THE IMPACT OF RISK ON THE INEQUALITY: EVIDENCES FROM THE IRISH AGRICULTURAL SECTOR

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INTRODUCTION

The European Common Agriculture Policy might be summarized in its three main goals: addressing the issues of risk and volatility, foster efficiency while providing equitable support, insure a high degree of environmental standard[1]. The importance of addressing these three dimensions with a holistic approach rather than a set of stand-alone policies has been stressed in several policy documents. Many links between risk and inequality have been drawn in the academic literature. On a formal plan, Atkinson (Atkinson, 1970) borrowed directly from the theory of behaviour under risk (Rothschild and Stiglitz, 1970, Rothschild and Stiglitz, 1971) to decipher the moral judgement embedded in different inequality indexes while, on a pragmatic plan, several authors have suggested that risk increases inequality as poorer household are more vulnerable to adverse shock (Babcock and Hennessy, 1996, Dercon, 1996, Ravallion, 1988) and recent models of household vulnerability directly integrate inequality as one of its component (Ligon and Schechter, 2003). Here we focus on the causal link between risk and inequality and we contribute to the understanding of this dynamic by estimating its strength.

There are different types of risk threatening a farm business (Hardeker et al., 2004): market risks (e.g. price volatility, demand shock), production risk (e.g. weather variability, pest and animal disease etc.), institutional risk (e.g. change in policy), financial risk (e.g. change in interests charged on the debt of the farm) and personal risk (e.g. health, accidents, divorce). In general, risk tends to reduce profit because farmers are risk averse (Antle, 1987, Binswanger, 1980, Chavas and Holt, 1996) and tend therefore swap expected profit against lower risk. Indeed, a farmer chooses the range of profit he might expect when he choose his input: if he borrows largely to invest in lands, buildings stock, and new machinery, he might expect to increase his next year profit while taking the risk of suffering heavier losses if the price turn out to be low (market risk) or if an epidemic hits his herd or poor weather reduces yields (production risk). However, if he prefers a conservative production plan, his exposure to risk diminishes as well as his expected profit. This is the reason why we might conceive lower profit as the cost of risk. Other example includes reluctance to invest in new technologies, to adopt new farming practice or tendency to favour diversification upon economy of scale. This trade-off between risk and profit affects both the short term and the long term competitiveness of the farm.

If all farmers tended to react similarly to risk, then risk wouldn't have any impact on the distribution of income: everyone would be simply poorer than if everyone was risk neutral. However, empirical evidences show that farmers exhibit declining absolute risk aversion (DARA) (Binswanger, 1980, Chavas and Holt, 1996) and it is generally accepted that richer farmers have more risk management tools. DARA means that poorer farmers are more risk averse which explains why they tend to renounce to a greater proportion of their expected profit for a given reduction in risk. Furthermore, richer farmer have access to a whole set of risk management solution such as credit, insurance and savings. Therefore, while bigger, richer and less risk averse farmer will be able to make the right investment decision to profit from market opportunities, expand their business and get even richer, smaller and poorer farmer will tend to be stuck at the bottom of the distribution, unable to invest because of credit constraints or because of lack of willingness of being exposed to risk perceived through a magnifying glass. This process tends to stretch out the distribution of income, increasing the overall level of inequality.

[1] http://ec.europa.eu/agriculture/analysis/perspec/app-briefs/index_en.htm

To sum-up, theory suggest that risk increases inequality because poorer farmers are more affected by risk due to their greater risk aversion and due to their lack of risk management tools. However, we still have no evidences of the severity of the impact of risk compared to other triggers of inequality. Is it sufficiently important to be taken into account in policy design? The goal of the present paper is to shed some lights on the question.

Our strategy is to rely on the large literature of inequality decomposition (Bourguignon, 1979, Shorrocks, 1982, Shorrocks, 1984, Fields and Yoo, 2000, Oaxaca, 1973, Blinder, 1973, Shorrocks, 1983). Most studies in inequality decomposition have focused on the difference in revenues between male and female or on the impact of education on the distribution of income. Several hundred (if not thousands) of studies have been conducted on this topic, most of them based on the human capital model(Lemieux, 2002). More recently, Fields has developed a decomposition method to explain the role of various factors in the changes of inequality (Fields and Yoo, 2000) while Shorrocks has developed a method based on the Shapley value (Shorrocks, 1999). Several authors have applied those models to the farming sector in developing countries (Morduch and Sicular, 2002, Adams, 2002, Bourguignon et al., 2001, Wan and Zhou, 2005) and, for the case of interest, in Ireland (Hynes et al., forthcoming, Hynes and O'Donoghue, forthcoming).

The last piece of the puzzle is to estimate the risk exposure of farmers. We use for this purpose the square and the cube of the residuals of a stochastic production function (Just and Pope, 1979, Antle, 1983, Di Falco and Chavas, 2006, Di Falco and Chavas, 2009). As we will show later, this capture the two features of risk: the conditional variance and skewness of the distribution of profit. The variance relates intuitively to the uncertainty about the expected profit as it is the scale of the distribution of all possible profit given the observed input choices while negative (positive) skeweness describe the presence of downside ("upside") risk. Lastly, we also use a diversification index (Berry, 1971) in order to capture risk preferences, the assumption being that more diversified farmers are more risk averse.

Based on the methods of Shorrocks and Fields (Fields and Yoo, 2000, Shorrocks, 1982), we analyze the role of risk in explaining Irish farmers' gross margin inequality controlling for a set of classical variables used in income generating function. In the second part, we present the methodology; in the third part, the data; in the fourth part, the results and in the fifth part we conclude.

METHODOLOGY

The impact of risk on inequality is complex. As Ravallion put it, "the existence of income risk need not to imply that the distribution of income change over time" (Ravallion, 1988) and the variability in the level of wealth over time might be due to income mobility as well as to risk. When it comes to the inequality between farmers, changes in inequality over time might be due to changes in input uses as well as changes in inputs' return due to weather events or output prices changes (Lemieux, 2002). Several techniques have been developed over the last two decades to deal with these caveats. We follow the methodology of Fields and Yoo (Fields and Yoo, 2000).

The method of Fields and Yoo (Fields and Yoo, 2000) has three steps. In the first step, we decompose the sources of inequality in order to obtain the contribution of each variable to inequality. This contribution is called the factor's inequality weight. For instance, if risk has a factor inequality weight of 30%, this means that 30% of inequality is explained by the inequality in risk. The second step is to decompose the change of these inequality weight from year to year. The goal is to know what triggers the changes: a change of the impact of risk on wealth, a change in the inequality in wealth or a change in the inequality in risk? The last step consists in analysing the contribution of each factor to the change in inequality. To sum-up, the method devised by Fields and Yoo and grounded on the work of Shorrocks (Shorrocks, 1982) allows estimating the contribution of each factor to inequality in each year, the source of changes of these contribution between years and the impact of each factor on the change in inequality.

The first step is based on the model of Shorrocks to decompose inequality (Shorrocks, 1982). The powerful result of Shorrocks is that, given six assumptions (listed in Appendix A), the factors' inequality weight will be independent of the inequality index chosen. In other terms, once we have chosen an inequality index satisfying the six conditions (as do the Gini index, Atkinson index and all entropy family indexes), "the relative importance of different income components is independent of the choice of inequality measure" (Shorrocks, 1982).
The model is based on a standard income generating function:

$$\mathrm{Y} = \sum_{k} a_{kt} Z^{k}$$

Where Y is the income, each Z^k is an explicative variable, each a is the coefficient associated with them, the subscript t indicates the period and k the variable. Given the six assumptions, the contribution of the variable k to inequality will be the same independently of the inequality index used. Therefore, we choose as Fields and Yoo the sample variance of gross margin as index of inequality as it is easy to handle.

Following Shorrocks, we rewrite the sample variance, σ^2, as:

$$\sigma^2(Y) = \sum_{k} \sigma^2(Y^k) + \sum_{j \neq k} \sum_{k} \rho_{jk} \sigma(Y^j) \sigma(Y^k)$$

where $Y^k = a_k Z^k$ is the income from source k, ρ_{jk} is the correlation between variable j and k and $\sigma()$ is the standard deviation. Given the six assumptions, we can write the contribution of factor K to the variance, $S_k()$, simply as:

$$S_k\big(\sigma^2(Y)\big) = \sigma^2(Y^k) + \sum_{j \neq k} \rho_{jk} \sigma(Y^j) \sigma(Y^k) = cov(Y^k, Y)$$

Then, to obtain the share of factor k to variance, we simply divide by the variance:

$$s^k = \frac{cov(Y^k, Y)}{\sigma^2(Y)}$$

It turns out that this expression is also valid for the Gini index, the Atkinson index and most inequality indexes traditionally used because they fulfil the six assumptions of Shorrocks. Indeed, despite the fact that each inequality index weights differently differences in pairs of income according to their location on the income distribution (Atkinson, 1970), the natural decomposition rule states that the contribution of one factor to inequality is the same for the whole set of inequality indexes fulfilling the six assumptions (Shorrocks, 1982).

We observe that the impact of each variable on inequality sum to 100%:

$$\sum_k s_k(Y) = 100\%$$

And that it also equals the r-squared:

$$\sum_k \frac{cov(a_k Z^k, Y)}{\sigma^2(Y)} = R^2(Y)$$

Therefore, the share of each regressor k in the inequality can also be written as:

$$p_k(Y) = \frac{s_k(Y)}{R^2(Y)}$$

This first step gives us therefore the inequality weight of each variable which is "the proportions of total inequality attributed to each source of income"(Shorrocks, 1982). This elegant method overcome therefore the challenge of justifying the choice of a particular ethical rule embodied in any particular inequality index and it voids the limitation of obtaining results only valid for one index.

The second step of the method tackle the fact that the changes in factors' inequality weights might be due to changes in the coefficients, in the distribution of the explanatory variables or in the distribution of income (Fields and Yoo, 2000). Again, the key word is decomposition.

We start by rewriting the share of factor k to variance, s^k, as:

$$\begin{aligned} s^k &= \frac{cov(Y^k, Y)}{\sigma^2(Y)} = \frac{E\left[\left(Y^k - \overline{Y^k}\right)(Y - \bar{Y})\right]}{\sigma^2(Y)} = \frac{E\left[\left(a_{kt}Z^k - \overline{a_{kt}Z^k}\right)(Y - \bar{Y})\right]}{\sigma^2(Y)} \\ &= \frac{a_{kt}E\left[\left(Z^k - \overline{Z^k}\right)(Y - \bar{Y})\right]}{\sigma^2(Y)} \\ &= \frac{a_{kt}\sigma(Y)\sigma(Z^k)\, E\left[\left(Z^k - \overline{Z^k}\right)(Y - \bar{Y})\right]/\sigma(Y)\sigma(Z^k)}{\sigma^2(Y)} \\ &= \frac{a_{kt}\sigma(Y)\sigma(Z^k) corr(Z^k, Y)}{\sigma^2(Y)} \\ &= \frac{a_k \sigma(Z^k) corr(Z^k, Y)}{\sigma(Y)} \end{aligned}$$

Then, we get the contribution of the change of each component to the change in s^k by logarithmically differencing the last expression. Indeed,

$$[\log(s^k)]' = \left[\log\left(\frac{a_k * \sigma(Z^k) * corr(Z^k, Y)}{\sigma(Y)}\right)'\right]'$$

$$= \left[\log(a_k) + \log\left(\sigma(Z^k)\right) + \log\left(corr(Z^k, Y)\right) - \log(\sigma(Y))\right]'$$

$$\Delta\% s^k = \Delta\% a_k + \Delta\% \sigma(Z^k) + \Delta\% corr(Z^k, Y) - \Delta\% \sigma(Y)$$

where $\Delta\%$ is the percentage rate of change. Then by dividing by $\Delta\%s_j$, the total change is decomposed in its different elements:

$$100\% = \underbrace{\frac{\Delta\%a_j}{\Delta\%s_j}}_{\substack{Contribution \\ of\ coefficient's\ change \\ to\ factor's\ inequality \\ weight's\ change}} + \underbrace{\frac{\Delta\%\sigma(Z_j)}{\Delta\%s_j}}_{\substack{Contribution \\ of\ std\ dev\ of\ Z''s\ change \\ to\ factor's\ inequality \\ weight's\ change}} + \underbrace{\frac{\Delta\%cor(Z_j, Y)}{\Delta\%s_j}}_{\substack{Contribution \\ of\ corr(Z,Y)'s\ change \\ to\ factor's\ inequality \\ weight's\ change}} - \underbrace{\frac{\Delta\%\sigma(Y)}{\Delta\%s_j}}_{\substack{Contribution \\ of\ std\ dev\ of\ Y''s\ change \\ to\ factor's\ inequality \\ weight's\ change}}$$

The problem with this specification is that the coefficient a_j and $corr(Z_j, Y)$are both determined by $cov(a_k Y^k, Y)$. As they cannot be changed independently, this can lead to some simultaneity bias. Therefore, Fields and Yoo propose another specification based on the assumption of perfect orthogonality between regressors. In this case, as all the correlation ρ_{jk} between sources of incomes ($Y^k = a_k Z^k$) are zero, we can rewrite the contribution of factor j to inequality simply as :

$$S_j(Y) = \sigma^2(a_j Z_j) = {a_j}^2 \sigma^2(Z_j)$$

As before, we divide then by the variance of Y in order to obtain the determinant's factor inequality weight:

$$s_j(Y) = \frac{{a_j}^2 \sigma^2(Z_j)}{\sigma^2(Y)}$$

Then, by logarithmically differentiating $s_j(Y)$, the rate of change of $s_j(Y)$ and its components:

$$\Delta\%s^j = 2\Delta\%a_k + 2\Delta\%\sigma(Z^k) - 2\Delta\%\sigma(Y)$$

And then we need only to divide by $\Delta\%s^j$ to obtain the share of each component in the change:

$$100\% \approx 2\frac{\Delta\%a_j}{\Delta\%s_j} + 2\frac{\Delta\%\sigma(Z_j)}{\Delta\%s_j} - 2\frac{\Delta\%\sigma(\ln GM)}{\Delta\%s_j}$$

It remains an approximation because real world changes are not infinitesimal and because the explicative variables are rarely if ever orthogonal to each other.

The third step, the *difference* question as Field and Yoo call it, consists in analysing the impact of each variable on the change in inequality.

We start by observing that given the fact that inequality is the sum of its factors' inequality weights:

$$I(.)_1 = \sum_j p_{j,1} I(.)_1$$

where I() is the inequality index and the subscript 1 refers to the period 1. The change in inequality can be rewritten as:

$$I(.)_2 - I(.)_1 = \sum_j \left[p_{j,2} I(.)_2 - p_{j,1} I(.)_1\right]$$

Therefore, the change in inequality is:

$$100\% = \frac{\sum_j \left[p_{j,2} I(.)_2 - p_{j,1} I(.)_1\right]}{I(.)_2 - I(.)_1}$$

This allows us expressing the contribution of factor j to the change in inequality by:

$$\Pi_j[I(.)] = \left[p_{j,2} I(.)_2 - p_{j,1} * I(.)_1\right] / [I(.)_2 - I(.)_1]$$

As Fields and Yoo stress it, Π_j is as a function of I(.), the index of inequality used. The estimated contribution of each factor to the change in inequality is indeed going to vary according to which index is used.

To sum-up, the methods pioneered by Shorrocks (Shorrocks, 1982)and developed by Fields and Yoo (Fields and Yoo, 2000) allow estimating the contribution of each variable to inequality (1^{st} step) and to its change over time (3^{rd} step). Furthermore, the change in each factor's inequality weight can be decomposed between change in the distribution of the variable in the population, the change of the effect of this variable on the dependent variable (here, the average return of each input in terms of gross margin) and the change of the distribution of income (2^{nd} step). We will present now the data on the Irish Agriculture and some general trend in terms of inequality.

ESTIMATION STRATEGY AND DATA

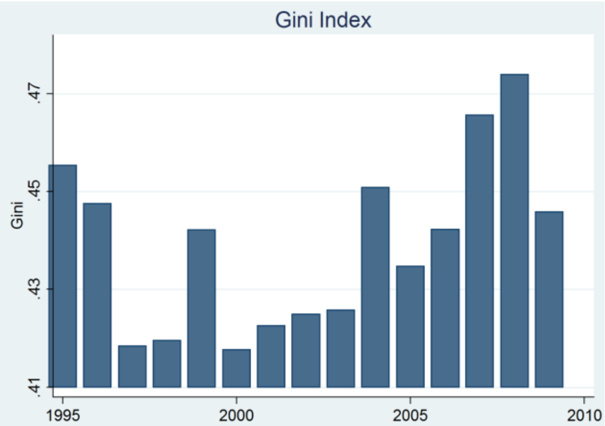
The database (the National Farm Survey, NFS) is collected in the Republic of Ireland from 1995 to 2009 by Teagasc, a semi-state research body in the Republic of Ireland. In addition of being of very high quality, the interest of using Irish data is the presence of significant market and production risk and a relative high level of inequality. Indeed, the Irish agricultural sector being export oriented and price-takers, it has been deeply affected by the volatility of the soft commodities of the last 3 years. In term of production risk, the Irish agriculture is mainly dominated by grass-based cattle herding and is therefore exposed to the variability of the weather: adverse weather condition leads to less grass and lower hay harvest, forcing farmers to buy feed. The fact that commercial farmers co-exist on the market with small part-time farmers bring naturally a high level of gross margin inequality. Therefore, Ireland offers a very interesting case study to analyze the impact of risk on inequality.

The annual survey is conducted at the NUTS 3 level covers a representative sample of approximately 1100 farms per year over the period representing the approximately 100'000 farmers in Ireland. This survey feeds the Farm Accounting Data Network at the European level. The farms stay on average five years in the survey and they are classified in 6 categories according to their main source of revenues: Dairy, Dairy and other, Cattle, Cattle and other, Sheep, Tillage.

The level of gross margin has grown on average from €30970 in 1995 to €35130 in 2009 with a maximum of €40880 in 2008. The years 2007-2009 have known an unprecedented volatility on agricultural commodities markets which lead to the boom and bust pattern of average gross margin, closely replicating the price movements.

The inequality in gross margin has been relatively high and stable over the period considered. It oscillates between 0.41 and 0.47 with a significant decline at the beginning of the period and a gradual rise from 2000 onward, which culminates in 2008. The relative high level of inequality comes from the fact that several type of farming coexist and that part time and hobby farmers are included in the sample along full-time business oriented farmers. Therefore, a large part of the inequality between farms comes from inequality in size of the farm and in the intensity of the production process. We will comment this further in the next section with the results of the model.

With respect to the explicative variables, the amount of capital invested in the farm has been gradually growing from 2003 onward, with a sharp rise in 2006 picking in 2008, while the size of farm measured in hectares has been mostly constant. In parallel, less and less labor has been employed on the farm (from an average of 1.4 full-time worker in 1995 to 1.15 in 2009). Farms became therefore more capitalized over time. All the details are in appendix B.



The dependent variable is the log gross margin. The explicative variables are: the net capital expenditure in thousands of Euros (e.g. major repairs to farm buildings, plant and machinery and land improvement), land (utilized agriculture area of the farm in hectares), labour (one labour unit is one full time worker on the farm), a series of dummy variable for the type of farming (Dairy is the base category), a series of dummy variables for the quality of soil (3 categories, the best one is the base category), a series of dummies for each of the height administrative regions of Ireland (the base category is the boarder region), a dummy variable for being client of Teagasc farm advisory services and a dummy variable for taking part to the Rural Environment Protection Scheme (REPS).
With respect to risk, we use a diversification index expressed as (Berry, 1971):

$$D = 1 - \sum_{i=1}^{N=6} \left(\frac{Gross\ Margin\ from\ product\ i}{Total\ Gross\ Margin} \right)^2$$

The rationale to include a diversification index is to control for economies of scale in specialized farms and principally to take into account diversification strategies implemented to mitigate exposure to risk.

Lastly we approximate risk faced by farmers by taking the square and the cube of the residuals (Antle, 1987, Just and Pope, 1979, Antle, 1983, Di Falco and Chavas, 2006, Groom et al., 2008, Franklin et al., 2006). This technique is intuitively simple: risk is the difference between the conditional expectation of gross margin and the actual gross margin. By taking the square and the cube of the residual, we obtain respectively the variance and the skewness of the distribution of the gross margin for each farm.

However, we have to assume that the regression is correctly specified and that the risk faced by all farmers is homogeneous, namely that the shock on the expected gross margin is drawn from the same distribution (Kamanou and Morduch, 2002). This second measure of risk is more agglomerated than the measure of price risk: it captures all idiosyncratic shocks. As we have controlled for price risk, we might assume that the specification capture mainly production risk such as lack of rain, plant and animal disease, pests or localized flood as well as market risk and price risk. Indeed, as each farm has an different output mixed, even price volatility usually considered as an aggregated risk is going to have an idiosyncratic impact on individual farm gross margin distribution.

To sum-up, the log of gross margin is regressed against a set of classical explicative variables, two proxies for the risk and an index of diversification. We ran an OLS cross-sectional regression on each year of the period using heteroskedasticity robust error term, controlling for clustering along production system.

RESULTS

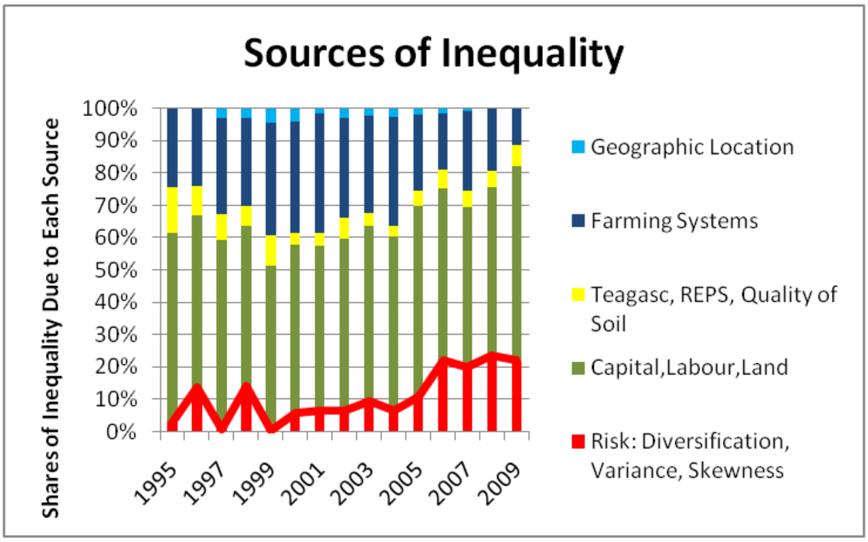
We start by presenting the results of the 15 OLS regressions. We got rid of the outliners and over-influential observations (161 from a total of 17383 observations). The table of estimates are in Appendix B. We obtain very high r-squared (between 0.72 and 0.92) and very high level of significance (most variables are significant at the 0.01 level), which is as expected given the large sample and the quality of the data.

The dummies on the type of farming are all negative, which is expected because the base category, the specialist dairy system, is most profitable system of farming in Ireland. The dummy on cattle has the biggest negative impact, translating the fact that many farmers operating cattle farms are only part-time farmers. The soil quality dummies are also all negative, which is expected because the base category is the best one. We also see that capital has only a limited impact on gross margin compared to other input such as land and labour. Both land and labour capture the size of the farms explaining their greater impact on gross margin. The work of Teagasc advisory teams seems to have a positive and important impact on gross margin. However, it is likely that farmers who are already more efficient and who are more business oriented constitutes a greater proportion of Teagasc's clients. Part-time farmers are indeed unlikely to be willing to pay for such services. Taking part to REPS increased gross margin by a significant amount and is quite stable over the period (around 30% for the six more recent years).

The impact of the diversification of the farms on gross margin has changed over the 15 years studied. Although it was positive at the beginning, it becomes progressively a handicap, echoing the greater need of specialisation to obtain economies of scale in market environment more and more competitive. Lastly, the impact of variance gain in pragmatic and statistic significance as time goes. Although mostly significant only at the 0.08 level until 2005, it becomes significant at the 0.01 level for the remaining years and have a very negative impact. The impact of skewness is mostly positive as a higher level of skewness means that the tail of the profit distribution becomes bigger on its right hand-side (higher probability to have "good surprise"). In other terms, greater upside risk lead to hire income and vice-versa.

Now we turn to the decomposition of inequality in its different sources. The table of results is in appendix C. The inequality in capital has only a small impact on the inequality in gross margin. This might be explained by the fact that all Irish farms have a good access to capital and are therefore at their equilibrium. Land and labour have the greatest factor inequality weights of all variables, which is quite logical as land and labour are closely related to the size of the farm. Inequality in size naturally leads to inequality in gross margin while bigger and more business oriented farm are likely to employ more full-time farmers. The type of farming system is the second most important factor explaining inequality. An outflow of farms from the specialist dairy system to the "dairy and other" system or to tillage system would reduce inequality while the effect would be inverse in the direction of "cattle", "cattle and other" and the sheep system. The geographic location, REPS and Teagasc advisory activities have a negligible impact on the inequality.

An interesting pictures comes out when we look at the variables linked to risk, namely, the diversification index, the variance and the skewness of the distribution of gross margin. Although the diversification index and the variance have almost no impact until 2005, they explain between 15% and 30% (2008) of the inequality in the four last years. These last years have been characterized by a high level of volatility of prices and gross margin and the results indicate that those risks have triggered a greater inequality. More diversified farms were not able to benefit from the rise of commodities prices while a greater variance stretched out the distribution of income between business oriented profitable farms quick to respond to markets signals and smaller farms to slow to respond to price signal. The effect of skewness is by contrast more stable over the whole period. It tends to raise inequality by 6% on average (once we take out the two years where it diminishes it), although it has a negative impact in 2008 on inequality. The next graph (figure 2) summarizes the results. We have plotted the net effect of each category. The figure doesn't change if we compare the category in term of their absolute impact on inequality.
The change of the factor inequality weights of the three variables linked to risk over the years is mostly due to the change in their impact on gross margin (rather than a change in their distribution or a change in the gross margin inequality). This brings two important conclusions in terms of policies. First of all, providing mechanism which would reduce the impact of risk such as insurances would also have an impact on the inequality of revenues. Second, the inequality in revenue per-se doesn't play an important role in the phases of rise. Therefore, it seems that risk cause more inequality than inequality causes risk. Offering better risk management scheme would therefore have some side benefits such as reducing the inequalities.



However, we should bring a note of caution before drawing too strong conclusions. Because of the joint determination of the coefficients and of the correlation between the dependent variables, we used the second method of factors' inequality weights' decomposition to get these results. As highlighted in the methodology part, this method relies on the assumption that the variables are orthogonal to each other, which is difficult to defend particularly between variance and skewness as both variables are created from the residuals. Nevertheless, it might provide and interesting guide.

We then applied the model to estimate the impact of each variable on the change in inequality (table of estimates are in appendix D). The results are less clear cut than the previous ones. Although the relative proportion of each variable is quite constant over time, their absolute share as well as the sign of their impact vary a lot between years. Overall, skewness has a big impact on the change in inequality while variance and diversification plays a role respectively only in the last four and five years of the period. Land and labour are an important factor while the type farming is only important when cattle are involved. The soil quality and REPS are marginal.

CONCLUSION

The goal of the present paper was to test the hypothesis that risk has an impact on the inequality. Many studies investigating the behaviour of farmers under risk have indeed concluded that poorer farmers, because they are more risk averse and less protected against risk, tend to reduce their risk by reducing proportionally more their expected gross margin. Because this trade-off between risk and profit is more acute among smaller and poorer farmer, risk would increase inequality over time. Here we have proposed a direct way of testing the hypothesis.

We rely on the large literature of income inequality decomposition in order to estimate the relative importance of risk compared to other factors. The methodology is applied to Ireland, an interesting case study because of the diversity of its agriculture, its exposure to international price volatility and its direct link to weather shock because of its pasture-based cattle-herding system. Irish farmers have been exposed to increasing risk over time, mostly because of a greater volatility in prices and the decoupling of production subsidies.

We have found that risk has a significant impact on inequality, raising up to 20%. Furthermore, we have seen that this impact have risen over time, coinciding with the rise in market risk linked to the reforms of pillar I of the Common Agricultural Policy. Providing better risk management tools to farmers is therefore of prime interest to maintain a diversity of agricultural producers. If the demand for risk is not addressed, this could lead to further rise of inequality and, at one extreme, to the exit of the market of all small producers. This would leave European country side with only big farms, likely to be more polluting and less interested in joining the voluntary agri-environmental schemes of the pillar II of the Common Agricultural Policy.

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Appendix A

This six assumptions are (Shorrocks, 1982):

1) The index of inequality, I(GM) is a continuous and symmetric function, $I(GM) == 0$ if and only if $GM = \mu e$, where e=(1,1,...1) and μ is the mean of GM.

2) $S^k(GM^1, \ldots GM^k;\ K)$ is continuous in GM^k where $S_k()$ is the contribution of factor k to the gross margin; $S_K(GM^1, \ldots GM^k;\ K) = S_{\pi_k}(GM^{\pi_1}, \ldots GM^{\pi_k};\ K)$ where π_i is any permutation of 1, ... K.

3) Independence of level of aggregation $S_1(GM^1, \ldots GM^k;\ K) = S_1(GM^1,\ GM -$ *GM1; 2=S(GM1,GM)*

4) Consistent decomposition: $\sum_k S_K(GM^1, \ldots GM^k;\ K) = \sum_k S_K(GM^k, GM) = I(GM)$

5) Population symmetry: $S(GM^k P, GMP) = S(GM^k, GM)$ where P is a permutation matrix (all individuals are treated symmetrically); Normalization for equal factor distribution: $S(\mu_k e, GM) = 0$ for all μ_k (the contribution of a factor to inequality is zero if all individuals receive the same amount from this income source)

6) Two factor symmetry: $S(Y^1, Y^1 + Y^1 P) = S(Y^1 P, Y^1 + Y^1 P)$

Appendix B

		capital	land	labour	teagasc	REPS	system1	system2	system3	system4	system5	system6	soil1	soil2	soil3	divers
1995	μ	62.35	45.20	1.54	0.41	0.08	0.24	0.22	0.09	0.19	0.16	0.10	0.49	0.40	0.12	0.41
	σ	111.91	29.00	0.74	0.49	0.28	0.43	0.41	0.29	0.39	0.36	0.30	0.50	0.49	0.32	0.21
1996	μ	56.81	44.09	1.49	0.48	0.18	0.28	0.19	0.08	0.21	0.16	0.08	0.47	0.42	0.12	0.43
	σ	112.57	28.00	0.72	0.50	0.39	0.45	0.39	0.26	0.41	0.37	0.28	0.50	0.49	0.32	0.22
1997	μ	58.70	46.57	1.51	0.48	0.23	0.29	0.23	0.16	0.13	0.11	0.08	0.48	0.41	0.10	0.44
	σ	104.04	28.05	0.69	0.50	0.42	0.46	0.42	0.36	0.33	0.31	0.28	0.50	0.49	0.30	0.21
1998	μ	63.71	46.58	1.48	0.49	0.30	0.29	0.24	0.15	0.14	0.11	0.08	0.50	0.41	0.09	0.45
	σ	116.67	27.43	0.66	0.50	0.46	0.45	0.43	0.35	0.34	0.31	0.28	0.50	0.49	0.28	0.21
1999	μ	58.39	46.85	1.44	0.50	0.34	0.28	0.22	0.17	0.15	0.10	0.07	0.50	0.41	0.09	0.46
	σ	121.03	27.63	0.66	0.50	0.47	0.45	0.42	0.38	0.36	0.31	0.25	0.50	0.49	0.29	0.22
2000	μ	84.69	48.31	1.43	0.00	0.34	0.32	0.19	0.17	0.15	0.10	0.07	0.51	0.40	0.09	0.43
	σ	151.92	27.81	0.63	0.00	0.47	0.47	0.39	0.38	0.35	0.30	0.25	0.50	0.49	0.29	0.22
2001	μ	80.49	50.55	1.45	0.55	0.28	0.35	0.17	0.18	0.12	0.10	0.07	0.53	0.40	0.08	0.49
	σ	161.48	29.70	0.66	0.50	0.45	0.48	0.38	0.38	0.33	0.30	0.26	0.50	0.49	0.27	0.20
2002	μ	79.08	48.83	1.37	0.52	0.29	0.31	0.15	0.21	0.14	0.10	0.09	0.51	0.40	0.09	0.53
	σ	164.24	29.66	0.62	0.50	0.46	0.46	0.36	0.41	0.34	0.30	0.29	0.50	0.49	0.28	0.20
2003	μ	72.22	50.00	1.34	0.53	0.30	0.31	0.14	0.19	0.16	0.11	0.09	0.53	0.38	0.10	0.51
	σ	138.87	30.80	0.59	0.50	0.46	0.46	0.34	0.39	0.37	0.31	0.29	0.50	0.49	0.30	0.20
2004	μ	82.81	50.25	1.34	0.53	0.32	0.31	0.14	0.21	0.16	0.10	0.09	0.52	0.38	0.10	0.51
	σ	160.58	32.35	0.63	0.50	0.47	0.46	0.34	0.41	0.36	0.30	0.29	0.50	0.49	0.30	0.21
2005	μ	90.36	49.47	1.30	0.58	0.38	0.30	0.12	0.22	0.19	0.10	0.07	0.51	0.38	0.10	0.75
	σ	174.43	31.58	0.61	0.49	0.49	0.46	0.32	0.41	0.39	0.30	0.26	0.50	0.49	0.30	0.16
2006	μ	99.66	51.63	1.31	0.61	0.48	0.30	0.11	0.20	0.21	0.10	0.08	0.54	0.38	0.08	0.81
	σ	196.83	31.73	0.60	0.49	0.50	0.46	0.32	0.40	0.41	0.29	0.28	0.50	0.49	0.27	0.17
2007	μ	165.34	51.79	1.27	0.67	0.49	0.28	0.09	0.20	0.24	0.10	0.09	0.54	0.38	0.08	0.78
	σ	302.86	32.67	0.60	0.47	0.50	0.45	0.28	0.40	0.43	0.30	0.29	0.50	0.48	0.27	0.19
2008	μ	250.42	51.71	1.27	0.61	0.47	0.27	0.08	0.23	0.24	0.09	0.09	0.53	0.38	0.09	0.80
	σ	485.23	32.81	0.60	0.49	0.50	0.44	0.27	0.42	0.42	0.29	0.29	0.50	0.49	0.28	0.19
2009	□	147.80	54.00	1.34	0.58	0.49	0.30	0.07	0.23	0.22	0.09	0.08	0.54	0.38	0.08	0.84
	□	278.84	34.59	0.62	0.49	0.50	0.46	0.26	0.42	0.42	0.29	0.28	0.50	0.49	0.27	0.14

Appendix B

Regression Results 1995-2002

	1995 ln(GM)	1996 ln(GM)	1997 ln(GM)	1998 ln(GM)	1999 ln(GM)	2000 ln(GM)	2001 ln(GM)	2002 ln(GM)
capital	8.71e-04***	5.05e-04***	5.88e-04***	3.07e-04***	5.02e-04***	4.07e-04***	2.38e-04**	1.43e-04*
	(1.77e-04)	(1.07e-04)	(1.54e-04)	(8.33e-5)	(1.38e-04)	(7.19e-5)	(9.04e-5)	(6.12e-05)
land	0.0101***	0.0117***	0.0124***	0.0132***	0.0146***	0.0150***	0.0145***	0.0153***
	(0.000893)	(0.000496)	(0.000706)	(0.000455)	(0.000877)	(0.000525)	(0.000601)	(0.000555)
labour	0.357***	0.343***	0.256***	0.232***	0.174***	0.164***	0.173***	0.144***
	(0.0349)	(0.0203)	(0.0280)	(0.0194)	(0.0329)	(0.0224)	(0.0291)	(0.0217)
teagasc	0.277***	0.178***	0.139***	0.113***	0.211***		0.0246^{+}	0.155***
	(0.0395)	(0.0215)	(0.0286)	(0.0218)	(0.0328)		(0.0285)	(0.0230)
REPS	0.185**	0.126***	0.190***	0.227***	0.317***	0.223***	0.226***	0.184***
	(0.0708)	(0.0332)	(0.0409)	(0.0275)	(0.0451)	(0.0304)	(0.0334)	(0.0278)
Dairy&co	-0.268***	-0.281***	-0.264***	-0.241***	-0.287***	-0.284***	-0.295***	-0.289***
	(0.0597)	(0.0326)	(0.0413)	(0.0308)	(0.0467)	(0.0343)	(0.0393)	(0.0399)
Cattle	-0.909***	-0.794***	-0.866***	-0.865***	-1.030***	-1.013***	-1.086***	-0.966***
	(0.0766)	(0.0379)	(0.0518)	(0.0361)	(0.0554)	(0.0360)	(0.0412)	(0.0366)
Cattle&co	-0.828***	-0.872***	-0.934***	-0.881***	-0.977***	-1.043***	-1.064***	-0.878***
	(0.0588)	(0.0316)	(0.0501)	(0.0338)	(0.0566)	(0.0385)	(0.0549)	(0.0413)
Sheep	-0.838***	-0.818***	-0.754***	-0.852***	-0.955***	-1.030***	-0.964***	-0.761***
	(0.0667)	(0.0357)	(0.0553)	(0.0435)	(0.0638)	(0.0484)	(0.0580)	(0.0440)
Tillage	-0.339***	-0.343***	-0.574***	-0.582***	-0.575***	-0.584***	-0.699***	-0.666***
	(0.0710)	(0.0404)	(0.0639)	(0.0412)	(0.0691)	(0.0491)	(0.0470)	(0.0466)
soil2	-0.169***	-0.159***	-0.118***	-0.102***	-0.179***	-0.192***	-0.188***	-0.169***
	(0.0416)	(0.0238)	(0.0331)	(0.0233)	(0.0355)	(0.0258)	(0.0278)	(0.0267)
soil3	-0.490***	-0.473***	-0.418***	-0.423***	-0.384***	-0.400***	-0.419***	-0.323***
	(0.0699)	(0.0412)	(0.0524)	(0.0429)	(0.0564)	(0.0451)	(0.0490)	(0.0432)
divers	0.335**	0.312***	0.0402^{+}	-0.0254^{+}	-0.0531^{+}	0.139^{+}	-0.187^{+}	-0.169^{+}
	(0.124)	(0.0670)	(0.102)	(0.0682)	(0.107)	(0.0752)	(0.0966)	(0.0866)
variance		-0.0490^{+}	-0.722^{+}	0.122^{+}	0.640^{+}	-0.152^{+}	-0.0196	-0.575***
		(0.0627)	(0.390)	(0.0765)	(0.682)	(0.102)	(0.306)	(0.136)
skewness		1.750***	0.433^{+}	1.864***	1.135^{+}	1.615***	4.177***	2.260***
		(0.0709)	(0.698)	(0.0901)	(1.124)	(0.115)	(0.659)	(0.188)
Dublin			0.123^{+}	0.0712^{+}	0.150^{+}	0.346**	0.440***	0.293**
			(0.166)	(0.0837)	(0.146)	(0.118)	(0.129)	(0.0919)
Mid-East			0.230***	0.357***	0.367***	0.308***	0.236***	0.289***
			(0.0608)	(0.0411)	(0.0643)	(0.0455)	(0.0490)	(0.0447)
Midlands			0.146*	0.164***	0.0561^{+}	0.0759^{+}	0.132*	0.119**
			(0.0577)	(0.0399)	(0.0673)	(0.0468)	(0.0538)	(0.0432)
Mid-West			0.0818^{+}	0.0947*	0.0370^{+}	0.0198^{+}	0.0124^{+}	0.0000651
			(0.0518)	(0.0416)	(0.0635)	(0.0462)	(0.0482)	(0.0414)
South-East			0.151**	0.227***	0.219***	0.239***	0.169***	0.134**

			(0.0531)	(0.0345)	(0.0600)	(0.0402)	(0.0458)	(0.0435)
SouthWest			0.115*	0.150***	0.132*	0.162***	0.0846*	0.135**
			(0.0497)	(0.0359)	(0.0543)	(0.0386)	(0.0422)	(0.0409)
West			0.0499^{+}	0.136***	0.0605^{+}	0.0747*	0.156***	0.0909*
			(0.0494)	(0.0353)	(0.0600)	(0.0378)	(0.0444)	(0.0410)
_cons	9.372***	9.424***	9.615***	9.552***	9.503***	9.681***	10.05***	9.888***
	(0.0810)	(0.0422)	(0.0824)	(0.0508)	(0.0869)	(0.0538)	(0.0677)	(0.0627)
N	1066	1007	1015	928	924	934	990	964
r2	0.722	0.884	0.792	0.895	0.784	0.887	0.850	0.871
p	3.88e-248	0	5.03e-288	0	7.03e-270	0	0	0

Standard errors in parentheses; $^{+}$ $p < .8$, * $p < .05$, ** $p < .01$, *** $p < .001$

Regression Results: 2003-2009

	2003 ln(GM)	2004 ln(GM)	2005 ln(GM)	2006 ln(GM)	2007 ln(GM)	2008 ln(GM)	2009 ln(GM)
capital	3.96e-04***	3.45e-04**	1.62e-04*	1.53e-04**	1.18e-04**	8.25e-05**	1.32e-04*
	(1.01e-04)	(1.14e-04)	(8.10e-05)	(5.58e-05)	(3.79e-05)	(2.54e-05)	(5.77e-05)
land	0.0153***	0.0149***	0.0159***	0.0155***	0.0150***	0.0150***	0.0134***
	(0.000601)	(0.000571)	(0.000480)	(0.000429)	(0.000527)	(0.000461)	(0.000575)
labour	0.158***	0.218***	0.184***	0.167***	0.190***	0.174***	0.198***
	(0.0278)	(0.0353)	(0.0244)	(0.0222)	(0.0242)	(0.0222)	(0.0285)
teagasc	0.108***	0.0950***	0.121***	0.158***	0.158***	0.139***	0.0956***
	(0.0223)	(0.0241)	(0.0246)	(0.0208)	(0.0277)	(0.0232)	(0.0273)
REPS	0.306***	0.371***	0.312***	0.294***	0.311***	0.342***	0.301***
	(0.0325)	(0.0331)	(0.0290)	(0.0211)	(0.0263)	(0.0238)	(0.0272)
Dairy&co	-0.261***	-0.312***	-0.221***	-0.224***	-0.273***	-0.196***	-0.149*
	(0.0436)	(0.0444)	(0.0518)	(0.0415)	(0.0575)	(0.0525)	(0.0616)
Cattle	-0.918***	-1.043***	-0.727***	-0.588***	-0.754***	-0.596***	-0.335***
	(0.0401)	(0.0391)	(0.0509)	(0.0504)	(0.0664)	(0.0539)	(0.0533)
Cattle&co	-0.870***	-1.038***	-0.632***	-0.456***	-0.673***	-0.529***	-0.347***
	(0.0421)	(0.0447)	(0.0506)	(0.0456)	(0.0647)	(0.0537)	(0.0555)
Sheep	-0.669***	-0.804***	-0.638***	-0.491***	-0.695***	-0.620***	-0.391***
	(0.0449)	(0.0464)	(0.0594)	(0.0518)	(0.0716)	(0.0618)	(0.0629)
Tillage	-0.631***	-0.677***	-0.443***	-0.306***	-0.321***	-0.325***	-0.301***
	(0.0539)	(0.0559)	(0.0619)	(0.0483)	(0.0559)	(0.0540)	(0.0658)
soil2	-0.142***	-0.128***	-0.114***	-0.0947***	-0.0969***	-0.132***	-0.115***
	(0.0272)	(0.0282)	(0.0261)	(0.0218)	(0.0262)	(0.0233)	(0.0311)
soil3	-0.235***	-0.247***	-0.316***	-0.284***	-0.254***	-0.265***	-0.259***
	(0.0403)	(0.0441)	(0.0523)	(0.0434)	(0.0487)	(0.0400)	(0.0537)
divers	-0.416***	-0.523***	-0.675***	-0.945***	-1.036***	-1.212***	-1.144***
	(0.0936)	(0.0946)	(0.145)	(0.131)	(0.144)	(0.128)	(0.163)
variance	0.571*	-0.247+	-0.394+	-1.611**	-0.631***	-2.072***	-0.913***
	(0.254)	(0.186)	(0.309)	(0.536)	(0.149)	(0.509)	(0.212)
skewness	2.515***	2.096***	3.019***	-0.301+	1.263***	-1.197+	1.954***
	(0.440)	(0.271)	(0.614)	(0.698)	(0.197)	(0.624)	(0.372)
Dublin	0.228*	0.522**		-0.118+	-0.0186		
	(0.104)	(0.186)		(0.108)	(0.115)		
Mid-East	0.237***	0.198***	0.0727+	0.0654+	0.0462+		
	(0.0443)	(0.0499)	(0.0440)	(0.0434)	(0.0511)		
Midlands	0.148**	0.138**	0.0397+	0.0115+	0.0822*		
	(0.0457)	(0.0479)	(0.0467)	(0.0395)	(0.0413)		
Mid-West	-0.00670	-0.0267+	-0.0349+	0.0144+	0.0226+		
	(0.0465)	(0.0468)	(0.0417)	(0.0380)	(0.0456)		
South-	0.0798+	0.0832*	0.0813+	0.0884**	0.0909*		

East							
	(0.0411)	(0.0423)	(0.0447)	(0.0309)	(0.0395)		
SouthWest	0.118**	0.0772*	0.0196+	-0.0231+	0.00764		
	(0.0420)	(0.0390)	(0.0390)	(0.0319)	(0.0393)		
West	0.0720+	0.0124+	-0.0572+	-0.0606+	0.00562		
	(0.0398)	(0.0411)	(0.0409)	(0.0329)	(0.0425)		
_cons	9.891***	10.03***	10.34***	10.58***	10.69***	10.90***	10.67***
	(0.0669)	(0.0674)	(0.103)	(0.101)	(0.0939)	(0.0797)	(0.127)
N	1001	999	905	817	796	712	552
r2	0.859	0.868	0.871	0.917	0.899	0.913	0.872
p	0	0	0	0	0.899	0.913	1.98e-212

Standard errors in parentheses; + $p < .8$, * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix C

	Factor's Contribution to Current Year Inequality									
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Capital	4.75%	2.30%	3.01%	1.64%	3.09%	3.58%	2.13%	1.16%	2.84%	2.71%
Land	30.07%	30.31%	38.27%	35.56%	39.11%	40.32%	39.67%	44.67%	44.01%	40.81%
Labour	23.56%	20.73%	17.20%	12.45%	9.20%	8.10%	9.17%	7.31%	7.60%	10.28%
Teagasc	7.21%	3.95%	3.66%	2.95%	5.54%		0.50%	3.57%	2.42%	2.00%
REPS	0.27%	0.00%	-0.23%	-0.49%	-0.80%	-1.50%	-1.19%	-0.93%	-1.60%	-1.32%
Dairy&co	-3.72%	-3.23%	-4.17%	-3.43%	-4.74%	-3.74%	-3.29%	-3.52%	-2.58%	-2.89%
Cattle	12.14%	6.88%	17.65%	15.85%	22.66%	19.71%	25.11%	25.05%	21.00%	23.52%
Cattle&co	12.34%	16.50%	14.83%	11.25%	12.97%	12.94%	13.23%	9.58%	12.35%	13.35%
Sheep	6.08%	5.71%	4.87%	6.10%	6.31%	8.81%	5.50%	3.07%	2.93%	3.29%
Tillage	-2.31%	-1.65%	-3.47%	-2.73%	-2.35%	-3.11%	-3.58%	-3.42%	-3.60%	-3.56%
Soil2	1.30%	1.40%	1.38%	1.07%	2.33%	2.74%	2.78%	2.58%	1.87%	1.37%
Soil3	5.32%	3.43%	3.38%	2.57%	2.22%	2.16%	1.84%	1.13%	1.20%	1.35%
Diversification	3.00%	2.49%	0.36%	-0.11%	-0.13%	0.57%	0.83%	0.64%	2.13%	2.47%
Variance		-0.05%	0.11%	-0.17%	-0.27%	-0.37%	0.01%	0.44%	-0.84%	0.07%
Skewness		11.21%	0.26%	14.34%	0.59%	5.67%	5.82%	5.58%	8.01%	3.91%
Dublin			0.01%	0.01%	0.05%	0.35%	0.17%	-0.06%	0.19%	0.47%
Mid-East			1.68%	2.31%	2.44%	1.77%	1.17%	2.23%	1.53%	1.05%
Midlands			0.03%	-0.17%	-0.08%	0.11%	0.26%	0.03%	0.12%	0.11%
Mid-West			-0.10%	-0.07%	-0.07%	-0.03%	-0.03%	0.00%	0.03%	0.08%
South-East			1.15%	1.71%	1.85%	1.61%	1.16%	1.08%	0.55%	0.56%
South West			0.76%	0.74%	1.11%	1.27%	0.62%	1.00%	0.72%	0.52%
West			-0.65%	-1.38%	-0.77%	-0.95%	-1.87%	-1.18%	-0.86%	-0.16%
Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Appendix D: Factors' Contribution to Next Year Inequality

	Impact of Each Year on Next Year Inequality									
	96-97	**97-98**	**98-99**	**99-00**	**00-01**	**01-02**	**02-03**	**03-04**	**04-05**	**05-06**	**06-**
Gini Index % Change	-4.1%	-0.5%	5.8%	-4.2%	0.8%	1.6%	1.2%	3.9%	-4.2%	1.9%	5.6
Capital	-21%	252%	27%	-5%	20%	-192%	186%	-11%	17%	-2%	-12
Land	-194%	732%	142%	66%	25%	300%	204%	-153%	-272%	-330%	-60
Labour	96%	1271%	-14%	68%	226%	-86%	67%	46%	39%	-105%	16%
REPS	7%	19%	-9%	10%	-25%	27%	-74%	18%	3%	52%	-8%

Dairy&co	21%	-81%	-21%	-19%	75%	-4%	87%	-11%	-13%	27%	9%
Cattle	-260%	533%	157%	99%	722%	-23%	-212%	24%	126%	-249%	19%
Cattle&co	79%	594%	52%	31%	87%	-226%	273%	15%	157%	-56%	75%
Sheep	23%	-134%	29%	-20%	-415%	-148%	6%	14%	12%	-31%	18%
Tillage	43%	-156%	2%	5%	-74%	-6%	-35%	-1%	-56%	10%	-9%
Soil2	-10%	50%	23%	-7%	-47%	12%	-36%	-15%	2%	-7%	-3%
Soil3	-1%	190%	-5%	8%	-19%	-57%	22%	10%	-7%	-27%	4%
Diversification	43%	33%	-5%	-16%	83%	-29%	143%	-5%	-75%	342%	76%
Variance	-6%	71%	-9%	-5%	65%	16%	-14%	-6%	-52%	97%	102
Skewness	278%	-3274%	-270%	-115%	-625%	515%	-518%	175%	220%	380%	-127
Sum	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100

Appendix E: Decomposition of Change in Factor Inequality Weight (Methode 2)

		Capital	Land	Labour	Teagasc	REPS	Dairy&co	Cattle	Cattle&co	Sheep	Tillage	Soil2	Soi
1996-1997	**β**	145%	64%	95%	114%	78%	-164%	20%	-69%	39%	95%	111%	86
	σ(var)	-75%	2%	16%	0%	16%	181%	73%	200%	76%	-1%	1%	36
	σ(GM)	-30%	-34%	10%	14%	-6%	-84%	-7%	31%	15%	-6%	12%	22
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	10
1997-1998	**β**	121%	166%	71%	100%	68%	107%	3%	205%	105%	155%	99%	-22
	σ(var)	-21%	-61%	28%	0%	33%	-9%	90%	-111%	-3%	-37%	0%	11
	σ(GM)	0%	4%	-1%	-1%	1%	-2%	-6%	-5%	1%	18%	-1%	-3
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	10
1998-1999	**β**	113%	665%	76%	117%	121%	272%	119%	201%	1233%	6%	120%	58
	σ(var)	8%	48%	0%	0%	12%	-32%	44%	77%	-135%	48%	0%	-13
	σ(GM)	21%	613%	-24%	17%	34%	141%	63%	178%	998%	-46%	20%	-55
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	10
1999-2000	**β**	-361%	34%	86%	.	113%	48%	-82%	73%	75%	25%	66%	53
	σ(var)	392%	9%	72%	.	0%	192%	-20%	-17%	-15%	7%	-4%	-3
	σ(GM)	-69%	-57%	59%	.	13%	140%	-202%	-45%	-40%	-68%	-38%	-51
	TT	100%	100%	100%	.	100%	100%	100%	100%	100%	100%	100%	10
2000-2001	**β**	104%	346%	107%	.	-22%	-107%	177%	-23%	52%	101%	37%	-69
	σ(var)	-12%	-675%	80%	.	66%	98%	30%	76%	15%	22%	0%	108
	σ(GM)	-8%	-429%	86%	.	-56%	-108%	107%	-48%	-33%	24%	-62%	-62
	TT	100%	100%	100%	.	100%	100%	100%	100%	100%	100%	100%	10
2001-2002	**β**	113%	58%	95%	97%	136%	49%	28480%	171%	123%	-52%	177%	151
	σ(var)	-4%	-1%	28%	0%	-8%	146%	-17964%	-33%	-1%	105%	-5%	-26
	σ(GM)	9%	-44%	23%	-2%	28%	96%	10416%	38%	22%	-47%	72%	25
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	10

		Capital	Land	Labour	Teagasc	REPS	Dairy&co	Cattle	Cattle&co	Sheep	Tillage	Soil2	Soil3	[illegible]
2002-2003	β	124%	0%	2513%	93%	106%	62%	42%	-24%	118%	57%	82%	106%	1
	σ(var)	-20%	363%	-1643%	0%	0%	22%	36%	197%	-43%	14%	5%	-15%	0
	σ(GM)	3%	263%	769%	-7%	6%	-16%	-22%	73%	-25%	-29%	-13%	-9%	3
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2003-2004	β	215%	55%	101%	64%	135%	165%	145%	194%	239%	443%	60%	1526%	1
	σ(var)	-228%	-97%	21%	0%	16%	0%	36%	-15%	-46%	113%	0%	780%	1
	σ(GM)	-113%	-142%	22%	-36%	51%	65%	81%	79%	93%	456%	-40%	2207%	3
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2004-2005	β	125%	60%	132%	81%	265%	100%	133%	140%	129%	92%	273%	78%	2
	σ(var)	-14%	-23%	20%	-3%	-62%	20%	-9%	-21%	8%	22%	-8%	1%	-
	σ(GM)	11%	-63%	52%	-22%	103%	19%	25%	19%	37%	15%	165%	-21%	-
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2005-2006	β	-120%	61%	69%	113%	120%	-93%	79%	109%	91%	110%	91%	45%	1
	σ(var)	260%	-13%	18%	-5%	-58%	63%	14%	-15%	2%	-16%	0%	47%	3
	σ(GM)	40%	-53%	-13%	8%	-38%	-130%	-7%	-6%	-6%	-6%	-9%	-8%	6
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2006-2007	β	-252%	47%	185%	1%	-338%	1434%	141%	106%	120%	308%	-46%	61%	5
	σ(var)	420%	-38%	14%	33%	-1%	-827%	-2%	13%	4%	242%	6%	2%	8
	σ(GM)	68%	-90%	99%	-66%	-438%	507%	40%	19%	24%	450%	-140%	-37%	3
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2007-2008	β	-268%	17%	127%	168%	83%	91%	153%	104%	89%	22%	93%	44%	1
	σ(var)	352%	14%	3%	-42%	-1%	15%	-40%	5%	27%	40%	1%	35%	-
	σ(GM)	-15%	-69%	30%	26%	-18%	6%	13%	9%	16%	-38%	-6%	-21%	-
	TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1
2008-2009	β	4151%	-342%	48%	144%	473%	125%	119%	122%	135%	217%	383%	-68%	2
	σ(var)	-4935%	154%	14%	-5%	-6%	19%	1%	7%	-5%	159%	-4%	-143%	1
	σ(GM)	-884%	-289%	-37%	38%	366%	45%	21%	29%	29%	276%	278%	-311%	4

TT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	1