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Farm subsidies and agricultural employment:

The education channel

Berlinschi R., Van Herck, K. and Swinnen J.F.M.[1]

1 Department of Economics, LICOS - Centre for Institutions and Economic Performance, K. U. Leuven, Belgium

ruxanda.berlinschi@econ.kuleuven.be

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Abstract

Agricultural employment in industrialized countries has been steadily decreasing despite important levels of farm subsidies. We argue that one explanation to this puzzle is the positive impact of subsidies on the education levels of farmers' children. If farmers are credit constrained, they may underinvest in their children's education. By increasing farmers' revenues, subsidies increase investment in education. If more educated children are less willing to become farmers, one long term effect of subsidies is to reduce labor supply in the agricultural sector. We provide a theoretical model and some empirical evidence supporting this argument.

Keywords: Agricultural Employment, Farm Subsidies, Education, Credit Constraints

JEL classification: Q12; Q18; I20; J62

1. INTRODUCTION

The past century has witnessed a major decline in western countries' workforce employed in the agricultural sector. A hundred years ago, almost one out of two persons in North America and Western Europe was employed in agriculture. In 2008, the share of agricultural employment was 3.4% in the EU15 and 1.5% in the US (Table 1).[1] This decline accelerated in the past decades. Between 1971 and 2009, agricultural employment in the EU15 decreased by 45% to 85%. In Spain for example, the share of agricultural employment dropped from 30% in 1971 to 4% in 2009 (Figure 1).

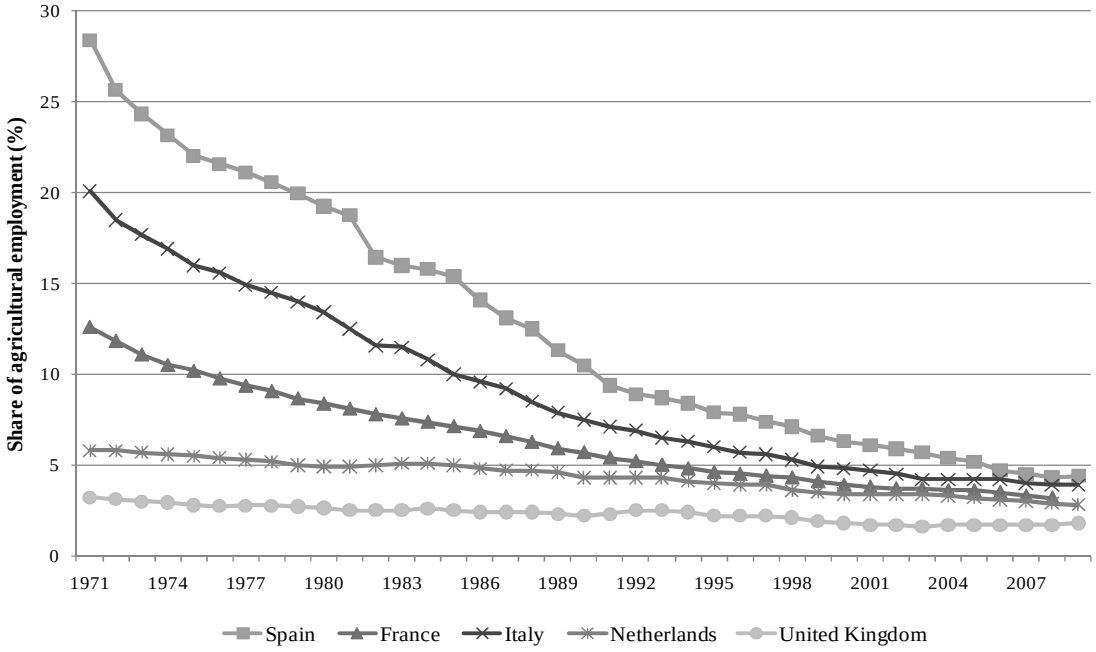
Table 1: Share of agricultural employment

Country	Share of Agricultural Employment in 1970	Share of Agricultural Employment in 2008
Australia	8.0%	3.3%
Canada	3.3%	2.4%
EU-15	13.4%*	3.4%
Iceland	n.a.	4.8%
Japan	17.4%	4.2%
New Zealand	10.6% (1986)	6.9%
Norway	12.2% (1972)	2.8%
South Korea	50.4%	7.2%
Switzerland	8.6%	4.0%
United States	4.5%	1.5%

Source: Eurostat, ILO, national statistics; * estimate

[1] Timmer (2009) describes the fast structural change in the agricultural sector of the rich economies and how it is propelling their economies to " A World Without Agriculture". He arguments that this process is occurring fast and illustrates this by the following statement "In the United States today there are more lawyers than farmers, more dry cleaning establishments than farmers".

Figure 1: Evolution of the share of agricultural employment (1971-2009)



Source: Eurostat, ILO

Agricultural activities in the EU15 are traditionally concentrated in family farms, which are usually transmitted from generation to generation.[2] The decline in agricultural employment is largely due to the fact that farmers' children in these countries have been turning more and more to industry or services rather than taking over their parents' farm (Calus et al., 2008). For example, in 2008, only 27% of all Dutch farmers older than 50 indicated that they had a successor and in the Belgian Flanders region, this percentage was even lower (13%) (De Bont and Van Everdingen, 2010; Vlaamse Overheid, 2009).

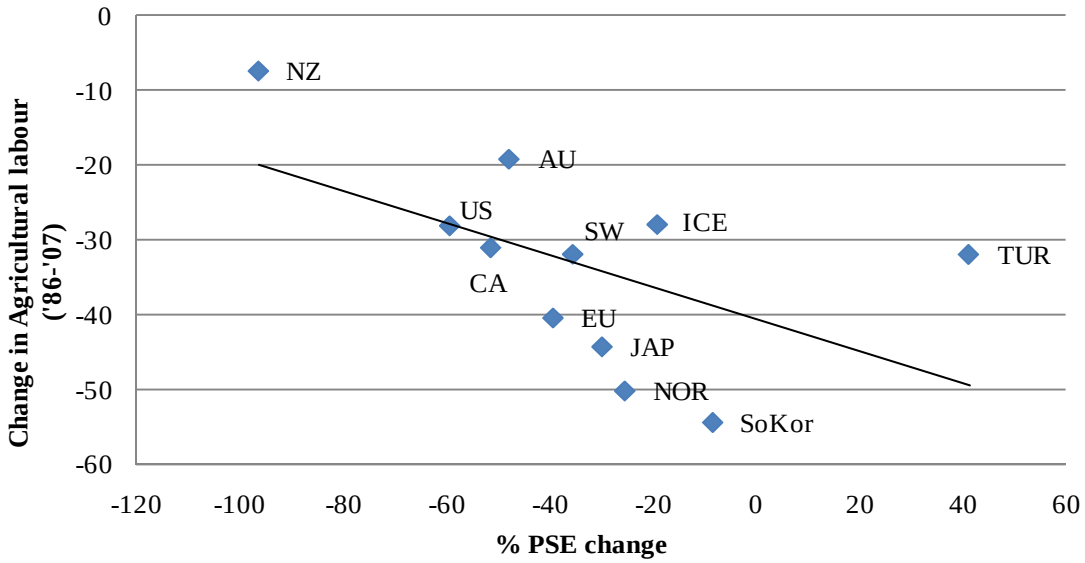
This decline in agricultural employment is taking place despite the fact that rich economies have introduced considerable farm income support. In the period 2003-2008, the US government spent between USD 12 billion and USD 20 billion per year for supporting farmers (USDA Economic Research Service). In the period 2005-2010, The EU spent more than 50 billion euros per year for supporting farmers through the Common Agricultural Policy (CAP). If one takes into account support through market regulations, European support to farmers in 2009 was around 87 billion euros (OECD, 2010).

Given the size of the income support directed to farmers, the speed of decline in agricultural employment is puzzling. Intuitively, one would expect subsidies to have a positive impact on agricultural employment. However, empirical evidence suggests that the opposite is happening. The outflow of labor from the agricultural sector has been strongest in the countries

[2] In 2007, 83% of the EU-15 agricultural labor force was concentrated in family farms and in some countries, such as Ireland (99%), Spain (99%) and Italy (96%) virtually all agricultural employment was in family farms. For a detailed overview of the reasons for the dominance of intergenerational farm succession, see Stiglbauer and Weiss (2000).

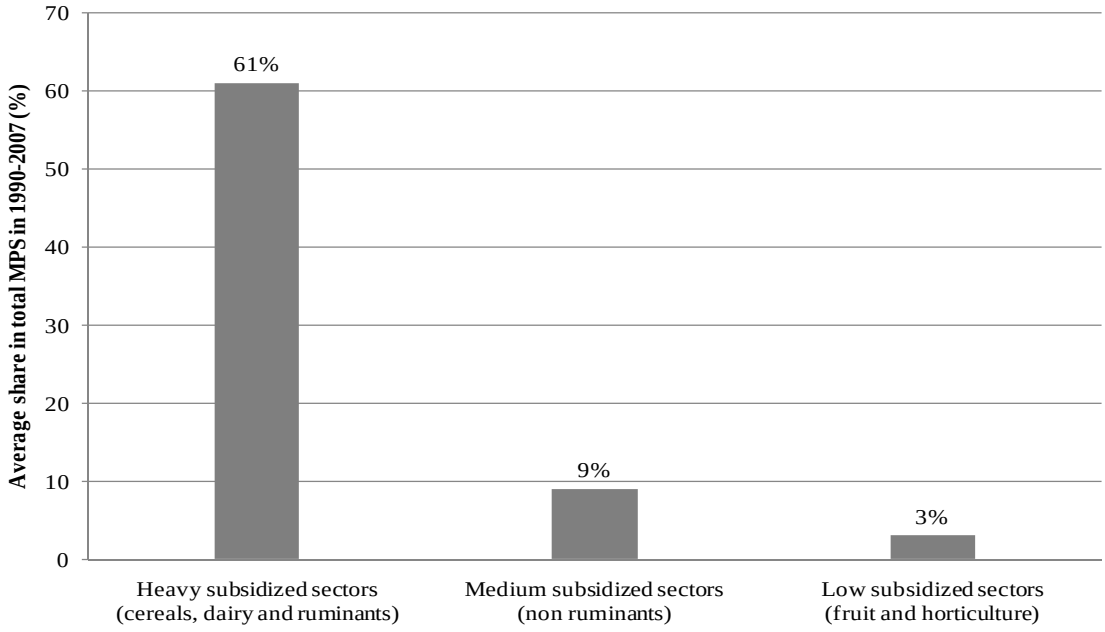
which have supported agriculture most heavily. A quick look at OECD data over the period 1987–2007 shows that changes in agricultural income support, captured by producer support estimate (PSE) indicator were negatively correlated with changes in agricultural employment (Figure 2). A similar pattern can be observed at the sub-sector level within agriculture. The most heavily subsidized sub-sectors had the strongest employment decline (Figure 3 and 4).

Figure 2:Change in agricultural labor and change in PSE (1987-2007)



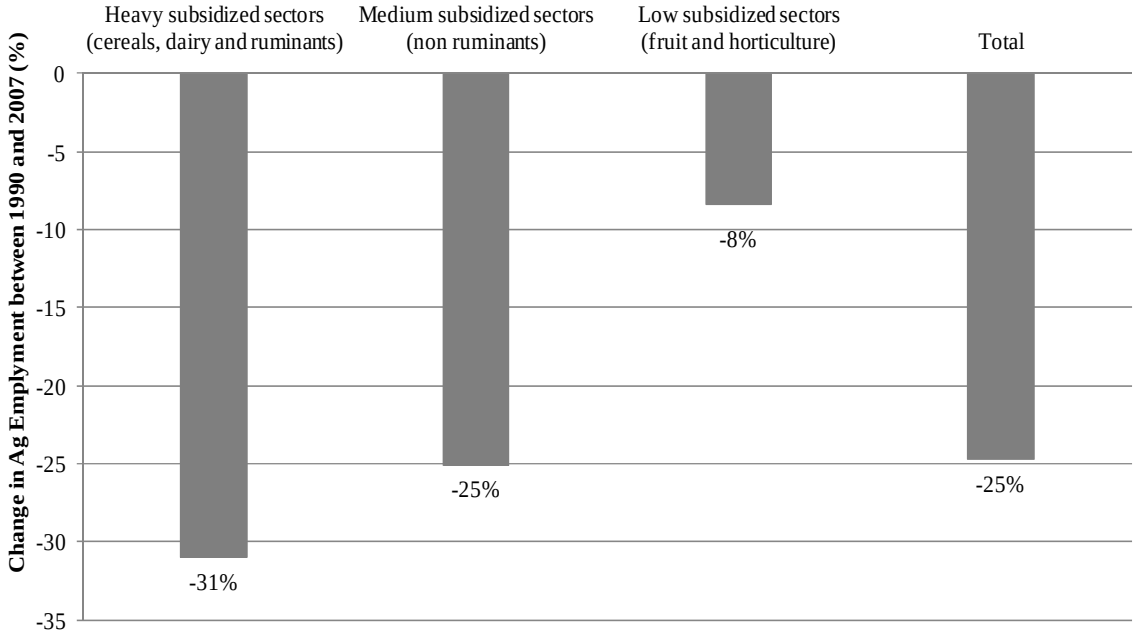
Source: OECD, ILO, national statistics

Figure 3: Average share in total market price support (MPS) in different subsectors in the EU (%; 1990-2007)



Source: Own calculations based on OECD

Figure 4:Change in agricultural labor in different subsectors in Belgium (%; 1990-2007)



Note that the data presented in Figure 4 is for Belgium, since no data is available on the EU 15 for this time period. However, for most of the EU 15 countries where we have data on, we find similar results.
Source: Own calculations based on Eurostat

A number of academic papers have analyzed the impact of subsidies on agricultural employment. Depending on their conclusions, they can be classified in three groups.

A first group of studies found no effect of subsidies on agricultural employment. Barkley (1990) reaches this conclusion using aggregate data on price support programs and agricultural employment in the US for the period 1940-1985. He argues that two opposite effects of subsidies offset each other. On the one hand, price support programs raise labor supply in agriculture, since they increase income from farming. On the other hand, price support programs reduce labor demand in agriculture, since they are usually coupled with obligations to set aside part of the land. Mishra et al. (2004) find similar results for the US. Glauben, Tietje and Weiss (2006) find that subsidies had no impact on agricultural employment in Western Germany.

A second group of studies found a positive impact of subsidies on agricultural employment. Foltz (2004) shows that US dairy price policies reduced the rate of farm exit in the dairy sector in Connecticut, in the period 1997-2001. Key and Roberts (2006) find that larger government payments, in the form of more base acres, had a small but statistically significant effect in facilitating US cash grain farm survival in the period 1982-1997. Breustedt and Glauben (2007) find that increases in subsidy payments and output prices significantly reduced the decline in the number of farms in the period 1993-1997 in 110 regions of the EU15. Pietola et al. (2003) find that policies which lowered output prices, such as subsidy cuts, accelerated the decline in farm population in Finland.

A third group of studies found a negative impact of subsidies on agricultural employment. Goetz and Debertin (1996) show that farm program payments accelerate capital-labor

substitution and are associated with higher migration out of agriculture. Goetz and Debertin (2001) use US county level data for the period 1980-1990 to show that government payments reduce the odds that the number of farm operators is decreasing in a county, but when this number is decreasing, payments increase the speed of decline. They argue that government payments may help farmers maintain their activity, but they may also help them buy out the farms of those seeking to exit, which accelerates the decline in the number of farmers. Hoppe and Korbi (2006) use individual farm level data for the period 1978-1997 to show that exit rates for farmers producing grain are generally higher than for those producing beef cattle. They relate this finding to the fact that grain farms receive more government assistance than beef cattle farms and argue that government programs speed the exit rate of small grain farms by providing funds for larger farms to buy them out. Based on regional Eastern German data, Petrick and Zier (2010) found that both coupled and decoupled direct payments had a negative impact on agricultural employment. In addition, they find a zero marginal effect of investment aid and transfers to less favored areas on agricultural employment, while agri-environmental measures had a positive effect on agricultural labor.

This conflicting evidence suggests that the impact farm support programs on agricultural employment is not straightforward. Several channels with opposite effects come into play and the total effect varies among regions and time periods. We believe that one important channel through which subsidies affect agricultural employment in the long run has been overlooked by the literature. This channel is the effect of subsidies on the education level of farmers' children.

When farmers are credit constrained, they may underinvest in their children's education. By increasing farmers' revenues, subsidies allow them to increase investment in education. If children with higher education levels are less willing to work in the agricultural sector then one long term effect of farm subsidies is to reduce labor supply in the agricultural sector.

The aim of this paper is to contribute to analysis of the impact of farm subsidies on agricultural employment by focusing on the education channel. We provide a theoretical model and some empirical evidence supporting our argument.

Our theoretical framework is a two period model of intergenerational investment in education, based on Acemoglu and Pischke (2001). The economy is composed of farmers with heterogeneous revenues exogenously given. In period one, each farmer decides whether to consume all his revenue or to invest part of it in his child's education. In period two, each child decides whether to work in the agricultural sector or in the non-agricultural sector (industrial or service sector), depending on the expected revenue in each sector. We assume that education increases expected revenues and that returns to education are higher in the non-agricultural sector. We show that in presence of credit constraints, subsidies have two opposite effects on agricultural employment. On one hand, for given education levels, they induce more children to choose the agricultural sector, since they increase agricultural revenues with respect to non-agricultural sector revenues. On the other hand, subsidies allow more farmers to educate their children, increasing the attractiveness of jobs in the non-agricultural sector for those children.

The overall effect of subsidies depends on farmers' revenue distribution. When the proportion of poor farmers is sufficiently high, subsidies reduce agricultural labor supply in the long term.

We provide some empirical support for this argument using data on farming households' revenues and their children's education levels and employment sectors in five European countries. In absence of data on the level subsidies received by each farmer, we assume that subsidies increase farmers' revenues by some factor and we estimate the effect of farmers' revenues on their children's schooling level and employment sector. We find that farmer's revenue has a positive and significant impact on the number of years of schooling of his child, which in turn has a negative and significant impact on the probability that the child will work in the agricultural sector. This evidence suggests that farm subsidies accelerated the decline in agricultural employment in the countries considered.

The rest of the paper is organized as follows. In section 2 we present the theoretical model. In section 3 we present the data, the estimation methods and the empirical results. Section 4 concludes.

2. THEORETICAL FRAMEWORK

We build a model of investment in schooling based on Acemoglu and Pischke (2001). The economy is composed of N farmers with revenues w_a, following a cumulative distribution function $F(w_a)$. Each farmer has one child. The game lasts two periods.

In period 1, each farmer consumes c, saves s and invest an amount h to educate his child. He dies at the end of the period.

In period 2, the child's education level is $e = 1$ if parents invested in his education and $e = 0$ otherwise.[3] Each child decides whether to work in the agricultural sector, i.e. overtake his parents' farm, or work in the non-agricultural sector, i.e. take a job in the industrial or services sectors. Child's expected revenue is denoted w_e and his consumption level is denoted $\tilde{c}$. The game ends at the end of period 2.

The farmer is altruistic towards his child. His utility function depends on his consumption level and on his child's consumption level:

$$U(c, \tilde{c}) = lnc + \beta ln\tilde{c}, \quad (1)$$

where $\beta < 1$ is the altruism rate.

Each farmer maximizes his utility with respect to his consumption level c, the amount of savings s and his child's education level e, subject to his budget constraint and to his child's budget constraint.

[3] For simplicity we assume the level of education to be a binary variable.

Assuming for simplicity that the interest rate is zero[4], the farmers' and his child's budget constraints are respectively given by:

$$c + he + s \leq w_a \quad (2)$$

$$\tilde{c} \leq s + w_c \quad (3)$$

The child's utility only depends on his consumption level. Therefore the child chooses the employment sector that allows him to earn the highest expected revenue.[5]

We assume that children without education earn the same revenue as their parents, w_a, if they choose to overtake their parents' farm. If they choose to work in the non-agricultural sector, they earn an expected revenue of w_{na}.

Education increases productivity and revenues. We assume that educated children earn $w_a(1+\theta_a)$ if they choose to work in the agricultural sector and $w_{na}(1+\theta_{na})$ if they choose to work in the non-agricultural sector, where θ_a and θ_{na} are the rates of return to education in the agricultural and non-agricultural sectors respectively.

We assume that:

$$\theta_{na} > \theta_a > 0, \quad (4)$$

i.e. the returns to education are lower in the agricultural sector.[6]

We assume that education is a pure investment good, i.e. it has no other value than increasing expected revenues.

Agricultural employment in period one is exogenously given by the number of farmers, N. Agricultural employment in period two is endogenously given by the number of farmers' children who choose to work in the agricultural sector.[7] We denote it $\tilde{N}$.

Our aim is to assess the impact of farm subsidies on agricultural employment in period two. We solve the model by backward induction. First, we determine child's employment choice for a given education level. Second, we determine parents' education decisions. Finally, we compute agricultural employment in period two and we analyze the effect of subsidies on this variable.

Uneducated children choose to work in the agricultural sector if $w_a > w_{na}$. Educated children choose to work in the agricultural sector if $w_a(1+\theta_a) > w_{na}(1+\theta_{na})$. Assumption (4) implies that all else equal, educated children are less likely to choose the agricultural sector.[8]

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[4] Introducing a positive interest rate would not alter the results.

[5] Other factors than revenue may affect the employment decisions of farmers' children. They may take into account leisure time and the probability of being unemployed in each sector and they may derive additional utility from overtaking their parents' activity. We assume that the monetary values of these other factors are included in the expected revenues of each sector.

[6] Based on a sample of high school graduates in the US, Orazam and Matilla (1991) have shown the returns to schooling are higher for non-agricultural occupations than for agricultural employment.

[7] We assume that individuals can only enter the agricultural sector by taking over the farm of their parents.

[8] Ceteris paribus, the minimum farm revenue inducing a child to choose the agricultural sector is higher when the child is educated: $w_{na}(1+\theta_{na})/(1+\theta_a) > w_{na}$.

We can classify farmers' children into three groups, depending on their parents' revenue. First, children of farmers with revenues w_a such that $w_a < w_{na}$ choose the non-agricultural sector independently of their education level. Second, children of farmers with revenues w_a such that $w_a > w_{na}[(1+\theta_{na})/(1+\theta_a)]$ choose the agricultural sector independently of their education level. Finally, children of farmers with revenues w_a such that $w_{na} < w_a < w_{na}[(1+\theta_{na})/(1+\theta_a)]$ choose the agricultural sector if and only if they are not educated. Therefore, the educational choices of these intermediate revenue farmers affect agricultural employment in period two.

Since the focus of this paper is the impact of farmers' educational choices on agricultural employment, we restrict our attention to these intermediate revenue farmers, i.e. we assume that the revenue of all farmers is higher than the expected revenue in other sectors for a non-educated person, but lower than the expected revenue in other sectors for an educated person[9]:

$$w_{na} < w_a < w_{na}[(1+\theta_{na})/(1+\theta_a)] \quad (5)$$

Assumption (5) implies that a child will overtake his parents' farm if and only if he is not educated. Then, the child's expected revenue can be written as:

$$w_c = w_a + e[w_{na}(1+\theta_{na}) - w_a]. \quad (6)$$

Each farmer maximizes (1) subject to (2), (3) and (6). We solve parents' optimization problem in two cases. First, we consider the benchmark case in which farmers are not credit constrained, i.e. they can borrow pledging the future income of their child. Second, we consider the more realistic case in which farmers are credit constrained, i.e. they cannot borrow pledging the future income of their child.

2.1. Benchmark case: absence of credit constraints

In this section we suppose that farmers can borrow money in period one, pledging on their child's income in period two. Thus, savings can be negative.

After solving parents' optimization problem, we obtain that parents invest in education if and only if:

$$w_{na}(1+\theta_{na}) - w_a > h \quad (7)$$

The right hand side of (7) is the cost of education. The left hand side of (7) is the benefit of education. As only non-educated children will choose farming, this benefit is equal to the difference between the expected revenue outside agriculture for an educated child and the farming revenue for a non-educated child. In absence of credit constraints, farmers invest in education if and only if the benefit of education exceeds its cost.

Note that the cost of education, h, is the same for everyone, while the benefit of education, $w_{na}(1+\theta_{na}) - w_a$ is higher for poorer farmers. Therefore, in absence of credit

[9] This assumption reduces the number of cases to be considered and simplifies the reasoning, but it is not driving our results. Similar conclusions can be reached without restricting farming revenues.

constraints, only the relatively poor farmers, i.e. those with revenues $w_a < w_{na}(1+\theta_{na}) - h$, invest in education.

The proportion of educated children in period two is then equal to $F(w_{na}(1+\theta_{na}) - h)$ and agricultural employment in period two is given by:

$$\tilde{N} = N[1 - F(w_{na}(1+\theta_{na}) - h)]. \quad (8)$$

Let's now analyze the effect of farming subsidies on $\tilde{N}$.

Suppose that subsidies increase farming revenues in both periods, from w_a to $(1+p)w_a$, with $p > 0$. Let $\tilde{N}(p)$ denote agricultural employment in period two as a function of subsidies.

Children of farmers with revenues w_a such that $w_a > w_{na}[(1+\theta_{na})/(1+\theta_a)]/(1+p)$ will choose the agricultural sector independently of their education level. The proportion of farmers in this interval whose child will take over the farm is thus equal to 1, while it was $1 - F(w_{na}(1+\theta_{na}) - h) \leq 1$ in absence of subsidies.

Children of farmers with revenues w_a such that $w_a < w_{na}[(1+\theta_{na})/(1+\theta_a)]/(1+p)$ will choose the agricultural sector if and only if they are not educated. These farmers invest in education if $h < w_{na}(1+\theta_{na}) - w_a(1+p)$.[10] The proportion of farmers in this revenue range whose child will take over the farm is thus equal to $1 - F([w_{na}(1+\theta_{na}) - h]/(1+p))$.[11] In absence of subsidies, this proportion was lower. Indeed, as F is a cumulative distribution function, $1 - F(w_{na}(1+\theta_{na}) - h) \leq 1 - F([w_{na}(1+\theta_{na}) - h]/[1+p])$.

Thus, we can state:

Result 1 *In absence of credit constraints, subsidies have a positive impact on agricultural employment in the next generation.*

Note that if subsidies are sufficiently high, all farmers' revenues satisfy $w_a < w_{na}[(1+\theta_{na})/(1+\theta_a)]/(1+p)$ and all children will choose to become farmers. Given assumption (5), a sufficient condition for this to happen is:

$$1 + p \geq (1+\theta_{na})/(1+\theta_a). \quad (9)$$

Let us now consider the more realistic case of credit constrained farmers.

2.2. Realistic case: presence of credit constraints

In this section we suppose that farmers cannot borrow money in period one, pledging on their child's income in period two. Thus, savings cannot be negative.

Then parents maximize (1) under (2), (3), (6) and the positive savings constraint:

$$s \geq 0 \quad (10)$$

[10] The solution to the maximization problem of these farmers is obtained by replacing w_a with $w_a(1+p)$ in the initial problem.
[11] This is the proportion of farmers who do not invest in education.

Solving this optimization problem, we obtain that parents invest in education if:

$$f(w_a) \equiv [(w_{na}(1+\theta_{na}))^{\beta}(w_a - h)]/w_a^{\beta+1} > 1 \quad (11)$$

The probability that a farmer invests in his child's education, i.e. the probability that (11) is satisfied, decreases with the cost of education, h, and increases with the non-agricultural skilled wage, $w_{na}(1+\theta_{na})$. The impact of farmer's revenue on this probability is not straightforward. One can check that $f(w_a)$ is increasing in w_a for $w_a < w_a^*$ and decreasing in w_a for $w_a > w_a^*$, where $w_a^* = (\beta+1)h/\beta$. This means that increasing poor farmers' revenues has a positive impact on investment in education, while the opposite is true for rich farmers.

The relationship between farming revenue and investment in education is non-monotonic because revenue has two opposite effects on farmers' educational choices. On the one hand, as farming revenue increases, the benefit of education decreases, so investment in education should decrease. On the other hand, as revenue increases, credit constraints become less binding, so investment in education should increase. The positive effect of revenue is dominant as long as $w_a < w_a^*$.

Let $\underline{w_a}$ and $\overline{w_a}$ be the solutions to $f(w_a) = 1$, with $\overline{w_a} > \underline{w_a}$. Farmers with revenues w_a such that $w_a < \underline{w_a}$ do not invest in education because they are credit constrained, and farmers with revenues w_a such that $w_a > \overline{w_a}$ do not invest in education because the returns are not sufficiently high. Farmers with revenues $\underline{w_a} < w_a < \overline{w_a}$ invest in education. Then agricultural employment in period two is equal to:

$$\tilde{N} = N(F(\underline{w_a}) + 1 - F(\overline{w_a})). \quad (12)$$

Let's now analyze the effect of subsidies on $\tilde{N}$. As in the previous section, suppose that subsidies increase all farming revenues from w_a to $(1+p)w_a$.

Children of farmers with revenues w_a such that $w_a > w_{na}[(1+\theta_{na})/(1+\theta_a)]/(1+p)$ will choose the agricultural sector independently of their education level. The proportion of farmers in this revenue range whose children will work in agriculture is 1. Thus subsidies increase the proportion of successors for farmers in this revenue range.

Children of farmers with revenues w_a such $w_a < w_{na}[(1+\theta_{na})/(1+\theta_a)]/(1+p)$ will choose the agricultural sector if and only if they are not educated. These farmers invest in education if $f_p(w_a) \equiv f(w_a(1+p)) > 1$. The proportion of farmers in this revenue range whose children work in agriculture is $F\left(\underline{w_a}/(1+p)\right) + 1 - F\left((\overline{w_a}/(1+p))\right)$, while it was $F(\underline{w_a}) + 1 - F(\overline{w_a}) \leq 1$ in absence of subsidies. Subsidies increase the proportion of successors for farmers in this revenue range if and only if:

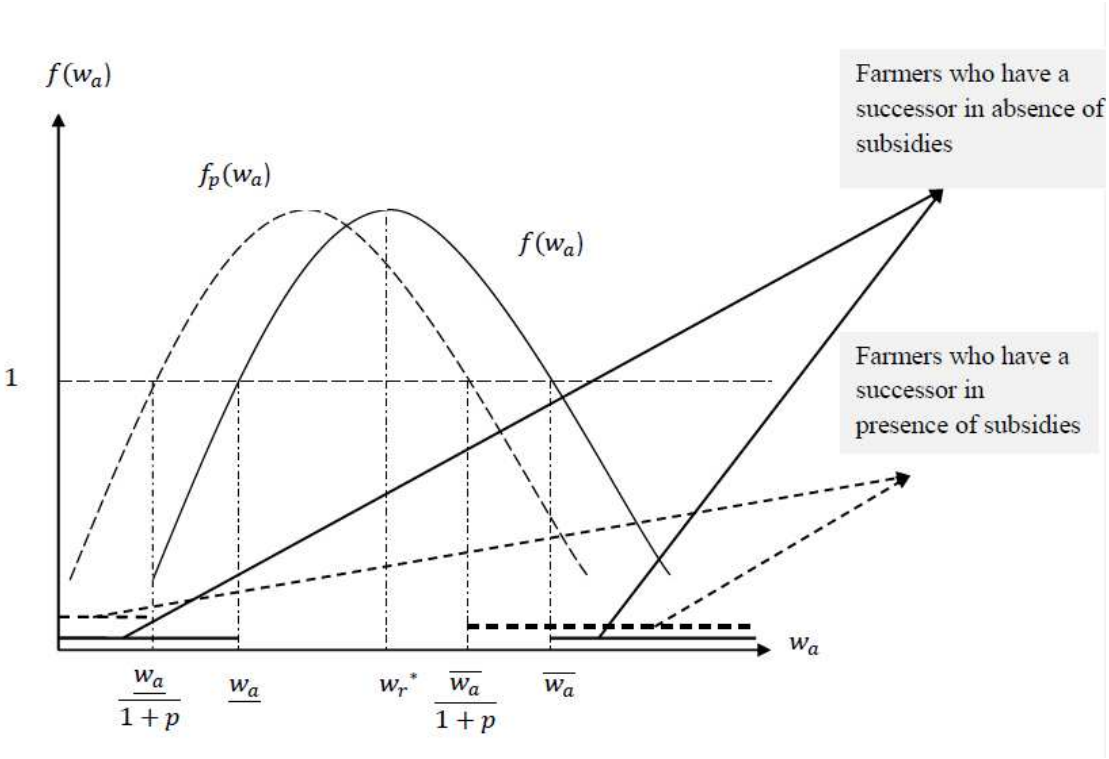
$$F(\overline{w_a}) - F((\overline{w_a})/(1+p)) < F\left(\underline{w_a}\right) - F\left(\underline{w_a}/(1+p)\right) \quad (13)$$

The right hand side of (13) is the proportion of farmers who are able to invest in education thanks to subsidies. The left hand side of (13) is the proportion of farmers who are not willing to invest in education because of subsidies.

These different farmers are represented in Figure 5. If the proportion of farmers with revenues between $(\overline{w_a})/(1+p)$ and $\overline{w_a}$ is sufficiently high, i.e. if $F(\overline{w_a}) - F((\overline{w_a})/(1+p)) > F\left(\underline{w_a}\right) - F\left(\underline{w_a}/(1+p)\right)$, then subsidies have a negative impact on agricultural employment in period two.

As in the previous section, if p is sufficiently high, all children will become farmers, i.e. sufficiently high subsidies increase agricultural employment.

Figure 5: Farmers' revenues and succession



Hence, we can state:

Result 2 *In presence of credit constraints, subsidies may have a positive, a nil or a negative effect on agricultural employment in the next generation. A negative effect is more likely when subsidies are not too high and when the proportion of poor farmers is important.*

Our theoretical framework shows that credit constrained farmers under invest in their children's education. An increase in their revenues through subsidies would increase the education levels of their children, accelerating migration out of agriculture in the next generation. The following section provides some empirical evidence supporting this argument.

3. EMPIRICAL FRAMEWORK

3.1. Data

We use data from the European Community Household Panel (ECHP). This is a survey based on a standardised questionnaire that involves annual interviewing of a representative panel of households and individuals in each country, covering a wide range of topics. The total duration of the ECHP was 8 years (waves), running from 1994 to 2001.

The sampling scheme of the panel allows identifying identical individuals and households in each year. We can thus identify children and their parents in two different waves of the ECHP.

From the first wave, collected in 1994, we selected households in which at least one of the parents was self-employed in the agricultural sector. We only consider self-employed farmers because most of the farms in the EU-15 are family farms and succession takes place within the household (Stiglbauer and Weiss, 2000). We included information on household characteristics, parents' income and education level.

From the sixth wave, collected in 1999, we selected the children of households which were in the education system in 1994 and finished their studies.[12] We gathered information on their current employment sector, their highest level of education and some personal characteristics.

Our dataset contains 97 individuals from Portugal, Spain, Italy and Ireland. For the other EU-15 countries, we were not able to identify a sufficient number of individuals self-employed in agriculture.

Unfortunately, the dataset does not include any information on the level of agricultural subsidies received by each farmer. Our approach is to assume that subsidies increase farming revenue by a given factor and to estimate the marginal impact of farming revenue on the education level and employment sector of farmers' children.

3.2. Empirical Specification and Variables

In order to assess the marginal impact of farming revenue on the education level and employment sector of farmers' children, we estimate an econometrical model in which we assume the educational and occupational decisions to be jointly determined.[13] We estimate the following model:

$$LEAVE_i = \alpha_0 + \alpha_1 SCHOOL_i + \alpha_2 SELF_i + \alpha_3 WAGE_i + \alpha_4 GENDER_i + \alpha_5 HHSIZE_i + \alpha_6 AGSIBLING_i + \alpha_7 SCHOOLPAR_i + country\ dummies + \varepsilon_i$$

$$SCHOOL_i = \beta_0 + \beta_1 LEAVE_i + \beta_2 SELF_i + \beta_3 WAGE_i + \beta_4 GENDER_i + \beta_5 HHSIZE_i + \beta_6 AGSIBLING_i + \beta_7 SCHOOLPAR_i + \beta_8 ALLOWANCE_i + country\ dummies + \mu_i \quad (15)$$

[12] The choice of using data from the first and the sixth wave was purely arbitrary.
[13] This approach is similar to Hennessey and Rehman (2007).

LEAVE is a dummy variable which takes the value of 1 if the child is not employed in the agricultural sector in 1999, and zero otherwise. Since the returns to schooling are expected to be higher outside the agricultural sector, individuals who already decided to leave the agricultural sector are expected to take up more education compared to those that decided to stay in agriculture and hence it is expected that LEAVE has a positive impact on the level of schooling of the child.

SCHOOL is the natural logarithm of the number of years of full time education of the child in 1999. We expected SCHOOL to have a positive impact on the probability to leave agriculture as the returns to schooling in non-agricultural employment are higher compared to agricultural employment.

SELF is the natural logarithm of self-employed farming income of the parents in 1994 (PPP adjusted, in euros).[14] We expect this variable to have a negative impact on the decision to leave agriculture, once education is controlled for, since it is a proxy for child's expected income in the agricultural sector. However, we expect a positive impact of SELF on the level of schooling of the child as a higher income reduces credit constraints of the parents which allows them to invest (more) in the education of their children.

WAGE is dummy variable which takes the value of one if the main source of income for the parents comes from an employment different from farming in 1994, and zero otherwise. Parents with an off farm employment experience acquire additional skills/information/networks to those useful in farming. If these assets are transmitted to children, the latter will be more likely to find an off farm employment themselves (Hennessey and Rehman, 2007). Being employed in another sector may also encourage parents to invest in the schooling of their children as they have a positive attitude towards working in off farm employment and they want to encourage their children to also take up employment in the non-agricultural sector. Therefore we expect that WAGE has a positive impact on the level of education of the child.

GENDER is a dummy variable that takes the value one if the child is a woman, and zero if the child is a man. Some studies found that the probability of succession is negatively correlated to the number of daughters.[15] We expect a positive impact of GENDER on the decision to leave agriculture. According to Eurostat data on female enrolment in education, women are more likely to engage in higher education and therefore we expect a positive effect of GENDER on the level of education of the child.

HHSIZE is the household size of the family in the first wave, measured by the number of adult equivalents according to the OECD equalized scale.[16] We expect HHSIZE to have positive impact on the decision to leave agriculture, since in larger household the probability that another family member will take over the farm is higher. The effect of HHSIZE on the level

14 We also include the squared term of self-employed income in the regression, but we did not find evidence of a non-linear impact, which could be related to the nature of the sample.
15 See for example Glauben et al (2004, 2010).
16 The household size is equal to 1 + 0.7*(number of adults in the household of 14 years or more -1) + 0.5*(number of children in the household younger than 14 years).

of schooling of the child is not straightforward. On the one hand, one may expect that in case that there are multiple children, there is less money per child available to invest in the child's education and hence there may be a negative impact of HHSIZE on the level of education of the child. On the other hand in larger households the older children may contribute to the education of the younger children. In this case this effect dominates, HHSIZE has a positive impact on the level of education of the child.

AGSIBLING is a dummy variable that takes a value of one if the child has a sibling which is also employed in the agricultural sector, and zero otherwise. The effect of AGSIBLING on the decision to leave the agricultural sector can be ambiguous. On the one hand, one might expect that when the child has a sibling working on the farm, he is less likely to also start working on the farm as there is maybe not enough work on the farm for two. However, on the other hand, the fact that sibling is working on the farm, is maybe be an indication that agricultural work is profitable and it could a stimulus for the child to also start working on the farm.

SCHOOLPAR is a dummy variable that takes the value of one if one of the parents has completed secondary education. As more educated farmers are more likely to adopt new technologies and more modern and efficient farms may be more attractive for farmers' heir, we expect SCHOOLPAR to have a negative impact on the probability that children leave agriculture, in line with other studies on this question.[17] In addition, we expect SCHOOLPAR to have a positive impact on the level of schooling of the child.

In order to eliminate the simultaneity bias due to the fact that educational and occupational decisions are jointly determined , we will estimate the model using an IV procedure. We instrument the variable SCHOOL with the level of education allowances received by the parents. Education allowances are expected to have a positive impact on the level of schooling of children[18], and there is no obvious reason why they should affect children's employment decisions other than through education. The instrumental variable ALLOWANCE is the natural logarithm of the education allowance received by the parents (PPP-adjusted, in euros), to which we added one euro to ensure that it takes the value zero for households that do not receive education allowance.

Country dummies control for country fixed effects.

The definitions and descriptive statistics for these variables are given in Table 2.

[17] See for example Mishra et al., 2004; Stiglbauer and Weiss, 2000; Glauben et al., 2004.

[18] An indicator for a good instrument is that the correlation between the instrument and the variable for which one instruments is high. This holds in our case and the correlation between SCHOOL and ALLOWANCE is high, namely 19%.

Table 2: Descriptive statistics

Variable name	Description	Children that stay in agriculture[19]	Children that leave agriculture
Outcome variables			
Leave	Dummy variable that takes a value zero if the child is employed in agriculture and one otherwise (Wave 6)	0	1
SCHOOL	Natural logarithm of the number of years that the child has been in full time education (Wave 6)	2.21	2.48
Household income variables			
SELF	Natural logarithm of the income from self-employed farming of the parents (in euro and controlled for PPP) (Wave 1)	7.97	7.90
WAGE	Dummy variable which takes a value of one if the main source of household income of the parents comes from wages and salaries and zero otherwise (Wave 1)	0.16	0.28

Table 2: Descriptive statistics (continued)

Variable name	Description	Children that stay in agriculture	Children that leave agriculture
Household and personal characteristics variables			
HIGH	Dummy variable that takes a value of one if the child has a higher education (equal or higher than the secondary level education) and zero otherwise (Wave 6)	0.37	0.71
GENDER	Dummy variable that takes a value of one if the child is a woman and zero when the child is a man (Wave 6)	0.32	0.42
HHSIZE	Household size of the family in the first wave and is measured as the number of adult equivalents according to the OECD equalized scale (Wave 1)	4.00	4.27
AGSIBLING	Dummy variable that takes a value of one when the child has a sibling working in agriculture and zero otherwise (Wave 6)	0.89	0.77
SCHOOLPAR	Dummy variable that takes a value of one if one of the parents emploed in agriculture has a higher education (equal or higher than the secondary level education) and zero otherwise (Wave 1)	0.26	0.08
Country dummies			
IRELAND	Dummy variable that takes a value of one if parents and child live in Ireland and zero otherwise	0.21	0.26
ITALY	Dummy variable that takes a value of one if parents and child live in Italy and zero otherwise	0.26	0.37
SPAIN	Dummy variable that takes a value of one if parents and child live in Spain and zero otherwise	0.11	0.10
PORTUGAL	Dummy variable that takes a value of one if parents and child live in Portugal and zero otherwise	0.42	0.27

[19] In 1999, 80% of the children were employed in the non-agricultural sector, while 20% of the children was employed in the agricultural sector.

3.3. Results

Table 3 gives the estimation results for the estimation model.

In the first stage regression, ALLOWANCE is positively correlated with children's schooling at the 1% level, which is an indication that the instrument is valid. SELF has a positive and significant effect on children's schooling, which indicates that an increase in farming will lead to a higher level of schooling of the child. This suggests that subsidies may play an important role in overcoming farmers credit constraints such that they are able to invest (more) in their children's education. AGSIBLING has a positive and significant impact on children's schooling. This suggests that when already one of the children is working in agriculture the parents may decide to invest in the schooling of the other children because there may be not sufficient work for both children on the farm.

In the second stage regression, we find that children's schooling has a positive and significant effect on the probability to leave the agricultural sector. Evaluated at the mean level of schooling, a 10% increase in schooling increases the probability of leaving agriculture by 22%.

Once education is controlled for, parents' farming income has a negative impact on children's decision to leave agriculture, as expected from the theoretical model. Evaluated at the mean self-employed farming income, a 10% increase in farming income decreases children's probability of leaving agriculture by 1.5%.

AGSIBLING has a negative and significant impact on the probability to leave agriculture, indicating that when of his siblings is working in agriculture the child will be less likely to leave the agricultural sector.

Table 3: Determinants of the decision to leave the agricultural sector for farmers' children, controlling for simultaneity bias; log likelihood estimations.

	Second Stage (Outcome variable=Leave)			**First Stage (Outcome variable: SCHOOL)**	
	Coefficient	**z-value**	**Marginal Effect**	**Coefficient**	**z-value**
Household income					
SELF	-0.221**	-2.28	-0.087	0.066**	2.40
WAGE	-0.400	-1.57	-0.158	0.130*	1.70
ALLOWANCE	-	-	-	0.030***	3.78
Household and personal characteristics					
SCHOOL	3.416***	12.36	1.342	-	-
GENDER	0.094	0.48	0.037	-0.013	-0.22
HHSIZE	0.090	1.13	0.035	-0.029	-1.27
AGSIBLING	-0.669*	-1.96	-0.245	0.189*	1.80
SCHOOLPAR	0.060	0.16	0.023	-0.046	-0.40
Country Dummies	Yes			Yes	
Constant	-5.578***	-5.84	-	1.642***	6.76-
Log likelihood	-54.61				
Wald test	195.57 (0.00)				
Wald test for exogeneity	390.18 (0.00)				
Correctly classified observations	72.16%				
Observations	97				

*significant on 10%, **significant on 5% and *** significant on 1%. We reported robust standard errors.

These findings support the theoretical analysis of section 2. Increases in farming revenues are partly used for investing in the education of farmers' children and they decrease the probability that those children will become farmers.

3.4. Robustness Checks

In this section we perform two types of robustness checks.

First, we estimate equation (16) using two stage least squares instead of instrumental probit. This estimation method requires less distributional assumptions, but ignores the binary nature of the dependent variable. The estimation results are presented in Table 5. They confirm the positive effect of farming income on schooling and the positive impact of schooling on the probability to leave agriculture.

Table 4: Determinants of the decision to leave the agricultural sector for farmers' children, controlling for simultaneity bias, OLS estimations.

	Second Stage (Outcome variable=Leave)		**First Stage (Outcome variable: SCHOOL)**	
	Coefficient	**z-value**	**Coefficient**	**z-value**
Household income				
SELF	-0.066	-1.52	0.066**	2.27
WAGE	-0.034	-0.30	0.130	1.60
ALLOWANCE	-	-	0.030***	3.58
Household and personal characteristics				
SCHOOL	1.147**	2.55	-	-
GENDER	0.129	1.58	-0.013	-0.20
HHSIZE	0.017	0.52	-0.029	-1.20
AGSIBLING	-0.249	-1.45	0.189*	1.71
SCHOOLPAR	-0.310**	-2.10	-0.046	-0.37
Country Dummies	Yes		Yes	
Constant	-1.248	-1.47	1.642***	6.39
Observations	97		97	

*significant on 10%, **significant on 5% and *** significant on 1%

We reported robust standard errors.

Second, we estimate equation (16) using a different measure for children's education level. Instead of the number of years of schooling, we use the dummy variable HIGH, which takes the value one if the child completed secondary education:

$$LEAVE_i = \alpha_0 + \alpha_1 HIGH_i + \alpha_2 SELF_i + \alpha_3 WAGE_i + \alpha_4 GENDER_i + \alpha_5 HHSIZE_i + \alpha_6 AGSIBLING_i + \alpha_7 SCHOOLPAR_i + \text{country dummies} + \varepsilon_i$$

$$HIGH_i = \beta_0 + \beta_1 LEAVE_i + \beta_2 SELF_i + \beta_3 WAGE_i + \beta_4 GENDER_i + \beta_5 HHSIZE_i + \beta_6 AGSIBLING_i + \beta_7 SCHOOLPAR_i + \beta_8 ALLOWANCE_i + \text{country dummies} + \mu \quad (17)$$

We estimate (17) with a recursive simultaneous bivariate probit model. This estimation method takes into account the possibility that educational and occupational choices are made jointly, as predicted in the theoretical framework.

The estimation results, given in Table 6, confirm our earlier findings. Farmers' income has a positive and significant impact on the probability that the child completed secondary

education. Having completed secondary education (or higher) significantly increases the probability of leaving the agricultural sector. A 10% increase in parents' farming income is associated with 1.5% increase in the probability of completing secondary education for the child. Completing secondary education increases the probability to leave agriculture by 85%.

Thus, the children of richer farmers have higher education levels and are then more likely to work in a different sector than agriculture. Under the assumption that subsidies increase farmers' income, we expect subsidies to have accelerated exit out of agriculture in these countries.

Table 5: Determinants of the decision to leave the agricultural sector for farmers' children, dummy variable for schooling, controlling for simultaneity bias'

	Second Stage (Outcome variable=Leave)			**First Stage (Outcome variable: HIGH)**		
	Coefficient	**z-value**	**Marginal Effect**	**Coefficient**	**z-value**	**Marginal Effect**
Household income						
SELF	-0.167*	-1.65	-0.046	0.317***	2.99	0.106
WAGE	0.242	0.84	0.063	0.086	0.28	0.028
ALLOWANCE	-	-	-	0.285***	3.92	0.096
Household and personal characteristics						
HIGH	2.324***	8.88	0.689	-	-	-
GENDER	0.194	0.68	0.053	0.147	0.47	0.049
HHSIZE	0.126	0.98	0.035	-0.105	-0.61	-0.035
AGSIBLING	-0.470	-1.47	-0.114	0.457	1.40	0.163
SCHOOLPAR	-0.692	-1.45	-0.228	-0.596	-1.11	-0.220
Country Dummies		Yes			Yes	
Constant	0.772	0.75	-	-3.023***	-2.60	-
Log likelihood			-82.79			
Wald test			86.77 (0.00)			
Wald test of rho equal to 0			301.86 (0.00)			
Observations			97			

*significant on 10%, **significant on 5% and *** significant on 1%. We reported robust standard errors.

4. CONCLUSION

Agricultural employment in western countries has been steadily decreasing in the past decades, despite important levels of farm subsidies. Studies that have analyzed the impact of subsidies on agricultural employment arrived to contradictory conclusions, suggesting that their direct positive effect on agricultural labor supply is sometimes counterbalanced by indirect

negative effects. In this paper we argue that that one such indirect effect, overlooked by the literature so far, is the impact of subsidies on farmers' children' education.

The evolution of agricultural employment largely depends on the willingness of farmers' children to overtake their parents' activity. By increasing farmers' revenues, subsidies allow them to increase investment in their children's education. Children with higher education levels have access to better paid jobs in the industrial or services sectors. They are therefore less likely to be willing to work in the agricultural sector. We presented a theoretical model and empirical evidence supporting this argument.

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