in the long term. Siegel (2014) urged investors to take a long-term view of returns by demonstrating that stocks provided real annual returns of 5% over the last 200 years. Stocks outperformed other traditional investment assets including bonds and gold.

Earlier, Mehra and Prescott (1985) and Mehra (2003) noted the long run outperformance of equity returns. Their study of 90 years of returns on the Standard and Poor 500 Index estimated real average annual returns for equities of 7%. The authors originated 'the equity premium puzzle' – the phenomenon for US stock returns to be considerably higher than rationally can be accounted by their relative volatility compared to returns for Treasury Bills.

Dimson, Marsh and Staunton (2002, 2003, 2014) took the 'the equity premium puzzle' anomaly further and investigated real returns on equities for 16 different countries over the 100-year plus periods. Their studies suggested that equities generated the highest returns compared to alternative asset classes, including bonds, bills and currencies. However, these commentators urged investors and analysts to be cautious due to survivorship bias and focus on periods that with hindsight are known to have been successful. Dimson et al. (ibid.) used this limitation to advocate a greater international diversification across various asset classes.

Real estate returns and prices

Historically, Clark (2002) explores the complex evolution of UK housing markets over the extended period 1550–1909. The more recent, commercially orientated literature, re-affirms real estate's dynamic complexity including, for example, an examination of cycles and 'bubbles' (Ball, Lizieri, & MacGregor, 1998; Baum & Hartzell, 2012; Bill, 2013). One problem with identifying bubbles in asset markets is the lack of sufficient long-term data to detect if asset prices deviate significantly from fundamental values (Ambrose, Eichholtz, & Lindenthal, 2013).

While global benchmarks exist to describe the universe of listed equity and bond securities (Bloomberg, 2015), the global real estate universe is less well defined (MSCI, 2015; S&P, 2015). Existing indices mostly cover trends in eligible real estate equities worldwide (FTSE/EPRA, 2015; S&P, 2015), while sector-specific indices (covering, for example, residential, forestry and farmland sectors) are less developed.

In continental Europe, Eichholtz (1997) studied the Dutch housing markets. He constructed a price index for the Herengracht (a canal side street in downtown Amsterdam) which suggested that over the 345-year period from 1628 to 1973, house prices increased 2.2 times. House prices doubled between 1628 and 1929 and growth flattened thereafter. Eichholtz discovered little real growth in real estate values over this three-century period. Shiller's (2006) assessment of the US real estate market matched Eichholtz's observations. Shiller constructed a US home price index starting from 1890. He found that real home prices were 66% higher in 2004 than in 1890. The increase in real values averaged 0.4% over the 114-year period.

Turning to commercial real estate, sources including *inter alia* Scott (1996), IPD (now MSCI) (1999), Wheaton et al. (2009) and Devaney (2010) reach a similar conclusion of muted but positive real growth over a long time period. Using Scott's findings, IPD (1999) examined UK commercial property returns starting from 1921. The report assessed cyclical characteristics of the sector, examined links between property and the wider economy and compared returns from property against other asset classes. This historical analysis suggested that property yielded returns of 8.8% p.a., which was above cash and gilts but below equities. However, this performance weakened after the 1980s compared to other asset classes. Annualised property returns over the 1970–1997 period stood at 12.3%, while returns for gilts and equities were surprisingly both, respectively, higher at 13.1 and 16.8% over the same period. De-composing these returns, nominal income return varied between 4% (in 1949) and 9.1% (1993) producing two-thirds of the nominal total returns, with capital growth averaging less than 3% per year. Inflation over this period ran at around 3.75%; real capital values appear to have fallen by an average of around 1% each year over the 75-year period 1921–1996.

For the US, Wheaton et al. (2009) suggested that real commercial office values in Manhattan were 30% lower in 1999 compared to 1899. The authors compiled a series using 86 repeat-sales transactions for office buildings in the area. The researchers restricted themselves only to 'institutional grade properties'. They considered buildings of 10 or more stories, with elevators and of no less than 250,000 square feet in area. After adjusting the transaction values for inflation, their results were in line with other studies on the subject suggesting modest nominal value appreciation – and real declines – for commercial property.

Devaney's (2010) assessment of office rents in the City of London over the 1867–1959 period enabled him to measure the long-term performance of this property segment. The series exhibited distinct periods of rise and decline displaying similarities to Wheaton et al.'s (ibid.) observations for the US, with real rental growth over the 92-year period close to zero (0.1% p.a.).

Land prices

Ricardo (1821) and then Von Thunen (1826) made the first contributions to systematic study of land prices (McDonald & McMillen, 2011). A century later, Thompson (1907) investigated the rental values of agricultural land in England and Wales. Thompson's study covered the nineteenth-century period (1801–1900). Thompson's (ibid., p. 602) analysis suggested that 'the average rent of agricultural land in England and Wales in 1900 was 30 per cent below the figure of 1872, 34 per cent below the maximum of 1877, and 13 per cent below the figure of 1846', although he drew attention to the difficulty in settling on finite descriptive statistics within heterogeneous markets. The other challenge for Thompson was to separate agricultural land from its residential, woodland or other auxiliary components, as improved farmland, including residential property built thereon for the farm operator, has a value distorted by that improvement. Thompson also struggled to deal with episodic price fluctuations in the series, highlighting farmland market heterogeneity.

Four other challenges complicate farmland valuation. The first is options around the transition into development land. Politics, the vagaries of planning and urban population growth muddy the waters of peri-urban agricultural land markets. Second, the post-Brexit subsidy regime is uncertain (Swinbank, 2017). Third, as well as its diversification benefits, land investment provides significant tax deferral advantages (Bailey, 2013; Freshwater, 2013; Oltmans, 2007). Finally, land and its associated country pursuits enhance social status (Lund, 2016).

Much of the published work on land prices has an urban dimension. In the US, Hoyt (1933) examined land values in Chicago over the period 1830–1933. Generally, Hoyt suggested that business conditions, commodity price levels, value of money and especially a rapid increase in population within a relatively short period drove urban land price inflation. The overall findings, however, suggested modest gains for urban land.

Also in the United States, Edel and Sclar (1973) examined the performance of land prices and house values in the Boston metropolitan area over a 100-year period. Their estimates suggested that over the century economic gains in real estate did not deliver a significant capital gain when adjusted for inflation. An explanation could involve the relative decline in traditional industries and a structural shift towards the 'sunbelt' states.

On the other hand, Atack and Margo (1996) assessed price changes for vacant land in New York City between 1835 and 1900. The authors used sales figures for individual lots obtained from four New York City daily newspapers. Their estimates suggested 'an extraordinary increase in the price of land in New York City' (ibid., p. 16). In 1845, average prices were $0.48 per square foot while by 1900 the average stood at $5.85 (a 1200% increase). Similarly, Case's (1997, in Glaeser and Quigley (2009)), examination of land values in the Boston area over the 1900–1997 period suggested superior returns. According to Case, real growth in the price of land in the area was 3.9% per annum. These cases of urban expansion are clearly special, and illustrate the need to separate farmland price growth from growth in development land values.

Allen (1988) assessed prices of freehold land in the seventeenth- and eighteenth-century England. During the early period of Allen's study, land was considered the only long-term investment asset available (see also Neild, 2008). By the beginning of the eighteenth century, however, the impact of overseas trade altered the situation. New long-term financial assets, for example government bonds, East India company shares and mortgages, came onto the market. As a result, land lost its appeal and no longer commanded a premium. The net return from land fell in line with other interest rates. For example, between 1600 and 1624, net returns on land and mortgages were, respectively, 4.63 and 10%. However, this gap contracted early in the eighteenth century. Between the years 1704 and 1713, land generated 4.81% net returns while mortgages offered 5.50%. Over the latter period 1805–1814, net returns were 2.82 and 5% on land and mortgages, respectively.

Offer (1991) examined tenure and landownership in England. His research covered the period from the 1750s to 1950s. He asserted that land, due to its finite supply, is a 'positional asset' and can confer social, political and economic authority in addition to its monetary returns. Nevertheless, status notwithstanding, Offer was puzzled by the economic rationale behind farmland investment. In England, as he commented, land was sold at a higher multiple (years' purchase, or YP) than government securities. Even allowing for its ancillary consumptive advantages, the premium exceeded rational explanation. Offer therefore criticised Allen's (1988) comments that a large YP was not sufficient to conclude that land was overpriced and suggested just the opposite. According to Offer, agriculture is volatile. It is a subject to unpredictable external and internal factors. Yet, its output was rated as being more secure (driving a higher YP) 'than income guaranteed by the crown' (ibid., p. 1), though investment in land was not 'comparable with the advantages which the money of a successful business man can command' (ibid., p. 15).

Lloyd (1992) used time series (error-correction, co-integration and ARIMA) modelling techniques to model land prices in England and Wales. The author employed the Oxford Institute Series for the period 1859–1990. Lloyd's estimates suggest that total returns on farmland are adequate. The real rate of return on farmland (with changes in rents) stood at 3.6% per annum over the 132-year period. Lloyd hypothesised that changes in rents influence short run dynamic behaviour of land prices while it is less responsive to inflation. These values were in line with Burt's (1986) findings. In his study of the land market in the United States, Burt estimates that the capitalisation rate for farmland prices had averaged 4%.

However, as with Eichholtz (1997), Wheaton et al. (2009) and Devaney (2010), Lloyd (1992) detected bouts of land market exuberance. To document his point, Lloyd (ibid., p. 13) quoted Sturmey's (1955) remarks:

> the history of English Farming over the lifetime of those living in 1900–39 suggested that, even if it was the Cinderella among industries in peace, in war-time pumpkins turned into carriages of gold and glass slippers were made to fit its feet, so that any farming venture commenced in the early war years was likely to show substantial returns before the Prince Charming tired of his bride and sent her back to the hearth. For the investor this meant largely the chance of capital profits on the realisation of properties when the war might end.

Despite these efforts, it appears from our literature review that compared to other asset classes, the evolution of land prices is currently an under-researched area. Therefore, a re-examination of this topic is needed.

Data

In the UK, a small number of land price/value-related series are provided (as is the case for other real estate sectors) by both public and private organisations. One of the best-known UK land prices series is produced by Savills. Savills reports two series. The first is farmland values for England, Scotland and Wales. This data-set is based on the quarterly valuation of a static portfolio of nine types of bare land with vacant possession in 25 regions across Great Britain by a panel of Savills agricultural valuers. The most recent data cover both arable and livestock land across eight different areas of Britain and are available from 1992 (Savills, 2015).

Second is a long-term farmland values series, which is one of the longest indicators available. This series is available from 1900 annually in current and at 2017 (forecast) prices (Savills, 2013). Its predecessor is the Oxford Institute Series, which recorded annual average prices for vacant possession and tenanted land sold at auction. This was a pioneering work carried out by D.K. Britton and J.T. Ward (Britton, 1949; Ward, 1959) and continued by G.H. Peters and A.H. Maunder who initiated the study on land prices (Farmland Market, 2006). The Oxford Institute Series are available in the public domain with data going back to 1945. The series was taken over by the Savills research department in 1989 and extended using historical records Oxford Institute contained to 1900 (Walsh, 2001).

Knight Frank (KF) (2015) produces its own English Farmland Index. It is an opinion-based index, compiled quarterly by Knight Frank's Farms & Estates and Valuations staff in the UK. According to the Knight Frank report, the index tracks the price performance of bare agricultural land without dwellings or buildings. The index is available from 2003. Knight Frank also reports farmland prices in pounds (£) per acre, with the series going back to 1963.

The MSCI (2014) UK Annual Rural Property Index is another farmland series. It measures ungeared total returns to direct investment in a sample of tenanted farmland. The index is available from year 1981. At December 2013, the index contained 4208 assets/estates covering 338,340 acres of land, with a total capital value of £3.1bn. The index covers eight regions including the South East, South West, Eastern, East Midlands, West Midlands, Yorks and Humberside, North West and North East, and what MSCI calls 'Other' regions, as well as 'all UK'.

The RICS/RAU (2014) Farmland Price Index for England and Wales (CALP/RICS series) offers an alternative to commercial data-sets. This is a transaction-based series which contains any transactions reported to the RAU which are of five hectares and above, and includes all types of farms, with or without buildings and residential property, if the residential element of the sale price is less than 50%. These rules are those adopted by the Ministry of Agriculture, Fisheries and Food (MAFF), forerunner to Department for Environment, Food and Rural Affairs (DEFRA), when it set up a land price series in 1973, to which the RICS index is a successor (from 1995). The price information supplements the opinion survey on prices for arable and pasture land, by region and nationally, together with opinion on supply and demand. The RICS/RAU (RICS/RAU, 2014) index is considered as being the only independent indicator of market movements in the UK.

In addition to current land prices series, several historical land price indices are available, including Thompson's (1907) series on the average rent per acre of agricultural land from 1800 to 1900; the Oxford Institute (available from Lloyd, 1992) data-set on prices of agricultural land in England and Wales for the 1850–1990 period; and DEFRA's (2006) agricultural land sales and price series for England from 1944 to 2004.

Except for the IPD series, the focus of the series discussed in Table 2 is on price appreciation rather than on the measurement of total returns. This is unfortunate, as it makes a comparison of returns on different asset types including farmland impossible before 1981.

The scarcity of long run evidence of rental income from farmland may in time be rectified, although this will require significant primary research. It is explained partly by the widespread owner-occupation of farmland as opposed to tenanted farms producing income and by distortions created by rent controls. The government collects and publishes rent data, but only back to 2005; Savills also has a rent series, again covering only recent history. Our long-term study is therefore limited to prices.

Table 2. UK land price series.

Series	Basis	Time-period	Measurement unit
Savills	Valuation based	1900 – 2015	£/acre
IPD (now MSCI)	Valuation based	1981 – 2015	£/acre
Knight Frank	Opinion based	1965 – 2015	£/acre
RICS/RAU	Transaction based	1994 – 2015	£/hectare
Norton and Gilbert (1889)	Transaction based	1781 – 1880	£/acre
Oxford Institute	Transaction based	1859 – 1990	£/hectare
DEFRA (2006)	Transaction based	1944 – 2004	£/hectare

Methodology

Clearly, existing land price series present some disparities. It is possible to question some as they are produced by commercial organisations with an interest in promoting the asset class. The series vary in duration; they cover different periods; their composition methodology also differs. To alleviate UK farmland market data variation and gain a greater appreciation of the UK farmland performance over long period of time, the current study produces a combined series.

Savills offers a land price benchmark which stretches over more than a century. As noted, it is one of the best-known series available in the UK. The current study however produces an alternative and currently maintained independent land price indicator which covers a longer period of time. This research uses this new data-set to investigate the long-term performance of land prices in England, and compares land price returns with alternative investment assets, including equities and gold.

Annual chain-linking

To produce an alternative land price series, this study combines existing series into one using an 'annual chain-linking' approach. Chain-linking is not the only methodology available to link series as different authors used different methods to achieve this aim. Liesner (1989), for example, used the simplest series combination solution. She (ibid., p. 271) 'used simple average estimates as the central point to construct national accounts'. In other words, Liesner simply averaged overlapping series which, as Savage, Danziger, and Markowitz (2012) point out, is statistically insufficient, as simple averaging distorts the dynamics of the series. Averaging is certainly an easy solution when combining overlapping series but the process does not consider individual series variations and related characteristics such as seasonality or/and cyclicality.

As an example of a more robust technique applied in a different context, Gruneberg and Hughes (2005) employed blending techniques involving correlation analysis to detect which of the available series had a greater statistical relationship. The authors used competing and overlapping construction series to build a reliable market series which commentators then used to model UK construction orders and output. Series viability was established from significant correlation coefficients.

For theoretical and empirical reasons, however, 'Chain-Linking' is considered as a better series combination approach. In contrast to series averaging, an advantage of chain linking is that it is 'joining together two indices that overlap in one period by rescaling one of them to make its value equal to that of the other in the same period, thus combining them into a single time-series' (OECD, 2005, p. 97). In other words, the chain-linking technique combines two series without losing time series properties.

Chain-linking has been used by major organisations, including the Scottish Government (2007), ONS (Tuke & Reed, 2001) and the World Bank (2012), to construct long-term economic series. McKenzie (2006) indicated that in the year 2006, 14 out of 29 OECD countries used some sort of linking methodology for index combination.

Tuke (2002) and Robjohns (2006) underscore the two major principles underpinning the chain-linking methodology. These are fixed base year chain-linking and annual chain-linking. Fixed base year chain-linking uses a set of weights which are applied to each component of the index to produce an aggregate measure. This method revises weights every five years. However, in a changing economy, it may not be adequate, as this approach does not reflect the current state of the market. Therefore, annual chain-linking is recommended to measure aggregate figures more frequently. As the name suggests, rebasing is performed every year.

Stutely (2010) suggests a four-step algorithm for chain-linking index numbers: (i) identify a time period/point at which series overlap; (ii) divide the rebased series by the base value; (iii) multiply the rebased series by the result; (iv) apply the rebasing principle on the rest of the series. Mathematically, this algorithm can be expressed as follows:

$$Z_t = \frac{Y_t}{1 + \left(\frac{X_t - X_{t-1}}{X_{t-1}}\right)} \tag{1}$$

where Z_t is new chain-linked series, Y_t is the base series, X_t is the series which is rebased and t is time period.

Equation 1 is used when the current series is a base and an older data-set is being rebased, in other words when chain-linking moves into the past. Table 3 below illustrates an example.

Performance measurement

When observing efficient markets (Fama, 1965, 1970; Fama, Fisher, Jensen, & Roll, 1969), the asset price should incorporate all available information and expected future earnings from that asset (Malkiel, 2003, 2005). This premise of the efficient market hypothesis (EMH) has been well documented (Malkiel, 2003, 2005; Shiller, 2003) suggesting that economic agents make rational decisions (Kahneman, 2012; Thaler & Sunstein, 2009).

While, theoretically, English farmland buyers should consider only the economic aspects of their investments, i.e. the expected and required income returns and capital growth from farmland, it is well known that property markets are not entirely efficient (Case & Shiller, 1989; Shiller, 2014). Presumably, the land market is also afflicted by information asymmetry, 'lemons' and the 'agency problem' (Anglin & Arnott, 1991; Case, Shiller, & Weiss, 1993; Wong, Yiu, & Chau, 2012). What is more, as noted above, although land values are at the core of urban economics, land values series have been inadequate and fragmented (Albouy & Ehrlich, 2013).

The present research produces a price series with a focus on capital returns to characterise the past. It examines price changes during the research period disregarding the income

Table 3. Example for chain-linking two series.

Year	RICS series	DEFRA series	DEFRA series (%)*	Old index rebased	Chained index
1992		3617.00	4.81	3791.06/(1+4.81%)	4397.51
1993		3791.06	11.55	5141.50/(1+11.55%)	4609.14
1994	5141.50	4229.04			5141.50
1995	5437.75				5437.75
1996	6704.75				6704.75
1997	7301.25				7301.25
1998	7065.50				7065.50
1999	7025.75				7025.75
2000	7103.50	`			7103.50

*the percentage series are growth numbers estimated using the following equation:; $R_t = V_{t+1}/V_t - 1$, where V_t is the current value of the series and V_{t+1} is the value of the series in a following period t.

received from the farmland. For this longitudinal analysis, a standard formula was adopted to estimate percentage changes of the English farmland prices over time. The formula adopted is as follows (Baum & Hartzell, 2012):

$$R_t = \left(V_t - V_{t-1}\right)/V_{t-1} \tag{2}$$

where R_t is the asset returns over the time period t, V_t is the current value of the asset at the time period t and $V_{t\text{-}1}$ is the value of an asset at the previous time period.

However, as commented by Baum and Hartzell (ibid.), a total return should incorporate income received from that asset:

$$TR_t = \left(Y_t + V_t - V_{t-1}\right)/V_{t-1} \tag{3}$$

where TR is the total return of an asset and Y_t is the income received from time *0* to *1*.

As noted, Y_t is not included in the current study.

Following on from this, the capital (price) returns on farmland need to be determined as an average over time. There are two traditional methods of calculating average return: these are the arithmetic mean and geometric mean (Anson, Fabozzi, & Jones, 2011). The arithmetic mean is the sum of all returns divided by the number of observations:

$$\widehat{R}_t = \frac{1}{t}\sum_{t}^{1} R_t \tag{4}$$

where $\widehat{R}_t$ is the average return on an asset over the period t.

The geometric mean uses compounding to estimate return which is estimated as follows:

$$R(G) = \sqrt[t]{\left[1 + R_1\right] * \left[1 + R_2\right] * \dots * \left[1 + R_t\right]} \tag{4}$$

where $R(G)$ is a return for the geometric mean.

This is the single average rate of return required to allow an investment made at the start of the period to accumulate to the same end value as the individual year returns would produce. This study uses the geometric mean to reflect the compounding nature of this measure and its likely application to forecasting.

Series construction

The study uses four independent series to construct long-range English farmland series. First, the most recent RICS/RAU farmland price series for the 1994–2013 period acts as the basis for the future chain-linked data-set (RICS/RAU, 2014). Second is DEFRA's (2006) average price of agricultural land in England, available for the 1944–2004 period. The combined series extends land prices time series from 2013 to 1944. The third series is the Oxford Institute's series of land prices, available for the 1859–1990 period from Lloyd (1992). The last data-set is Norton, Trist and Gilbert's (1889) average price (£ per acre) of agricultural land from 1781 to 1880.

Linking various available series allows the construction of a land price data-set which goes back to the end of the eighteenth century. However, this approach has some limitations.

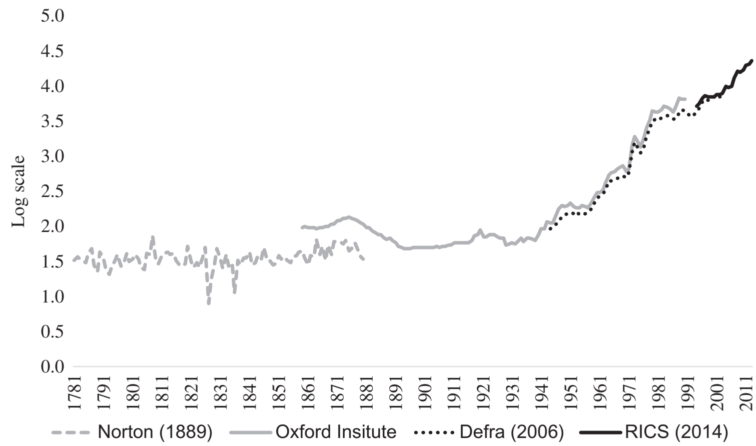

Figure 2. England farmland prices (1781–2012) (£/ha). *Source:* Norton and Gilbert (1889), Lloyd (1992), DEFRA (2006); RICS/RAU (2014).
*Norton et al. (ibid.) series were converted from acres to hectares dividing land values by 2.47.

Table 4. Series summary statistics and correlation estimates.

	Series			
Summary statistics	Norton and Gilbert (1889)	Oxford institute	DEFRA (2006)	RICS/RAU (2014)
Mean	37	686	2365	11,092
Median	35	96	12,723	8619
Std. Deviation	11	1494	2421	5510
Kurtosis	1	6	−1	0
Skewness	1	3	1	1
Range	65	6670	7561	17,816
Minimum	8	47	93	5142
Maximum	73	6717	7654	22,957
Count	100	132	61	20
Correlation coefficients	Norton and Gilbert (1889)	Oxford Institute	DEFRA (2006)	RICS/RAU (2014)
Norton and Gilbert (1889)	1	N/A	N/A	N/A
Oxford Institute	0.43	1	N/A	N/A
DEFRA (2006)	N/A	0.99	1	N/A
RICS/RAU (2014)	N/A	N/A	0.88	1

Notes:*Land prices (£/ha); **Correlation in levels.

A long-term series combination is imperfect unless the data sources and method employed are identical, which is not the case. Annual chain-linking is a mechanical procedure and combines series disregarding their heterogeneity. Nonetheless, correlation analysis helped vet the series' comparability.

First, the RICS/RAU farmland price series was extended by chain-linking it with DEFRA's (2006) farmland series. The correlation coefficient of the levels series over the period 1994–2004, when the two series overlap, is 0.88. Very strong positive correlation provides *prima facie* linking evidence. The combined series was then further extended by chain-linking it with the Oxford Institute series. The correlation analysis over the 1944–1990 period, when both series overlap, indicates almost perfect positive correlation with a correlation coefficient of 0.99. Figure 2 shows that these data-sets appear to be almost identical. Accordingly, by chain-linking both series, the farmland series was extended to 1859. Finally, the Oxford Institute's land price series was chain-linked with Norton and Gilbert's (1889) average price

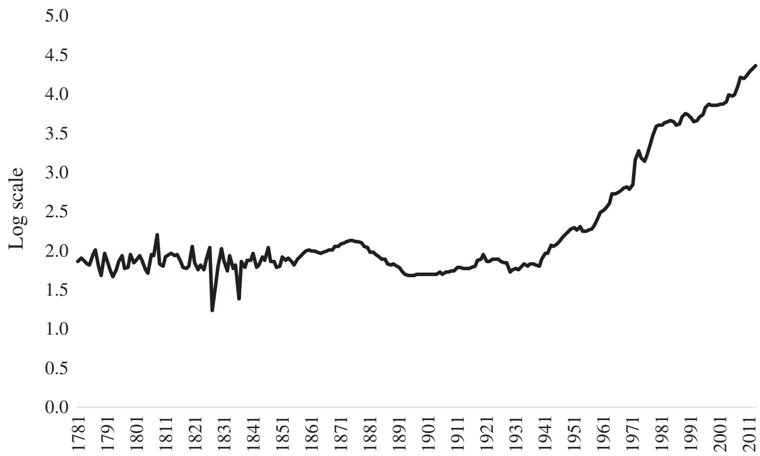

Figure 3. Chain-linked average price of agricultural land in England (£/ha) (1781–2013).

of agricultural land, extending the series to 1781. Unfortunately, it transpires that both Oxford Institute's and Norton's et al. series are not so well correlated, only registering a 0.43 correlation coefficient. The new chain-linked price series is therefore more reliable after 1859.

Figure 2 graphs all four series. Table 4 presents the key statistical properties of selected series and their correlation estimates.

Results

UK farmland price growth

Figure 3 presents a 233-year nominal series of the average price of agricultural land in England. The results suggest that, despite bouts of instability, farmland hardly appreciated until the 1970s. The introduction of the Town and Country Planning Act 1947 altered the dynamics of housing supply and inflated the value of peri-urban land outside green belts (Cheshire, 2014). One possibility is that 'survivor bias' could have generated spurious results. The phenomenon artificially inflates or deflates performance by restricting analysis to designated category assets (here restricted to continuously farmed land). In effect, the series could have sidelined farmland which transitioned from agriculture to urban development and hence ignored peri-urban planning gains, enabled by information and transportation technology.

For Lloyd (1992) and Francis (2000), the key historical influences on land prices in England after the WWII were British Government policy and inflation. Interventions to encourage domestic production and state protectionism attracted institutional investors and high net wealth individuals (HNWI) to farmland and stimulated demand, and inflation clearly drives land prices. In this policy and inflationary milieu, the UK's accession to the European Community ushered in 'a new era of volatility' (Francis, 2000; Lloyd, 1992). Demand, fuelled by the extension of trade links (Francis, ibid.), was compounded by two oil crises during 1973–74 and 1978–81 (Lee & Ni, 2002) which stoked food and commodity prices (Cooper & Lawrence, 1975) and pushed land prices higher. Following Lloyd (ibid., p.

22.), 'the combined effect of soaring inflation, economic recession and CAP support mechanisms had dramatic ramifications on the land market and led to the most turbulent period in the market's history since the frenetic activity in the 1920s'. On the supply side, seeing land price inflation farmers were reluctant to sell their land, which further elevated land prices. Ironically, rather than heralding in a new era of agricultural stability and prosperity, disequilibrium and turbulence characterised UK land markets in the 1970s (Francis, ibid.). Land prices inflated by 145% between 1970 and 1973, and by 66% between 1975 and 1979.

Following a hiatus in the 1980s and 1990s, more recently the cost of farmland in the UK has risen again (Jadevicius & Martin, 2014). Figures from the RICS/RAU (2014) Rural Land Market Survey suggest that average land values increased by 3% to £9,594 per acre (£23,217 per hectare) in the first half of 2014. Land prices were 12% higher compared to the same period in 2013. Compared to 1994, when RICS/RAU began recording rural land prices, land values have increased 400% from £2,028 per acre (£4,908 per hectare).

UK farmland real price growth

The impression of substantial farmland price growth depicted in Figure 3 is strengthened by looking at real price performance over the research period shown in Figure 4 and Table 5. Certainly, English farmland prices have experienced interchanging eras of growth and decline. Visual series analysis suggests three distinct transition periods. The 1801–1945 period saw negative real price growth of −0.09%. However, growth accelerated between 1946 and 1970 when real values advanced by around 2.45% per annum. Over the 1971–2013 period, real growth in land values remained almost unchanged at 2.42%. During the overall 1781–2013 period, average real land price growth (as measured by the geometric mean) was 0.33%. .

Interestingly, these estimates share similarities to other traditional asset classes including other forms of real estate. Real returns from UK farmland were close to returns on US Stocks and US (short term) Bonds, respectively, if compared to Siegel's (2014) estimates.

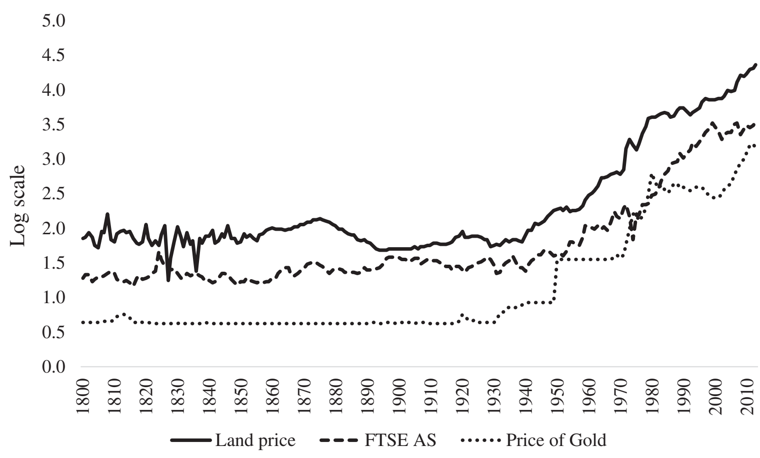

Figure 4. Real agricultural land, stock and gold prices in England (£/ha) (1781–2013). *Source*: The historical inflation data comes from O'Donoghue, Goulding, and Allen (2004) and the ONS (2014).
**The series were transformed into real by deflating nominal values by CPI index using the following equation: $R_t = N_t/PI_t * 100$, where R_t is real value, N_t is nominal value and PI_t is price index at the time period t (Dallas Fed, 2014; O'Donoghue et al., 2004).

Table 5. Nominal and real land price growth.

	Mean(G)	Std. Dev.	Min.	Max	Count
Nominal land price growth					
1781 – 2013	2.52	26.24	−84.00	200.00	232
1801 – 2013	2.76	25.72	−84.00	200.00	213
1801 – 1945	0.37	28.93	−84.00	200.00	145
1946 – 1970	6.74	8.94	−12.20	32.83	25
1971 – 2013	8.81	19.44	−18.25	103.33	43
Real land price growth					
1781 – 2013	0.33	26.56	−82.95	194.06	232
1801 – 2013	0.71	26.17	−82.95	194.06	213
1801 – 1945	−0.09	29.87	−82.95	194.06	145
1946 – 1970	2.45	9.65	−14.12	28.54	25
1971 – 2013	2.42	18.20	−29.56	89.80	43

Notes:*Growth is a geometric mean returns over the sample period.

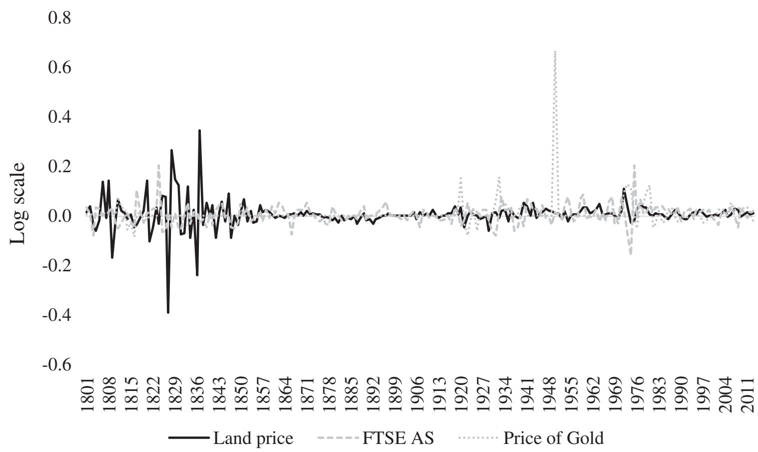

Figure 5. Real growth series of agricultural land (£/ha), FTSE all share index and the price of gold ($/ounce) (1800–2013). *Source:* FTSE series come from GFD (2015) and LSE (2015); Gold values obtained from Officer and Williamson (2015).

According to Siegel, real capital appreciation of the US stock market was 1.6% p.a. over the 1802–1997 period. As noted above, office rents in the City of London did not appreciate above inflation (Devaney, 2010), while Dutch house prices grew by 0.5% p.a. in real terms over the three centuries (Eichholtz, 1997). Taking a long-term view, the escalation of UK farmland prices was significant, aligning with Dutch housing (Eichholtz, ibid.), and beating inflation, US commercial office values (Wheaton et al., 2009) and office rents in the City of London (Devaney, ibid.).

This evidence of farmland performance is more meaningful when it is compared with the performance of the FTSE index and the price of gold. The geometric mean of annual real price changes over the period 1801–2013 was 0.71% for farmland, 0.45% for the FTSE index and 0% for gold.

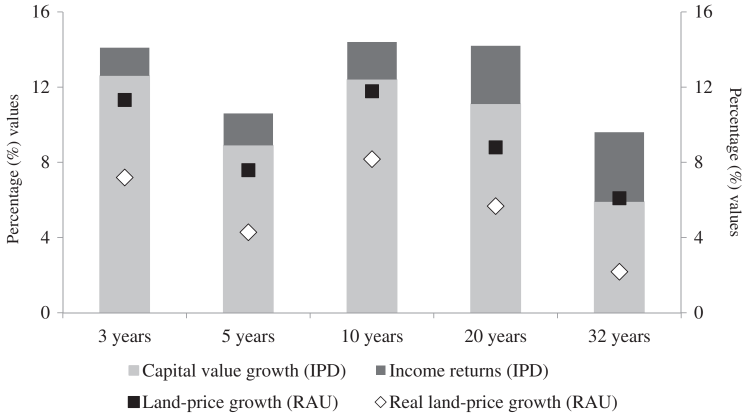

Figure 6. Farmland total returns. *Source*: MSCI (2014) and authors' calculations.
*Returns are arithmetic mean over the designated period.

Farm income

The price series analyses exclude farm income whose incorporation would enable the computation of annual returns and would enrich the current study. MSCI (2014) does include income in its UK Annual Rural Property Index which boosts total annual returns from a farmland by about 1.5% (Figure 6). Unfortunately, MSCI's data only stretches back to 1988. By addressing this so-called 'performance measurement' issue (Baum and Hartzell, ibid., p. 475), were an imputed income return added to price series, it is likely that even passively managed farmland total returns would comfortably exceed the inflation rate.

In some respects, as a safe haven, farmland behaves more like gold due to its low correlation with other financial asset returns (Kuethe, Walsh, & Ifft, 2013; Painter, 2010). Correlation coefficients were −0.061 and 0.126 between land price growth and the FTSE index and the price of gold, respectively; low correlations were also observed between real land price growth and other assets, i.e. −0.004 and 0.185 with equities and gold.

Conclusion

This research extended the English farmland price series to cover the past two centuries of data. The extended series helps reduce information asymmetry and improve resource allocation for investment analysts, farmers, developers, planners and other stakeholders. The combined series illuminates English average farmland price dynamics and changing land market fortunes.

To construct the series, we adopted a chain-linking approach. The constituents for the longitudinal data-set were Norton's et al. average price per acre of agricultural land, the Oxford Institute land prices series, DEFRA's average price of agricultural land in England and RICS/RAU's farmland price series. The acknowledged issues around long-run chain component heterogeneity do not, in the opinion of the authors, undermine the substantive contribution of the research to extend the price series back, certainly to 1859 and maybe to 1781.

From 1781 to 2013, the geometric mean of UK farmland real price growth was 0.33% annually. Later, from 1801 to 2013, growth accelerated to 0.71%. From the time series data, which ignore rental income and the various tax advantages of holding land, we infer that land, in aggregate, provided investors a 'safe haven' and/or hedge against inflation. To transform the times series into a robust investment performance measure would require inclusion of data on farm incomes. This, it appears, would perhaps add another 1–2% of income return to produce total real returns of around 1.5–2.5%.

The linked series provides a springboard for further farmland price research, geared around the paper's limitations. First is macroeconomic modelling of farmland fundamental price drivers such as GDP or evidence of long-term rental income. While Brexit has unsettled the forecasting landscape, models still facilitate informed comparison of returns on farmland with other asset types. The second research avenue is data-intensive farm-scale modelling to reflect spatially differentiated net income prospects. At the micro-level, farm prices depend on expectations of long-run income streams from diverse sources, including production, transfer payments and peri-urban development opportunities. The final area for future farmland price research involves incorporating nuanced cultural and social dimensions of land holding in different settings.

Disclosure statement

No potential conflict of interest was reported by the authors.

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