What Moves the German Land Market? A Decomposition of the Land Rent-Price Ratio

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Abstract

The price increases on agricultural land markets over the last decade have triggered a debate about land as an attractive investment opportunity for agricultural and non-agricultural investors. In a static environment, the rent-price ratio provides a first indicator of the profitability of an investment in land. In this paper, we apply the dynamic Gordon growth model to Western Germany and decompose the rent-price ratio into the expected present values of rental growth rates, real interest rates, and a land premium, i.e., the excess return on investment. This analysis reveals that the recent price surge on agricultural land markets was not unprecedented; that the land market rent-price ratio is rather low and varies considerably among federal states; and that (expected) premia for land are mostly negative. Finally, we find that changing expected present values of returns on land investments are the major driver for land price volatility.

Key Words

agricultural land market; rent-price ratio; Campbell-Shiller decomposition; dynamic Gordon growth model

1 Introduction

The German agricultural land market has witnessed a sharp price surge in the last decade. Indeed, the average price for arable land increased from 9,205 euros per hectare in 2007 to 24,064 euros per hectare in 2017 (STATISTISCHES BUNDESAMT, 2018). A similar development can be observed in other European countries as well, e.g. Great Britain (EUROPEAN COMMISSION, 2018). In light of the importance of land as a production factor in agriculture, it is not surprising that the booming land market has become the subject of extensive empirical research. These research activities address different research questions. A first strand of literature focuses on understanding the specific role of economic determinants of land prices. This kind of analysis is usually conducted in a hedonic pricing framework. LATRUFFE and LE MOUËL (2009) assert that agricultural support policy instruments contribute to increased land prices in general. A meta-analysis on the impact of subsidies on agricultural land prices provided by FEICHTINGER and SALHOFER (2013) reveals that agricultural subsidies significantly contribute to an increase in land prices. Likewise, HENNIG et al. (2014) report a significant positive effect of payment entitlements on land rental prices. Focusing on biogas subsidies, HABERMANN and BREUSTEDT (2011) and HENNIG and LATACZ-LOHMANN (2017) investigate how and where land rental prices in Northern Germany are inflated by bioenergy feed-in tariffs and assert that increasing rental rates due to biogas production can only be identified in regions with high livestock density. In the same vein, RITTER et al. (2015) document a positive relationship between arable land prices and the density of wind turbines in the state of Brandenburg, Germany. A further potential cause for increasing land prices that has been studied is the heightened interest of non-agricultural investors in the aftermath of the financial crisis. It has been conjectured that the lack of profitable investment alternatives in the traditional financial markets has redirected a flow of external capital into the agricultural sector (DEININGER and BYERLEE, 2011). This additional demand from outside the sector has aggravated the price pressure on land markets. In the media, the (large scale) land acquisition by financial investors is often labelled as "land grabbing" (e.g. KAY et al., 2015). VAN DER PLOEG et al. (2015) assert that this process is not confined to developing countries but also takes place in the European Union. However, for the case of Germany there are only a few empirical studies that try to provide evidence for this "investor hypothesis", such as FORSTNER et al. (2011) and HÜTTEL et al. (2016b). Finally, urban sprawl is often claimed to be a major price driver on agricultural land markets, particularly in densely populated and industrialized countries (KUETHE et al., 2011; ZHANG and NICKERSON, 2015; LEHN and BAHRS, 2018). According to this view, high real estate prices on the fringe of metropolitan areas spill over to rural land markets.

A different strand of literature scrutinizes from a more general perspective whether soaring land prices can be traced back to economic fundamentals or whether speculative bubbles exist. The distinction between price changes due to fundamental factors and "excessive" speculation is crucial for the current policy debate on the regulation of agricultural land markets. The presence of speculative bubbles can be considered as market failure and such an incidence may warrant market interventions, such as direct capping of prices or refusal of "abnormally high" bids in land tenures. For the U.S. land market, FALK (1991) and FALK and LEE (1998) found that land price changes cannot be fully explained by changes in cash rents (at least in the short run). POWER and TURVEY (2010) also found evidence for short run price bubbles. In contrast, GLOY et al. (2011) conclude from their study that recent U.S. farmland values are in line with economic fundamentals. This view is also supported by OLSEN and STOKES (2015), who fail to reject the no-bubbles hypothesis. TIETZ and FORSTNER (2014) arrive at a similar conclusion for the agricultural land market in Germany.

The aforementioned work on speculative bubbles in land markets rests on the present value model of asset prices, according to which land prices can be derived from appropriately discounted future returns (cash rents and price changes) of owning this asset. In this view, the relationship between land rental prices and sales prices should be stationary unless a bubble drives a wedge between them. The present value model of land prices also constitutes the theoretical underpinning of this article. However, instead of focusing on the presence of bubbles, we aim at decomposing the rent-price ratio into various fundamental components.

The idea of decomposing the rent-price ratio into the aforementioned components has been proposed by CAMPBELL and SHILLER (1988) in the context of stock markets and has been used for numerous empirical applications in financial markets since then. For example, SHILLER and BELTRATTI (1992) analyzed the U.S. and the British stock market to explain co-movements between stock prices and bond yields. VUOLTEENAHO (2002) applied the method to firm-level stock returns and PLAZZI et al. (2006) to the commercial real estate market in the U.S. CAMPBELL et al. (2009) later performed the analysis on real estate markets. They find that housing premia account for a considerable part of fluctuations in the rent-price ratio in the U.S. housing market, while the covariances of interest rate, rental growth rate and housing premia dampen the variance of the rent-price ratio. Similar findings are reported by KIM and LIM (2014) for the Irish housing market. KISHOR and MORLEY (2015) modify the Campbell-Shiller decomposition and allow for a nonstationary residual that captures deviations of the rent-price ratio value from its long-run stationary value. Their analysis shows that much of the variance in the rent-price ratio can be explained by the variation in expected housing returns.

Given the theoretical and empirical relevance of the present value model for financial assets, it is somewhat surprising that the variance decomposition of the rent-price ratio has not been applied to agricultural land markets so far. The objective of the paper is to address this research gap. The economic factors that are considered in the decomposition include real interest rates, the growth rate of rental prices, and a risk premium. Disentangling these factors can help to answer a couple of relevant research questions: 1. How does the rent-price ratio differ among regions? 2. Do market participants expect growing cash rents? 3. Can land market investors expect returns that exceed real interest rates? 4. What factors contribute to the variability of the rent-price ratio in land markets? In our empirical application we analyze the relationship of rental prices and sales prices of agricultural land for Western Germany as a whole as well as for single states. We find that the rent-price ratio exhibits considerable variation over time and among states.

The remainder of this article is structured as follows: in the next section, we briefly review the Campbell-Shiller decomposition of the rent-price ratio and explain how we implement this approach empirically. Section 3 presents the study region and details the derivation of the model variables from the available data set. The empirical results are reported in Section 4 and the concluding remarks in Section 5 relate our findings to the current discussion about the efficiency of agricultural land markets.

2 Model and Empirical Approach

2.1 The Campbell-Shiller Decomposition

The starting point of the model derivation is the definition of the return of investing into one hectare of agricultural land:

$$\varphi_t = \frac{R_t + P_t - P_{t-1}}{P_{t-1}}, \tag{1}$$

where R_t denotes the real rental price per hectare at time t and P_t is the real sales price of one hectare of agricultural land at time t. The log rent-price ratio is then defined as

$$r_t - p_t = \log\left(\frac{R_t}{P_t}\right), \tag{2}$$

where r_t is the log of the real rental price and p_t is the log of the real sales price. Using these definitions and applying a first order Taylor approximation, CAMPBELL and SHILLER (1988) show that the log rent-price ratio $r_t - p_t$ equals the expected net present value of the future return minus the future real rent growth:

$$r_t - p_t = \\ k + E_t \sum_{j=0}^{\infty} \rho^j \varphi_{t+1+j} - E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \tag{3}$$

with

$$\rho = (1 + e^{\overline{r-p}})^{-1},$$

$$k = (1-\rho)^{-1}\left[\ln(\rho) + (1-\rho)\ln(\tfrac{1}{\rho} - 1)\right],$$

where φ is the gross real return, Δr is the growth rate of real rents, ρ is a discount factor to calculate the present value of future returns and rents, and k is a constant of linearization holding the level of the rent-price ratio. The discount factor ρ is linked to the average of the rent-price ratio and results from the first-order Taylor approximation. Eq. (3) is known as the dividend ratio model or the dynamic version of the Gordon growth model. It asserts that the rent-price ratio is high when returns are expected to be high or when rents are expected to grow slowly. Note that the classic version of the Gordon growth model, $P_t = \frac{(1+\Delta r)R_t}{\varphi - \Delta r}$ is a special case of Eq. (3) if the future return and the future rent growth are assumed to be constant over time, i.e., if $E[\varphi_{t+1}] = \varphi$ and $E[R_{t+1}] = (1+\Delta r)R_t$. The simple present value for land prices, $P = \frac{R}{\varphi}$, is obtained in case the growth rate of land rents Δr is zero. By relaxing the assumptions of a constant growth rate, the dynamic version of the Gordon growth model can address some of the inconsistencies of the simple present value model that have been criticized, for example, by CLARK et al. (1993)[1].

Following CAMPBELL et al. (2009) and KIM and LIM (2014), the model can be modified by decomposing the return to agricultural land φ into the real risk-free interest rate i and the excess return over the real risk-free interest rate π, called 'land premium' hereafter with $\pi_t = \varphi_t - i_t$. Then, the log rent-price ratio from Eq. (3) can be expressed as

$$r_t - p_t = \\ k + E_t \sum_{j=0}^{\infty} \rho^j i_{t+1+j} \\ - E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} + E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+1+j}. \tag{4}$$

Finally, introducing the following definitions for the expected present values of φ_t, i_t, π_t and Δr_t

$$\Phi_t = E_t \sum_{j=0}^{\infty} \rho^j \varphi_{t+1+j},$$
$$I_t = E_t \sum_{j=0}^{\infty} \rho^j i_{t+1+j},$$
$$\Pi_t = E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+1+j},$$
$$G_t = E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j} \tag{5}$$

the rent-price ratio model can be stated as:

$$r_t - p_t = k + \Phi_t - G_t \tag{6}$$

or

$$r_t - p_t = k + \Pi_t + I_t - G_t. \tag{7}$$

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1 CLARK et al. (1993) show that within the framework of the present value approach the time series properties of land rents are inherited to the time series of land values. Thus, it would be inconsistent, for example, to use the simple present value formula $P = \frac{R}{\varphi}$ when observing an explosive series of land rents.

2.2 Implementing the Dynamic Gordon Growth Model

To implement the dynamic version of the Gordon growth model, the unobserved expectations of the present values of future returns, interest rates and dividend growths (Eq. (5)) have to be estimated. Two different options to estimate these expectations are proposed in the literature. Among these is the vector autoregressive (VAR) approach as introduced by CAMPBELL and SHILLER (1988) and later applied by CAMPBELL and AMMER (1993), CAMPBELL et al. (2009) and AMBROSE et al. (2013). Alternatively, KISHOR and MORLEY (2014) and KIM and LIM (2014) suggest a state space model that can be estimated by a Kalman Filter. In this paper, we opt for the VAR approach as it is most appropriate to consider the interdependencies between the components (CAMPBELL, 1991).

A standard first-order VAR is defined as

$$Z_t = AZ_{t-1} + \varepsilon_t, \tag{8}$$

where A is the coefficient matrix, Z_t is the vector of variables, and ϵ_t is an error term. In our case, Z_t is given by $Z_t = (\pi_t, i_t, \Delta r_t)$, and the estimated expected present values are computable by

$$\hat{A}\left(I - \rho\hat{A}\right)^{-1} Z_t, \tag{9}$$

where $\hat{A}$ denotes the estimate of the coefficient matrix A, I is the identity matrix, and ρ the discount factor given by Eq. (3). The first three elements of the resulting vector are the estimated expected present values. Given these estimates, the rent-price ratio for each point in time is given by

$$r_t - p_t = k + \hat{\Pi}_t + \hat{I}_t - \hat{G}_t + e_t, \tag{10}$$

with forecast discrepancy e_t. By definition, the variance of $r_t - p_t$ can be decomposed as follows

$$\begin{aligned} \mathrm{var}(r_t - p_t) = \\ \mathrm{var}(\hat{I}_t) + \mathrm{var}(\hat{\Pi}_t) + \mathrm{var}(\hat{G}_t) + \mathrm{var}(e_t) \\ +2\,\mathrm{cov}(\hat{I}_t, \hat{\Pi}_t) - 2\,\mathrm{cov}(\hat{I}_t, \hat{G}_t) \\ +2\,\mathrm{cov}(\hat{I}_t, e_t) - 2\,\mathrm{cov}(\hat{\Pi}_t, \hat{G}_t) \\ +2\,\mathrm{cov}(\hat{\Pi}_t, e_t) - 2\,\mathrm{cov}(\hat{G}_t, e_t), \end{aligned} \tag{11}$$

where var(·) and cov (·) denote variances and covariances, respectively. Equations (10) and (11) form the basis for the empirical analysis in Section 4.

At this point one may critically ask, if the proposed decomposition approach can account for specific characteristics of the agricultural land market. In contrast to stock markets, supply and demand on land markets are driven by entry and exits of farms, the transaction frequency is lower, and the length of rental contracts lasts several years. It is important to note, however, that our model is rather general, simply because it rests on an accounting identity. Basically, Eq. (4) provides a consistency condition for expectations on future prices, dividends and returns. In a sense, it cannot be "incorrect/inaccurate" and it holds for any kind of asset. Sector specific aspects can enter the model via the estimation of expectations of present values of interest rates, premia and growth rates. Specifically, the vector Z_t in the VAR equation (8) may be enhanced by variables that capture peculiarities of agricultural land markets.

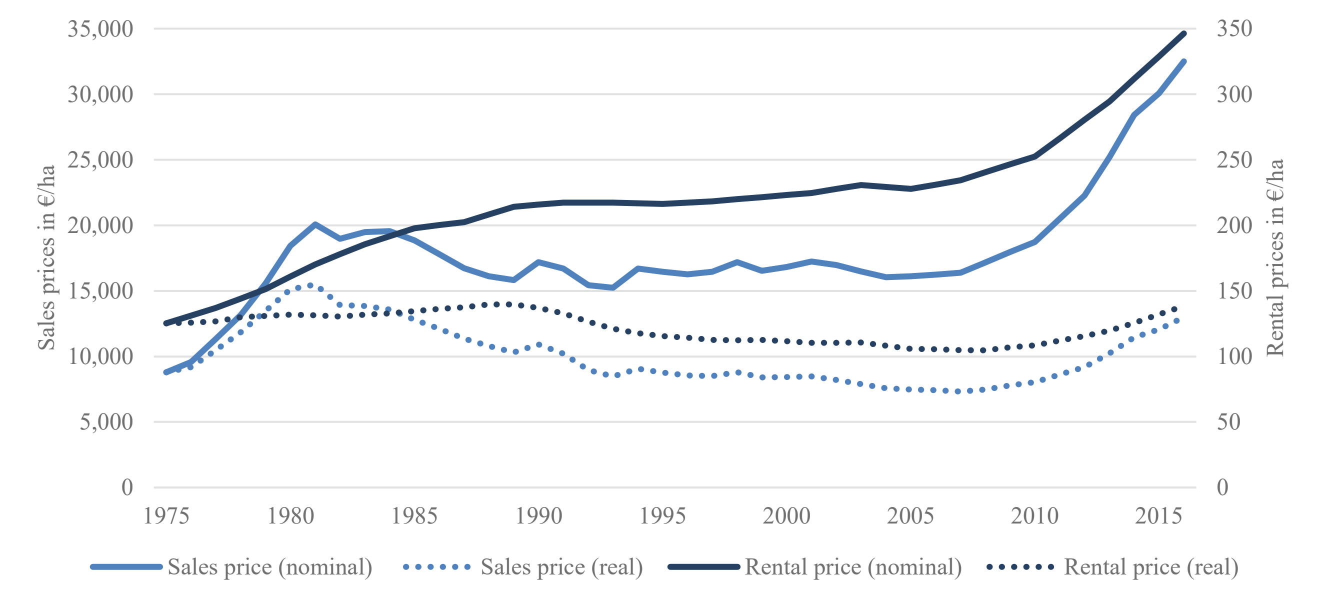
3 Study Region and Data

In our empirical analysis, we study the rent-price ratio for Western Germany as a whole and for each of its eight federal states separately excluding the two city-states. Western Germany[2] is considered an interesting study region because sales and rental prices of agricultural land as well as production and farming structures differ among federal states. The question arises if this heterogeneity translates into differences in the level and the structure of the rent-price ratio.

Land price data from 1975-2016 are extracted from the *Statistisches Jahrbuch* 1976-2017 published

[2] At this point one may ask why we do not extend our analysis to Eastern Germany. Since land price data for Eastern Germany are only available since 1992, extending the analysis to the new federal states would decrease the length of our time series and thus the reliability of our results. We also emphasize that concerns about the role of investors, as outlined in the introduction, applies to Western Germany as well. This claim can be documented by the Ministry of Agriculture in Lower Saxony, who issued a bill imposing upper limits for the acquisition of agricultural land (although the bill did not become effective). Moreover, the joint workgroup on the land market policy (BUND-LÄNDER-ARBEITSGRUPPE "BODENMARKTPOLITIK", 2015) has formulated political goals that hold for Germany as a whole. These goals comprise the broad distribution of land ownership, the prevention of dominant land market positions on the supply and demand side, the capping of land rental and sales prices, prioritizing the agricultural use of farmland, and establishing greater transparency on land markets.

Figure 1. Sale and rental prices for Western Germany



Source: own calculation

by the STATISTISCHES BUNDESAMT.[3] Prices refer to agricultural land including arable land and grassland. Nominal agricultural land sales prices are available on country and federal state level on an annual basis. Land rental prices are also available at country and federal state level, but only for every second (1975-2007) or third year (after 2007) due to the frequency of the underlying Agricultural census. To conduct an analysis on a yearly basis, we linearly interpolate the rental prices. It is important to note that the rental price data reflect prices of running contracts, i.e., they reflect the average of the rent paid for agricultural land during a contract period of several years. Rental price data for newly concluded contracts would have been more suitable for our analysis since they reflect the most recent information about expected productivity of land, but unfortunately, these data are not available for the desired time period. This implies that rental prices in our analysis appear more sluggish than they actually are. To conduct the analysis for Western Germany as a whole, we use federal state data on land sales and rental prices and average them using the agricultural area of every federal state as weights. Nominal prices are converted into real prices by measuring inflation with the Consumer Price Index (CPI) for Germany published by STATISTISCHES BUNDESAMT.[4]

In addition, the real interest rate is required for the analysis. We use the yield of government bonds with a maturity of 9 to 10 years as proxy for the nominal risk-free interest rate. This maturity is chosen since the agricultural land market is characterized by long lasting ownerships and this is the longest maturity available over the study period. The real risk-free interest rate is computed using the Fisher equation[5] and is the same for all states. Again, deflation is conducted via the CPI. Since the CPI is subject to macroeconomic changes, its variability may be transmitted to the deflated variables in our analysis. The return to agricultural land, φ_t, is calculated according to Eq. (1), which implies a truncation of the study period to 1976-2016. Finally, the land premium, π_t, is derived as the difference between the real return and the real interest rate.

Figure 1 depicts sales and rental prices in Western Germany in nominal and real terms and reveals some noteworthy facts. In nominal terms, land prices reach

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3 All volumes of *Statistisches Jahrbuch* are accessible at https://www.destatis.de/DE/Publikationen/Statistisches Jahrbuch/StatistischesJahrbuch.html

4 The Consumer Price Index can be found at https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/Preise/Verbraucherpreisindizes/Verbraucherpreisindizes.html.

5 The Fisher equation reads as:

$$i_t = \frac{1 + i_{nom,t}}{1 + r_{inf,t}} - 1$$

where i_t denotes the real interest rate, $i_{nom,t}$ is the nominal interest rate and $r_{inf,t}$ the inflation rate.

a peak in 2016 after a decade of steady increase. This development is well documented and has led to concerns about the effectiveness of existing land market regulations in Germany (e.g., BUND-LÄNDER-ARBEITSGRUPPE "BODENMARKTPOLITIK", 2015). In real terms, however, this price boom is not unprecedented: at the beginning of the 1980s, real land prices were even higher than today, before they began to descend for more than two decades. Also, real rental prices declined between 1988 and 2006 and their current value does not exceed the peak value in 1988. In both boom periods, sales prices increased faster than rental prices. This finding may be in part explained by the aforementioned smoothing effect of persisting rental contracts. On the other hand, it could point to a price bubble, which has been found for the farmland market in the eighties in the U.S. (e.g., FALK, 1991). For Germany, however, no such evidence has been reported so far (e.g., TIETZ and FORSTNER, 2014).

Time series of real sales prices and rental prices for the eight federal states of Western Germany are portrayed in Figure A 1. Not surprisingly, sales price levels vary considerably among states. For example, prices in Baden-Wuerttemberg, Bavaria and North Rhine-Westphalia are two times higher on average compared to Lower Saxony, Schleswig-Holstein, Hesse, Rhineland-Palatinate and Saarland. Also, the price evolution follows different patterns. Prices in Bavaria and Lower Saxony have exhibited a strong increase in the last decade, while real land prices have stagnated or even declined in Saarland and Hesse. Similar findings apply to real rental prices (Figure A 1b).

4 Results

4.1 Development of the Rent-Price Ratio and its Determinants

Table 1 summarizes means and standard deviations of the core model variables, i.e., the rent-price ratio $\frac{R_t}{P_t}$, the growth rate of rental prices Δr_t, gross returns φ_t, and land premia π_t. Between 1975 and 2016, the average Western German rent-price ratio amounted to 1.26%. In a static economic environment, this figure gives a clue about the profitability of investments into agricultural land. To put this value into perspective, a comparison with other markets is helpful. In the U.S., for example, the average rent-price ratio for farmland between 1900 and 2012 is considerably higher than in Western Germany (LENCE, 2014). A rather low rent-price ratio mirrors what has been labelled as the "farmland valuation puzzle" in the literature (e.g., LENCE and MILLER, 1999). It describes the fact that rental prices appear low compared to sales prices. Again, we find pronounced regional differences between states. For example, the rent-price ratio in Schleswig-Holstein (2.2%) is more than twice as high as in Baden-Wuerttemberg (0.84%).

The time series of the rent-price ratio for Western Germany and selected federal states are depicted in Figure 2. In the late 1970s, the rent-price ratio in Western Germany exhibited a strong decrease due to surging sales prices. It reached a minimum of 0.8% in 1981, recovered thereafter and varied around a value of 1.3%. In recent years, a decrease occurred again,

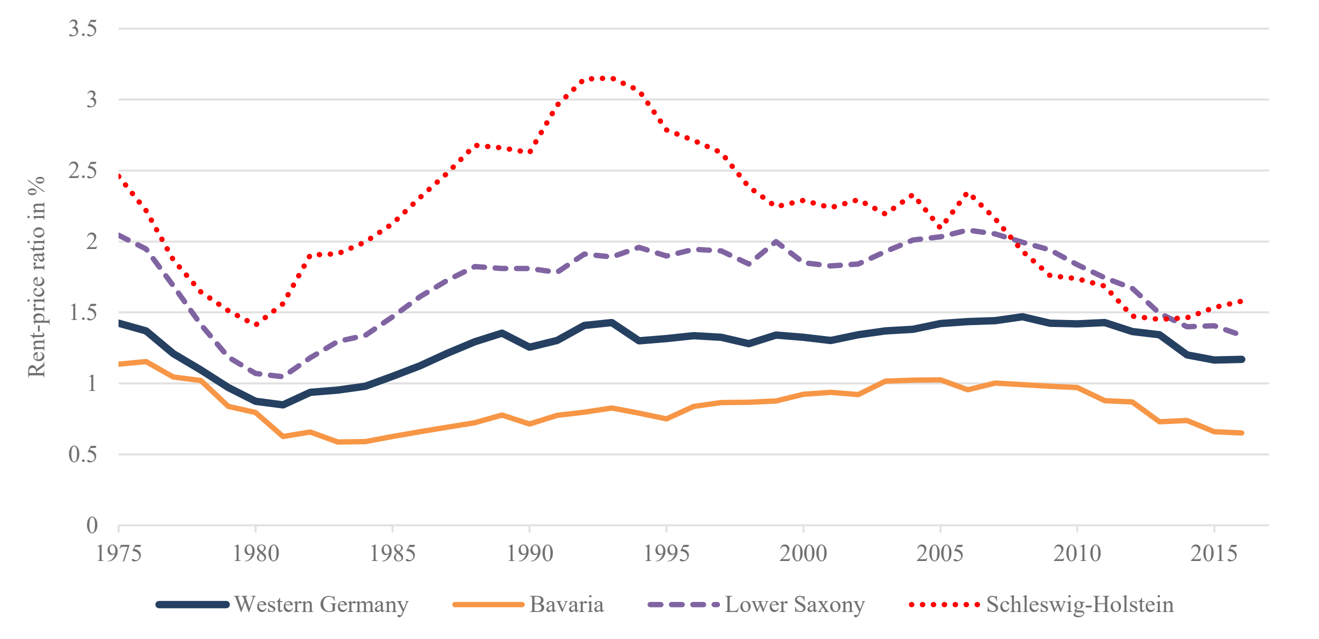
Table 1. Descriptive statistics of model variables in %, 1976-2016

	$\frac{R_t}{P_t}$		Δr_t		φ_t		π_t	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Western Germany	1.264	0.170	-0.027	2.374	2.419	6.673	-0.511	7.487
Baden-Wuerttemberg	0.836	0.152	-0.251	1.898	0.390	5.113	-2.539	5.892
Bavaria	0.845	0.148	0.269	2.499	2.875	9.153	-0.054	9.848
Hesse	0.944	0.149	-0.707	2.303	-0.421	9.529	-3.350	9.533
Lower Saxony	1.725	0.287	0.864	2.603	3.697	8.483	0.768	9.291
North Rhine-Westphalia	1.022	0.186	0.519	2.300	2.005	7.985	-0.924	8.620
Rhineland-Palatinate	1.698	0.307	-0.776	2.111	0.804	7.721	-2.125	8.210
Saarland	0.827	0.130	-1.026	2.504	-0.300	8.631	-3.230	8.763
Schleswig-Holstein	2.181	0.487	0.353	2.922	4.053	9.321	1.124	9.933

Note: here, the rent-price ratio $\frac{R_t}{P_t}$ is calculated for the period 1975-2016.

Source: own calculation

Figure 2. Rent-price ratio in Western Germany and selected federal states



Source: own calculation

Table 2. VAR estimation results for Western Germany

Dependent variable	Estimated coefficient (standard error) for π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.620*** (0.13)	-0.34 (0.24)	0.46 (0.43)	0.54
i_t	-0.002 (0.03)	0.94*** (0.05)	-0.04 (0.10)	0.89
Δr_t	0.060 (0.05)	-0.03 (0.09)	0.50*** (0.17)	0.30

Note: the asterisks *** denote statistical significance at the 1% significance level.
Source: own calculation

yet less pronounced than in the eighties. Similar patterns can be observed in the selected federal states in Figure 2, even though the rent-price ratios differ in terms of the level. While Bavaria exhibits a lower rent-price ratio than the whole of Western Germany with around 0.8% on average, the rent-price ratios in Lower Saxony (Avg. 1.7%) and Schleswig-Holstein (Avg. 2.2%) are on average higher (see also Table 1). The standard deviation of the rent-price ratio in Table 1 depicts regional differences in the variability, which is highest in the federal states with higher rent-price ratios. The factors causing this variation of the rent-price ratio will be inspected in greater detail in Section 4.3.

Table 1 also confirms that real rental rates for agricultural land stagnated on average in Western Germany during the observation period 1976-2016. Only Bavaria, Lower Saxony, North Rhine-Westphalia and Schleswig-Holstein exhibit positive growth rates. Real returns on investing in agricultural land are positive, though modest (2.4% on average for Western Germany). Investments in agricultural land in Lower Saxony and Schleswig-Holstein have the highest average return at around 4%. Two states (Hesse and Saarland) even show negative returns. In light of these low returns, it is not surprising that the land premium, i.e., the excess return above the risk-free interest rate is negative for all states except Schleswig-Holstein.

Figure A 2 in the Appendix gives an impression of the movement of interest rates, returns and land premia over time for Western Germany. As can be seen, returns and premia exhibit strong volatility, with high levels in the late 1970s and a subsequent strong decrease until 1981. Since then, both have increased slightly. Land premia became positive over the last decade as a result of increasing land prices and low real interest rates.

These findings may raise the question of how low or even negative returns can be rationalized. First, one has to recall that the figures reported in Table 2 are ex-post values, while investment decisions are based on ex-ante expectations. Second, the view of a financial investor, who buys land and leases it out thereafter, does not apply to the majority of transactions on land markets. Typically, farmers buy land for their own operations. In this case, their return is the marginal income generated by the production factor land and this value may exceed lease rates. Third, financial investors may benefit from risk reducing diversification effects. Fourth, tax benefits, which may constitute an additional incentive for farmers to pay high land prices, are not considered. Finally, in contrast to other financial assets, land may offer an intrinsic, non-monetary value to owners.

4.2 Estimation Results of the VAR

We run a VAR over the study period 1976-2016. The lag order of the VAR is determined by means of the Bayesian Information Criterion (BIC), which indicates that a first-order VAR is the adequate choice for the majority of the models. We use seemingly unrelated regressions (SUR) to estimate the VAR, which allows for dependencies in the error terms. The stability of the results is checked by testing whether the modulus of the eigenvalues of the coefficient matrix is less than one. This stability condition is fulfilled for every VAR. The results for Western Germany are presented in Table 2. Our findings indicate that real return, real premium and real rent growth are predictable to a moderate degree ($\bar{R}^2 = 0.54$ and $\bar{R}^2 = 0.30$, respectively), whereas the real interest rate is highly predictable ($\bar{R}^2 = 0.89$). For all three variables, only the coefficient of the own lagged variable is statistically significantly different from zero for Western Germany. The point estimates for the remaining federal states of Western Germany are summarized in Table A 1 in the Appendix. Since significant non-diagonal coefficients occur for some federal states, we refrain from changing the model to a simple AR(1) model.

To increase the predictability of the variables, we also tried other model variants. Following CAMPBELL et al. (2009), we extended the VAR model by including further information that is available to market participants and might influence their expectations. More specifically, we chose the exit rate of agricultural farms as a proxy for land supply because farm exits feed land into local land markets. In the first step, we calculated the exit rate of farms as the percentage change in farm number. In a second step, this exit rate of farms was weighted by the average farm size each year. Moreover, we added the cereal yield growth rate to the model assuming that this variable represents productivity gains and thus the demand for agricultural land. However, the inclusion of these agricultural sector variables neither substantially increased the fit of the VAR model nor significantly changed the results. This can be explained by the rather small variability of these variables over time. While e.g. farm sizes vary among federal states, the change of farm sizes and exit rates over time is rather small. Thus, we present the results for the parsimonious model only.

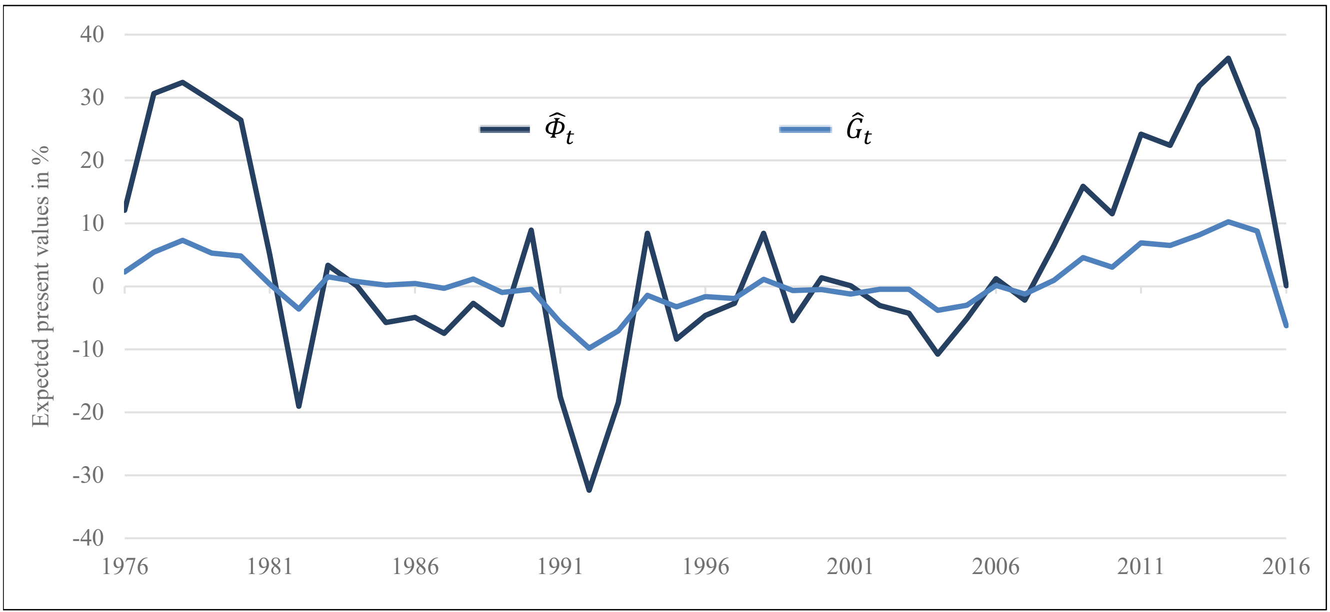
4.3 Decomposition of the Rent-Price Ratio

Figure 3 presents the components of the rent-price ratio according to Eq. (6), i.e., expected present values for return ($\widehat{\Phi}_t$) and rental growth ($\widehat{G}_t$). Since expected values are estimated from past observations via a VAR, it is not surprising that the patterns of $\widehat{\Phi}_t$ and $\widehat{G}_t$ resemble those of the realizations of returns, φ_t, and rental growth, Δr_t, in Figure A 2. Their levels differ because of the capitalization factor given in Eq. (9).

The dynamic Gordon growth model is an implicit model and it has not been designed to identify economic factors that underlie market fundamentals. However, it is tempting to construe the changing expectations of returns and rental growth rates from an ex-post perspective. In doing so, three phases seem noteworthy: First, expected future returns declined at the beginning of the eighties, which may reflect the discussions about budgetary problems of the Common Agricultural Policy (CAP) of the European Union, which eventually led to the introduction of milk quotas (CUNHA und SWINBANK, 2011). This could have implied uncertainty and resulted in decreased expectations of rental growth rates, which in turn caused a plunge of returns in the formerly overheated land market.

Second, after a phase of consolidation, present values of expected returns show an overall minimum in 1992, a landmark in the CAP reform that resulted in the MacSharry reform, which changed the design of the CAP by partially shifting from price support to direct income support. It has been conjectured that the sensitivity of arable farmland values to governmental support increased in the aftermath of this reform (e.g., DUVIVIER et al., 2005). Right after 1992, expectations of future returns for agricultural land increased, reflecting resolved uncertainty as well as the monetary value of new income tools. Similar patterns are observed for the expected present value of rental growth.

Figure 3. Expected present values of real return ($\widehat{\Phi}_t$) and real rental growth ($\widehat{G}_t$) of agricultural land in Western Germany



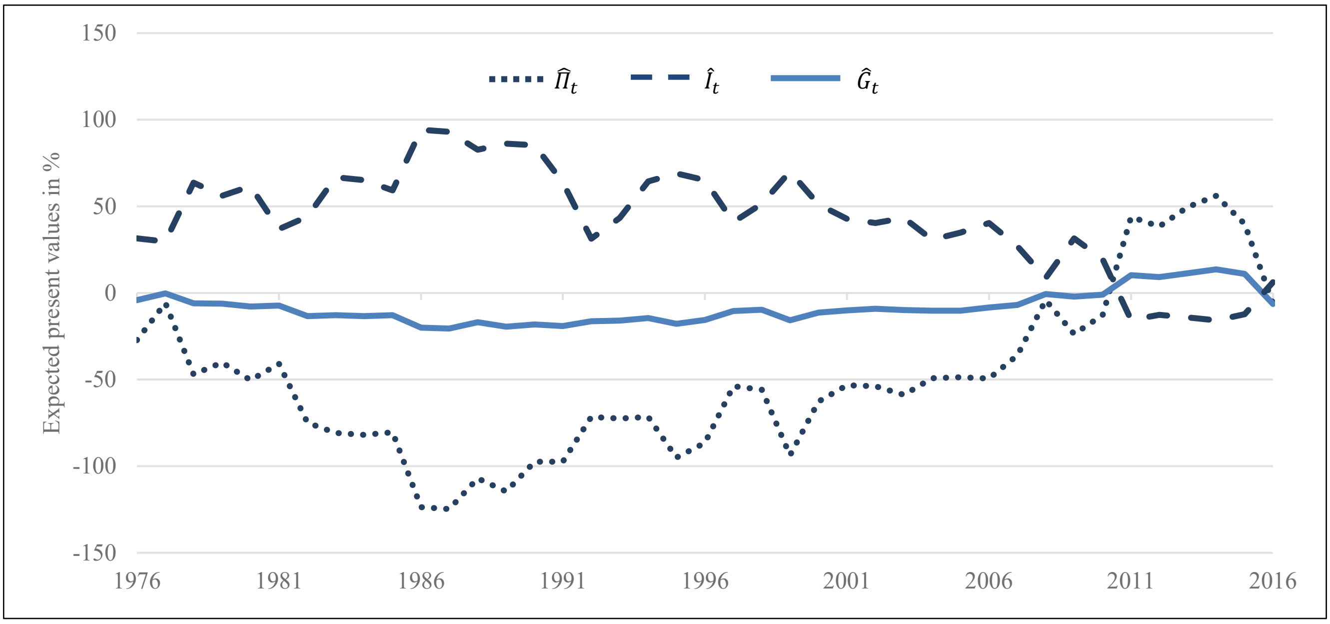
Source: own calculation

Third, after the decoupling of direct payments from production in 2003, expected future returns and rental growth rates increased towards an overall maximum in 2014. PATTON et al. (2008) and KILIAN et al. (2008) provide evidence that decoupled payments are capitalized to a stronger degree in farmland rental values than coupled payments which were granted before 2003. This effect could further be enhanced by several factors: On the one hand, the expansion of renewable energies in the beginning of the 2000s might have increased the value of land (HABERMANN and BREUSTEDT, 2011; RITTER et al., 2015). On the other hand, surging food prices at that time led to a higher profitability of land (FAO, 2018). Furthermore, it is conjectured that the financial crisis in 2007/08 raised external interest for investments in agricultural land (cf. HÜTTEL et al., 2016b).

After 2014, expected present values of rental growth rates and returns decreased sharply. This is in line with the finding of HÜTTEL et al. (2016a) who report that a mean reversion of land rental prices was expected by market participants. This decrease correlates with the agricultural policy reform of 2014, which replaced the Single Payment Scheme (SPS) with the Basic Payment Scheme (BPS). As a consequence of this reform, further constraints are involved in the granting of direct payments, so that certain farms may have experienced a reduction of direct payments. Furthermore, in recent years, a reduction of these payments in favor of public welfare aspects was publicly discussed (e.g., BUCKWELL et al., 2017; WBAE, 2018). In fact, it is widely acknowledged that direct income support in general drives farmland values (e.g., LATRUFFE and LE MOUËL, 2009; BREUSTEDT and HABERMANN, 2011). In addition, an amendment of the German Renewable Energy Act (EEG) was prepared in this period replacing fixed feed-in tariffs by auctions from 2017 on and hence lowering financial support. These recent discussions might have led market participants to downsize their expectations about future rental growth rates for land. Moreover, considering the high level of sale prices at this time, it follows directly from Eq. (1) that expectations about future returns are likely to decrease.

The aforementioned patterns are similar in most federal states of Western Germany, but some notable differences occur (see Figure A 3a). For example, Bavaria experienced a stronger decrease in expectations of future returns in the early 1990s. A potential cause could be the particularly strong protests in Bavaria against the planned MacSharry reform in 1992 (WILSON and WILSON, 2001). At the end of the study period, it can be seen that the expectation of future returns decreased earlier in Schleswig-Holstein compared to Bavaria and Lower Saxony. The latter two states might have expected stronger benefits from the 2013 CAP reform (LFL, 2013).

Figure 4. Expected present values of real premium ($\hat{\Pi}_t$), real rental growth ($\hat{G}_t$) of agricultural land and real interest rate ($\hat{I}_t$) in Western Germany according to Eq. (7)



Source: own calculation

Figure 4 decomposes the expected present values of the return on agricultural land into the present values of real risk-free interest rates and the present value of the land premium. This figure confirms the earlier findings that land premia were negative for three decades rendering investments in farmland unattractive for financial investors. This view changed in the aftermath of the financial crisis and the alleged rush for land (cf. HÜTTEL et al., 2016b). The period of positive expected land premia, however, seems to be transient. In Figure A 3b, the corresponding present values for the federal states are presented.

4.4 Variance Decomposition of the Rent-Price Ratio

Before decomposing the variance of the rent-price ratio, we compare the estimated rent-price ratio according to Eq. (10) with the actual rent-price ratio for Western Germany in Figure 5. The forecasted rent-price ratios for the selected federal states of Western Germany are provided in Figure A 4 in the appendix. Most remarkable is the level difference accruing between the actual and estimated rent-price ratio, which amounts to about 0.7 percentage points across the federal states. At the beginning and at the end of the observation period, the estimated rent-price ratios seem to be in line with the actual rent-price ratio, but Figure 5 also reveals periods where the estimated and actual rent-price ratio move in different directions. This inability of the estimated rent-price ratio to mimic the level and movements of the actual rent-price ratio perfectly has been observed in other recent studies as well. CAMPBELL et al. (2009) explain this finding by arguing that the VAR is constructed to fit historical patterns of real return, real premium, real interest rate, and real rent growth, but not to fit the historical rent-price ratio. An economic explanation is that market participants' expectations incorporate more information than the time series that feed the VAR model (CAMPBELL and SHILLER, 1988).

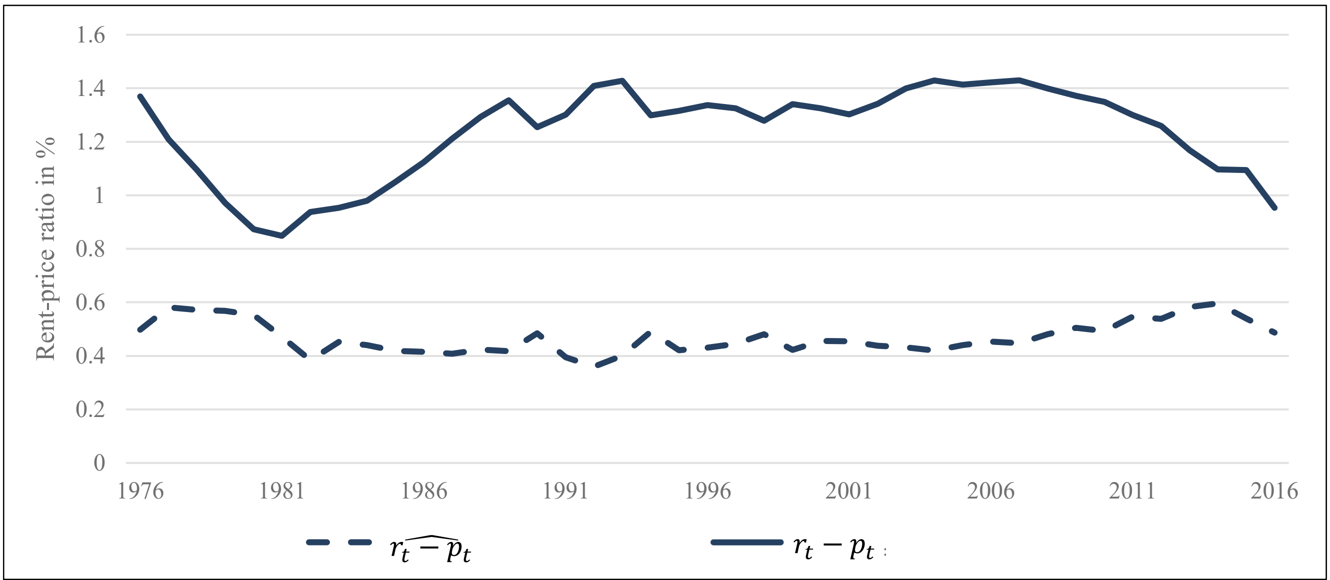
Table 3 summarizes the variance decomposition results of the log rent-price ratio according to Eq. (11). Comparing the variance of the estimated and the actual log rent-price ratio, we find that the former underestimates the latter in all cases except Bavaria. In Bavaria and Lower Saxony, the divergence between both variances is rather small. In Schleswig-Holstein, the divergence is higher, which implies that a larger share of the variance cannot be explained by the components of the dynamic Gordon growth model.

Regarding the importance of the individual components in Table 3, we find similar results for the federal states. The largest share of the variance results from $\hat{\Pi}_t$, the estimated expected present value of the real premium to one hectare of agricultural land. The estimated expected present value of the real interest rate, $\hat{I}_t$, accounts for a lower share of the variance. Merging the premium and the interest rate shows a high relevance of the estimated expected present value of return, $\hat{\Phi}_t$ (see bottom of Table 3). $\hat{G}_t$, the estimated expected present value of real rent growth, and the residual ϵ_t account for the smallest share of the variance.

The observed variances are mostly in line with previous literature on the stock and housing markets. CAMPBELL et al. (2009), KIM and LIM (2014) and KISHOR and MORLEY (2015) identify $\widehat{\Pi}_t$ as the main source of rent-price ratio variability on the U.S. and Irish housing markets. Nevertheless, we observe some differences for the farmland market. BERNANKE and KUTTNER (2005) report for the stock market that the variance of expected present values of future premia, $\widehat{\Pi}_t$, is only three times as high as the variance of expected present values of future rent growth, $\widehat{G}_t$, and CAMPBELL et al. (2009) report for the housing market a ratio of 2.5. In our analysis, however, we find clearly higher ratios, which is related to our data preparation. First, the aforementioned linear interpolation of the rental price data reduces the variability. Second, the variability of the land premium data may be enhanced by the deflation of the interest rate via the CPI (see Section 3).

In Table 3, we also find evidence about the relationship between the components of the dynamic

Figure 5. Forecasted ($\widehat{r_t - p_t}$) and actual rent-price ratio ($r_t - p_t$) in Western Germany



Source: own calculation

Table 3. Variance decomposition of the log rent-price ratio for Western Germany and selected federal states, 1976-2016

	Western Germany	Bavaria	Lower Saxony	Schleswig-Holstein
$\text{var}(r_t - p_t)$	0.022	0.031	0.034	0.054
$\text{var}(\widehat{r_t - p_t})$	0.015	0.038	0.028	0.011
$\text{var}(\widehat{\Pi}_t)$	0.215	0.808	0.447	0.329
$\text{var}(\hat{I}_t)$	0.088	0.178	0.181	0.067
$\text{var}(\widehat{G}_t)$	0.008	0.110	0.045	0.091
$\text{var}(\epsilon_t)$	0.048	0.078	0.077	0.083
$2\text{cov}(\widehat{\Pi}_t, \hat{I}_t)$	-0.262	-0.720	-0.530	-0.268
$-2\text{cov}(\widehat{\Pi}_t, \widehat{G}_t)$	-0.082	-0.594	-0.280	-0.342
$-2\text{cov}(\hat{I}_t, \widehat{G}_t)$	0.048	0.256	0.165	0.135
$2\text{cov}(\hat{I}_t, \epsilon_t)$	0.034	0.085	0.027	0.067
$2\text{cov}(\widehat{\Pi}_t, \epsilon_t)$	-0.096	-0.286	-0.147	-0.239
$-2\text{cov}(\widehat{G}_t, \epsilon_t)$	0.021	0.116	0.049	0.131
$\text{var}(\widehat{\Phi}_t)$	0.025	0.118	0.107	0.088
$-2\text{cov}(\widehat{\Phi}_t, \widehat{G}_t)$	-0.013	-0.115	-0.080	-0.118
$2\text{cov}(\widehat{\Phi}_t, \epsilon_t)$	-0.051	-0.141	-0.176	-0.156

Note: the last three rows (variances and covariances including $\widehat{\Phi}_t$) are based on a different VAR model, where $Z_t = (\varphi_t, \Delta r_t)$.
Source: own calculation

Gordon growth model. Altogether, the covariances between the components dampen the total variation of the rent-price ratio. The positive covariance between $\hat{\Pi}_t$ and $\hat{G}_t$ contributes negatively to the total variation. This is also the case for $\hat{\Phi}_t$ and $\hat{G}_t$. $\hat{\Pi}_t$ and $\hat{I}_t$, however, are negatively correlated, which also implies a negative contribution. The results reported for Western Germany are similar in the selected federal states and vary only in their relative size. Of particular interest are the negative correlations between $\hat{\Pi}_t$ and $\hat{I}_t$ and $\hat{G}_t$ and $\hat{I}_t$. These could support the hypothesis that owning land offers potential for portfolio diversification of financial investors.

5 Conclusions

Agricultural land is a complex asset, which is held for various reasons. The approach that we pursue in this paper considers land as a financial asset. This particular view is motivated by the ongoing discussion about land as being an attractive investment opportunity for agricultural and non-agricultural investors. In contrast to the majority of analyses that aim to explain either land price or rental price levels, we focus on the relationship between sales and rental prices. In a static economic environment, the rent-price ratio provides a first indicator of the profitability of an investment in land. To allow a more sophisticated analysis, we apply a decomposition of the rent-price ratio and its variance into the (expected) growth rates, real interest rates, and a land premium that represents an excess return on investment. The benefits of this dynamic Gordon growth model can be summarized as follows: First, the model provides a theoretically consistent link between land prices, land rents and interest rates. It follows, for example, that if land prices are currently high, then investors must either expect high future lease rates or low future returns or even a combination of both.[6] In contrast to the classic Gordon growth model, which also provides this insight, the effect of a high (or low) land lease growth rate now depends on how long it is expected to be high (or low), because expected returns and land lease growth rates are no longer assumed to be constant. Second, it is forward looking and incorporates market participants' expectations, though the way how expectations are estimated is not specified. Third, the decomposition does not only relate to levels, but also to the variability of land rents and prices.

Applying this model to sales and rental prices in Western Germany over four decades reveals a couple of interesting findings: First, it turns out that the recent land price surge, which has triggered intense discussions about tightening land market regulations (cf. ODENING and HÜTTEL, 2018), is not unprecedented. Actually, real land prices were higher in the eighties. Second, related to research question 1, the rent-price ratio amounts to a mere 1.3% on average and is relatively low. That is, agricultural land is rather "expensive" in relation to earnings from renting it out. This can be explained by the existence of intrinsic values for landowners, by option values related to future non-agricultural use (e.g., TURVEY, 2003) or by the fact that land is a production factor, which can generate income that exceeds land rents. Interestingly, the rent-price ratio varies considerably among states: On average, it is more than two times higher in Schleswig-Holstein than in Bavaria or Baden-Wuerttemberg. Though our model does not provide an explanation for this gap, it suggests that differences regarding price formation on land markets are in place, which might be the result of different farm structures in the various federal states. For example, farms in Schleswig-Holstein manage more land and have a lower share of own land on average than farms in Bavaria. Moreover, different cultural attitudes, e.g., emotional links to farmland, may explain regional variation of the rent-price ratio. Third, considering the components of the rent-price ratio, we can only observe positive rental growth rates in recent years. Moreover, we observe rather low returns on investments in land. Land premia, i.e., returns beyond a risk-free interest rate, are even negative on average in Western Germany, rendering investments in land unprofitable for financial investors at least from an ex post perspective (research questions 2 and 3). Finally, as an answer to research question 4, a variance decomposition of the rent-price ratio shows that changing expectations of present values of returns on land investments are the major driver for rent-price ratio volatility while expected present values of rental growth are relatively stable.

Our results allow some careful policy implications. In fact, they challenge the view of agricultural

[6] The second part of this statement can be best understood by recalling that returns (by definition) do not only depend on lease payments, but also on the relative price change. High land prices in the previous period (ceteris paribus) decrease the numerator and increase the denominator in Eq. (1) and thus reduce the return. CAMPBELL et al. (1997: 263) stress that this relation between prices, dividends and returns does not only hold ex post but also ex ante when taking expectations.

land as a profitable investment opportunity for financial investors. Rent seeking financial investors, however, are the key ingredient for the "land grabbing" narrative that drives the current policy debate about land market regulation in the EU. In our study region, positive land premia emerged only for a few years in the last decade and seem to have vanished again in recent years. Though CROONENBROECK et al. (2019) report that only 1% of all BVVG auctions in Eastern Germany have been won by foreign investors we do not question that financial investors are engaged on agricultural land markets in Germany. In fact, portfolio diversification or inflation protection may provide incentives for investing in land. However, our results cast doubt that a "rush" on land from outside the sector will take place in the near future. The reason is that given the meanwhile high level of land prices and moderate expectations about future growth of lease rates, investors cannot expect high returns in the future any more. Overall, these findings query the need for stricter land market regulations that protect farmers against financial investors.

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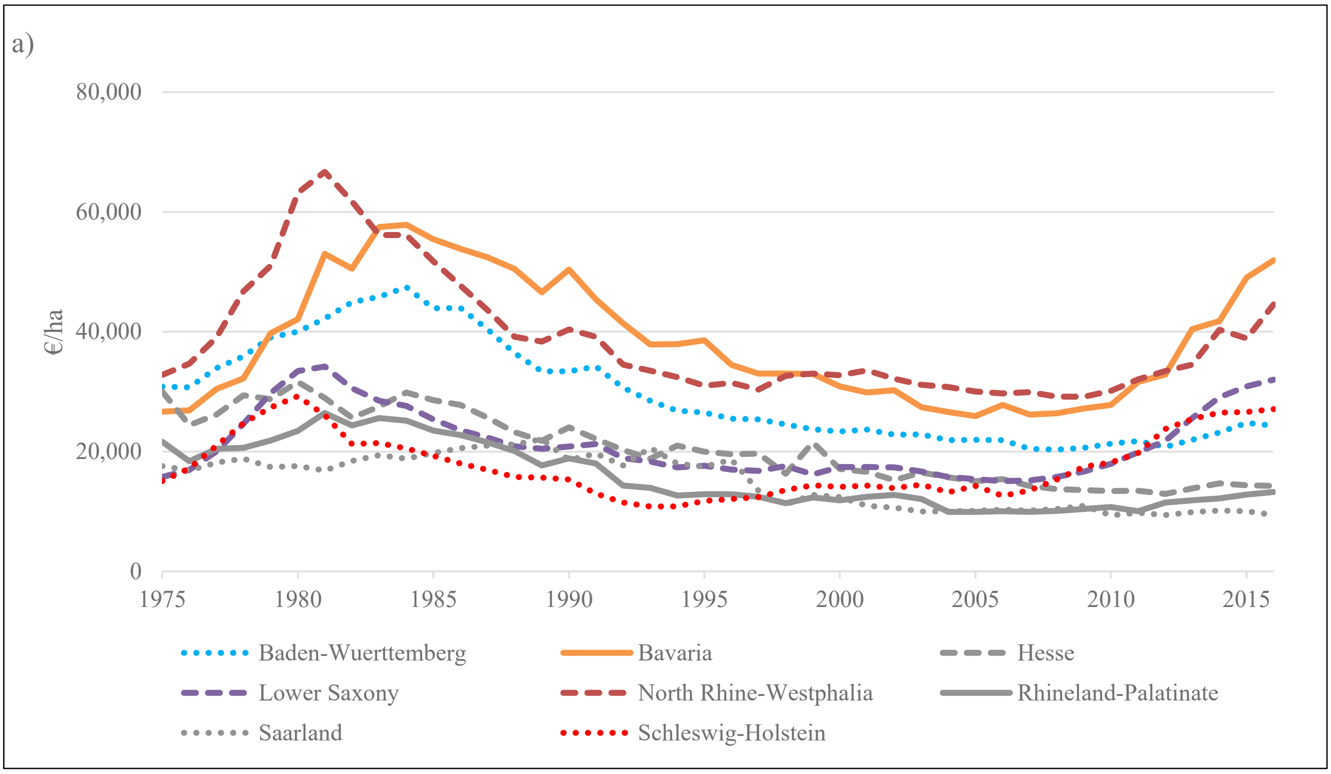
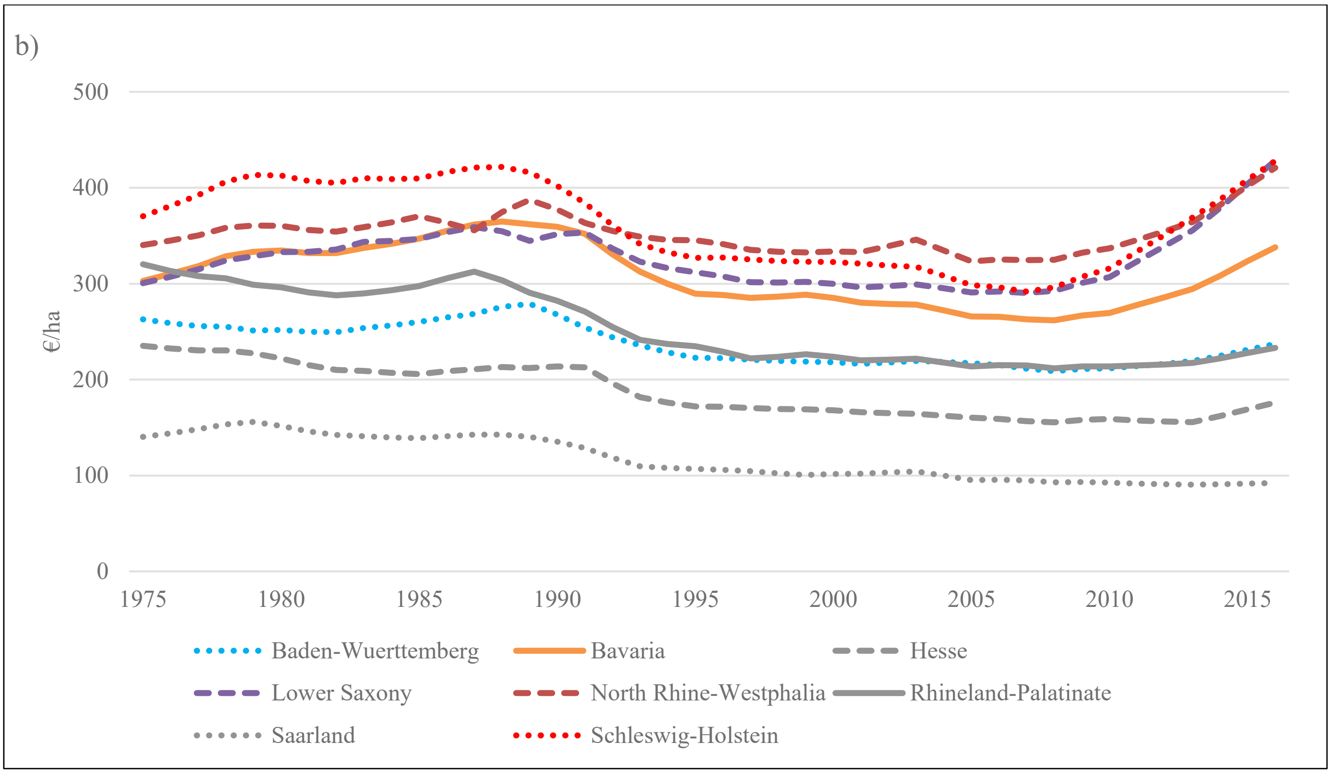
Appendix

Figure A 1. Real prices of agricultural land for the federal states of Western Germany, 1975-2016, a) Sale prices b) Rental prices

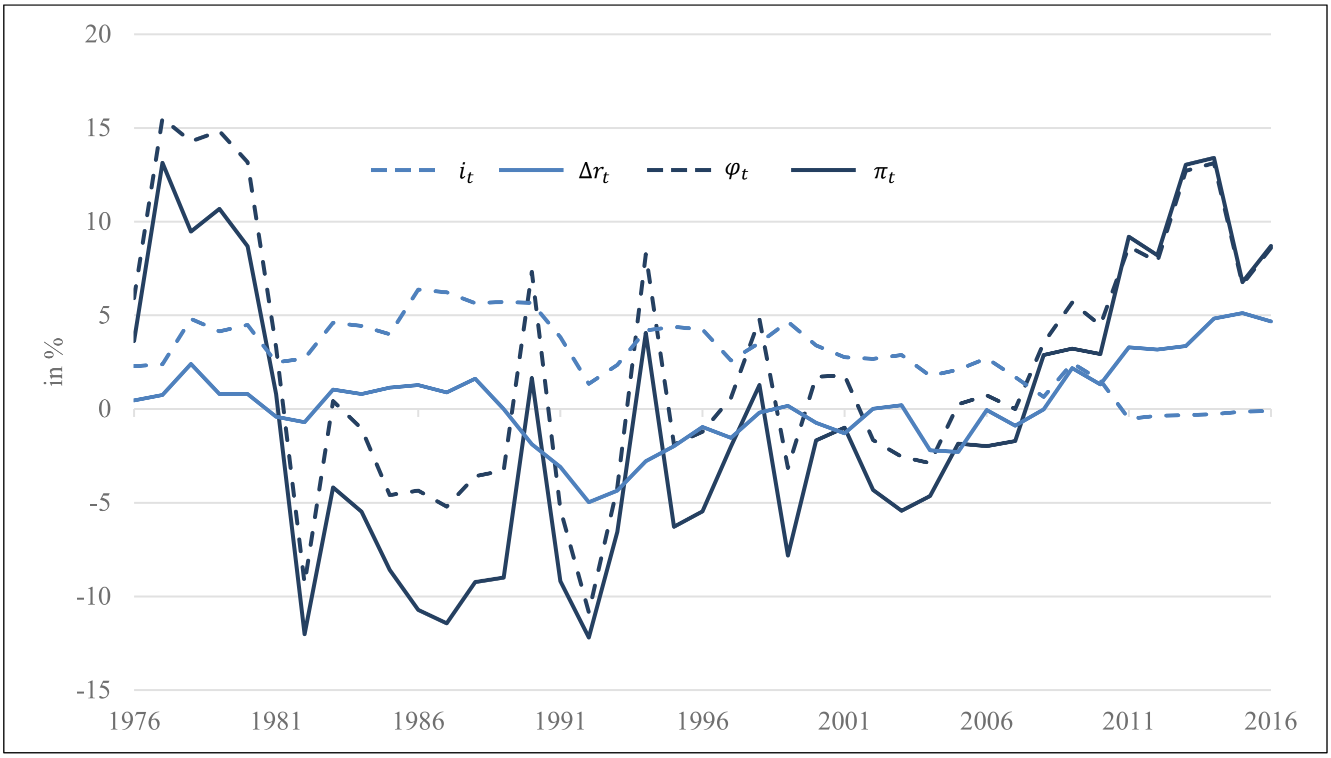


Source: own calculation



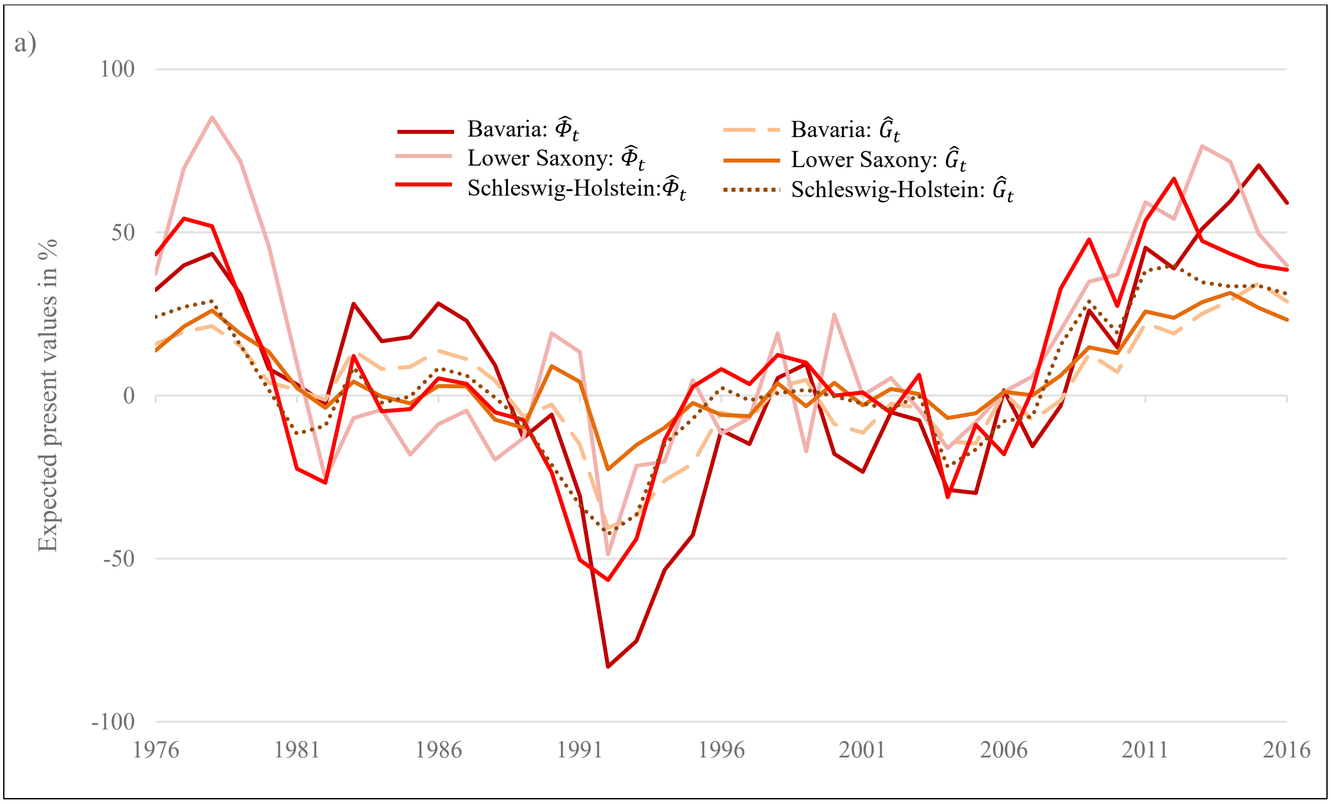
Source: own calculation

Figure A 2. Real risk-free interest rate for Germany (i_t), real rental growth rate (Δr), return (φ_t), and premium for agricultural land in Western Germany (π_t)

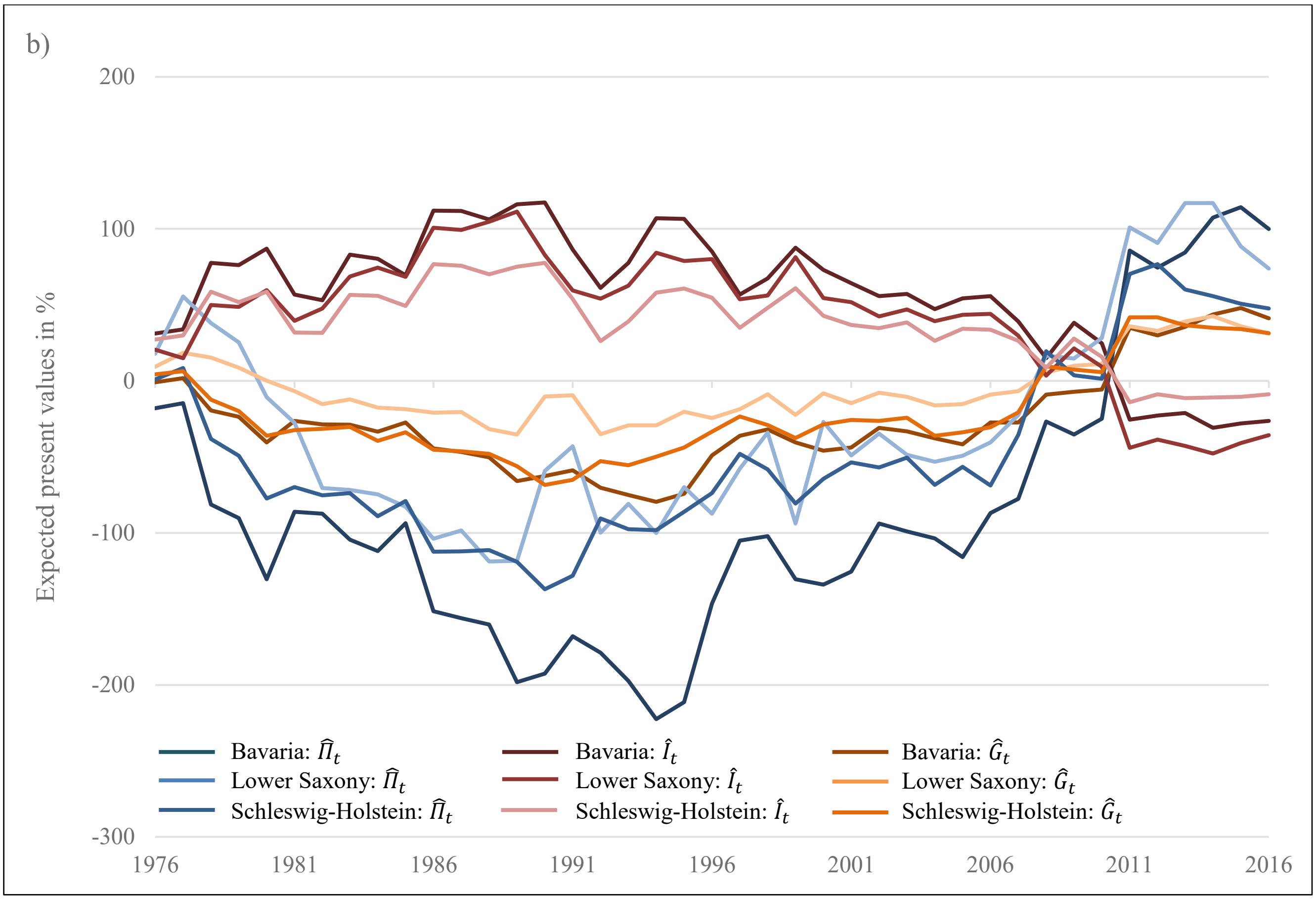


Source: own calculation

Figure A 3. Expected present values of … (Bavaria, Lower Saxony and Schleswig-Holstein, 1976–2016)
a) … real return ($\hat{\Phi}_t$) and real rent growth ($\hat{G}_t$) of agricultural land according to Eq. (6),
b) … real premium ($\hat{\Pi}_t$), real rent growth ($\hat{G}_t$) of agricultural land and real interest rate ($\hat{I}_t$) according to Eq. (7)

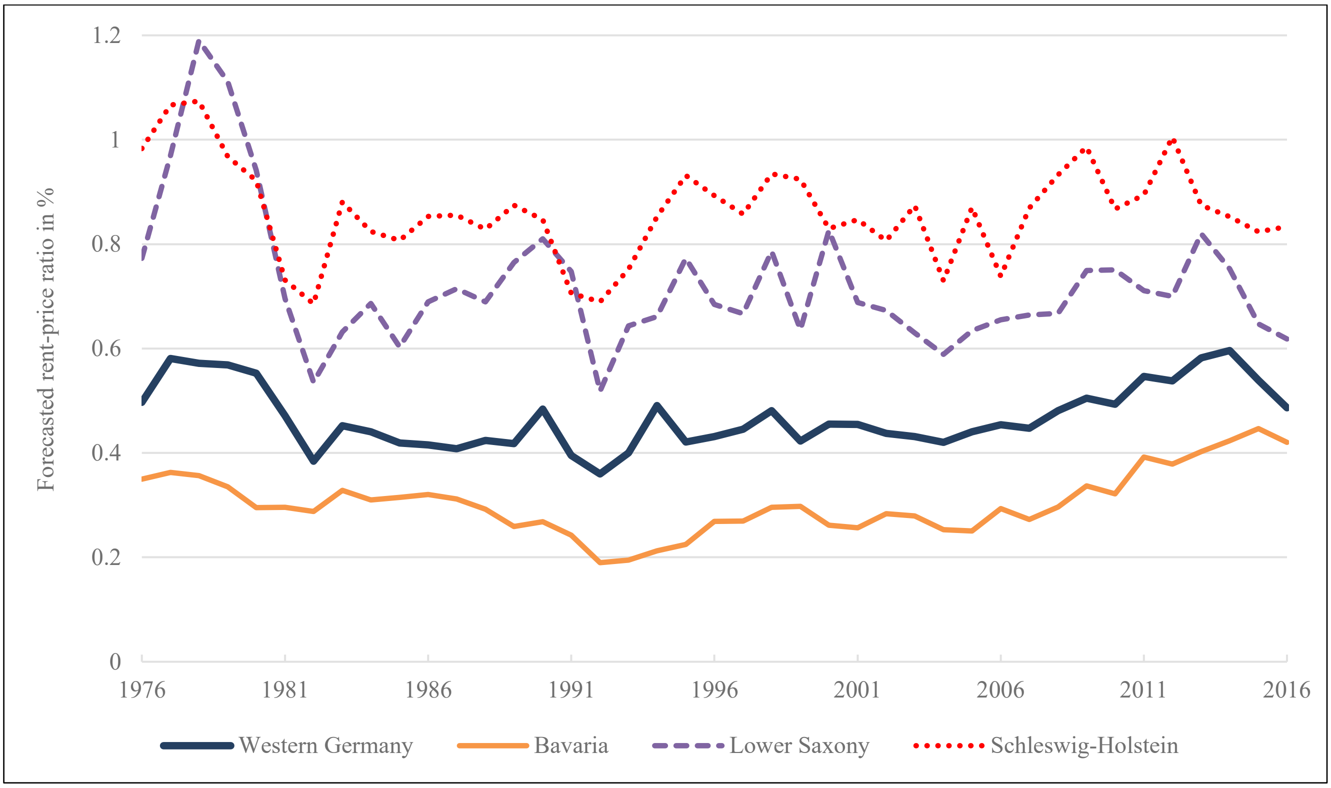


Source: own calculation



Source: own calculation

Figure A 4. Forecasted rent-price ratio for Western Germany and selected federal states



Source: own calculation

Table A 1. VAR estimation results for the federal states of Western Germany

Dependent variables in	Estimated coefficient (standard error) for			
Baden-Wuerttemberg	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.45*** (0.14)	-0.57 (0.26)	0.14 (0.40)	0.46
i_t	-0.01 (0.03)	0.93*** (0.06)	0.02 (0.10)	0.89
Δr_t	0.07** (0.04)	0.01 (0.06)	0.74*** (0.09)	0.63
Bavaria	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.03 (0.16)	-0.62 (0.40)	1.78*** (0.64)	0.54
i_t	0.02 (0.02)	0.95*** (0.05)	-0.07 (0.08)	0.89
Δr_t	0.04 (0.02)	-0.05 (0.05)	0.80*** (0.09)	0.73
Hesse	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	-0.34** (0.14)	-1.48*** (0.39)	0.08 (0.58)	0.25
i_t	-0.03 (0.02)	0.89*** (0.05)	-0.15** (0.07)	0.91
Δr_t	0.01 (0.03)	-0.10 (0.08)	0.67*** (0.12)	0.49
Lower Saxony	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.70*** (0.13)	-0.16 (0.45)	0.38 (0.45)	0.59
i_t	0.01 (0.02)	0.94*** (0.05)	-0.08 (0.08)	0.89
Δr_t	0.05 (0.03)	-0.01 (0.08)	0.73*** (0.12)	0.64
North Rhine-Westphalia	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.45*** (0.13)	-0.50* (0.31)	1.23*** (0.46)	0.42
i_t	-0.03 (0.02)	0.91*** (0.05)	0.06 (0.08)	0.89
Δr_t	0.01 (0.04)	-0.03 (0.09)	0.59*** (0.14)	0.29
Rhineland-Palatinate	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.02 (0.16)	-0.88** (0.37)	0.36** (0.58)	0.15
i_t	-0.02 (0.02)	0.90*** (0.06)	-0.07 (0.09)	0.89
Δr_t	0.03 (0.03)	-0.13* (0.07)	0.60*** (0.11)	0.56
Saarland	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	-0.24* (0.15)	-1.51*** (0.26)	-0.36*** (0.40)	0.22
i_t	-0.01 (0.02)	0.94*** (0.06)	-0.05 (0.06)	0.89
Δr_t	0.07** (0.03)	-0.10 (0.08)	0.65*** (0.10)	0.59
Schleswig-Holstein	π_{t-1}	i_{t-1}	Δr_{t-1}	$\bar{R}^2$
π_t	0.49*** (0.14)	-0.36 (0.34)	-0.57 (0.51)	0.38
i_t	0.01 (0.02)	0.94*** (0.05)	-0.04 (0.07)	0.89
Δr_t	0.04 (0.02)	-0.07 (0.06)	0.81*** (0.09)	0.79

Note: the asterisks *, **, and *** denote statistical significance at the 10%, 5% or 1% significance level, respectively.
Source: own calculation