A Microsimulation Model for the Agricultural Land Rental Market in Ireland

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Abstract

Agricultural land rental markets contribute towards structural change in the farming sector by offering farmers the opportunity to adjust their farm size without committing to a transfer of land ownership. In Irish agriculture, the share of agricultural land being rented is however, among the lowest in Europe. Many Irish farmers continue to produce output and remain in agricultural employment despite persistently negative market returns. This implies that land-use decisions are not solely influenced by market returns. In this paper, we utilize Teagasc National Farm survey data to analyse the agricultural land rental market in Ireland with a newly developed microsimulation model. This model is compared to an equilibrium model of the land rental market. The microsimulation model has a number of advantages over the equilibrium model in addressing path dependency, the interaction between landowners and tenants and the farm size concentration. The model requires some further refinement in simulating the variability of land rental prices between contracts.

Keywords: Microsimulation, Agricultural Land Rental Market, Sealed-Bid Auction, Price Determination, Farm Size Concentration.

JEL code: C15, D31, Q12, Q15

1 Introduction

In this paper, we analyse the agricultural land rental market in Ireland with a newly developed Agent-based micro-simulation model (ABMM). The agricultural land market in Ireland is studied closely as significant policy changes occur including reforms to the taxation system at the national level (Geoghegan et al 2017) and reforms to the Common Agricultural Policy at an EU level (O'Neill and Hanrahan 2012). Farm succession and inheritance are given much attention due to their important contributions towards land mobility and generational renewal (Duesberg et al 2017 and Leonard et al 2017).

Microsimulation modelling is increasingly applied to agricultural economics research (Ramilan et al 2011; O'Donoghue 2013 and Loughrey et al 2016). In our ABM model, we attempt to address the question of how an increase in profit maximization behaviour could affect the agricultural land rental market in Ireland. ABM models have previously been used to develop simulated agricultural land market auctions (Balmann 1997, Happe et al 2006 and Arsenault et al 2012).

We compare the results of the ABM model with those derived from a standard equilibrium model based largely on the methods outlined in (Hennessy et al 2009). ABM models can account for "the emergence of structures at the macro or societal level from individual action" (Gilbert 2007). In economics, the empirical validation of agent-based models has made 'substantial advances' but more research is required in advancing hypothesis testing (Fagiolo et al 2019).

In our case, the ABM modelling approach provides flexibility around the determination of prices where there is bilateral trading between landowners and tenants. We find that the equilibrium modelling approach can perform well in modelling the impact of farm subsidies on land rental prices and in illustrating the gains from trading in the agricultural land rental market but is limited by the assumption of one single market clearing price.

Our ABM model is based on Teagasc National Farm survey data, which forms the Irish component of the FADN database. Similar to Viaggi et al (2013), the farm profits (including subsidies) determine the formation of bid prices (of potential tenants) and asking prices (of landowners). A fictitious market agent mediates between land owners and potential tenants in establishing the price for each parcel of rented land. In this model, the market operates through sealed bids with each market participant making a maximum of one bid per available land parcel. For each available parcel, the bidder with the highest bid gains access to the land through a rental agreement with the landowner. It is assumed that the landowner makes decisions with reference to a reservation price, below which the landowner will not release land to the market. All bids and reservation prices are attributed to farm profitability.

In the ABM model, limits are placed on the extent to which farms can acquire additional land and no farm exits are permitted. It is assumed that these limits can be enforced by a central authority with a role similar to the SAFER (Sociétés d’Aménagement Foncier et d’Établissement Rural) organisation in France (See, for example, Boinon 2003 and Piet et al 2012). The model is used to calculate the farm size concentration at the end of the auction period. Previous research by Freeman et al (2009) used an agent-based modelling approach to analyse the evolution of the farm size distribution in Canada between 1960 and 2000, finding among other things that farms with an initial land holding greater than the mean were significantly more likely to survive and grow relative to the smaller farms with an initial holding size below the mean.

The results from our ABM model show that an increase in profit maximisation behaviour leads to a substantial transfer of agricultural land from the cattle and sheep sectors and towards the more profitable dairy sector. In this model, we show that when agricultural land is transferred solely on the basis of profit maximization, the farm size concentration can increase significantly. This occurs in the absence of countervailing forces such as an influx of new entrants, who may contribute differently to the extent of concentration. Loughrey and Donnellan (2017) identified Ireland as having a relatively low inequality and concentration of farmland size in comparison to other EU member states. Piet (2016) explains however, that farms in excess of 50 hectares operate more than 50 per cent of the total agricultural land area in Ireland.

In the next section, we outline some of the literature relating to the spatial dimension of agricultural land markets and the simulation of farmland auctions. We follow this with a theory section, a description of the data sources and the methodology used to develop the ABM model. This is followed with results and finally by the conclusion.

2 Literature

There is a growing economic literature on the spatial dimension of agricultural land markets (including simulation modelling). In the following, we describe some of the relevant economic literature including the literature concerned with simulation modelling of agricultural land markets.

Patton and McErlean (2003) identify spatial autocorrelation in the agricultural land market in Northern Ireland and conclude that agricultural land prices are not solely determined 'by the inherent characteristics of the land, but tend to reflect also the average local price per acre'. This lagged spatial dependence is attributed to 'the circularity of price setting' whereby 'property owners, prospective buyers, real estate agencies, tax assessors and others base their estimates of values of agricultural land on observed sales in the vicinity'. The spatial dimension can also play an important role in influencing the extent to which farm subsidies influence land market prices. For instance, Graubner (2018) provides a formal analysis of spatial competition in agricultural land rental markets and concludes that the land subsidy is only fully transferred to land rental prices where the importance of space is low or non-existent.

In developing a simulation model of the land market in Chile, Berger (2001) highlights the typically local nature of supply and demand for agricultural land and the importance of competition between neighbours in shaping the agricultural land market. Berger (2001) concludes that 'in rural areas, where many farms with a high marginal productivity attempt to expand their acreage, this can lead to excessive land prices that may even prevent the realisation of economies of scale. Ignoring these spatial dynamics by assuming perfect land allocation among farms is not always an adequate representation of reality'. Storm et al (2014) explain the advantage of agent-based models in recognizing 'the importance of land immobility, the location of farms in space, and the interdependence of farms via competition on the spatial land market'.

Agent-based models of land markets are quite commonly applied to both rural and urban settings. For instance, Filatova et al (2009) outline a model of the urban land market where the 'centralized equilibrium price determination mechanism' is replaced by 'decentralized bilateral agent trading dispersed in time and space'. This modelling of 'bilateral agent trading' is evident in the farmland simulation models of Balmann (1997) and Arsenault et al (2012). Polhill et al (2007) outline a neat method for the negotiation of selling price based on the weighted sum of the farm profitability of the purchaser, the profitability of the land parcel for sale and an exogenous interest rate.

A number of land simulation models have included the role of market power in price determination including Arsenault et al (2012) and Filatova et al (2009). In these models, the relative market power of buyers and sellers is attributed to the number of agents in either category. A similar approach was applied in the econometric models outlined in Cotteleer et al (2008). Freeman et al (2009) accounted for the impact of farm income variability and risk aversion in influencing the bidding price. Some land market simulation models are based on one period of time where the focus is placed on the static impact of policy changes e.g. Viaggi et al (2013). A number of other models have a multi-period setting including Balmann (1997) and Bert et al (2015).

3 Theory

We begin this section by describing the theoretical background to the ABM model. We begin with the understanding that the farm size of each farm may be comprised of rented land or owned land. We formalise according to Ciaian and Swinnen (2006), the land decision-making problem of a profit-maximizing individual farm in the following:

$$\text{Max}\, \pi_i = pf\left(a^{rent-in} + a^{own}\right) - (r+t)a^{rent-in} + (r-t)a^{rent-out} \qquad (1)$$

where *p* is the price of farm output, *r* is the rental price of land, *t* represents transaction costs, $a^{rent-in}$ is the amount of land rented-in by the farmer, $a^{rent-out}$ is the amount of land rented-out by the farmer, a^{own} is the amount of land owned by the farmer.

In the ABM model, we do not assume that the initial state of the land market is perfectly competitive. This means that participation in the agricultural land market can bring about improvements in farm household welfare, relative to the initial state. We assume that the same production function applies to both land rented and land owned and that total farm size equals the sum of land rented-in and owned minus land rented-out.

$$a = a^{rent-in} + a^{own} - a^{rent-out} \qquad (2)$$

By behaving according to the profit maximization motive, farm operators with a marginal value product of land higher than the marginal cost of land (r+t) will tend to rent-in additional land.

In the sealed-bid auction setting of this model, potential tenants compete for rented land and this competition ensures that the rental costs approach the value of the marginal product of the land.

$$\left(p\,\frac{\partial f(A)}{\partial (A)}\right) \leftarrow (r+t) \qquad (3)$$

It is assumed that a market agent or auctioneer coordinates between landowners and potential tenants. This market agent collects all available information on sealed bids and reservation prices and identifies the highest bidder for each land parcel available on the market and mediates between landowners and tenants in finalising the agreed rental price. An important assumption in this model is that each farmer makes only one sealed bid for each parcel of land.

For the individual tenant farmer, the marginal product of the land equals the rental price plus transaction costs plus a surplus s to the tenant farmer. This surplus allows the tenant farm operator to earn a profit from renting-in additional land. A tenant farmer may achieve a surplus from renting-in additional land where the marginal value product of the land exceeds the market rate for the rented plot of agricultural land.

$$p\,\frac{\partial f(A)}{\partial (A)} = (r+t+s) \qquad (4)$$

In addition, we add a second derivative to account for diminishing returns. We estimate additional costs associated with expanding the land area by 20 hectares or more. It is assumed that increasing the land area beyond this threshold will necessitate additional building costs and further costs associated with operating and maintaining those buildings and potential interest expenses associated with the purchase of livestock.

On the supply side, farms will tend to rent-out land where the marginal value product of the land is lower than the marginal cost of land. For the supply side of the market, the transaction costs are subtracted from the rental income. The assumed competition between landowners reduces rental costs so that they approach the value of the marginal product of the land. As in the case of tenant farmers, landowners may achieve a surplus where the market rate exceeds the willingness to accept, which is based on the marginal product of the land under the current ownership. The marginal product of the land can vary according to the farmers' management ability.

$$p \frac{\partial f(A)}{\partial (A)} \leftarrow (r-t) \qquad (5)$$

There are a number of constraints in the ABM model. In this model, farms may not always expand to the point where the marginal product and marginal costs of the land are equal. It is assumed that a central authority closes the auction when the share of rented land in a region reaches 30 per cent of the utilizable agricultural area in that region. In the ABM model, we exclude the option of farm exit so that farms with very low or negative returns remain active in farming. In the equilibrium model, farm exits are permitted and the number of remaining farms can reduce significantly. Within each land market group, we make the strong assumption that land parcels are homogenous and that differences in gross margins are due to variability in farm management.

4 Methodology

In this section, we provide details on the methods applied in the ABM model. Similar to Viaggi et al (2013), we simulate transactions in the land market assuming that farms seek to maximize total farm profit under the further assumption that land can be reallocated among a group of farms within a particular region or local area.

$$\text{Max} \prod = \sum_i \pi_i(a_i, u_i, x_i) \qquad (6)$$

subject to

$$\sum_i a_i \leq A \qquad (7)$$

Where $\prod$ is the total farm profit in the region, π_i represents the profit function of farm i, a_i represents the land available in farm i and x represent other factors affecting farm profitability. In the ABM model, the term u_i represents the land, which is unavailable to the market as all farms retain some hectares for their own farming activities.

In the ABM model, there is a constraint so that no farm is simulated to fall below ten hectares in land area. The land which is potentially available to the market a_i is therefore constrained to be the Utilizable Agricultural Area (UAA) of each farm in the sample minus 10. The land available to the market equals zero for the case of a farm with an initial farm size, which is less than 10 hectares.

$$\alpha_i = Max(0, UAA_i - 10) \qquad (8)$$

This can be contrasted with the equilibrium model, where the available land equals the total utilizable agricultural area of the region i.e. $\sum_i a_i = \sum UAA_i$. Farm exits are permitted in the equilibrium model and all farmland can potentially form part of a transaction.

Demand

In the ABM model, we place limits on the degree of participation in the market. The model stipulates that no dairy or livestock farm can participate in the land rental market when farm size exceeds 120 hectares. For tillage farms, the model stipulates that no farm can participate in the land rental market when farm size exceeds 200 hectares. The higher threshold for the tillage sector is due to the greater land intensity on tillage farms.

These thresholds are designed in order to remain within the scope of the family farm model i.e. where the majority of the farm labour is due to the farm operator and other family members. While we do not explicitly account for the relationship between farmland size and economic returns, our preliminary analysis suggests that the current average farmland sizes of Irish dairy and particularly livestock farms are below the optimal levels from a microeconomic perspective.

The individual demands for additional agricultural land d_i can be therefore described in the following:

Dairy and Livestock $\quad d_i = Max(0, 120 - UAA_i) \qquad (9)$

Tillage $\quad d_i = Max(0, 200 - UAA_i) \qquad (10)$

We attempt to simulate land transfers based on a scenario where profit maximisation is the only motive. It can be noted that other non-pecuniary motivations influence land-use decisions (Howley et al 2015).

In order to carry out the simulations, we first divide the sample of Teagasc National Farm survey farms into six groups based on two soil quality categories (good and medium soils) and three regional categories. We exclude the farms with poor soils due to the low sample size. In forming regional categories, we distinguish between the Border Midlands and West NUTS 2 region, the combination of the South-West and Mid-West NUTS 3 regions and the third regional category is due to the NUTS 3 South-East and Eastern regions.

We estimate the adjusted gross profit per hectare for each individual farm in each of the six regional groups. This adjusted gross profit per hectare is the gross revenue per hectare plus an adjustment for direct payments minus variable costs and family labour costs and is described in equation 11. The adjusted gross profit per hectare represents the shadow price of land and the potential demand from each farm for an additional unit of rented agricultural land.

As in the case of Balmann (1997) and Freeman et al (2009), the marginal value product of land is based on the expected gross margin of each individual farm. We do not account for the influence of the riskiness of the farm returns in the formation of bid prices.

The maximum willingness to pay or bid price from each potential tenant farmer is influenced by the direct payments and the extent to which these payments are capitalised into the bids of each potential tenant. Previous research has not given much attention to the capitalisation of direct payments into the formation of bid prices. Viaggi et al (2013) is among the few exceptions. The complexity and uncertainty around the estimation of capitalisation rates is a likely contributor.

In the baseline scenario, we assume that 50 per cent of direct payments are included in the value of each bid. This does not necessarily translate into a capitalisation of direct payments of 50 per cent given the interactions with the supply side of the market.[1]

The bid price or maximum willingness to pay from each tenant is therefore given in the following:

$$Price_{BID} = \pi_{GROSS} = \frac{\sum(p * q) - VC - FLC}{a} + cDPha \qquad (11)$$

Where P_{bid} is the maximum willingness to pay equal to the π_{GROSS} gross profit per hectare. The notation p represents prices, q the quantity of agricultural output, VC represents variable costs, FLC represents family labour costs, which includes the estimated labour costs associated with the farm operator

[1] O'Neill and Hanrahan (2016) estimate that the average capitalisation of direct payments is approximately 21 per cent for cattle farms, 41 per cent for dairy and 50 per cent for tillage farms. On sheep farms, the capitalization is not statistically significant but the average capitalization is 35 per cent.

and other family members. The notation c represents the capitalisation rate and $DPha$ represents the value of the direct payments per hectare.

In the ABM model, it is assumed that the variable costs per hectare increase when the acquired land exceeds 20 hectares. For dairy farms, the assumed increase is €200 per hectare and for livestock farms, the assumed increase is €100 per hectare. These adjustments are made to account for additional building costs, electricity and interest costs associated with the purchase of livestock. More precise estimates of these additional costs are required, but revisions are unlikely to greatly alter the results.

Within each of the six land markets, each farm is ranked according to their respective gross profits. In the ABM model, all farms with a size greater or equal to 12 hectares are ranked. The farm with the lowest gross profit offers their land for leasing to a potential tenant. The market agent collects the bids and allocates parcels to the farm in the market with the highest adjusted gross profit per hectare. Farms exit the market if they reach the thresholds outlined in equations (9) and (10).

Microsimulation Model

It is assumed that each farm has the same strategy i.e. rent-in land at the cheapest possible price or alternatively let-out land at the highest possible bid price. In this sealed-bid auction, the most profitable farms will seek to rent-in parcels at the lowest possible price from the farms with the lowest profitability. At the same time, the farms with relatively low profitability will seek to let-out land to the highest bidder i.e. from the farm with the highest gross profit.

The simulation process begins by transferring agricultural land from the least profitable farm to the most profitable in an iterative process. In this process, we assume that land is transferred in a parcel size of two hectares. As described in (9) and (10) the model is constrained so that farms exit the land rental market after reaching a certain threshold.

In this simulation model, the land rental market closes at the point where the rental share in the region reaches 30 per cent. This would bring the rental share closer to that witnessed in many Western European countries (Loughrey et al 2019). It should be noted however, that the rental share in Ireland is unlikely to reach to the levels reported in EU member states such as Germany and France given that landowners and farmers are largely the same population.

Price Determination in the Microsimulation Model

In determining the rental price for each z parcel, it is assumed that a market agent mediates between the land owner and tenant and seeks to identify a mutually beneficial price with reference to the typical price of existing land rental agreements in the market. At this point, we do not make specific assumptions about whether the agent acts on behalf of the landowner or the potential tenant.

Similar to the AgriPoliS model outlined in Happe (2004), we establish the rental price for each parcel in the context of the existing regional rental rates. This allows for some smoothing and variability in the land rental price between each z parcel of land.

$$P_z = \sqrt{\frac{RES_{iz}+BID_{jz}}{2} * RP} \qquad (12)$$

where P_z refers to the land rental price for parcel z, RES_{iz} refers to the reservation price of the landowner i, BID_{jz} refers to the maximum willingness to pay of the highest potential bidder j. RP refers to the median land rental price per hectare in each regional market. It is assumed that all transactions take place in a short period of time.

5 Data

The main data source is the Teagasc National Farm survey. These data are frequently used to determine the broader financial situation on Irish farms and contribute to economic and rural development research and policy analysis. These data include the level of gross output, costs, income, investment and indebtedness across the spectrum of farming systems and sizes. The data form the Irish component of the Farm Accountancy Data Network (FADN) database, which is used to evaluate farm incomes and the impacts of the Common Agricultural Policy across the EU for the EU Commission.

A farm accounts book is recorded for each year on a random sample of farms, selected by the Central Statistics Office, throughout the country. Our models are based Teagasc NFS data for the period 2015 to 2017. For 2017, there are 889 farms included in the data, representing approximately 84,750 farms nationally. The simulations are applied to all farms with good or medium soils. In 2017, there are 797 farms with either good or medium soils, representing approximately 78,150 farms nationally and these 797 farms form the sample for this study.

The panel is unbalanced in the sense that there is some attrition from year to year as farmers leave the sample and are replaced by other farms. The attrition rate is relatively low however and a sizeable proportion of the farms are contained in the dataset for all of the years concerned. We find that 751 farms have three observations from the period 2015 to 2017. New farmers are introduced during the period to maintain a representative sample and the sample size for all farms (dairy and non-dairy) is usually kept to between 850 and 1000 farms. In tables 1 and 2, we provide some summary statistics relating to each of the six land market regions.

Table 1: Summary Statistics for Six Regional Markets

Region	Soil Quality	No. Farms	Weighted No. Farms	UAA (Ha.)	Rental Share
South-West and Mid-West	Good	110	8,773	405,275	16.6%
East	Good	186	16,570	797,525	22.0%
BMW	Good	164	18,216	764,366	15.8%
BMW	Medium	190	21,788	818,101	21.1%
South-West and Mid-West	Medium	75	6,668	281,095	17.0%
East	Medium	72	6,124	308,924	18.2%

Table 2: Rental Price Statistics for Six Regional Markets

Region	Soil Quality	Median Rented Price (€)	25th Percentile of Rented Price	75th Percentile of Rented Price
South-West and Mid-West	Good	350	250	434
East	Good	355	250	420
BMW	Good	252	218	363
BMW	Medium	217	150	308
South-West and Mid-West	Medium	314	242	410
East	Medium	250	211	342

6 Results

In this section, we detail the results from our simulations. We display the simulation results showing the change in the farm size distribution and the extent of land transfer from the livestock sectors to the dairy sector. We pay particular attention to the determinantion of prices in the microsimulation model and the equilibrium model. We conclude that the microsimulation model requires further refinement to address the question of price determination.

In table 3, we show the simulated changes in average farm size for each farming sector. Table 3 shows that under the simulation model and with the greater emphasis on profit maximization, the average farm size in the dairy sector increases by 18.4 hectares while the average farm size in the cattle sector declines by 6.7 hectares and the average farm size in the sheep sector by approximately 10.2 hectares.

Table 3: Simulated Average Farm Size by System

System	Average Farm Size	Average Farm Size [Post-Simulation]	Change in Farm Size
Dairying	55.8	74.2	18.4
Cattle	36.1	29.3	-6.7
Sheep	50.9	40.7	-10.2
Other	74.7	77.8	3.1
Tillage	59.5	63.7	4.2

In table 4, we show the implications for the share of agricultural land allocated to each farming system. One can see from the results that the share allocated to the dairy sector increases from 23 per cent to 30.6 per cent of agricultural land in Ireland. In the case of the cattle sector, the share of agricultural land declines from 44.7 per cent to 36.3 per cent. The share of land allocated to the sheep sector declines to 13.7 per cent. An increase occurs in the tillage sector where the share remains close to 7 per cent of total land area.

Table 4: Simulated Share of Agricultural Land by System

System	Initial Share	Share Post-Simulation	Percentage Change
Specialist Dairying	23.0%	30.6%	33.0%
Cattle Rearing and Other	44.7%	36.3%	-18.7%
Sheep	17.1%	13.7%	-20.0%
Tillage	3.6%	3.8%	4.1%
Other (Inc. Dairy and Other)	11.6%	12.4%	7.0%

In table 5, we show the simulated impact on farm size inequality within each group.

Table 5: Farm Size Inequality by Group under Profit Maximisation

Group	Region	Soil Type	Initial Gini Coefficient	Gini Coefficient [Post-Simulation]
1	South-West and Mid-West	Good	34.9	46.4
2	East	Good	39.3	47.1
3	BMW	Good	35.8	48.5
4	South-West and Mid-West	Medium	30.6	48.4
5	East	Medium	31.2	49.5
6	BMW	Medium	30.6	40.2

These initial results suggest that farm size inequality increases in all regions but the increase is greatest in two of the markets where the soil is of medium quality. In these markets, the initial inequality is lower relative to other markets. In the BMW region with medium quality soils, the expansion of the land area is largely concentrated among initially medium sized farms and this limits the increase in farm size inequality.

The change in the farm size distribution can be decomposed to account for the effect of re-ranking on the farm size distribution (See, For Example, O'Neill et al 2017). One can then identify the extent to which the rise in inequality can be attributed to the initially large farms expanding further and whether or not the small but highly profitable farms could affect the results.

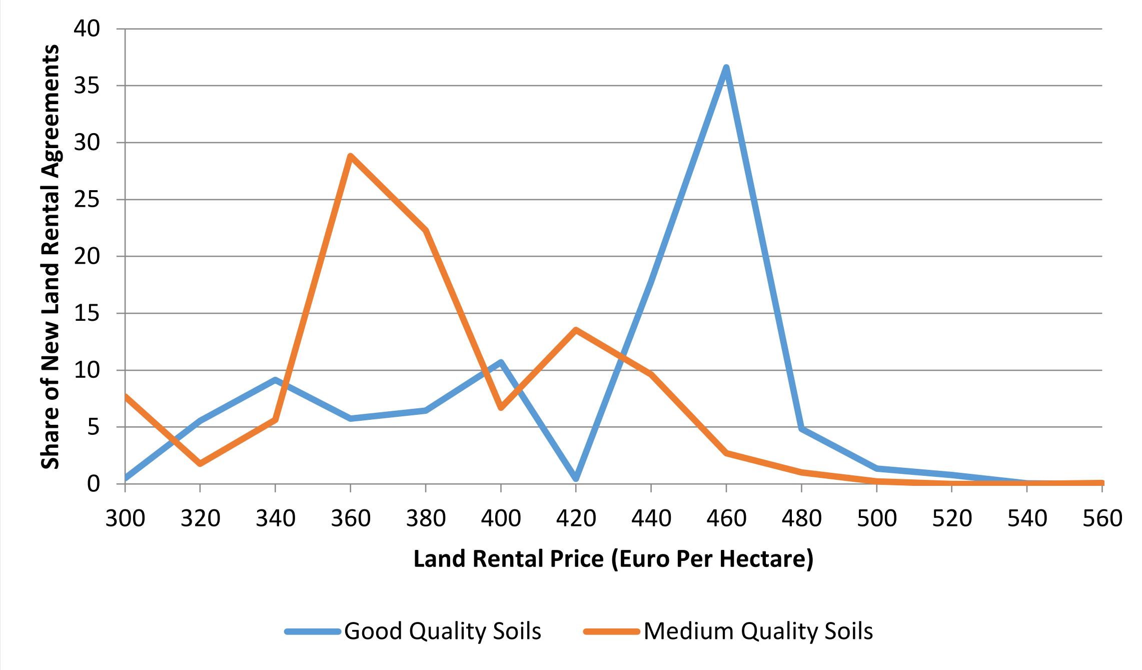
Results for Price Determination

The ABM model provides for some variability in land prices between individual transactions. In this way, the ABM model differs from the equilibrium model, where there is an assumption of one market clearing price for all transactions within a given regional market. The ABM model provides for this variability in prices through the application of Eq. 12. While ensuring some variability in land rental prices between transactions, the method does not fully replicate the existing variability of land rental prices. This is partly due to the relatively small sample size of transactions between farmers.

In figure 1, we show that the simulated land rental prices are highly concentrated in a number of the regional land markets. For instance, the simulated land rental prices are concentrated heavily between €440 and €480 per hectare in the markets with good soils. In this model, a relatively low number of transactions take place in each regional market. We must bear in mind that the model stops when the rental share reaches 30 per cent of the UAA in each region. This partly explains the high concentration of land rental prices.

It is well established that the actual distribution of land rental prices is much more variable than the simulated land rental prices described in figure 1. The determination of prices in the microsimulation therefore requires further refinement.

Figure 1: Distribution of Land Rental Prices in Microsimulation Model

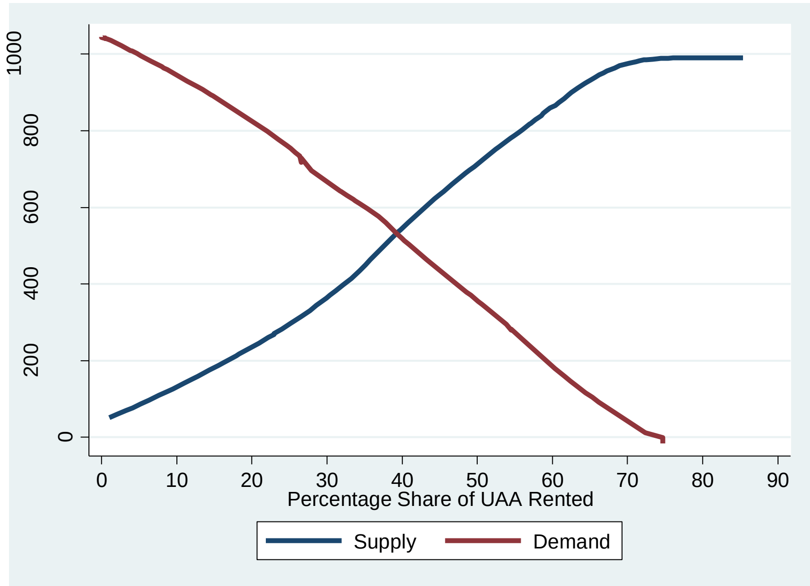


Source: Authors calculations using the ABM model and Teagasc NFS data 2015-2017

Given the problems associated with replicating or approximating the actual distribution of land rental prices in our simulation model, we also describe the land market with a simple equilibrium model where prices are determined at the point where total supply equals total demand. In figure 2, we show the supply and demand for agricultural land with good quality soils in the south-west and mid-west region under this equilibrium modelling approach. Figures 2-4 are constructed using the twoway and lowess commands in Stata.

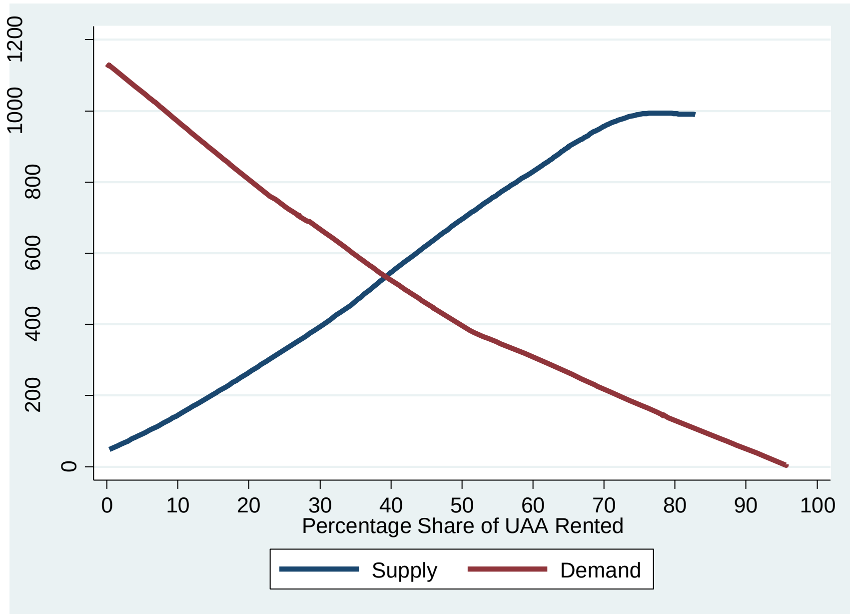
Figure 2 describes a market where land rental decisions are based solely on farm profitability and where farm exits are permitted. Figure 2 shows that the equilibrium price in this market is approximately €550 per hectare, where approximately 40 per cent of the land area is rented. The demand curve shows that many of the bidders in this market would be willing to pay amounts in excess of €600 per hectare for land. Assuming that all transactions take place at the market clearing price, then some economic surpluses can be gained from renting-in additional land at the equilibrium price. At the same time, a significant number of low income farmers could gain economically from renting out their land at the equilibrium price.

Figure 2: Market for Good Agricultural Land in South-West and Mid-West Region



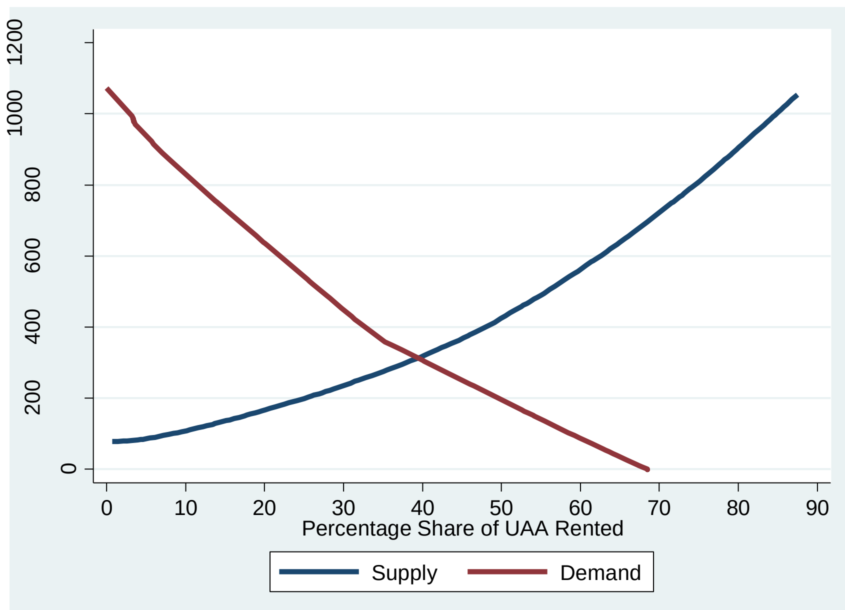
In figure 3, we show the equilibrium model for the East region with good quality soils. In this market, the equilibrium price is similar to that shown in figure 2. Tillage farming is more prevalent in the east region relative to the south-west and mid-west region. Although, we do not account for urban influence in our models, it should be noted that land markets in this region tend to be more influenced by urbanization and non-agricultural usage.

Figure 3: Market for Good Agricultural Land in East Region



In figure 4, we show the equilibrium model for the land market in the BMW region. This market contrasts sharply with the markets depicted in figure 2 and figure 3. In the BMW region, there is a concentration of non-viable farms in the sheep and beef enterprises (O'Donoghue 2017, p.171). This affects the shape of the supply curve in the land market under the assumption of profit maximization. The equilibrium rental price is much lower in this market relative to the other markets where there are good soils. Figure 4 shows an equilibrium rental price of approximately €300 per hectare, which is somewhat higher than the median price of existing rental agreements (€252 per hectare) as reported in table 3.

Figure 4: Market for Good Agricultural Land in BMW Region



7 Conclusion

In this paper, we have introduced a new agent-based microsimulation model to analyse the agricultural land rental market in Ireland. The model requires some refinement to deal with the question of price determination but provides a number of valuable insights. The findings from the microsimulation model indicate that a greater emphasis on profit maximization behaviour in the land rental market would be likely to lead to significant increases in farm size concentration and inequality.

This increase in farm size inequality would be likely to occur in the absence of countervailing factors such as may arise from an influx of highly-trained new entrant farmers into the land market or through targeted reforms to the system of farm subsidies. The model results also confirm the expectation that an increase in profit maximisation behaviour leads to a significant transfer of agricultural land from the cattle and sheep sectors and towards the more profitable dairy sector. The results point to a small increase in land area for the tillage sector, which can be partly attributed to relatively lower labour costs and lower building costs associated with expansion of the land area.

In addition to the microsimulation model, we display results based on an equilibrium model, where prices are determined by the total supply and total demand for agricultural land and with the assumption of one single market clearing price in each regional market. This model assumes the presence of a central auctioneer organising the operation of the market. Under this equilibrium model of price determination, our results confirm sharp differences between the land markets in the south and east regions and the largely disadvantaged BMW region in Ireland. It appears plausible that agricultural market returns are the dominant factor in influencing the demand for agricultural land rental in many parts of Ireland but other considerations must play an important role on the supply side of the market and this motivates further research into the topic.

The microsimulation model and the equilibrium model can both be refined to account for the assumptions regarding transaction costs and the costs associated with fragmentation. Future work could account for the distinction between one year land rental agreements and longer term leasing agreements as well as the question of land sales.

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