The Impact of Knowledge Transfer on Farm Level Margins during the Economic Recession

Cawley, A.[a, b], O'Donoghue, C[c], Heanue, K.[a], Hilliard, R[b]. and Sheehan, M[d].

[a] *Rural Economy and Development Programme, Teagasc*
[b] *JE Cairnes School of Business and Economics, NUI Galway*
[c] *College of Arts , Social Sciences and Celtic Studies, NUI Galway*
[d] *Business School, Edinburgh Napier University*

Abstract: The provision of effective knowledge transfer is dependent on the accessibility and quality of service available, coupled with the motivation of prospective clients to learn and implement new skills. In an agricultural context, the allocation of resources particularly in terms of location and the quality of their staffing are important considerations to ensure the successful transfer of specialist knowledge to farm level. The economic crisis from late 2008 increased the burden on public finances for many countries in Europe, which is likely to have affected the provision of public KT services as a consequence. Many public agricultural extension services needed to rationalise their resources to ensure the continued provision of effective knowledge transfer. This paper evaluates the impact of this consolidation by examining the economic return to farms for KT clients during the period. Focusing on the Irish case, the public KT service is provided by Teagasc experienced significant office closures (43%) and staff reduction (31%) since the economic crisis, yet client numbers declined only slightly (4.5%) over the period 2008-2014. Accordingly, using data from administration records to reflect the changed organisational structure combined with farm level outcomes available from the Teagasc National Farm Survey, the impact of KT is tested. The results show that annual contract holders gained a 12.3% benefit to their market gross margin. However, there was a negative effect for each additional client assigned to the adviser which averaged at 9.6%. This implies that the recruitment of additional advisers would positively impact on client margins further.

Key words: knowledge transfer; agricultural advisers; organisational change; panel data

Introduction

Knowledge transfer (KT) is a key aspect of agricultural sector policy delivered through public and private extension organisations. KT provision has the ability to diffuse best practice farm management and technologies to the agricultural sector (Tamini 2011). This occurs as a result of enhancing client capabilities through improved problem solving skills, decision making and more effective farm management through an efficient KT service (Vanclay and Leach 2011). Public KT services act as policy levers to influence farmer behaviour and therefore also assist in achieving objectives such as sustainable production, environmental mitigation and food safety legislation (O'Donoghue and Hennessy 2015). Thus, it is essential that the KT services operate effectively to support the implementation of initiatives across a range of outcomes, including to achieve impact on the profitability at farm level. However, providing an efficient public agricultural advisory body is confronted with many challenges including fiscal challenges and the dependence on the broader policy environment (Anderson 2008). It is imperative that public KT bodies deliver impact on farm level, notwithstanding their financial responsibility to the taxpayer. In other words, the service must represent 'value for money' to ensure its continued relevance and validity. Accordingly, a robust evaluation of existing KT services is a pertinent exercise to continually develop and provide an efficient service whilst identifying a quantifiable rate of return for the recipient farmer (Kidd et al. 2000). Indeed, studies on evaluating impact in agricultural advisory services have increased since the mid-2000s (Faure et al. 2012). This study provides

an evaluation of KT impact on farm level profitability, but does so during a period of diminished resources restricted by constraints enforced by the economic crisis.

This paper focuses on the Irish example, where uniquely the public KT provider Teagasc retains a predominantly public funded KT service alongside its research programme unlike many other European countries (Läpple et al. 2016, Prager et al. 2016). However, during the economic crisis Teagasc was forced to consolidate their resources with a 43.4% decline in offices and a 38.4% decline in adviser numbers, despite a minor 4.5% drop in client numbers. This implied a significant change in the allocation of resource to meet client demand. Accordingly, an evaluation on the impact of KT on farm level in the context of this consolidation would inform the effect of the increased workload and efficiency of remaining resources and whether specific areas were neglected in terms of service provision. This will identify the implications of this consolidation on the ultimate objective of delivering impactful KT to farm level, and therefore outline the consequences of the consolidation process.

Several studies evaluate the impact of agricultural KT on farm level income (e.g. Davis et al. 2012; Dercon et al. 2009; Läpple and Hennessy 2015) and typically the results are varied given the multiple methodological options and the diverse range of outcomes (Anderson and Feder 2004; Läpple and Hennessy 2015). However, many studies take a national perspective on the outcome as opposed to disentangling the relationships by region or on the allocation of available resources. Läpple et al. (2016) offer one such exception in terms of knowledge spillover and found significant differences between Irish regions in terms of access to KT services as well as across farm systems. Specifically, they found that counties located in the south east such as Waterford, Kilkenny and Wexford had lower client adviser ratios and higher innovation rates which is in contrast with the counties in the western region, namely the counties of Mayo, Galway and Roscommon. The analysis presented here builds on this work by focusing on farm level margins for KT participants versus non-participants using an annual panel data set, whilst applying random effects regression techniques to provide estimates on the impact post organisational change. This extends existing knowledge on impact by linking to a period when economic conditions restricted the available resources, resulting in an increased workload particularly in terms of the ratio of clients assigned to each adviser. Thus, the ability of a KT service to respond to an economic shock and maintain an impactful service is tested, which extends on existing literature by conditioning on the access of farmers to the KT service, an area identified by Faure et al. (2012) for further research.

The remainder of the paper is structured as follows: initially the theoretical context and background for agricultural KT is outlined along with the research question, followed by a review of the relevant literature. Next an overview of the methodology is provided and the data is described. Finally the results are discussed and conclusions drawn which outlines some caveats and direction for future research.

Context

The role of agricultural KT is wide ranging and incorporates a plethora of objectives. Concomitant with conventional tasks of providing technical assistance to farmers to improve productivity, KT providers must also balance emerging functions on issues such as environmental protection, sustainability and linking small holders to high value and export markets (Anderson 2008). There is also a substantial scheme assistance element to KT as advisers help to ensure farmers realise their financial subsidy entitlements. Thus, the primary objective of a KT service is to provide assistance and expertise to farmers to improve their situation in specific contexts, by overcoming barriers such as a lack of knowledge, influence or natural and capital resources (Van den Ban and Hawkins 1988).

KT is provided by both public and private organisations distinguished on the basis of 'interest' with public bodies funding activities related to public interest issues as opposed to primarily serving private interests aligned to profit generation (Klerkx and Leeuwis 2008). On this basis, governments have a legitimate need to influence farmer behaviour through a mixture of regulation, incentives, and advice (Garforth et al, 2003). Nonetheless it is imperative that KT providers utilise their resources efficiently to maximise impact to justify their significant subsidisation from public expenditure. In addition, KT clients often have to pay some level of fee for service (Garforth et al. 2003), and thus it is important that clients also experience a gain from interacting in advice which in turn incentivises participation further. Ultimately, achieving 'value for money' is the common goal on both the provider and recipient side.

There are various forms of agricultural KT with diverse levels of interaction and learning methods involved. More recently, it has been argued that traditional linear formats were in decline with an increasing role for participatory forms that promote learning through peer interaction (Läpple et al. 2016). This reflects a move from the top-down model to a more horizontal format where knowledge is shared under the facilitation of an adviser (Black 2000; Garforth et al. 2003). In addition, one-to-one consultations have retained their importance with private KT organisations providing much of this individualised work as opposed to the multifunctional role of the public organisation (Prager et al. 2016). Structured educational programmes are also an important KT typology where students learn in a class based environment (Black 2000). Each form reflects the diversity in the methods to attract, communicate and transfer specialised knowledge from the research or policy arena to farm level. Therefore it is important to avoid a generalised 'one-size-fits-all' model, given the diversity among the knowledge base of recipients (Asheim and Coenen, 2005; Pannell et al. 2014). However, the spatial availability of these activities is often asymmetrical given organisational challenges such as the mobility of staff, client densities, or practical issues such as the location of farms. Furthermore, an increasingly heterogeneous market for agricultural KT may lead to certain market failures due to this asymmetry of information or the perception of service value (Klerkx and Leeuwis 2008). This poses additional challenges for evaluation as network ties vary considerably and the impact on individual farms may also vary as a result. In other words, a farmer located in an area with a lower level of access to KT, may be less likely to participate intensively, thus less likely to receive the same level of impact as a farmer located in an area with higher access and service options.

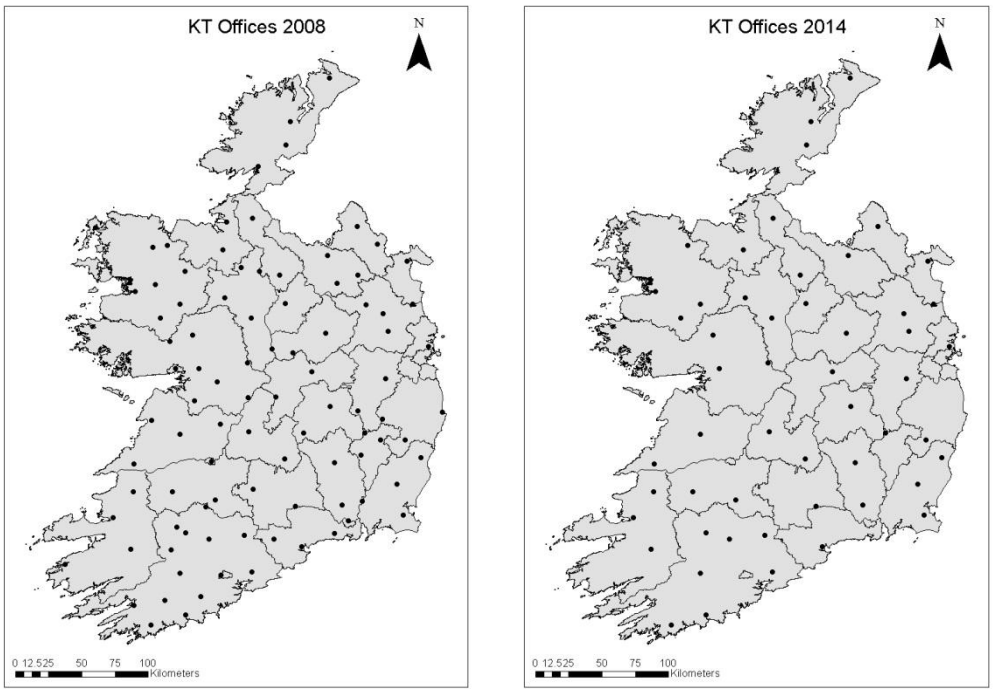
Accordingly, KT offices may be strategically located in advantaged regions where impact is likely to be more pronounced (Läpple and Hennessy 2015). For example, particular areas may be chosen as more suitable for intensive forms of production based on the soil type which may then be selected as ideal locations to base the provision of KT services, given dissemination benefits and likelihood of participation. Conversely, mountainous areas characterised by more marginal land may not appeal to KT providers given lower profitability expectations and lower participation rates. Thus, the location of KT centres is based on the needs of specific stakeholders or target audiences from a practical and in some cases politically feasible point of view (Leeuwis 2004). However, public KT providers must ensure access to meet the demand for KT services and assure public good benefits above what would be expected in a private organisation (Anderson and Feder 2004; Faure et al. 2012; Kidd et al. 2000). Indeed, it has been argued that smaller scaled farmers will suffer a lack of access if KT services are solely the function of private enterprises (Anderson and Feder 2004; Labarthe and Laurent 2013). This additional responsibility to ensure access for public KT providers is an important consideration in a consolidation process.

In addition, KT staff must continuously acquire appropriate expertise, knowledge and skills to provide effective advice to maintain their reputation as experts who have the capacity to exert a positive influence on large numbers of clients (Cliffe et al. 2016; Garforth et al. 2003). In addition, ensuring advisers are familiar with the local area can increase the likelihood that farmers will interact (Van den Ban and Hawkins 1988). This also alleviates any form of 'institutional void' where a disconnect exists between public bodies and farmers in a local network leading to a 'them' and 'us' mentality (Fisher 2013). This form of localised learning can also increase the likelihood that knowledge will 'stick' in local areas grounded in social interaction (Ashiem and Coenen 2005). Indeed a modern form of KT has emerged where farmers themselves act as advisors based on their familiarity and motivation reacting with client confidence (Faure et al 2012). Therefore to ensure the recruitment process functions effectively to attract appropriate personal that have the technical expertise, adequate interpersonal skills and local prowess to diffuse knowledge to clients of similar cultural background is also important.

Teagasc KT

Teagasc is unique in that it operates an organisational structure that recognises the importance of combining research with effective KT (Prager et al. 2016) by allocating 70% of their operating budget of €160 million per annum between the two key pillars of the organisation (Teagasc 2016). This structure ensures the latest technologies and practices discovered in research can be transferred to clients to improve their farm level performance. Nonetheless, Teagasc was forced to consolidate and rationalise resources from the end of 2008 due to fiscal economic challenges caused by the global recession. Indeed, there was a significant reduction in resources involving the disposal of assets, office closures, staff reductions and redeployments (Cawley and Boyle 2011). Specifically, 40 local advisory offices closed (a decline of 43.4%), and staff numbers were reduced by 145 (a decline of 38.4%) implying negative consequences for service provision. Consequently, the spatial dispersion of existing KT offices increased which could have negatively impacted on client participation rates given the associated increased distances to their nearest retained office. However, Teagasc client numbers remained relatively static at 41,025 (a slight decrease of 4.5%) over this period. The organisational change created significant reductions in available resources from both a staff and office based perspective (Cawley and Boyle 2011). All regions were affected across the country to various degrees. The scale of office closures is illustrated in Figure 1. These office closures increased the average distance to local KT offices

Figure 1 KT Office Closures 2008-2014

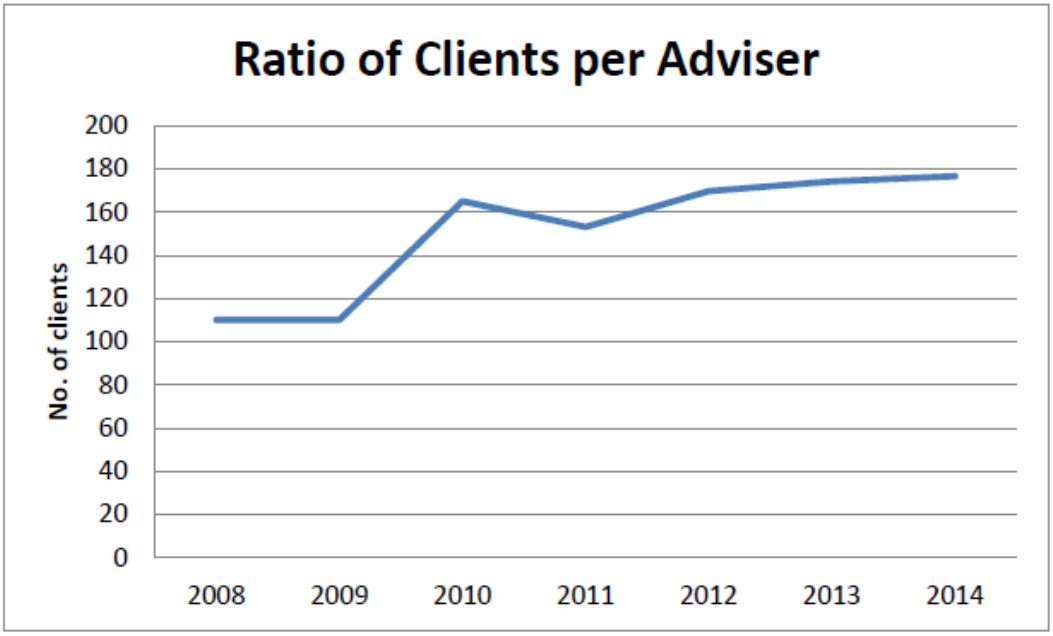


Evidently, the closure of offices increased the distances to the nearest office for farmers over this period. This increase was an additional 7 kilometres on average with 52 offices retained, therefore ensuring the organisation remained accessible to farmers (Prager and Thomson 2014). However, this does not reflect the increased distances for farms in specific regions accurately, with the distances in the north western region increasingly disproportionately to those in other areas. Specifically, the western region of Mayo, Galway and Roscommon experienced a trebling of average distance compared to other regions.

Similarly, the increased ratio of clients per adviser was significant, and differed considerably by region. Nationally, the ratio increased by 55.1% on average (see Figure 2). However, the west region experienced an increase of 79.8% whereas in the southwest the increase was 13.5%. Furthermore, particular services were relocated in an attempt to meet demand for particular KT activities with reduced resources. Taking the agricultural training courses as an example, smaller offices relinquished this service to larger KT centres to facilitate larger groups and maximise efficiencies from the KT service. The increased ratio of clients per adviser over this period is presented in Table 1.

In general most local offices experienced a significant rise in the number of clients assigned to each adviser as a result of the consolidation. These varied regionally from office to office but on average the increase was 48 additional clients to each adviser. On a regional basis the ratio of clients to advisers was recorded as lowest in 2014 in the south west at 124 clients per adviser on average. Conversely, the highest ratio was recorded in the west over this period with 212 clients per adviser in 2014, an increase of 80% from the 2008 level of 118 reflecting the dramatic change over the period. Furthermore, the range of ratios across the country became increasingly skewed, from a range of 106-118 clients in 2008 to 124-212 clients in 2014. Thus, the difference rose from 12 clients to 88 clients per adviser on average. This implies that advisers would have less time for individual consultations with each client and may have had to facilitate additional clients in group based formats of KT.

Figure 2 Average ratio of clients per adviser 2008-2014



The following table illustrates the change in client ratios and average profit level for clients during the period in question.

Table 1. Regional Change from Consolidation

Region	Mean MGM per ha 2008	Mean MGM per ha 2014	Percentage increase	Clients per adviser 2008	Clients per adviser 2014	Percentage increase
Border	€433	€624	44%**	112.5	195.6	74%***
Dublin	€580	€872	50%	110.0	190.5	73%***
Mid-East	€679	€868	28%*	109.2	171.7	57%***
Midlands	€577	€762	32%**	119.2	180.8	52%***
Mid-West	€512	€986	93%***	106.6	188.2	77%***
South-East	€734	€1,135	55%***	119.9	175.0	46%***
South-West	€731	€1,122	53%***	109.6	124.4	13%**
West	€199	€422	112%	118.2	212.6	80%***

*Note: Border counties include Louth, Leitrim, Sligo, Cavan, Donegal and Monaghan; Mid-East include Kildare, Meath and Wicklow; Midlands include Laois, Longford, Offaly and Westmeath; Mid-West include Clare, Limerick and North Tipperary; South-East include Carlow, Kilkenny, Wexford, Waterford and South Tipperary; South-West include Cork and Kerry; West include Mayo, Galway and Roscommon; Market gross margin is calculated by deducting direct subsidy payments from farm gross margin and refers to Teagasc clients only; Ratios are aggregated from local office data within each region; * represents statistical significance of p values -*** for 1% significance, ** for 5% significance and * for 10% significance*

Evidently, particular regions were affected more than others in the consolidation process. However, all regions experienced an increase in the ratio of clients, and the impact of this increase on profitability is the key focus of this analysis.

Research Question

What was the impact of KT on farm level margins post rationalisation of KT resources?

Literature Review

Much of the literature on the impact of KT services on agricultural income primarily adopts KT as an aggregated binary variable and outcomes are measured on the basis of participation versus non participation. Typically these types of analyses are undertaken on a national basis (Davis et al. 2012; Läpple et al. 2013; Läpple and Hennessy 2015). However, there are a limited number of studies that focus on the regional or spatial aspect of how KT is delivered and absorbed by clients (Läpple et al. 2016). To distinguish between regions, and isolate causal relationships based on a service that offers a plethora of diverse services on a wide ranging set of outcomes is central to these difficulties. This paper addresses these gaps in the literature by focusing on the spatial characteristics of KT resources and the subsequent impact on farm margins for clients.

Moreover, basing the analysis purely on location may not suffice to explain the impact of KT (Fisher 2013). Rather it is important to consider the type and quality of KT received as a central objective. For example a recent study found that although farmers received more than one visits from extension agents on an annual basis, the impact of these visits was questionable (Onobougo et al. 2014). Their study suggests that multiple visits would be beneficial to farmers but this was not the case for the majority who received fewer on farm consultations. To address this issue in this study we also aggregate KT participation into a binary variable, but focus only on annual contract holders implying the KT received is aimed at technical advice as opposed to other objectives such as scheme assistance duties. Teagasc annual contracts vary from a basic package that includes scheme assistance plus invitations to events and up to date news publications to an intensive development package that includes discussion groups and intensive on farm consultations. Thus, we assume that contract holders are interested in services other than solely scheme assistance and on this basis we distinguish contract holders as participants in programmes that also have a degree of technical KT. Indeed the failure to control for clients who are motivated by the scheme assistance offering may lead to mistakenly identifying a subsidy effect as a KT effect (Nordin and Höjgård 2016).

Läpple et al. (2016) addressed spatial variability in their analysis on agricultural innovation and knowledge spillover in Ireland and found a clear regional divide in terms of knowledge spillover potential given the distribution of research and KT services. Utilising a proxy based on farmers participating in non-scheme related KT and geographic information system (GIS) maps they regressed their variables using a Tobit model to draw these conclusions. However, their work was primarily focused on the spatial concentration of agricultural innovativeness based on an index whereas in this paper we focus on farm margin ensuring an intuitive comparable outcome measure is identified. Similarly Coccia (2008) conducted research into the spatial mobility of KT in Italy by developing a function based on the number of contacts with a knowledge centre and the distance to that centre and found that technology adoption decreases as the distance to the centre increases. Again this paper shows that spatial factors are likely to affect the outcome of KT participation, but the focus is limited to technology adoption as opposed to farm level outcomes. A similar study was conducted on the effectiveness of extension outlets to influence technology adoption and concluded that it is imperative that offices are located strategically close to target peer farms in remote areas to ensure widespread diffusion of information. Genius et al. (2013) found that extension provision should be sought to complement existing informal social networks to ensure effective knowledge transfer.

Broadening the focus outside of agriculture there are examples in the literature that focus on the spatial effects associated with KT. For instance, a relationship between concepts such as strong social capital ties, cohesion, trust built within a network and effective KT have been reported (Inkpen and Tsang 2005; Reagans and McEvily 2003). These imply that locally based networks that have endured over time gain additional benefits due to factors such as familiarity, relevance and collective action. It appears that agricultural KT providers have reacted to this evidence, by providing more participatory formats of extension where familiarity and peer learning are key elements (Garforth et al. 2003). However, the extent to which these forms continued to impact farm margin during a period of resource constraint has not been researched in detail, and will help to identify the consequence of the consolidation for clients.

Data

The data for this research is two-fold. First data on KT participation and farm performance was obtained from the Teagasc National Farm Survey (NFS). The NFS is an annual panel data source collected as part of the Farm Accountancy Data Network of the European Union consisting of approximately 1,000 farms per annum. The panel is unbalanced in the sense that farms do not remain permanently in the sample and may be dropped permanently or temporarily before re-entering the sample (Hynes and Garvey 2009). This dataset provides data on the level of gross output, margins, costs, income, investment and indebtedness across the spectrum of farming systems, sizes and profiles in the various regions (Connolly *et al.* 2010). It also indicates whether a particular farmer was a Teagasc client providing an indication of KT participation as well as the type of participation. The data was obtained for the years 2008-2014 inclusive to examine impact since the organisational change was implemented.

Second, data on KT provision was derived from internal administrative records in Teagasc to identify existing offices and the respective number of advisers and clients in each KT centre. The rationalisation programme initiated meant the closure of 40 local offices leaving 52 offices open - a decline of 43.4%. In addition, there were statistically significant reductions in the numbers of advisers available a fall from 377.5 in 2008 to 232.2 in 2014, a decline of 38.4%. Concurrently, the number of clients during this period remained relatively static with 42,994 clients in 2008 as opposed to 41,025 in 2014 indicating a slight decrease of 4.5%. This implies an increase in the ratio of clients to advisers as shown in Figure 3. This ratio can be adopted as an indication of KT provision and thus used for assessment (Prager et al. 2017). The number of clients attributed to each Teagasc adviser on average has increased significantly over this period, and this ratio varies spatially. These ratios appear higher in the regions that would be considered less favoured in terms of land capability, with farm systems associated with lower incomes such as beef and sheep more common. Conversely, dairy farmers are more common in regions with lower ratios such as the south east and south west (Läpple et al. 2016).

The location of each office was obtained by applying their specific Building Identification code from the Irish postal service's Geo-reference directory, and measuring the geographic distance to each farm observation in kilometres. It is hypothesised that the distance to a local office negatively affects the decision to participate in KT services.

The dependent variable for this analysis is market gross margin per hectare defined as all income attributed to the farm enterprise excluding subsidies. This provides an indication of the financial performance of the farm based on the value of their output. The primary explanatory variable is based on advisory contracts which exclude scheme assistance and other services. These contracts are assumed to involve more technically based KT to various

levels of intensity including one-to-one consultations, farm walks, discussion group activities and access to the most recent research. Therefore the key hypothesis is that KT clients with annual contract are motivated to participate to improve their technical expertise and thus improve their market gross margin.

In addition to the resource based variables listed above, appropriate controls are included to explain the variation in market gross margin including farm system, land type, and personal characteristics such as farmer age, education and off farm employment. The sample is drawn from Teagasc clients only to ensure the analysis focuses on a similar cohort of farmers that are assumed as more progressive. The summary statistics are presented in Table 2.

Table 2. Data Description and Summary Statistics

Variable	Description	Mean	SD	Min	Max
MGM/ha	Market gross margin per ha	755.6	719.8	-762.5	8333.3
Ln MGM/ha	Log of market gross margin per ha	6.210	1.193	-1.516	9.03
KT contract holder	= 1 if Teagasc contract holder	.74	.44	0	1
Clients per adviser	Ratio of clients per adviser	156.6	23.5	102.9	232.1
Region: Border	= 1 if farm is in border region	.18	.38	0	1
Dublin	= 1 if farm is in Dublin region	.01	.09	0	1
East	= 1 if farm is in eastern region	.11	.31	0	1
Midlands	= 1 if farm is in midlands region	.12	.33	0	1
Mid-west	= 1 if farm is in midwest region	.08	.27	0	1
South-east	= 1 if farm is in southeast region	.18	.38	0	1
South-west	= 1 if farm is in southwest region	.20	.40	0	1
West	= 1 if farm is in the western region	.12	.33	0	1
Ln Land Value/ha	Log of land value per ha	-.11	.54	-3.92	2.70
Dairy	= 1 if system is dairy	.31	.46	0	1
Cattle Rearing	= 1 if system is cattle rearing	.14	.34	0	1
Cattle Other	= 1 if system is cattle other	.23	.42	0	1
Mainly Sheep	= 1 if system is mainly sheep	.11	.31	0	1
Pigs & Poultry	= 1 if system is pigs & poultry	.00	.03	0	1
Tillage	= 1 if system is tillage	.10	.29	0	1
Other	= 1 if system is other	.12	.32	0	1
Forestry	= 1 if farm has forestry	.13	.33	0	1
Farm Size	No. of utilisable hectares	58.05	47.09	0	1116.6
Stocking Density	Total livestock units per ha	1.40	.67	0	4.26
Labour	Units of unpaid family labour	1.24	.49	0	3.83
Age	Age of farmer	54.6	11.63	21	90
Years Agri ed	= .5 if short course ; = 2 if ag cert; = 4 if ag university	.97	1.05	0	4
Off farm job	= 1 if employed off farm	.21	.41	0	1
Good soil	= 1 if soil is classified as good	.56	.50	0	1
Medium soil	= 1 if soil is classified as medium	.34	.47	0	1
Poor soil	= 1 if soil is classified as poor	.09	.29	0	1
Dist_advoff	Distance to advisory office (km)	15.27	8.06	0.15	52.39

Note: All summary statistics based on Teagasc clients only

The summary statistics show a diverse spread of farmers with various systems across all regions.

Methodology

Although accessibility and the quality of resources are the key themes of this research, simply having access to a given resource cannot be assumed productive in terms of impact and thus there are many dynamic factors that explain this process (Fisher 2013). Accordingly, there is

an inherent difficulty in evaluation the impact of these types of KT services given the broad range of extension methods and outcome measures (Läpple and Hennessy 2015). Indeed, there are many underlying issues that affect farm performance (Anderson 2008). Nonetheless given the core objective of this research of estimating the impact of KT on farm margins post restructuring, a random effects regression model was chosen as most suitable given the nature of the data acquired and the inherent biases for self-selection and unobserved characteristics such as innate ability.

Exploiting the panel nature of the NFS, issues such as heterogeneity and omitted variables can be addressed (Kilcline et al. 2014). The random effects model is preferred on the basis of two selected criteria. Firstly, random effects models assume that all explanatory variables are uncorrelated with the individual effects (Baltagi and Liu 2012). In other words, the individual effects of each observation are assumed to be random. This enables the individual component associated with heterogeneity of each observation to be absorbed through the error term (Kilcline et al. 2014). Second, although a Hausman test suggests a fixed effects model for this analysis, the lack of variation across years in terms of farm system and nearest office characteristics causes many observations to drop out as they remain static. Thus we retain valuable information that adds to the model to explain the variation in farm margin.

Accordingly the model is specified as follows:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it}$$

where Y_{it} is the dependent variable of market gross margin per hectare for farm i in year t, α_i is the individual farmer effect, X is a vector of explanatory variables including KT annual contracts, the spatial variables outlined above and controls and ε is the idiosyncratic error term. Furthermore the standard errors are adjusted to control for heteroscedasticity concerns.

Results

First, contract holders experienced a positive impact to KT participation on their market gross margin per hectare. The value of this impact was estimated at 12.3% and was statistically significant. Second the increased workload on advisers negatively impacted participants, but this effect was practically small per additional client at 0.2%. This means that for each additional client assigned to an adviser, the overall margin decreased by 0.2%. While this may seem practically insignificant as advisers typically manage large numbers of clients, once the total increase in clients is assumed, the decrease becomes more significant. Thus, given that during this period of consolidation, advisers gained an additional 48 clients each on average, this effect implies a cumulative negative effect of 9.6 % on market gross margin per hectare on average. Furthermore given that these ratios vary considerably from region to region, the effect of the additional clients was asymmetrical with areas in the north and western regions more likely to have experienced a larger negative effect. For example, an adviser located in the western region experienced an increase of 94.4 clients, which implies a decrease of 18.9% on average market gross margin per hectare. Conversely, an adviser in the south west region experienced an increase of 14.8 clients implying a decrease of just 2.96% on overall gross margin per hectare. Therefore, the regional disparities increased over this period, and an annual KT contract in some regions was less lucrative than others in terms of profitability. However, it is also important to note that these regions are more likely to rely more heavily on subsidy payments due to a variety of factors including the lower profitability of dominant beef and sheep systems, climate, and topography compared with other regions. Thus, including subsidies in the model is likely to reduce this spatial imbalance, and the inclusion of subsidies in the dependent variable increases the impact of KT on farms to 17.1%, therefore offsetting the negative effect of the consolidation further. However, for the

purpose of clarity this analysis focused on profitability excluding subsidies. The full sets of results of the random effects estimator are presented in Table 3.

Table 3. Random Effects Model Coefficient estimates

Variable	Coefficient	SE	p	Confidence Interval	
KT contract holder	0.123	0.053	0.021	0.018	0.227
Clients per adviser	-0.002	0.001	0.054	-0.004	-0.000
Region: Dublin	0.214	0.153	0.160	-0.085	0.514
East	-0.005	0.085	0.949	-0.171	0.160
Midlands	0.032	0.086	0.711	-0.137	0.201
Midwest	0.071	0.078	0.361	-0.081	0.224
Southeast	-0.004	0.075	0.960	-0.143	0.151
Southwest	-0.071	0.076	0.347	-0.219	-0.077
West	-0.251	0.102	0.013	-0.451	-0.052
Ln Land Value/ha	0.062	0.043	0.149	-0.022	0.146
Cattle Rearing	-1.230	0.067	0.000	-1.362	-1.098
Cattle Other	-1.114	0.052	0.000	-1.243	-1.038
Mainly Sheep	-1.113	0.077	0.000	-1.285	-0.985
Pigs & Poultry	-1.244	1.336	0.352	-3.862	1.374
Tillage	-0.382	0.078	0.000	-0.535	-0.230
Other	-0.237	0.033	0.000	-0.302	-0.172
Forestry	-0.374	0.077	0.000	-0.525	-0.222
Stocking Density	0.477	0.037	0.000	0.405	0.550
Labour	0.080	0.036	0.027	0.009	0.150
Age	0.000	0.010	0.961	-0.019	0.020
Age squared	-0.000	0.000	0.627	-0.000	0.000
Agri. Short Course	0.211	0.059	0.000	0.095	0.326
Agri. Certificate	0.236	0.049	0.000	0.139	0.333
Agri. University	0.057	0.121	0.637	-0.180	0.293
Off-farm job	-0.011	0.050	0.828	-0.088	0.109
Medium soil	-0.161	0.042	0.000	-0.244	-0.078
Poor soil	-0.493	0.120	0.000	-0.727	-0.258
Dist_advoff	-0.004	0.003	0.137	-0.009	0.001
Year	0.080	0.005	0.000	0.070	0.089
Constant	-153.6	9.894	0.000	-172.9	-134.2
n = 3,517					
Overall r^2 = 0.6484	Between r^2 = 0.7713		Within r^2 = 0.1123	Rho = 0.4032	

Note: Dependent variable is the log of market gross margin per hectare; years are 2008-2014 inclusive; Border region omitted for collinearity; dairy system omitted for collinearity; good soil omitted for collinearity; standard errors adjusted for heterogeneity

Evidently, there was a benefit to holding an annual contract with Teagasc over this period in terms of profitability due to the increase in market gross margin per hectare. However, this benefit was reduced as the ratio of clients per adviser increased. All other coefficients are in line with expectations. All farm enterprises show a negative coefficient against the base case of dairy production which is the most profitable. Stocking density is an important indicator of margin as it relies on efficient use of land. Agricultural education positively affects margin whilst poorer soil shows a negative impact. The distance to the local advisory office also shows a negative coefficient as expected, albeit not statistically significant. It is also important to consider agricultural price indices over the period under study with a slower fall in input prices particularly in earlier years when the economic crisis began to take hold,

followed by similar rises to output prices (CSO 2017). Nonetheless, availing of an annual contract with Teagasc was positive for farm margin.

Conclusion

There are two main implications of these results. First, the impact on farm level margin remains positive despite the organisational change and clients should be motivated to continue to participate given these positive outcomes. In line with literature on evaluation of KT, these findings reinforce the positive impact of KT participation for client performance (Akobundu et al 2004; Davis et al. 2012; O'Donoghue and Hennessy 2015). Furthermore, the scale of the organisational change offers an insight into the responsiveness of the organisation to continually meet demand, and on this evidence KT retained a beneficial impact on farm profitability. Second, the increased workload on each adviser negatively affected farm margins albeit at a practically small level. This also implies the reverse as a decrease in this ratio would reduce the negative impact on market gross margin further. Accordingly, additional advisory staff would enhance the positive relationship between KT participation and farm level margin. This is in line with previous literature that argue a stable or increasing workforce of advisers is necessary to continue to provide up to date efficient advice in a competent and flexible manner (Prager et al. 2016; Sutherland et al. 2013; Swanson and Rajalahti 2010; Garforth et al. 2003; Labarthe and Laurent, 2013a).

Nonetheless, the organisational consolidation altered the existing role of the adviser and KT services needed to evolve and adapt to the increased demand on resources. However, these results indicate that this process was managed effectively in terms of service impact, but falls short of explaining the types of activities that drove this impact. Thus, future research should examine how the restructuring was experienced by those involved to gain a deeper understanding to the underpinning processes that drove this continued impact. Providing evidence as to the different levels of impact associated with the various KT formats would enrich this analysis further.

References

Akobundu, E., J. Alwang, A. Essel, G. W. Norton, and A. Tegene (2004). "Does Extension Work? Impacts of a Program to Assist Limited-Resource Farmers in Virginia." *Applied Economic Perspectives and Policy* 26: 361-372.

Anderson, J. R. (2008). *Agricultural Advisory Services*. Washington, DC: World Bank

Anderson, J. R. and G. Feder (2004). "Agricultural extension: Good intentions and hard realities." *The World Bank Research Observer,* 19 (1): 41-60.

Asheim, B. T. and L. Coenen (2005). "Knowledge bases and regional innovation systems: Comparing Nordic clusters." *Research Policy,* 34 (8): 1173-1190.

Baltagi, B. H. and L. Liu, (2012). "The Hausman-Taylor panel data model with serial correlation." *Statistics and Probability Letters,* 82: 1401-1406.

Black, A. W., (2000). "Extension theory and practice: a review." *Australian Journal of Experimental Agriculture,* 40**:** 493-502.

Cawley, N. and Boyle, G. (2011) *Teagasc Statement of Strategy: 2012-2015,* [online] available: http://www.teagasc.ie/publications/2012/1289/Teagasc-Strategy-Statement.pdf [accessed 28 Jun 2016].

Central Statistics Offices (2017). "Agricultural Input and Output Price Indices by Agricultural Produce and Year." *Statbank*, [online] available: http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/saveselections.asp [accessed 21 Feb. 17].

Cliffe, N., Stone, R., Coutts, J., Reardon-Smith, K. and S. Mushtaq (2016). "Developing the capacity of farmers to understand and apply seasonal climate forecast through collaborative learning processes." *The Journal of Agricultural Education and Extension*, 22 (4): 311-325.

Coccia, M. (2008). "Spatial Mobility of Knowledge Transfer and Absorptive Capacity: Analysis and Measurement of the Impact within the Geoeconomic Space." *Journal of Technology Transfer*, 33 (1): 105-122.

Connolly, L., Kinsella, A., Quinlan, C. and Moran, B. *National Farm Survey* Carlow: Teagasc Publications Office, 2010.

Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R. and Nkuba, J. (2012). "Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa." *World Development*, 40 (2): 402-413.

Dercon, S.,Gilligan, D., Hoddinott, J. and Woldehanna, T. (2009). "The Impact of Agricultural Extension and Roads on Poverty and Consumption Growth in Fifteen Ethiopian Villages." *American Journal of Agricultural Economics*, 91(4): 1007-1021.

Faure, G., Desjeux, Y., and P. Gasselin (2012). "New Challenges in Agricultural Advisory Services from a Research Perspective: A Literature Review, Synthesis and Research Agenda." *The Journal of Agricultural Education and Extension* 18(5): 461-492.

Fisher, R. (2013). "A gentleman's handshake: The role of social capital and trust in transforming information into usable knowledge," *Journal of Rural Studies* 31: 13-22.

Garforth, C., Angell, B., Archer, J., and Green, K. (2003). "Fragmentation or creative diversity? Options in the provision of land management advisory services." *Land Use Policy* 20 (4): 323-333.

Genius, M., Koundouri, P., Nauges, C. and V. Tzouvelekas (2013). "Information transmission in irrigation technology adoption and diffusion: social learning, extension services, and spatial effects." *American Journal of Agricultural Economics* pp: 1-17.

Hynes, S. and E. Garvey (2009). "Modelling Farmers Participation in an Agri-environmental Scheme using Panel Data: An Application to the Rural Environmental Protection Scheme in Ireland." *Journal of Agricultural Economics* 60 (3): 546-562.

Inkpen, A. C. and E. W. Tsang (2005). "Social capital, networks, and knowledge transfer." *Academy of management review* 30 (1): 146-165.

Kidd, A. D., Lamers, J.P.A., Ficarelli, P.P. and Hoffmann, V. (2000). "Privatising agricultural extension: caveat emptor." *Journal of Rural Studies* 16 (1): 95-102.

Kilcline, K. O'Donoghue, C., Hennessy, T. and S. Hynes (2014). "Economic factors affecting concentrate usage on Irish sheep farms." *International Journal of Agricultural Management*, 3 (4): 243-252.

Klerkx, L. and C. Leeuwis (2008). "Matching demand and supply in the agricultural knowledge infrastructure: Experiences with innovation intermediaries." *Food Policy* 33 (3): 260-276.

Labarthe, P. and Laurent, C. (2013). "Privatization of agricultural extension services in the EU: Towards a lack of adequate knowledge for small-scale farms?" *Food Policy* 38; 240-252.

Läpple, D., Hennessy, T. and C. Newman (2013). "Quantifying the Economic Return to Participatory Extension Programmes in Ireland: an Endogenous Switching Regression Analysis." *Journal of Agricultural Economics* 64 (2): 467-482.

Läpple, D. and T. Hennessy, (2015). "Assessing the Impact of Financial Incentives in Extension Programmes: Evidence From Ireland." *Journal of Agricultural Economics* 66: 781-795.

Läpple, D., Renwick, A., Cullinan, J. and Thorne, F. (2016). "What drives innovation in the agricultural sector? A spatial analysis of knowledge spillovers." *Land Use Policy* 56: 238-250.

Leeuwis, C., and Van den Ban, A. (2004). *Communication for rural innovation,* Oxford: Blackwell Publishing Ltd.

Nordin, M. and S. Höjgård (2016). "An evaluation of extension services in Sweden." *Agricultural Economics* 48: 1-10.

O'Donoghue, C. and Hennessy, T., (2015) "Policy and Economic Change in the Agri-Food Sector in Ireland," *The Economic and Social Review* 46 (2): 315-337.

Onubuogu, G. C., Esiobu, N. S., Nwosu, C. S. and C. N. Okereke (2014). "Resource use efficiency of smallholder cassava farmers in Owerri Agricultural zone, Imo State, Nigeria," *Scholarly Journal of Agricultural Science* 8 (7): 142-252.

Pannell, D. J., Llewellyn, R. S. and M. Corbeels (2014). "The farm-level economics of conservation agriculture for resource-poor farmers," *Agricultural, Ecosystems & Environment,* 187: 52-64.

Prager, K., Creaney, R. and A. Lorenzo-Arribas (2017). "Criteria for a system level evaluation of farm advisory services." *Land Use Policy* 61: 86-98.

Prager, K., Labarthe, P., Caggiano, M. and A. Lorenzo-Arribas (2016). "How does commercialisation impact on the provision of farm advisory services? Evidence from Belgium, Italy, Ireland and the UK." *Land Use Policy* 52: 329-344.

Prager, K. and K. Thomson (2014). *AKIS and advisory services in the Republic of Ireland,* Report for the AKIS inventory (WP3) of the PRO AKIS project, Aberdeen: James Hutton Institute

Reagans, R. and B. McEvily (2003). "Network Structure and Knowledge Transfer: The Effects of Cohesion and Range." *Administrative Science Quarterly* 48 (2): 240-267.

Tamini, L.D. "A nonparametric analysis of the impact of agri-environmental advisory activites on best management practice adoption: A case stud of Québec." *Ecological Economics* 70: 1363-1374.

Teagasc (2016) "Our Organisation," *About Us,* [online], available: http://www.teagasc.ie/about/our-organisation/ [accessed 27 May 2016].

Vanclay, F. and G. Leach (2011). "Enabling change in rural and regional Australia Shaping change: natural resource management, agriculture and the role of extension," (Australasia Pacific Extension Network (APEN).

Van den Ban, A. W. and H. S. Hawkins (1988). *Agricultural Extension*. Essex, Longman Scientific & Technical.