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Take-up of Free School Meals: Price Effects and Peer Effects

Angus Holford
Institute for Social and Economic Research
University of Essex

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Non-technical summary

Every day in the UK, almost 300,000 entitled children do not participate in the Free School Meals (FSM) programme, foregoing a transfer worth up to £400 per year. FSMs represent a social safety net, providing a minimum nutritional intake to children who might otherwise not obtain it. This objective is severely undermined when take-up is deterred by barriers of stigma or lack of information.

This paper explores the determinants of school meal participation using an administrative dataset of all primary schools in Scotland between 2004 and 2011. During the 2007-08 academic year, FSMs were temporarily made available to *all* children in the first three years of primary school (ages 5-8 years) in five areas of Scotland. This saw take-up of school meals increase among non-FSM-registered pupils by 14 percentage points from 38%. Among FSM-registered individuals, for whom school meals were *always* free, take-up rose by 5 percentage points from 86%. This was despite the scheme providing no financial incentive for the latter group to change their behaviour.

This paper attributes the rise take-up of FSMs by those *always* entitled to a positive peer effect: FSM-registered individuals became more likely to participate *because* a greater proportion of other students in the school were doing so. This result generalises to schools never exposed to universal entitlement. The magnitude of the effect is such that in a typical school a 10 percentage point rise in peer-group take-up would reduce non-participation by almost a quarter.

This positive peer effect arises because higher peer-group take-up (i) reduces the probability that an FSM-participant is stigmatised by needing to eat apart from his friends, and (ii) provides a favourable signal for the quality and desirability of school meals.

These results suggest that improvements can be made at *all* levels of administration, in order to raise participation in FSMs and benefit the most deprived children. Within schools, every effort should be made to allow classmates taking school meals and packed lunches to eat together at the same time. Local authorities can ensure that FSM-registered pupils remain anonymous when obtaining their school lunch. Finally, national governments should target future interventions regarding FSM entitlement at year-groups within the most deprived schools, rather than singling out individuals.

Take-up of Free School Meals: Price Effects and Peer Effects *

Angus Holford†

July 3, 2012

Abstract

Almost 300,000 entitled children do not participate in the UK's Free School Meals (FSM) programme, worth up to £400 per year. Welfare take-up can be deterred by stigma and lack of information. This paper uses a school-level dataset and fixed-effect instrumental variables strategy to show that peer-group participation has a substantial role in overcoming these barriers. Identification of endogenous peer effects is achieved by exploiting a scheme which extended FSM entitlement to all children in some school cohorts. Results show that in a typical school a 10 percentage point rise in peer-group take-up would reduce non-participation by almost a quarter.

Keywords: School meals, peer effects, welfare stigma, aggregated data

JEL classifications: H75, I28, I38, Z13

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†Institute for Social and Economic Research, University of Essex, Wivenhoe Park, Colchester, CO4 3SQ. E-mail: ajholf@essex.ac.uk. Tel: +44 (0)1206 872 472

1 Introduction

In the UK, approximately 1.1 million children who come from from low income households or without a parent in full time employment are entitled to receive a Free School Meal (FSM) at lunchtime each schoolday. FSMs represent a social safety net, providing a minimum nutritional intake to children for whom malnutrition would otherwise hinder their physical and cognitive development, and increase the likelihood of disruptive classroom behaviours.

This objective is severely undermined by non-participation: Around 300,000 children entitled to FSMs are either not registered, or are registered but fail to take it up, costing their parents up to £400 per year.

This paper explores why individuals registered for the FSM programme choose not to participate. It is motivated by the observed behaviour of FSM-registered individuals during a pilot scheme for 'universal' (as opposed to 'means-tested') entitlement to FSMs. The pilot took place in five local education authority (LEA) areas of Scotland during the 2007-08 academic year, when FSMs were made available to *all* children in the first three years of primary school (ages 5-8 years).

This scheme directly targeted non-FSM-registered individuals, who usually were required to pay. Figure 1 shows take-up by this group to have risen substantially in 2008 when their price was temporarily reduced to zero, but returning to its previous trend immediately afterwards. This is consistent with the unregistered group treating school meals as a normal consumer good, with temporary exposure to zero price causing no structural change in their demand.

Figure 2 shows that for the registered group (who never had to pay) take-up rose by around 4.5 percentage points from 2007 to 2008. Assuming a montonic treatment response this means that 30% of FSM registered students previously foregoing their entitlement were persuaded to start taking it. These individuals were likely to be from the most deprived, 'hardest-to-reach' backgrounds, and

Figure 1: Take-up rate of school lunches: Pupils not registered for Free School Meals

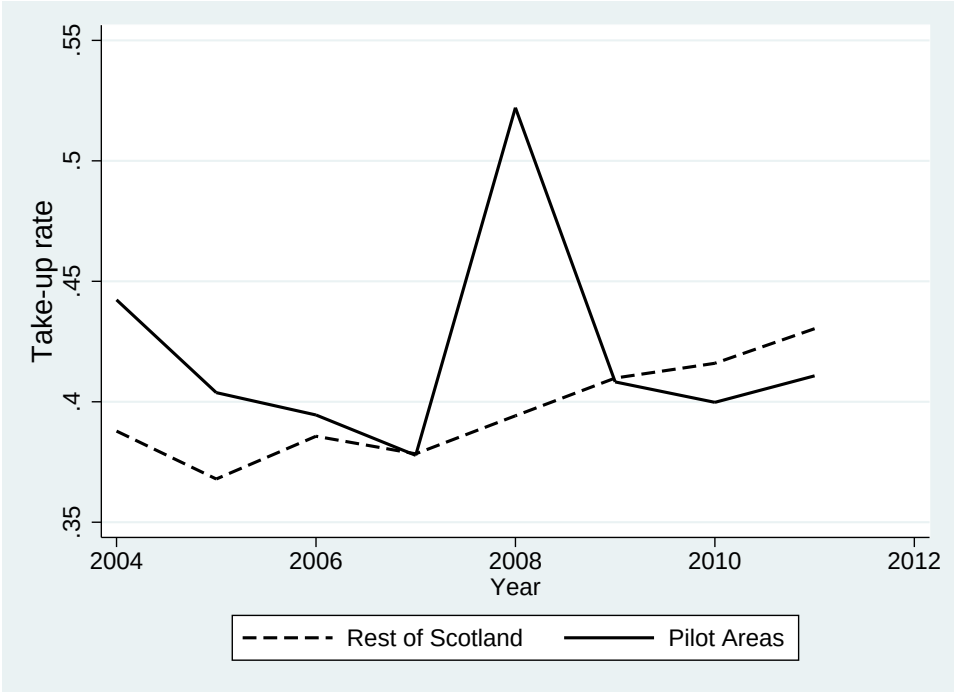
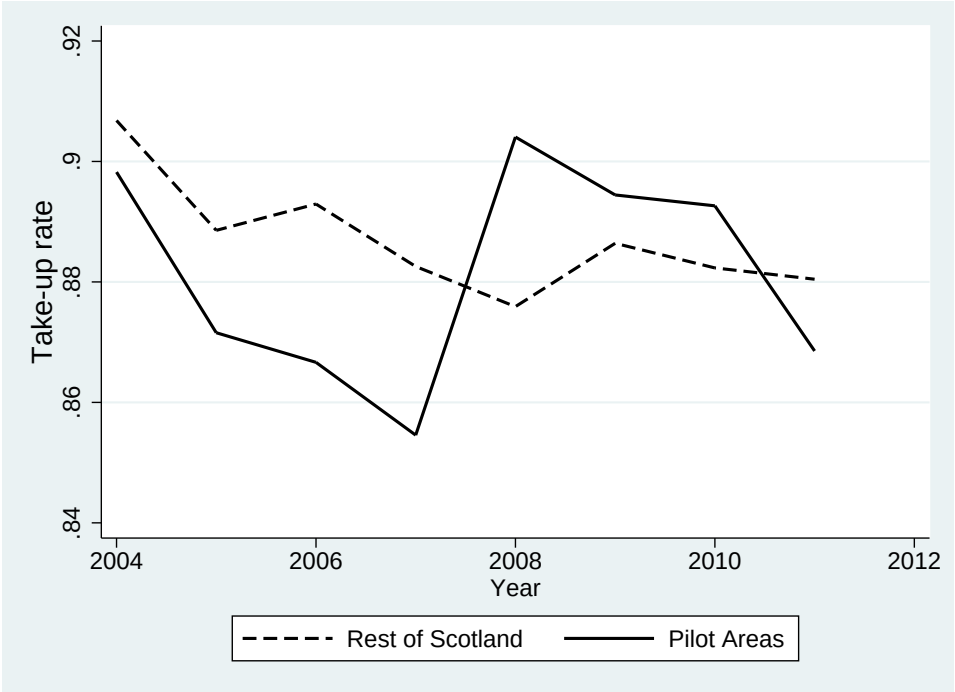


Figure 2: Take-up rate of School Lunches: Pupils registered for Free School Meals



hence stood to benefit most from doing so. Figure 2 also shows that the information gained and habits formed during exposure to the universal entitlement scheme served to keep take-up high beyond 2008.

This rise in FSM-registered take-up occurred despite the scheme providing no financial incentive, nor any change in nutritional content or quality of the school meals (see MacLardie et al, 2008, p.47). One explanation supported by this paper is the removal of stigma for FSM-registered individuals when meals are also free for everyone else. However, the positive effect on take-up is also in evidence for schools which had anonymised payment for school meals prior to the pilot. Other mechanisms must therefore be in operation.

This paper shows that positive endogenous peer effects are at work: FSM-registered individuals were made more likely to participate *because* more of their peers did so. This is attributed both to (i) reducing the probability that an FSM-participant must eat apart from his friends (another form of stigma), and (ii) to the signal sent through peer-group participation that school meals are a desirable good (a mechanism of information).

The implication of these findings is that the following policies aimed at maximising the welfare effect of the FSM programme should be pursued: Within schools, support for cashless or anonymised catering systems should continue, but every effort should also be made to allow children eating school and packed lunches to sit together. At the national level, the greatest welfare gains can be made by targeting universal entitlement at the youngest year-groups (making school lunch participation a social norm before other habits are formed) within the most deprived schools.

More generally, the positive peer effects identified here demonstrate that interventions addressing the behaviour of children generate greatest compliance in the 'targeted' population if provided at a group level, rather than only to specific individuals.

2 Theory and literature

2.1 Demand for school meals

Akin et al. (1983) model participation in the United States' National School Lunch Program (NSLP) as a function of the price for a school lunch, household income, other household characteristics, and proxies for individual tastes. Demand is shown to vary negatively with the price faced individually, but the authors also identified a significantly different demand system for those paying 'full price', compared with those eligible for a free or reduced price meal. This marks the distinction between school lunches as a 'consumer good' and as a 'welfare entitlement'. One would expect 'consumers' and 'welfare recipients' to weight various financial, internal and social considerations differently in making their participation decisions.

2.2 Peer effects and welfare participation

The existing literature proposes two key reasons for non-participation in welfare schemes: (i) stigma and (ii) lack of information. Both are concerned with the behaviour of others affecting one's own behaviour: 'peer effects'.

Stigma is defined as a disutility or psychic cost associated with receipt of a welfare entitlement (see Moffitt, 1983, for example). This typically attaches to behaviours marking an individual out as different. In this light, as participation among an individual's neighbours and associates (his 'peers') becomes more common, the less reluctant the individual should become himself to participate.

Lack of information may cause an individual to be unaware of the qualifying criteria, application process, or value of some entitlement, preventing or dissuading him from applying. This information can be disseminated via social networks: The more common is receipt of a given entitlement among an individual's reference group, the better the information he should have at his

disposal.

Aizer and Currie (2004), Cohen-Cole and Zanella (2008) and James (2011) explore this topic by modelling individual participation in specific welfare programmes as a function of 'peer group' participation. Peer or reference groups are defined to comprise others from the same ethnic or language group in the same geographical area or school. In this work the 'stigma' mechanism captured is related to the 'culture' of welfare use in different minority groups. The 'information' mechanism is specifically concerned with applying for and accessing the relevant service. The strength of these peer effects is permitted to vary with the local prevalence of suitable reference individuals.

This paper addresses participation in Free School Meals *conditional on having registered* with the Local Education Authority. The positive endogenous peer effects identified in this paper reflect the following mechanisms:

(i) *Stigma*: Those taking packed lunches and school lunches are usually segregated at meal times in school. Raising peer-group participation therefore reduces the probability that an FSM participant must be stigmatised by eating apart from members of his school class or friendship group. This emphasises the importance of the extent to which taking a school lunch *per se* is a social norm.

(ii) *Information*: Increasing peer group participation signals to non-participants that the school lunch service is an attractive product. This emphasises that individuals give weight to how other individuals *act*, as opposed to what school authorities and meal providers *claim*, in relation to school lunches.

2.3 Identification of peer effects

Identifying endogenous peer effects entails tackling the 'reflection problem', derived in detail by Manski (1993) and Moffitt (2001). This involves addressing the two-way causation of individual and peer-group behaviour, and distinguish-

ing between the following explanations for an association between the behaviour of one individual and his peers:

(i) Correlated effects: individuals behaving similarly because they have similar characteristics or face the same constraints.

(ii) Exogenous or contextual peer effects: the individual's behaviour is directly affected by the *characteristics* of his peers.

(iii) Endogenous peer effects: the individual's behaviour is directly affected by the *behaviour* of his peers.

The key challenge for the present paper is to identify peer effects in welfare participation using data which is aggregated at the school level. Section 4 presents a simple model of demand for FSMs and explains the restrictions necessary to do so.

3 Data

This paper uses publicly available administrative datasets obtained from the Scottish Government and Scottish Index of Multiple Deprivation websites.[1]

All measures regarding registration for FSMs or take-up of school meals refer to the specific 'representative' survey day in February of each year when a 'School Meals Census' was conducted. Prices for standard school meals are set annually by LEAs.

The dataset aggregates children in all seven years of primary school. Peer effects are likely to operate most strongly within school cohorts, rather than across all year-groups. Only pupils in the first three years of school were ever exposed to the pilot scheme. Estimates of endogenous peer effects therefore represent a lower bound of the true effects on take-up for the targeted age-groups.

[1] URLs: `http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/Datasets`, `http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/PubSchooMeals` and `http://www.scotland.gov.uk/Topics/Statistics/SIMD/DataAnalysis`, all accessed 16th February, 2012

The complete dataset contains 17,300 observations, representing 2,301 schools from 2004 to 2011 inclusive. School meal prices are unavailable for 2011, and potentially disclosive data (involving fewer than five individuals) is missing. For reasons to be explained in the next section, estimation is limited to schools with anonymised payment systems in place. The preferred specification is therefore estimated using $n = 1,033$ schools over a maximum of $T = 7$ time periods.

4 Theoretical and empirical model

4.1 Individual behaviour and aggregated data

This section models take-up of FSMs adopting the linear-in-means (linear probability model) framework proposed by Manski (1993). This framework is standard in applications of social interactions and peer effects for its tractable functional form and absence of parametric assumptions. Moreover, parameters from a linear model of *individual* behaviour are retained when variables are *aggregated* across members of a social group.

Consider the following demand equation for individual i, who is registered for FSMs (hence the superscript 'f'), in school j at time t:

$$y^f_{ijt} = \alpha + \beta u_{jt} + \gamma \overline{y}_{[-i]jt} + \phi \mathbf{X}^f_{ijt} + \theta \mathbf{Z}_{jt} + \psi \rho^f_{[-i]jt} + \eta_j + e_t + \epsilon_{ijt} \tag{1}$$

Here, $y^f_{ijt} = 1$ if individual i takes a free school lunch, and zero otherwise.

Define $\overline{y}_{[-i]jt}$ to be the proportion of the remaining individuals at the school; individual i's peers, or reference group; who take a school meal. The structural parameter γ captures endogenous peer effects in consumption.[2]

[2]One may expect individual take-up of FSMs to respond differently to participation by FSM-registered and unregistered peers. Appendix A.5 explains why it is not possible separately to identify these peer effects.

Letting $\rho^f_{[-i]jt}$ represent the proportion of an FSM-registered individual's peers who are also registered for FSMs, the structural parameter ψ captures 'contextual' peer effects in consumption.

The dummy variable $u_{jt} = 1$ for schools exposed to universal FSM-entitlement at time t, and zero otherwise. Universal entitlement may directly increase FSM-registered take-up by removing the stigma associated with individuals' FSM-registration status being observable to others.

A vector of individual controls affecting participation ($\mathbf{X}^f_{ijt}$), and school level characteristics ($\mathbf{Z}_{jt}$) are controlled for, along with a school fixed effect (η_j) and year effect (e_t). Finally, ϵ_{ijt} is an individual error term with heteroscedasticity of known structure.

If endogenous peer effects exist, then a problem of two-way causation is evident in equation (1): A shock to take-up by individual i will directly affect the take-up rate among the FSM-registered pupils in his reference group. ϵ_{ijt} is therefore correlated with $\overline{y}^f_{[-i]jt}$; an endogeneity bias is present.

Aggregating and averaging equation (1) across FSM-registered individuals in school j yields:

$$\overline{y}^f_{jt} = \alpha + \beta u_{jt} + \gamma \overline{Y}_{[-i]jt} + \phi \overline{\mathbf{X}}^f_{jt} + \theta \mathbf{Z}_{jt} + \psi \rho^f_{[-i]jt} + \eta_j + e_t + \overline{\epsilon}_{jt} \qquad (2)$$

The dependent variable is now $\overline{y}^f_{jt}$, the proportion of FSM-registered individuals who take a school meal.

The variables $\rho^f_{[-i]jt}$, $\mathbf{Z}_{jt}$, u_{jt} and η_j are constant across FSM-registered individuals within the school at time t, and so impervious to aggregation. Individual characteristics $\mathbf{X}^f_{ijt}$ aggregate to $\overline{\mathbf{X}}^f_{jt}$, so are no longer identified separately from contextual effects of the characteristics of the FSM-registered peer group. In practice, data on mean pupil or household characteristics is not available below the school level, so nor is $\overline{\mathbf{X}}^f_{jt}$ identified distinctly from $\mathbf{Z}_{jt}$.

In turn $\rho^f_{[-i]jt}$ is likely to be highly correlated with omitted aggregated individual or school level characteristics, so its estimated coefficient will not be interpretable as the parameter of contextual peer effects described above.

This highlights the danger in attempting to infer individual behaviour using aggregated data, referred to as the 'ecological inference' problem. For example, it may be found that take-up of FSMs is higher in schools in more deprived areas. This may reflect an individual effect: more deprived FSM-registered individuals being more likely to take their entitlement; or a contextual effect: households with more deprived neighbours being more likely to perceive welfare use as a social norm.

It is now shown that endogenous peer effects *can* be identified, to capture the mechanisms of stigma and information as described in section 2.2, above.

4.2 Identifying assumptions

The explanatory variable in equation (2); $\overline{Y}_{[-i]jt}$; is the mean of peer-group take-up across the FSM-registered individuals i: $\overline{Y}_{[-i]jt} = E_i[\overline{y}_{[-i]jt}]$. It is equal to the following weighted average of take-up by FSM-registered pupils ($\overline{y}^f_{jt}$), which is equal to the dependent variable; and take-up by unregistered pupils ($\overline{y}^n_{jt}$):

$$\overline{Y}_{[-i]jt} = (\rho^f_{[-i]jt}\overline{y}^f_{jt}) + (1 - \rho^f_{[-i]jt})\overline{y}^n_{jt} \tag{3}$$

The objective is to identify the structural parameter γ, representing endogenous peer effects in consumption of FSMs.

The functional dependence of the explanatory variable on the dependent variable could be eliminated by modelling take-up of FSMs as a function only of the participation rate by non-registered pupils, $\overline{y}^n_{jt}$. Doing so, however, imposes the assumption that FSM-registered pupils ignore the behaviour of their FSM-registered peers (with whom they are likely most closely to empathise) when

making their own participation decision. Moreover, take-up by unregistered pupils is likely also to be causally affected by that of registered pupils.

The chosen solution is to provide exogenous sources of variation in peer group take-up ($\overline{Y}_{[-i]jt}$), but which have no direct effect on FSM-registered take-up ($\overline{y}^{f}_{jt}$), the dependent variable.

To do this, the assumption that FSM-registered individuals cannot observe which of their peers are FSM-registered is maintained. This is justified by restricting estimation to schools with anonymised payment systems. In this case, if endogenous peer effects exist participation decisions must be conditional on the proportion of *all* pupils at the school who take a school meal (as represented in equations (1) and (2)), rather than distinguishing between FSM registered and unregistered groups.

Moreover, for these schools, as for those with universal entitlement, there should be no stigma associated with being observed to take a free school lunch, as in neither case can FSM-registered recipients be identified. For schools with anonymised payment, therefore, universal entitlement would not have a direct effect on FSM-registered take-up. This imposes the restriction $\beta = 0$ in equations (1) and (2).

In appendix A.1, it is shown that schools with anonymised payment systems were very similar to other schools in terms of size, prices charged for school lunches, FSM entitlement and registration rates, and take-up of school meal, both free and paid for. These systems are also shown not to be introduced in response to take-up or FSM-registration rates in the previous period. I argue therefore that the results obtained here should generalize to the remainder of schools in Scotland were they to introduce such systems.

4.3 Identifying instruments

Demand for paid-for school meals should be higher in schools with universal entitlement, higher in schools charging lower prices for school meals, and should rise by more when universal entitlement is introduced the higher the price was initially. However, neither universal entitlement, the price-when-charged, nor their interaction should have a direct effect on take-up by FSM-registered pupils. These interventions can therefore be used as exogenous instruments in the first-stage equation determining peer-group take-up.

Define p_{jt} to be the price-when-charged for a school meal, u_{jt} to be a dummy for universal FSM entitlement, and χ_{jt} to be remaining explanatory variables from equation (2). The final empirical specification is as follows:

$$\begin{aligned} E[\overline{y}^f_{jt}|p_{jt}, u_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \alpha + \gamma E[\overline{Y}_{[-i]jt}|p_{jt}, u_{jt}, p_{jt}u_{jt}, \chi_{jt}] \\ +\phi\overline{\mathbf{X}}^f_{jt} + \theta\mathbf{Z}_{jt} + \psi\rho^f_{[-i]jt} + \eta_j + e_t \end{aligned} \tag{4}$$

Here, $E[\overline{Y}_{[-i]jt}|p_{jt}, u_{jt}, p_{jt}u_{jt}, \chi_{jt}]$ is the fitted value of peer-group take-up from the first-stage regression conditioning on the instruments outlined above. Hence, the parameter γ (estimates of which are presented in table 2) represents the first-round effect of an exogenous change in peer group participation $\overline{Y}_{[-i]jt}$ on the take-up rate of FSMs. In the presence of endogenous peer effects this initial change will have second and subsequent round feedback effects, which are considered in section 5.4, below.

5 Results

5.1 Baseline reduced form estimates

Table 1 presents baseline school fixed effect estimates for take-up among both the FSM-registered and non-registered, making no attempt to model peer effects

but controlling for observable school characteristics.

Universal FSM entitlement was associated with take-up among *unregistered* pupils (who previously had to pay) increasing by approximately 11 percentage points, other things equal. This rose to 14 percentage points when considering only schools with anonymised payment. This larger coefficient may reflect the removal of the hassle in 'topping up' credit on pre-payment cards in schools with anonymised payment but introducing universal entitlement.

For FSM-registered pupils the reduced form effect of universal entitlement is larger for all schools (4 percentage points) than the anonymised payment sample (2.6 percentage points). The difference is due to the direct effect of universal entitlement removing the stigma of being observed to take an FSM applying only in schools *without* anonymised payment.

As expected, demand for *paid-for* meals varies negatively with price, and increases by more with universal entitlement the higher was the price initially. Imputing a price of £1.50 and paid-for take-up of 38%, the coefficients on price in the first and second columns of table 1 correspond to price elasticities of demand of -0.31 and -0.64 respectively.

The coefficient on price is smaller in absolute value for all schools than for the anonymised payment sample. Anonymised payment may make demand more responsive to price as the requirement to 'top-up' credit represents a greater inconvenience if it must be done more regularly, or draws attention to mounting costs more vividly than paying daily with cash.

Both the school's pupil-teacher ratio and anonymised payment itself were associated with essentially zero change in take-up by either group, but as schools' intake expanded, take-up by the unregistered group fell slightly. Assuming school canteens have a fixed capacity over time, this is likely to reflect actual or perceived congestion in dining areas. The school's FSM entitlement rate, and the employment deprivation rate of the local area are positively signed for

the unregistered, and negatively signed for the registered group. The ecological inference problem, explained in section 4 above, mean a direct interpretation to these coefficients cannot be inferred.

Table 1: Reduced form coefficients for take-up rate of school meals by school

	Not Registered for FSMs		Registered for FSMs	
	All schools	Anonymised payment	All schools	Anonymised payment
Universal FSM entitlement	0.1110***	0.1360***	0.0402***	0.0260*
	(0.0178)	(0.0198)	(0.0095)	(0.0125)
Price	-0.0774	-0.1622**	.	.
	(0.0675)	(0.0543)	.	.
Price × universal	0.2546***	0.1360*	.	.
	(0.0518)	(0.0613)	.	.
Total school intake (×100)	-0.0364*	-0.0312*	-0.0046	-0.0061
	(0.0134)	(0.0115)	(0.0052)	(0.0098)
Pupil-teacher ratio (×100)	-0.0087	0.0674	-0.0131	0.2066
	(0.0789)	(0.1239)	(0.0415)	(0.1072)
Anonymised payment	-0.0096	.	-0.0021	.
	(0.0092)	.	(0.0044)	.
FSM entitlement rate	0.1812**	0.2277	-0.1815***	-0.1532***
	(0.0541)	(0.1229)	(0.0491)	(0.0435)
Employment deprivation rate	0.0026*	0.0009	-0.0001	-0.0018
	(0.0010)	(0.0021)	(0.0005)	(0.0012)
Observations	10607	4769	12259	6011
Schools	1794	1404	1846	1462
Maximum observations per school	7 (2004-2010)	7 (2004-2010)	8 (2004-2011)	8 (2004-2011)
Mean observations per school	5.9	3.3	6.6	4.1

Notes: Standard errors (clustered by LEA) in parentheses. Symbols: *, **, ***; significant at 5%, 1% and 0.1% respectively. All coefficients are from school and year fixed effect linear regressions. Prices are not available for 2011. School meal prices among pilot-area schools were demeaned before interacting with universal entitlement, such that the coefficient on Universal FSM entitlement represents the effect for a pilot-area school with the average initial price. Observations weighted in proportion to number of pupils present and registered for FSMs on survey day.

5.2 Structural estimates

Preferred estimates for the structural model of demand for Free School Meals are presented in Table 2. The upper panel contains first-stage coefficients in the auxiliary equation for peer-group take-up. The lower panel contains naive 'OLS' estimates (assuming peer-group take-up to be exogenous), alongside second-stage instrumental variable ('IV') estimates.[3] In this application, the bias in OLS point estimates turns out to be negligible.

All equations incorporate school and year fixed effects, and the same set of additional covariates as the reduced forms. Price, universal entitlement and their interaction vary only across LEAs, not individual schools. All standard errors and diagnostic tests therefore adjust for 32 LEA clusters. Because the objective is to obtain structural parameters for a model of *individual* behaviour, observations are weighted in proportion to the number of students present and registered for FSMs on the survey day.

The first ('All of Scotland') specification is identical to that outlined above. It excludes universal entitlement, price and their interaction from the second-stage structural equation. The F-statistic for the exclusion of these instruments from the first-stage is 35.20, which is both statistically signficant at all conventional levels and large in absolute value.

Hansen's J-statistic indicates that the null hypothesis of valid instruments (uncorrelated with the second-stage error term and correctly excluded from the estimated equation) cannot be rejected.

The coefficient on peer-group take-up in the second stage is 0.281, which is positive and statistically significant at the 5% level. This indicates that in a typical school, a 10 percentage point rise in peer-group take-up would reduce non-participation by almost a quarter, from 12% to close to 9%.

[3]These and all further two-stage least squares applications use the Stata 'xtivreg2' procedure of Schaffer (2010).

Table 2: Structural equation estimates: Take-up rate of school meals among those registered for FSMs. (Schools with anonymised payment systems only).

	First stage estimates for peer-group take-up ($\overline{Y}_{[-i]jt}$)	
	All of Scotland	Non-pilot LEAs only
Universal FSM entitlement	0.1014***	.
	(0.0135)	.
Price	-0.1177***	-0.1232**
	(0.0331)	(0.0383)
Price × universal	0.1558***	.
	(0.0409)	.
F-statistic (p-value) for exclusion of first stage instruments	35.20 (0.0000)	10.37 (0.0034)
Hansen's J-statistic (p-value) for over-identification of all instruments	1.906 (0.3856)	(Model is just identified)

	Second stage estimates for take-up of FSMs, $\overline{y}^f_{jt}$			
	All of Scotland		Non-pilot LEAs only	
	OLS	IV	OLS	IV
Peer-group take-up, ($\overline{Y}_{[-i]jt}$)	0.2954***	0.2809*	0.2837***	0.2981
	(0.0474)	(0.1218)	(0.0616)	(0.1895)
Observations	4387		3605	
Schools	1033		832	
Maximum observations per school	7 (2004-2010)		7 (2004-2010)	
Mean observations per school	4.2		4.3	

Notes: Standard errors (clustered by LEA) in parentheses. Symbols: *, **, ***; significant at 5%, 1%, and 0.1% respectively. All coefficients are from school and year fixed effect regressions. In the lower panel, 'OLS' columns report estimates from a naive specification assuming peer-group take-up is exogenous. 'IV' columns report estimates from two-stage least squares specifications, with the first stages presented in the upper panel. School meal prices among pilot-area schools were demeaned before interacting with universal entitlement, such that the coefficient on Universal FSM entitlement in first stage represents the effect for a pilot-area school with the average initial price. Additional regressors in both stages are school size, pupil-teacher ratio, FSM entitlement rate, proportion of peers FSM-registered, and employment deprivation rate. Observations weighted in proportion to number of pupils present and registered for FSMs on survey day.

The policy significance of this coefficient is explored below (section 5.4) by simulating an intervention using the reduced form of equation (4).

A second specification restricts the sample to schools outside the pilot areas. These are never exposed to universal FSM entitlement, so the only source of exogenous peer-group take-up is the price charged to FSM-unregistered pupils, which is always positive. The F-statistic for its first stage exclusion is 10.37, marginally significant at the 5% level.

Take-up of FSMs is found to be similarly responsive to peer-group take-up as in the previous specification. However, the coefficient of 0.298 is imprecisely estimated and no longer statistically significant.

5.3 Alternative structural assumptions

The positive estimated peer effect in the first specification above is identified under the assumption that with anonymised payment, universal entitlement had no direct effect on take-up of FSMs. This assumption is supported by the stability of the peer effect parameter between the specifications, firstly using all anonymised payment schools, and then those never exposed to the pilot scheme.

A third specification assuming universal entitlement *does* directly affect take-up among the FSM-registered, is presented in Table 3.

The coefficient on peer-group take-up is still positive but much smaller in absolute value, and statistically insignificant. The coefficient on universal entitlement, while statistically insignificant, implies that the first round direct effect of this intervention is to raise take-up by 1.4 percentage points. This represents over half of the final reduced form effect observed in column 4 of Table 1.

Table 3: Structural equation estimates with universal entitlement included in second stage.

First stage estimates for peer-group take-up ($\overline{Y}_{[-i]jt}$)		Second stage estimates for take-up of FSMs ($\overline{y}^{f}_{jt}$)		
			OLS	IV
Universal FSM entitlement	0.1014*** (0.0135)	Universal FSM entitlement	-0.00004 (0.01383)	0.01366 (0.01399)
Price	-0.1177*** (0.0331)	Peer-group take-up, ($\overline{Y}_{[-i]jt}$)	0.2295*** (0.0482)	0.1794 (0.1344)
Price × universal	0.1558*** (0.0409)			
F-statistic (p-value) for exclusion of first stage instruments	11.47 (0.0002)	Hansen's J-statistic (p-value) for over-identification of all instruments	2.396 (0.1216)	
Observations	4387	Schools	1033	
Maximum observations per school	7 (2004-2010)	Mean observations per school	4.2	

Notes: Standard errors (clustered by LEA) in parentheses. Symbols: *, **, ***: significant at 5%, 1%, and 0.1% respectively. All coefficients are from school and year fixed effect regressions. 'OLS' columns report estimates from a naive specification assuming peer-group take-up is exogenous. 'IV' columns report estimates from two-stage least squares specifications, with the first stages presented on the left hand side. School meal prices among pilot-area schools were demeaned before interacting with universal entitlement, such that the coefficient on Universal FSM entitlement in the first stage represents the effect for a pilot-area school with the average initial price. Additional regressors in both stages are school size, pupil-teacher ratio, FSM entitlement rate, proportion of peers FSM-registered, and employment deprivation rate. Observations weighted in proportion to number of pupils present and registered for FSMs on survey day.

The validity of the first-stage instruments cannot be rejected at the 10% level, and the F-statistic for exclusion of the first stage instruments is statistically significant at all conventional levels. However, the imprecise estimates and relatively small absolute value of the F-statistic in common with the second specification in Table 2 demonstrate that price variation alone is insufficient to identify endogenous peer effects precisely. Changes in entitlement *regime* are necessary to generate sufficiently strong exogenous variation in peer-group take-up.

5.4 Simulating a policy intervention

This paper has investigated whether participation in the school meal programme by FSM-registered individuals can be raised by increasing participation among their peers. The principal instrument available to policymakers - the price which unregistered pupils are charged, including the possibility of charging them nothing - is directly binding on unregistered pupils only.

Knowing the decomposition of $\overline{Y}_{[-i]jt}$ into $\overline{y}^f_{jt}$ and $\overline{y}^n_{jt}$ according to equation (3), equation 4 can be rearranged into a reduced form to obtain the following expression. It represents the 'social multiplier', or overall effect on FSM participation, taking into account endogenous peer effects, of raising participation among those not registered for FSMs:

$$\frac{\partial E[\overline{y}^f_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]}{\partial E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]} = \frac{\gamma(1-\rho^f_{[-i]jt})}{1-\gamma\rho^f_{[-i]jt}}. \tag{5}$$

The complete derivation of this expression is presented in appendix A.4

To assess whether this represents an effective mechanism for policymakers to raise take-up, consider a moderate £0.50 reduction in price. This would raise take-up of paid for school lunches by 8.1 percentage points in the main estimation sample considered here (see column 2, Table 1) .

Substituting the parameter $\gamma = 0.281$ from the preferred specification above into equation (5), the resulting change in take-up of FSMs then varies according to $\rho^f_{[-i]jt}$, the proportion of an FSM-registered pupil's peers who are also FSM-registered, as follows:

$$\begin{aligned}
\Delta\overline{y}^f_{jt} &= 0.0154 \quad if \quad \rho^f_{[-i]jt} = 0.40 \\
\Delta\overline{y}^f_{jt} &= 0.0193 \quad if \quad \rho^f_{[-i]jt} = 0.20 \\
\Delta\overline{y}^f_{jt} &= 0.0211 \quad if \quad \rho^f_{[-i]jt} = 0.10 \\
\Delta\overline{y}^f_{jt} &= 0.0220 \quad if \quad \rho^f_{[-i]jt} = 0.05
\end{aligned} \tag{6}$$

For reasonable assumptions concerning the prevalence of FSM-registered pupils in a school, an eight percentage point increase in the demand for paid-for meals raises participation in FSMs by between 1.5 and 2.2 percentage points. This degree of responsiveness shows that a substantial return in terms of welfare participation can be achieved through a strategy targeting peer group participation.

However, for a price elasticity of demand closer to zero than -1, a price reduction entails a fall in sales revenue. An increase in subsidy would be required to address this shortfall, the cost of which would need to be weighed against alternative strategies, and the welfare payoff to improved participation among 'in need' households, which are not quantified here.[4]

6 Conclusion

Free school meals represent a social safety net, providing a minimum nutritional intake to children who might otherwise not receive it. This objective is undermined when these individuals are deterred from participating by stigma or informational barriers.

Participation by FSM-registered individuals, who never had to pay, was observed to rise during a scheme of universal entitlement, when meals became free to everyone else. This is attributed partly to the removal of stigma associated with being *observed* as FSM-registered, but predominantly to a causal effect of the rise in peer-group participation.

This positive endogenous peer effect occurs through (i) reducing the probability that an FSM-participant must eat apart from his friends (another form of stigma) and (ii) the signal sent by peer-group participation that school lunches are a desirable good (a mechanism of information). This result generalises to

[4]The effect of FSM-participation on several indicators of child welfare is briefly explored in appendix A.3.

cases never exposed to universal entitlement.

In light of these results, improvements can be made at *all* levels of administration, in order to raise participation in FSMs and benefiting the most deprived children. Within schools, every effort should be made to allow classmates taking school meals and packed lunches to eat together at the same time. LEAs can ensure that FSM-registered pupils remain anonymous when obtaining their school lunch. Finally, national governments should target future interventions regarding FSM entitlement at early year-groups within the most deprived schools, rather than singling out individuals.

References

Aizer, A., Currie, J., 2004. Networks or neighborhoods? Correlations in the use of publicly-funded maternity care in California. Journal of Public Economics 88, 2573–2585.

Akin, J. S., Guilkey, D. K., Popkin, B. M., Wyckoff, J. H., 1983. The demand for school lunches: An analysis of individual participation in the School Lunch Program. The Journal of Human Resources 18 (2), 213–230.

Cohen-Cole, E., Zanella, G., March 2008. Welfare stigma or information sharing? Decomposing social interactions effects in social benefit use. Working Paper 531, Department of Economics, University of Siena.

James, J., 2011. Essays on the Economics of Education and Health. Ph.D. thesis, University of Essex.

MacLardie, J., Martin, C., Murray, L., Sewel, K., 2008. Evaluation of the free school meals trial for P1 to P3 pupils. Tech. rep., Scottish Government Social Research.

Manski, C. F., 1993. Identification of endogenous social effects: The reflection problem. Review of Economic Studies 60 (3), 531–542.

Moffitt, R., 2001. Policy interventions, low-level equilibria, and social interactions. In: Durlauf, S. N., Young, H. P. (Eds.), Social Dynamics. Brookings Institution, Ch. 3, pp. 45–82.

Moffitt, R. A., 1983. An economic model of welfare stigma. American Economic Review 73 (5), 1023–1035.

Schaffer, M., 2010. xtivreg2: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models.

A Appendices

A.1 Selection into anonymised payment

The main estimates presented above limit the sample to schools with anonymised payment systems for school meals. Table A1 presents a simple analysis of selection into anonymised payment, and mean characteristics for schools with and without anonymised payment in 2008, the year of the pilot scheme.

On the left hand side are random effects logit coefficients for a discrete-time duration model of selection into anonymised payment. Schools became increasingly likely to adopt the practice over time, and the negative sign on employment deprivation rate and FSM entitlement rate (albeit insignificant) suggests that schools in more affluent areas are oversampled. This is borne out by the statistically significant differences in these variables for 2008. However, schools with 17.7% (mean among anonymised payment schools) and 19.8% (other schools) of pupils entitled to FSMs would observationally be very similar - this difference is not *economically* significant.

The relative deprivation of pilot areas does mean their schools are underrepresented, however: In 2008, only 18% of pupils in the anonymised-payment sample were exposed to universal entitlement, compared with around 25% of the overall primary school population.

The introduction of anonymised payment did not respond to the take-up *rate* of either free or paid-for meals in the previous period. It was, however, more likely the larger the *number* of would-be direct beneficiaries; those taking an FSM; and less likely the larger the number of those directly inconvenienced; those taking paid-for meals.

This notwithstanding, the raw differences between anonymised payment and other schools are small enough to believe that the results obtained should generalize to the remainder of schools in Scotland were they to introduce such

systems.

Table A1: Survival analysis and descriptive statistics regarding selection of schools into anonymised payment systems.

Random-effects logit coefficients for first introduction of anonymised payment		Mean school characteristics for 2008 by anonymised payment status		
			Anonymised payment	Other schools
Log(time, years since 2003)	0.3351** (0.1299)			
Lagged school characteristics:		School characteristics:		
Take-up rate of FSMs	0.0121 (0.402503)	Take-up rate of FSMs	0.8822 (0.0141)	0.8663 ** (0.0156)
Take-up rate of paid-for meals	0.2659 (0.4240)	Take-up rate of paid-for meals	0.4164 (0.0241)	0.4152 (0.0253)
No. FSM-registered	-0.0240** (0.0077)	No. FSM-registered	42.38 (4.29)	45.97 ** (5.72)
No. FSM-unregistered	0.0031** (0.0010)	No. FSM-unregistered	235.30 (5.36)	221.80 (15.58)
No. taking FSM	0.0334*** (0.0090)	No. taking FSM	34.48 (3.58)	37.13 * (5.04)
No. taking paid-for meal	-0.0078** (0.0026)	No. taking paid-for meal	89.49 (5.56)	84.22 * (5.17)
Pupil-teacher ratio	-0.0344* (0.0153)	Pupil-teacher ratio	17.01 (0.25)	16.82 (0.24)
Employment deprivation rate	-0.0350*** (0.0077)	Employment deprivation rate	12.40 (0.79)	14.35 *** (1.12)
Universal entitlement	-0.1787 (0.2172)	Universal entitlement	0.1807 (0.0867)	0.3065 *** (0.1463)
Price	0.4709 (0.2519)	Price	1.5237 (0.0423)	1.4576 *** (0.0594)
FSM entitlement rate	-0.3628 (0.6680)	FSM entitlement rate	0.1767 (0.0164)	0.1984 *** (0.0233)

Notes: Standard errors in parentheses, clustered by LEA for random-effects logit. Symbols: ***, **, *; random effect logit coefficients or differences-in means-statistically significant at 5%, 1% and 0.1% levels respectively. Observations weighted in proportion to school size (enrollment).

A.2 Registration for FSMs conditional on entitlement

A.2.1 Introduction

The main body of this paper addressed peer effects in participation in the FSM programme, conditional on registration. This section reviews the impact of the universal entitlement pilot scheme and peer effects on *registration* for FSMs, conditional on entitlement.

This is of interest for three reasons. Firstly, LEAs have a financial and public relations incentive to maximise registration for FSMs, as distinct from participation. LEAs receive an additional grant from central government for each FSM-registered pupil enrolled. This outweighs the cost of providing the free school meal (even if it is taken up). In addition, a higher proportion of FSM-registered pupils bestows a more favourable 'contextual value added' score in school league tables, other things equal.

Secondly, if peer-group take-up raises registration for FSMs in addition to participation *conditional onregistration*, then the estimates in the main section understate the success of endogenous peer effects in persuading 'needy' pupils to participate.

Thirdly, it is important to establish that the increased rate of FSM-registered take-up observed during the pilot scheme was not the result of declining registration.

A.2.2 Theory and econometric model

Individuals can only expect to benefit directly from registration if they intend to participate. Given this, one would expect registration to respond positively to peer group take-up by the same mechanisms as does participation.

Adopting the same procedure as the main body of this paper, the sample is limited to schools with anonymised payment systems. Peer group take-up is

instrumented with the price-when-charged, and the interaction of price with universal entitlement.

Additional explanatory variables include the proportion of an FSM-entitled pupil's peers who are FSM-entitled; and exposure to universal FSM-entitlement in the current and previous periods.

Peer-group entitlement is included as a proxy for overall peer-group registration. This is expected to yield a positive peer effect by (i) reducing the internal stigma associated with being FSM-registered, regardless of participation, and (ii) providing information regarding the application process. However, there is no exogenous source of variation in overall peer-group registration that does not directly effect registration conditional on entitlement. As in the main body, it is expected that measures relating to FSM-entitlement will be correlated with unobserved individual characteristics, meaning the coefficient on this variable will not be interpretable as a peer effect.

Universal entitlement is expected directly to reduce registration, because it removes individuals' incentives to ensure they are registered. However, positive experience of participation under the universal entitlement regime may persuade entitled pupils to register in following years.

Estimation in this section is based on schools in LEAs believed to have exerted some effort in identifying entitled but unregistered pupils in each given year, over the period 2004-2009, when separate figures for entitled and registered pupils are included in the dataset. There remains substantial variation in the accuracy of figures for FSM-entitled pupils, but this analysis assumes it is correct, and an exogenous variable, outside the control of LEAs.

In 2007 (the year prior to the pilot scheme), the mean registration rate was 93.01%, and median 97.22%, indicating that the majority of schools achieved a very high registration rate. However, over a quarter of schools recorded less than 90% registration, with the lowest rate observed at less than 40%.

Pilot area LEAs averaged 98.5%, compared with 92.5% in the rest of Scotland. This difference probably reflects the greater financial and political return to resources devoted to identifying FSM-entitled pupils in more deprived areas. By the same token, schools with fewer FSM-entitled pupils are more likely to be excluded from the sample due to their LEAs not attempting to identify these pupils. The estimates obtained are therefore not representative of all schools in Scotland.

A.2.3 Results

First and second stage estimates are presented in table A2.

The proportion of peers entitled to FSMs has a negative sign but is not statistically significant at conventional levels. This is believed to be because more deprived or lower income individuals are less likely to register, lacking the information regarding the process and benefits to applying. These individuals are more likely to be present in schools with higher rates of FSM entitlement.

The coefficient on peer-group take-up is positive and similar in magnitude to that obtained in the model of FSM participation: The first round direct effect of a 10 percentage point increase in peer-group take-up of FSMs is to raise registration for FSMs, conditional on entitlement, by 2.2 percentage points. This estimate is imprecise and not statistically significant at any conventional level.

The OLS coefficient on peer-group take-up is smaller in absolute value, implying a negative endogeneity bias. This reflects peer-group take-up being positively correlated with the overall registration or entitlement rates, and hence with unobserved individual characteristics that reduce the probability of registration.

The coefficient on current universal entitlement is negative, and lagged universal entitlement positive, but both are but very close to zero, and very imprecisely estimated. These estimates provide no evidence in favour of the universal

entitlement programme having caused any temporary decline or long term improvement in registration for free school meals.

Table A2: Structural equation estimates for registration, conditional on entitlement.

First stage estimates for peer-group take-up ($\overline{Y}_{[-i]jt}$)		Second stage estimates for registration, conditional on entitlement		
Price	-0.1146** (0.0310)		OLS	IV
Price x universal	0.1253*** (0.0220)	Peer group take-up	0.1070 (0.0547)	0.2208 (0.7017)
Prop'n of peers FSM-entitled[1]	0.3432*** (0.0553)	Prop'n of peers FSM-entitled	-0.3575 (0.1934)	-0.3957 (0.2704)
Universal FSM-entitlement	0.1111*** (0.0124)	Universal FSM-entitlement	0.0078 (0.0230)	-0.0049 (0.0713)
Lag(Universal FSM-entitlement)	0.0238 (0.0158)	Lag(Universal FSM-entitlement)	0.0199 (0.0157)	0.0158 (0.0227)
F-statistic (p-value) for exclusion of first stage instruments	29.07 (0.0000)	Hansen's J-statistic (p-value) for over-identification of all instruments	1.405 (0.2358)	
Observations	2089	Schools	547	
Maximum observations per school	6 (2004-2009)	Mean observations per school	3.8	

[1](Under means testing)

Notes: Standard errors (clustered by LEA) in parentheses. Symbols: *, **, ***; significant at 5%, 1% and 0.1% respectively. All coefficients are from school and year fixed effect regressions. 'OLS' columns report estimates from a naive specification assuming peer-group take-up is exogenous. 'IV' columns report estimates from two-stage least squares specifications, with the first stages presented on the left hand side. School meal prices among pilot-area schools were demeaned before interacting with universal entitlement, such that the coefficient on Universal FSM entitlement in the first stage represents the effect for a pilot-area school with the average initial price. Additional regressors in both stages are school size, pupil-teacher ratio, and employment deprivation rate. Observations weighted in proportion to number of pupils enrolled in the school and entitled to FSMs.

A.3 The impact of school meals on child welfare

The main body of this paper focused on the objective of increasing participation in the FSM programme. Recognizing that participation is an intermediate outcome, this appendix documents attempts to evaluate the causal effect of FSM participation on indicators of child welfare.

A.3.1 Aggregated data: Absences due to illness

Firstly, the aggregated dataset used above was augmented with school-level 'Attendance and Absence' statistics[5], and used to model the causal effect of FSM participation on absences due to illness.[6]

A causal effect is expected firstly because FSM participation should raise the opportunity cost of missing school. This is especially pressing where an FSM would usually be the only hot meal the child receives during the day. In addition, if FSM participation reduces the incidence of key nutrient deficiences, it could also reduce absences due to illness directly through improving pupils' physical health.

A fixed-effect two-stage-least-squares procedure is adopted. The dependent variable is the proportion of pupil half-days over the entire school year which are missed due to absence. No information is provided on the cross-sectional or temporal distribution of these absences. School meal participation is instrumented with the following exogenous interventions: (i) Exposure to the pilot scheme of universal FSM-entitlement; (ii) the price charged for school lunches; (iii) The interaction of exposure to universal entitlement with the price-when-charged; and (iv) - (vi) the interaction of each of the above with the proportion of students registered for FSMs.

[5]URL: `http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education\AttendanceAbsenceDatasets`, accessed 26-1-2012

[6]An identical exercise was conducted for absences due to exclusions and truancy, reflecting more extreme behaviours, with far fewer instances observed. Negligible effects were found.

The main body of this work established that instruments (i)-(iii) had a significant direct effect on take-up by FSM-unregistered pupils, and a significant indirect effect, through endogenous peer effects in consumption, on take-up by FSM-registered pupils. Instruments (iv)-(vi) recognise that because instruments (i)-(iii) are directly binding only on those *not* registered for FSMs, their impact will be larger, the fewer FSM-registered pupils are present at the school.

Although theoretically over-identified, empirical specifications accounting for the take-up rate of school meals by both FSM-registered and unregistered pupils as endogenous explanatory variables were effectively unidentified. Alternative specifications with a single explanatory variable are presented in table A3. One models the effect of *overall* school meal participation only. This restricts the effect of school meal participation on attendance behaviour to be the same for FSM-registered and unregistered pupils. The second includes the take-up rate by FSM-registered pupils only. This restricts the effect of a school meal on attendance behaviour to be zero for unregistered pupils.

First-stage results are presented in the upper panel of table A3. Both models are strongly but not over-identified. Second stage results are presented in the lower panel, alongside naive OLS coefficients. OLS is positively biased in both cases. The coefficients for overall take-up are not statistically signficant at any conventional level.

However, the IV coefficient on FSM-registered take-up is statistically significant at the 10% level ($p = 0.075$), and indicates that a 5 percentage point increase in take-up of FSMs would reduce the rate of absences due to illness by 0.17 percentage points. In a school with sample average characteristics this equates to two additional FSM-registered students taking a school meal, resulting in 70 additional pupil-days attendance per year, or 35 days of absence due to illness averted for every marginal participant.

Table A3: Structural equation estimates for absences due to illness.

First stage estimates for endogenous explanatory variables

	Take-up rate among FSM-registered	Take-up rate among all pupils
Universal FSM-entitlement	0.0769***	0.1301***
	(0.0120)	(0.0173)
Price	0.0747*	-0.0905*
	(0.0314)	(0.0402)
Price × universal	-0.2400***	0.0964
	(0.0446)	(0.0568)
Universal × prop'n FSM-registered	-0.1121***	-0.1343***
	(0.0272)	(0.0295)
Price × prop'n FSM-registered	-0.4390**	0.1786***
	(0.1267)	(0.0430)
Price × univ' × prop'n FSM-reg'd	0.3284*	0.0762
	(0.1383)	0.1341
F-statistic (p-value) for exclusion of first stage instruments	107.82	39.99
	(0.0000)	(0.0000)
Hansen's J-statistic (p-value) for over-identification of all instruments	2.341	4.284
	(0.8003)	(0.5093)

Second stage estimates for rates of absences due to illness

	OLS	IV	OLS	IV
Take-up rate among FSM-registered	-0.0004	-0.0341	.	.
	(0.0014)	(0.0191)	.	.
Take-up rate among all pupils	.	.	0.0042	-0.0076
	.	.	(0.0031)	(0.0152)

Observations: 8937 Schools: 1844

Max(Obs per school): 6 (2004-2009) Mean(Obs per school): 5.4

Notes: Standard errors (clustered by LEA) in parentheses. Symbols: *, **, ***: significant at 5%, 1% and 0.1% respectively. All coefficients are from school and year fixed effect regressions. School meal prices among pilot-area schools were demeaned before interacting with universal entitlement, such that the coefficient on Universal FSM entitlement in first stage represents the effect for a pilot-area school with the average initial price. Additional regressors in both stages are school size, FSM registration rate and their interaction; and pupil-teacher ratio and employment deprivation rate. Observations weighted in proportion to number of possible half-days of attendance.

Given that on average 3.7 days of school are lost per pupil per year due to illness (2.3% of the total), and that one standard deviation is 3.1 days, this is

an implausibly large figure. It is possible that a positive peer effect exists in school attendance, but it seems unlikely that any multiplier effect could account for this entire increase in attendance.

Absence due to illness is a short term and indirect indicator of health and behavioural changes, and inference from the aggregated datset is liable to obscure changes occuring at the individual level. The next section documents attempts to capture these mechanisms using individual longitudinal data from the Millennium Cohort Study (MCS).

A.3.2 Individual data: Health behaviours and long-term outcomes

The Millennium Cohort Study is a longitudinal survey of children born in the UK between September 2000 and January 2002, and their households. The third and fourth sweeps of interviews occured in 2006 and 2008, when most cohort members were aged 5 and 7, and in their first and third years of compulsory education respectively. Restricted-use geographical identifiers link individuals to their LEA of residence at each sweep.

This should afford the opportunity for both static modelling of individual behaviours and attitudes, and also dynamic models for the evolution of child bodyweight outcomes and cognitive ability.

However, the dataset places great constraints on attempts to do so in practice. Firstly the sample is small, containing 2200 observations resident in Scotland at both sweeps 3 and 4, of whom 400 were exposed to universal entitlement during the 2007-08 academic year. This is before accounting for missing data. These pupils are further subdivided into FSM-registered and unregistered individuals, and those interviewed after rather than during this period of universal entitlement.[7]

[7]The sample could be increased by including individuals from elsewhere in the UK, but this is unlikely to improve precision. This is partly because the demand system may differ across nations, but mainly because identification for these individuals would rely almost exclusively

Secondly, the reported school meal participation variable changes over time, at sweep 3 representing 'usual' arrangements (an ill-defined phrase), and at sweep 4 participation 'at least once a week'. Moreover, only in sweep 4 do follow-up questions fully establish which parents believe their child to be eligible for a free school meal. In ambiguous cases, registration was imputed according to a strict interpretation of the entitlement criteria.[8]

These drawbacks meant that models for selection into school meal participation were hampered by weak identification and incorrectly signed coefficients on key instruments, especially those depending on few observations. The remainder of this section therefore provides a simple descriptive evaluation of the effects of exposure to the universal entitlement regime.

Table A4 presents a series of difference-in-difference estimates. These represent the causal effect of the scheme under the 'common trends' assumption that each dependent variable would, in the absence of the universal entitlement scheme, evolve by the same amount in the pilot and non-pilot areas. This framework is silent on the number of individuals changing their school lunch arrangements, or the mechanism being captured: The coefficient of interest is the causal effect of 'intention-to-treat'.

Individuals who moved into or out of Scotland or between pilot and non-pilot areas, or who have missing data in either sweep, are excluded from estimation. For the physical and cognitive development estimates, only individuals interviewed after the school summer holiday in both sweeps are used. This ensures that all pilot-area sample members have experienced their full year of exposure to the universal entitlement regime, and also that variation in the length of

on price variation: There was no universal entitlement scheme outside Scotland at sweep 4, and only around 50 cohort members resident in Kingston-upon-Hull exposed to universal entitlement at sweep 3.

[8]FSM registration status is available in the Education Administrative Dataset linked to the MCS, but for England only, and this data is not released alongside detailed geographical identifiers. The Growing Up in Scotland longitudinal dataset was also considered for this section, but the usable sample size would have been still smaller, and geographical identifiers unlikely to be released for this purpose (correspondence with Scottish Centre for Social Research).

time between measurements is minimised. Fruit consumption and enjoyment of school are expected to respond more rapidly, so these results distinguish between the causal effect of current and past exposure to the scheme.

Table A4: Difference-in-difference estimates for cognitive and physical development, health behaviours and educational engagement.

	Physical development					
	BMI (units)		Height (cm)		Weight (kg)	
	Boys	Girls	Boys	Girls	Boys	Girls
Pilot area	-0.172	-0.009	-1.930***	-0.957	-0.990**	-0.355
	(0.211)	(-0.215)	(0.562)	(0.524)	(0.430)	(0.4050)
After	0.035	0.212	12.577***	12.470***	5.034***	5.130***
	(0.130)	(0.173)	(0.337)	(0.312)	(0.266)	(0.261)
Diff-in-diff ('post'[4])	**0.101**	**0.193**	**0.120**	**0.120**	**0.016**	**0.312**
	(0.298)	(0.304)	(0.741)	(0.498)	(0.608)	(0.573)
Observations						
Pilot	112	113	113	113	112	113
Non-pilot	475	432	479	434	475	433

	Cognitive Ability[1]		Fruit Consumption[2]	Educational Engagement[3]
	Boys	Girls	(pooled)	(pooled)
Pilot area	1.422	1.047	-0.026	-0.016
	(1.187)	(1.070)	(0.031)	(0.030)
After	3.945***	4.507***	-0.108***	-0.194***
	(0.722)	(0.688)	(0.019)	(0.018)
Diff-in-diff ('post'[4])	**-1.057**	**-2.016**	**0.038**	**0.109****
	(1.679)	(1.513)	(0.047)	(0.045)
Diff-in-diff ('current'[5])			**-0.013**	**-0.063**
			(0.064)	(0.061)
Observations				
Pilot	107	112	315	315
Non-pilot	472	430	1404	1404

Notes: Standard errors in parentheses. Symbols: [1]: Pattern construction t-score. [2]: More than three portions consumed per day. [3]: Child reported to 'always enjoy' school. [4]: Difference-in-difference based on pilot-area individuals *after* a full year's exposure to universal entitlement. [5]: Difference-in-difference based on pilot-area individuals *still undergoing* their year's exposure to universal entitlement. *, **, ***: Significant at 5%, 1% and 0.1% respectively.

The top line of each panel shows the initial difference (at age 5) between pilot and non-pilot area individuals. The statistic for boys' height and weight (pilot-area boys were 2cm shorter and 1kg lighter) is an alarming indicator of the relative deprivation of the pilot-areas, although there were no statistically significant differences for girls, or other measures for boys. The second line of each panel shows the mean change in each dependent variable between ages 5 and 7.

The 'difference-in-difference' estimates show that although on average pilot area individuals gained more weight, more height and more BMI units, none of these changes were statistically significant. Improvements in cognitive ability, however, slowed relative to non-pilot individuals. This is unsurprising, as it is to be expected that children from lower income households lose ground during the early years of education, invalidating the common trends assumption.

The one significant difference-in-difference estimate is for enjoyment of school, among individuals previously exposed to the universal entitlement scheme. However, the lack of a corresponding positive sign for those still exposed to the scheme means that attributing this to a causal effect is dubious: It is unlikely that a lagged benefit would accrue where a current one is absent.

For fruit consumption, neither the (positive) post-universal nor (negative and smaller) current entitlement difference-in-difference estimates is significant. These signs and magnitudes could be reconciled with a longer term net benefit of the scheme if, for example, parents do not perceive and report the fruit content of school lunches during the scheme, but afterwards find their children less resistant to healthier packed lunches with a higher fruit content.

A.4 Reduced form of the estimating equation

Section 5.4 assessed the effect of a hypothetical policy intervention on FSM participation using the 'social multiplier' for the overall effect of a change in take-up of paid-for lunches on the take-up of free school lunches (equation A1). This section shows how this is derived from the estimating equation (A2).

$$\frac{\partial E[\overline{y}^f_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]}{\partial E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]} = \frac{\gamma(1-\rho^f_{[-i]jt})}{1-\gamma\rho^f_{[-i]jt}}. \tag{A1}$$

$$\begin{aligned} E[\overline{y}^f_{jt}|p_{jt}, u_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \alpha + \gamma E[\overline{Y}_{[-i]jt}|p_{jt}, u_{jt}, p_{jt}u_{jt}, \chi_{jt}] \\ +\phi\overline{\mathbf{X}}^f_{jt} + \theta\mathbf{Z}_{jt} + \psi\rho^f_{[-i]jt} + \eta_j + e_t \end{aligned} \tag{A2}$$

* * *

Peer-group take-up, $\overline{Y}_{[-i]jt}$, is linearly decomposed into $\overline{y}^f_{jt}$ and $\overline{y}^n_{jt}$ according to equation (A3):

$$\overline{Y}_{[-i]jt} = (\rho^f_{[-i]jt}\overline{y}^f_{jt}) + (1-\rho^f_{[-i]jt})\overline{y}^n_{jt} \tag{A3}$$

In addition, $\rho^f_{[-i]jt}$ is known for each school and γ is estimated from equation (A2). As such, the following expression holds for a given school and time period:

$$\begin{aligned} &\gamma.E[\overline{Y}_{[-i]jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \\ &\quad \gamma.E[(\rho^f_{[-i]jt}\overline{y}^f_{jt}) + ((1-\rho^f_{[-i]jt})\overline{y}^n_{jt})|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] \end{aligned} \tag{A4}$$

As $\rho^f_{[-i]jt}$ is a known constant, the expression is linear in the conditional expectations of $\overline{y}^f_{jt}$ and $\overline{y}^n_{jt}$ (equation A5 overleaf):

$$\gamma.E[\overline{Y}_{[-i]jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \tag{A5}$$
$$\gamma\rho^f_{[-i]jt}E[\overline{y}^f_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] + \gamma(1-\rho^f_{[-i]jt})E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]$$

Substituting this expression into equation (A2) yields:

$$E[\overline{y}^f_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \alpha + \tag{A6}$$
$$\gamma\rho^f_{[-i]jt}E[\overline{y}^f_{jt}|p_{jt}, p_{jt}.u_{jt}, \chi_{jt}] + \gamma(1-\rho^f_{[-i]jt})E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] +$$
$$\phi\overline{\mathbf{X}}^f_{jt} + \theta\mathbf{Z}_{jt} + \psi\rho^f_{[-i]jt} + \eta_j + e_t$$

This rearranges into the following reduced form, from which the coefficient on $E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}]$ is recognisable as the partial derivative in equation (A1), above:

$$E[\overline{y}^f_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] = \tag{A7}$$
$$\frac{\alpha}{1-\gamma\rho^f_{[-i]jt}} + \frac{\gamma(1-\rho^f_{[-i]jt})}{1-\gamma\rho^f_{[-i]jt}}E[\overline{y}^n_{jt}|p_{jt}, p_{jt}u_{jt}, \chi_{jt}] +$$
$$\frac{\phi}{1-\gamma\rho^f_{[-i]jt}}\overline{\mathbf{X}}^f_{jt} + \frac{\theta}{1-\gamma\rho^f_{[-i]jt}}\mathbf{Z}_{jt} + \frac{\psi}{1-\gamma\rho^f_{[-i]jt}}\rho^f_{[-i]jt} +$$
$$\frac{\eta_j + e_t}{1-\gamma\rho^f_{[-i]jt}}$$

A.5 Separate peer effects by FSM-registration status

In the general case, one would expect individual take-up of FSMs to respond differently to participation by FSM-registered and unregistered peers. This could be motivated by peer effects from FSM-unregistered peers predominantly operating through the signal of *willingness to pay*, as an indicator of the quality of the service provided free to the FSM-registered groups, while take-up by FSM-registered peers predominantly operates by reducing the stigma associated with any individual being observed to take a free school lunch.

This paper obtains a correctly specified model by limiting the sample to schools with anonymised payment, thereby restricting the effect of take-up by FSM-registered and unregistered peers to be the same. This section demonstrates why identification of separate peer effects by FSM-registration status proved not to be possible.

Equation (1) in the main body can be generalized to equation (A8), assuming distinct peer effects from the FSM-registered and unregistered groups:

$$y^f_{ijt} = \alpha + \beta u_{jt} + \gamma(\rho^f_{[-i]jt}\overline{y}^f_{[-i]jt}) + \delta(\rho^n_{[-i]jt}\overline{y}^n_{jt}) + \phi\mathbf{X}^f_{ijt} + \theta\mathbf{Z}_{jt} + \psi\rho^f_{[-i]jt} + \eta_j + e_t + \epsilon_{ijt} \tag{A8}$$

The explanatory variable constructs $(\rho^f_{[-i]jt}\overline{y}^f_{[-i]jt})$ and $(\rho^n_{[-i]jt}\overline{y}^n_{jt})$ are equal to the interaction of the proportion of the individual's peers belonging the reference group and the participation rate among that reference group as adopted by Aizer and Currie (2004), Cohen-Cole and Zanella (2008), and James (2011).

Aggregating and averaging equation (A8) across all individuals in school j at time t, yields equation (A9), overleaf:

$$\overline{y}^f_{jt} = \alpha + \beta u_{jt} + \gamma(\rho^f_{[-i]jt}\overline{y}^f_{jt}) + \delta(\rho^n_{[-i]jt}\overline{y}^n_{jt}) + \phi\overline{\mathbf{X}}^f_{jt} + \theta\mathbf{Z}_{jt} + \psi\rho^f_{[-i]jt} + \eta_j + e_t + \overline{\epsilon}_{jt} \tag{A9}$$

The same variable $\overline{y}^f_{jt}$ now appears on the left and right hand sides. However, because $\rho^f_{[-i]jt}$ varies across schools and over time, the explanatory variable $(\rho^f_{[-i]jt}\overline{y}^f_{jt})$ is functionally dependent on, but not perfectly collinear with, the dependent variable $\overline{y}^f_{jt}$. The equation is therefore still technically identified.

Nevertheless no parameter of the resulting reduced-form can be identified separately from the unknown γ, and there is no exogenous source of variation in this FSM-registered peer measure (in the data nor in theory) with which it can be instrumented.

This paper chooses to restrict the sample to cases where the assumption that $\gamma = \delta$ can be imposed, meaning that if endogenous peer effects exist, participation decisions condition on the participation of *all* peers, irrespective of FSM-registration status.