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Abstract

We investigate income risk for Swedish farmers and the effects of introducing EU's income stabilisation tool (IST) using a unique data set allowing us to compare results when using different income definitions. Risk is measured, respectively, by the probability of losing 30 percent of the average income during the three preceding years (IL30) and by the coefficient of variation (CV). Results are highly sensitive to the definition of income. Using gross value added, the probability of an IL30 varies between 25 and 45 percent per year during the period 2004-2015, which is similar to other Swedish small scale enterprises. It then falls to between 15 and 25 percent when using individual income. Similarly, the CV for gross value added is 1.34 and falls to 0.46 for individual income. The IST would reduce the CV to 1.07 for gross value added and to 0.40 for individual income. As to costs, using gross value added, the annual public costs for the IST is € 146.8 million and the farmer's premium € 1 712. With individual income, the annual public costs fall to € 28.5 million and the farmer's premium to € 412. The results suggest that the Swedish tax system provides ample possibilities to reduce the income risk and that little would be gained by incorporating the IST in the Swedish rural development programme.

Background

During the last two decades, there has been continuous discussion on the feasibility of incorporating risk management tools in the EU Common Agricultural Policy, CAP (see, for instance, EU Commission, 2001, 2005, 2008a, 2008b; and 2011; Meuwissen et al., 2003; Cafiero et al., 2007; Berg et al., 2009; Matthews, 2010 and 2017; Tangermann, 2011; Cordier, 2015).

Like other entrepreneurs, farmers are exposed to risks of various types that could affect incomes. From the societal perspective, risk exposure is problematic if it makes entrepreneurs less inclined to engage in and develop a sector than optimal. This is not unlikely since society, with a larger investment portfolio, has better possibilities of balancing risks than the entrepreneur. The entrepreneur could mitigate the consequences of risk exposure by obtaining insurance. However, agricultural risks such as frosts, draughts, flooding, and world market price variations, are to a large extent systemic (OECD, 2009; Tangermann, 2011), implying that private insurance could be too costly to be of interest to the entrepreneur. In that case, overall resource allocation might be improved if entrepreneurs were provided subsidised risk protection. In addition, as suggested in Article 39 of the Treaty on the Functioning of the European Union,[1] society may decide to intervene due to concerns about farmers' living standard.

Until the mid-1990s, CAP's market measures protected EU farmers from adverse effects on income caused by price fluctuations. However, increasing budget costs and criticism from trading partners led to a gradual retreat from this policy (Josling, 2008; Swinnen, 2008; Anania and Pupo D´Andrea, 2015; Bureau and Mahe, 2015; EU Parliament, 2016) and after the implementation of the 2003 reform, which decoupled most of the supports from production (OECD, 2004; ECA, 2016), the CAP provides much less protection. The decoupled supports give farmers a stable lower bound for income but, as Cordier (2015), and Mahe and Bureau (2016) point out, above this lower bound incomes fluctuate in response to price and yield variations just as they would have done without the supports.

However, constructing efficient income insurance entails several problems. One is moral hazard. Production risks could be mitigated by farmers' choice of management strategy, by investing in drainage, irrigation or biosecurity measures, etc., but such activities generate costs that might be tempting to avoid if insurance was available (Hardaker et al., 2015). If income risks differ between MS, and insurance is to be subsidised by the EU, another problem is to find a construction that does not favour high-risk MS at the expense of low-risk MS. Failing this could result in welfare losses caused by inefficient resource allocation between MS. It has also been debated to what extent agricultural risks actually are systemic (Meuwissen et al., 2008; OECD, 2009) and, if they do not differ significantly from those in other sectors, providing only farmers with subsidised insurance could cause welfare losses due to inefficient resource allocation between sectors. Incorporating income insurance in the CAP could also lead to large annual variations in costs which may be difficult to accommodate within a given budget. In addition, if subsidised income insurance is to be considered non trade disturbing it has to fulfil three requirements (Bardaji et al., 2016); (1) the income loss must exceed 30 percent of the average income for the preceding three years, or an Olympic[2] average, (2) compensation should be less than 70 percent of the

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN.

[2] This is the average income during five years excluding the best and the worst year.

loss, and (3) compensation should relate to income only (not type or volume of production, output prices or factor prices). As the RDPs, contrary to measures in Pillar 1 of the CAP, are co-financed by the MS and, as there is no additional funding for the IST, this give MS incentives to limit its costs.

So far, the uptake of the IST has been limited and only two MS (Hungary and Italy), and the region Castilla y Leon in Spain, have incorporated it in their RDPs (EU Commission, 2016). However, according to EU Commission (2017b), none of these ISTs are yet operational. One reason may be that farmers do not perceive the conditions of the IST attractive enough. Alternatively, MS may regard the costs of the IST as to high since it competes with other measures in the RDP. To our knowledge, only a few empirical studies have looked into these issues.

This could be because of difficulties in obtaining relevant income data that is comparable across MS. It can be argued that what primarily affects entrepreneurial incentives (and living standard) is what is left of revenues (including subsidies) after deduction of all costs and taxes. One might assume that such data could be obtained from tax records. However, several MS tax farmers according to, for instance, number of hectares or animals and not income (Hill, 2012). Accordingly, Gross Farm Income (GFI), Farm Net Value Added (FNVA) or Farm Family Income (FFI) are often used as proxies.[3] These are all available from EU's Farm Accountancy Data Network (FADN) and, depending on how "inputs" are defined, any of them could fit the definition in Regulation (EU) No. 1305/2013. However, only FFI comes close to the income concept most relevant for incentives and standard of living.

But even FFI may be inadequate as it does not account for income taxes or income from other sources than primary production, so called "other gainful activities" – OGA – (Hill and Bradley, 2015; ECA, 2016). It could seem natural to include earnings from OGA when discussing how to address income risks in agriculture because using the farm's resources for other gainful activities is regarded as part of prudent management (OECD, 2009) and one might want to preserve incentives for doing so.

Hill and Bradley (2015) point out that there presently is no system for generating data on agricultural household income in the EU though the situation may be different in individual MS. Sweden is an example as data on personal-, as well as household income for all citizens can be obtained from tax records. In this study we, therefore, investigate the risk of experiencing an income loss of at least 30 percent of the average annual income for the preceding three years, which we

[3] GFI is total sales revenues plus subsidies, minus costs for variable inputs (except hired labour) and VAT. FNVA equals GFI minus depreciation. FFI equals FNVA minus wages for hired labour, interests and rents paid (Hill and Bradley, 2015).

call IL30, among Swedish farms using different income concepts – both at the farm, household and individual level, and with- and without subsidies – and compare this with the risk of an IL30 for other Swedish small scale enterprises (SSE). The latter has, as far as we know, not been done before but is of interest for the question of overall resource allocation. Finally, we estimate what the effects of the IST would have been for Swedish farms given the income risks found in our study. First, however, we give an overview of the results on income risk for farmers in the EU found in the literature.

Previous results

In Table 1 we present results from some studies investigating income risk for farmers in the EU as a whole and in single MS. We do not claim the list to be exhaustive but as the studies differ regarding data sources, study period, definition of income, and risk concept, we find their results illustrative for some of the problems concerning income insurance. We have not found any studies comparing farmers' income risks to those of other small scale entrepreneurs.

Table 1 about here

Regardless of differences in risk measure, the studies covering the EU-15 or the EU-25 found that risks differed considerably between MS and sectors. The studies covering EU-25 found larger risks than those covering EU-15 (probably as the former included the new MS (EU-10) and their observation period covered the financial crisis). In all studies, the risk for Swedish farmers was above the average (risk of IL30 in Sweden 33 percent in the studies by the EU Commission; CV for Sweden 0.35 in De May et al., and 0.28 and 0.57 when defining income as, respectively, FNVA and FFI in Hill and Bradley). In *EU Commission (2009)* compensations varied between 15 and 20 percent of the CAP budget over the period. About half of this would have gone to farms in Italy and Spain. *EU Commission (2017b and c)* only reported compensations for one year (about 40 percent of the CAP budget) and did not comment on its allocation between MS. *De May et al.* were primarily interested in farmers' risk behaviour. As there was evidence of strategic behaviour in all MS and sectors, they concluded that the IST could generate moral hazard. *Hill and Bradley* found that risk exposure was highly sensitive to the definition of income.

Of the studies focusing on single MS, *Pigeon et al.* investigated differences in risk between crop, diary and cattle farms. Cattle farms had the highest risk while the largest annual variation was found for crop farms. A model to predict compensations with farm characteristics was tested. Given the large confidence intervals, authors concluded that the mutual funds would need a substantial amount of capital. They were also concerned about moral hazard. *Pérez-Blanco et al.* estimated farmers' WTP for insurance. The authors concluded that the average WTP (4 percent of expected income without insurance) was sufficiently large for farmers to be interested in the IST. *Castañeda-Vera and Garrido* estimated a number of key parameters for crop farms under monoculture (first entries in table) and crop rotation (second entries). To see how the IST compared to crop insurance and to direct payments income was measured as GFI minus direct payments. Generally, direct payments generated better results (higher expected incomes, higher P5, higher CEs, and lower CVs) than the IST, which, in turn generated better results than crop insurance. *Trestini et al.* investigated how risk was affected by changes in income definition and differences in farm characteristics. As in Hill and Bradley (2015) risk was found to be sensitive to income definition. Risk was also found to be higher for farms in mountain areas, for young farmers, and for farms run in societal forms. Authors concluded that, if introduced, the IST should be accompanied by advisory services to raise farmers' awareness of how differences in management strategies could affect risk.

To sum up, despite differences in methodology between studies, it appears clear that income risks differ between MS, sectors, farms of different size, and over time. This could explain why the IST is not in Pillar 1 of the CAP. The differences are also likely to affect MS' interest in the IST as it has to be financed partly by own budget means. Moreover, the estimated compensations in the studies by the EU Commission and Pigeon et al., should be regarded as lower bounds as the studies did not account for changes in behaviour that could result if the IST was introduced. In addition, the results in Hill and Bradley (2015), and Trestini et al (2018) indicate that risk is sensitive to how "income" is defined. Mahe and Bureau (2016) provide simulation results for EU milk farms to further illustrate this point. With GFI, prices would have to fall by more than 10 percent to trigger an IL30, while defining income as FNVA would require a price fall of only half the size. They also conjecture that the larger the share of purchased inputs, the larger the risk, which could make the IST less attractive to small scale family farms owning their land and relying less on paid labour.

However, none of the studies have used data on personal- or household incomes for the analyses or included income from OGA. OECD (2009) notes that tax systems in most MS allow farmers to smooth incomes over time. In Sweden, sole proprietorship firms, the legal form for most Swedish farms and SSEs, can deposit up to 30 percent of the revenues a given year on a special account for up to six years during which they are not subject to tax. As the income tax is progressive, revenues will be taxed at a lower rate if deposits are made during good years and retrieved in bad years. Accordingly, it would be of interest to see how the risk is affected by using personal- or disposable incomes instead of farm value added.

Data and method

We investigate income risks among Swedish farms and non-agricultural small scale enterprises (SSEs). We use a unique data set that contains annual information separating agricultural income from income generated by OGA at both the farm and the farmer level, as well as annual information on income and disposable income for each individual in the farm household. We also have information on the amount of CAP subsidies received for each farm. Thus, for the farms, we analyse risk exposure at the aggregate level (all farms) as well as according to sector of production and economic size class using data on both value added, household, and personal income. All analyses at the individual and household levels are also done separately for female and male farm operators. For the SSEs, we have information on value added each year and analyse risk exposure at the aggregate level (all SSEs) as well as according to the same economic size classes as used for the farms. However, as our data does not allow identification of the owner of the SSE, we cannot analyse risk exposure in individual or household income for SSE-operators.

First we describe the farm and SSE level data and then the data for individual farmers. *For our farm/firm level analysis* we use the Swedish Board of Agriculture's (SJV) farm register which contain a full sample of roughly 70 000 Swedish farms a year.[4] This data is then merged with Statistic Sweden's (SCB) business register, which contains firms' financial records, e.g. value added, production value and investments. We define income as GFI. According to Mahe and Bureau (2016), this may result in smaller income risks than if we had used FNVA or FFI. To compute income risk relevant for the IST we need data on incomes for the three preceding years. This exists for around 62 000 farms each year. We also restrict the sample to farms who register for CAP subsidies which decreases the sample to around 46 000 farms a year.

[4]With at least two hectares of arable land or 5 hectares of agricultural land (arable land and pastures) and animal production.

The farm- and the business registers differ in two ways. First, while the farm register goes back to the 1990s the business register only covers the period from 2001. Second, the business register contains firms and the farm register contains farms where a “farm” may include more than one firm (about 19 percent of the farms). This is not a problem since we have information from SJV about which firms make up a farm. We can therefore aggregate the data on firms to the farm level. Also, since we have information about each firm’s commitment to farming and OGA, we can divide the farm value added into a “farming” part and a part resulting from OGA. We also have information on all CAP subsidies received and on farm characteristics from SJV. Our data from the business register contains all farms and about 86 percent of all Swedish firms.

To obtain a sample of SSEs comparable to the farms, we select all SSEs with no more than 3 employees (including the owner) with revenues from other sectors than farming or forestry in the business register. This results in observations on the financial records for a sample of about 370 000 SSEs a year during the period 2001-2015.

To measure farmers’ *individual and household earnings and disposable incomes* we use SCB’s Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA), which includes a broad range of indicators on demographics, labour market status, income, and education for the entire Swedish population (aged 16 and older). This gives us a full sample of individuals with earnings from business or work in agriculture,[5] as well as information on the labour market status and earnings of the spouses during the period 1997-2015. The data on farmers’ individual incomes include income from sales revenues as well as from CAP supports but, in contrast to the farm level data, we cannot separate out the latter. Hence, it is not possible to exclude CAP supports when using data on individual, household, and household disposable incomes for the analysis. By using the household indicator in LISA, and linking LISA to SCB’s Multigenerational Register, we acquire information on household composition. Farm employees and their family members are excluded, but both the farmer and the spouse may be in the sample if both have incomes from farming. Earnings from forestry and extension services are included in income from farming. As the data in LISA only indicate whether the main income comes from “farming or forestry”, we cannot separate income from these two sources unless the farmer has different firms for farming and forestry. For Sweden, where farming and forestry are closely linked, this is not a big problem. Also, we can analyse if earnings from forestry (12 percent of the individuals have earnings mainly from forestry) or from exten-

[5] The Swedish Standard Industrial Classification (SNI) code is used for classifying firms as agricultural businesses.

sion services (0.9 percent have earnings mainly from extension services) affect our results.

A drawback is that our data does not allow identification of the *owner* of the SSE. Hence, we cannot analyse risk exposure in individual or household income for SSE-operators. However, as the Swedish tax system provides the same opportunities for income smoothing for all sole proprietorship firms, it is reasonable to expect that changing the definition of income from value added to individual- or household income will have similar effects on the income risk for SSE-operators as for farmers.

To analyse the effects of incorporating the IST in the Swedish RDP, we compare expected incomes for farmers, $E(Y)$, and volatility of farmer incomes, CV_Y, with and without the IST using both farm and individual level data. When using farm level data, income is defined as either GFI excluding Pillar 1 supports, as GFI, or as GFI plus income from OGA. When using individual level data, income is defined either as individual farm income, as individual income from farming and OGA, as household income (from farming and OGA), or as household disposable income (in all cases including Pillar 1 supports). These analyses are done for all farms as well as according to economic size class[6] and sector of production. For details, see appendix.

Results

Table 2 presents some descriptive statistics for our farm/firm level data (panel A) and individual level data (panel B). Note that, at the farm/firm level, we have added an economic size class not present in the EUROSTAT – gross value added below 0 – because our data show that negative gross value added are not uncommon and often persist for some years.

Table 2 about here

The SSEs are located in both urban and rural regions and span several sectors. They also exhibit a smaller share of sole proprietorship firms than the farms. However, the average number of employees is about the same and farm revenues, including CAP subsidies, are almost equal to the revenues from market

[6] Economic size classes constructed, as in the studies by the EU Commission and Hill and Bradley, according to the definitions in EUROSTAT (https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:European_size_unit_(ESU)).

sales for the SSEs. The distribution over income classes is also similar albeit the share of farms with negative gross value added is somewhat larger. There are more male than female farmers and a larger share of male than female farmers in the higher income classes. About 54 percent of the male and 75 percent of the female farmers are found in income classes below the median wage for men and women in Sweden. Elsewhere, we have shown that individual gross incomes in the agricultural sector are lower than in the Swedish economy at large (Nordin and Höjgård, 2018).

Starting with our *farm and SSE level data*, Figure 1 shows the income risk as the annual shares of Swedish farms and SSEs experiencing an IL30 during the period 2004 to 2015. Income is measured as gross value added (for the farms including CAP subsidies). We also show GDP-growth and the development of the Swedish price index for agricultural products for the same period. As can be seen, the main difference between the farms and the SSEs is the larger annual variation in the income risk among the farms. For both farms and SSEs, there appears to have been a shift towards larger risks around 2008/2009. One could conjecture that this was caused by the financial crisis (note the dip in GDP-growth 2008/ 2009). For the farms, the income risk is, as expected, negatively correlated with the development of agricultural prices.

Figure 1 about here

It is notable that we find higher income risks, closer to 40 percent risk of an IL30, than those found for Swedish farms by the EU Commission. This may be because our sample includes a larger share of small farms.[7] An indication of this is found in Figures 2A (farms) and 2B (SSEs) where enterprises are divided into the same economic size classes as used in previous studies. Disregarding farms with negative GFI, the risk of an IL30 decreases the larger the economic size. The SSEs show a similar pattern except when it comes to the largest size class, > € 120 000, where the income risk is about the same as in the smallest size class, € 0 – 4 799. In all size classes, annual variation in risk is larger for the farms than for the SSEs.

Figures 2A and 2B about here

[7] EU Commission utilised FADN data. For Sweden, FADN data only include farms with an annual output (GFI minus subsidies) of at least € 15 000 (EU Commission, 2015). Thus, had we used FADN data, there would be no farms in the size classes € 0 – 4 799 and € 4 800 – 9 599 and only few in the size class € 9 600 – 19 199.

Our results regarding how income risks change with economic size for the farms' are similar to those in EU Commission (2009). Thus, they question the hypothesis in Mahe and Bureau (2016) that small farms, due to lower risks, would find the IST less attractive than large farms. However, "farm size" could be defined in terms of *physical units*, such as hectares or number of animals, instead of in terms of income which might change the results. When studying farms that are small in terms of physical units[8] but have high or relatively high incomes (size class ≥ € 19 200), we find that the risk of an IL30 is, in fact, high, around 40 percent (results available on request). Actually, for farms that are small in terms of physical units, the risk of an IL30 is higher for those with high incomes (size class ≥ € 19 200) than for those with low incomes (size class < € 19 200). Nevertheless, as most farms that are small in physical terms also have low incomes, the results still do not support Mahe and Bureau (2016).

In Figure 3 we investigate if CAP supports and income from OGA stabilise farm incomes. Excluding Pillar 1 supports, as in Castañeda-Vera and Garrido (2017), increases the risk although the variation in sales revenues and costs is exactly the same. On the other hand, when revenues from OGA are added to GFI, there is a marginal reduction in the income risk.

Figure 3 about here

It is noteworthy that, while Pillar 1 supports reduce both the income risk and its annual variation during the first few years, this is not the case after 2006. This is likely an effect of the implementation of the 2003 reform[9] which decoupled the bulk of the CAP supports from production and may have taken farmers some time to adapt to. That income from OGA does not affect annual variations in risk is as expected since it is small in relation to sales revenues from farming and Pillar 1 supports (about 13 percent of total income on average, see Table 1 above).

Next, we investigate if income risks differ according to sector (Figure 4). Evidently, the risk of an IL30 is largest for farms with main incomes from forestry (most likely because felling occurs with long intervals) and smallest for farms with main incomes from milk production. Disregarding forestry, which may be specific for Swedish farms, the ranking of sectors is similar to that in EU

[8] For 67 percent of the sample we match the data with data from the Swedish Board of Agriculture on hectares of arable land and number of animal units. This data is available for the years: 2005, 2007, 2010 and 2013. Based on the farms' hectares of arable land and their number of animal units, we divide the farms into large- mid- and small-sized farm. Each group contains a third of all farms.

[9] In Sweden, this reform was implemented during 2005.

Commission (2009 and 2017b and c) and Bradley and Hill (2015). Annual fluctuations in risks are the largest in the forestry sector, smaller in the crop and the meat sectors, and smallest in the milk, and advisory services sectors. For all sectors, except advisory services, there also appears to be a shift to higher risk levels in 2008/2009.

Figure 4 about here

We have inquired if there is a correlation between economic size class and sector that could "explain" the distribution of IL30 risks. However, differences between sectors remain even within a sample of large sized farms which indicates that the lower risk in milk production is not only related to the larger size of farms in the dairy sector compared to farms in other sectors.

We then turn to our *individual level data*. In Figures 5A and 5B we investigate if income risks are affected by using individual incomes instead of GFI and if they differ between farms run by male (Figure 5A) or by female operators (Figure 5B). Individual farm incomes are defined as the operator's gross earnings[10] from farming as reported in tax records. It also includes work related transfers (therefore earnings and not income)[11] but not off-farm income. To arrive at household farm income, we add the spouse's earnings from farming, defined in the same way as the operator's. Note that the results regarding observed risks when defining income as GFI are for farms in economic size classes 2-7 (this differs from Figure 1 above which also included farms with negative GFI). Note also that the time series for individual and household incomes are longer than those for GFI because the database LISA covers a longer period than the business register.

Figures 5A and 5B about here

The most striking observation is that income risks are substantially smaller and have smaller annual variations when incomes are measured by personal or household earnings from farming than when measured by GFI. This is not unexpected given the possibilities to smooth income over time in the Swedish tax system. In addition, when we inquire into the costs of hired labour, results (available on request) indicate that they react to changes in the farms' economic conditions (i.e. increase when GFIs increase and vice versa). As the wage is fixed,

[10]This is what is left of revenues from farming (including subsidies) after the deduction of cost for all inputs (including depreciation, interests, and rents), pay-roll taxes on wages of hired labour and taxes on capital gains.
[11] Primarily parental leave and sickness benefits.

it must be working times that change. That is, it appears that the working time of hired labour is used as “buffer” for farmers’ incomes.

Male operators’ farm incomes are less risky (4 percentage points difference) than female operators’. This may be somewhat unexpected but could be because male operated farms are larger (Table 1 shows that male operators have 40 percent higher earnings from farming than female operators). Another explanation is that the loss of farm income for women, to some extent, is related to parental leave and sickness benefits.[12] For men, these transfers are much less important components of personal income. It also appears that personal incomes from farming for male operators are marginally less risky than household farm income while, for female operators, it is the other way around. An intuitive explanation is that adding two equally risky incomes will not substantially reduce the overall risk and, given that women’s farm incomes are more risky than men’s (see Figures 6A and 6B below), the differing effects for men and women when going from personal to household income follow naturally.

Disaggregating farmers according to size of personal income give similar results as when disaggregating farms according to economic size class as measured by GFI. That is, income risks decrease when personal incomes increase (figures AX and AY in Appendix). However, in all size classes risks are smaller when using personal income instead of GFI as income proxy.

In Figures 6A (men) and 6B (women), we add the individuals’ incomes from off-farm work to incomes from farming to arrive at individual total earnings. A first observation is that the risk of experiencing an IL30 again is smaller for men than for women. For both male and female farmers the risk then falls when off farm incomes are included but the effect is larger for female farmers. This could be because off farm income constitutes a large share of total earnings for female farmers (Nordin and Höjgård, 2018). It also appears that including off farm income reduces the annual variations in risk for female but not for male farmers.

Figures 6A and 6B about here

Figures 7A (male operators) and 7B (female operators) show the results when income is defined as, respectively, household incomes from farming, total household earnings, and household disposable incomes. Total household earnings include off farm income in addition to income from farming, and household dis-

[12] We have data on parental leave, unemployment, sickness benefits and early retirement.

posable incomes include returns on capital and non-work related transfers[13] in addition to income from farming and OGA, and deduct income taxes. As can be seen, household disposable incomes are less risky than total household earnings which, in turn, are less risky than household incomes from farming regardless of whether the farm is run by a male or a female operator.

Figures 7A and 7B about here

Finally, we investigate how incorporating the IST in the Swedish RDP would have affected income risks and what the costs of the instrument would have been. It is assumed that all farmers choose to join the mutual fund(s), i.e. that the IST covers the whole farming population and that there is no adverse selection. It is also assumed that incorporating the IST would not affect farmers' behaviour – that is, the IST would not lead to moral hazard. Neither do our estimates account for the costs of setting up the mutual fund(s) or the costs of administrating them. Hence, the cost estimates should be regarded as lower bounds.

In Table 3 (farm level data) we first present estimates of expected incomes and income volatilities *without* the IST ($E(Y)$ and CV_Y). We then show the corresponding estimates *with* the IST ($E(\Upsilon)$ and CV_Υ), as well as the farmer's premium (35 percent of the expected annual payments from the IST), the expected payment from the IST averaged over all farms E(IST), the expected payment for farms that experience an IL30 E(IST if IL30), and the expected public costs E(C) of the IST (65 percent of the expected annual payments) if there is only one mutual fund providing IST for all Swedish farms. However, as risks differ between sectors of production, farmers' interest in the IST may also differ depending on the income risk in their specific sector. Hence, in the lower panel, we show estimates of farmers' expected incomes, coefficients of variation, farmer's premium, etc., assuming that there is one mutual fund providing an IST for each sector.

Table 3 about here

The first row shows the results if there were no Pillar 1 supports. Introducing the IST would then raise farmers' expected incomes and reduce income volatility. Expected income *with* the IST, $E(\Upsilon)$, is estimated by subtracting the annual premium from the sales revenues and then adding the expected annual IST-payment averaged over all farmers, E(IST). The expected IST-payment for farmers that actually experience an IL30, E(IST if IL30), would of course be higher, €

[13] Mainly child allowance, social benefits, and housing benefits.

15 953 instead of € 5 458. The last column shows that the annual public costs of the IST would be € 163.8 million. The second and third rows show the corresponding results if the IST was to complement Pillar 1 supports. Effects on expected income and income volatility would be smaller, as would the expected IST-payments, farmer's premium and the public costs. This reflects that adding Pillar 1 supports and income from OGA to sales revenues raises baseline income which, other things equal, reduces the risk of an IL30.

Assuming that the IST was to *replace* Pillar 1 supports we get similar effects as Castañeda-Vera and Garrido (2017). That is, substituting Pillar 1 supports with the IST would reduce expected incomes and increase income volatility – compare the results *without* the IST (second, third, and fourth columns in the first row) with those *with* the IST (fifth, sixth and seventh columns in the second row). As a result, the public costs of the IST would also be higher. However, as can be seen from Figure 8, there would be large annual variations in the public costs for the IST whether or not it was to replace Pillar 1 supports. That is, they would vary from about € 100 million to about € 225 million (if the IST was used as a complement to supports) or from about € 100 million to about € 275 million (if it was used as a substitute for supports).

Figure 8 about here

The lower part of Table 3 presents results disaggregated according to sector illustrating the case when there would be one mutual fund for each sector. As we focus on what effects this would have on farmers' premiums and the public costs of the IST, we only provide results for the case where the IST is used as a complement to Pillar 1 supports. Thus, comparison of the farmers' premiums in the respective sectors to the average premium for all farmers (second row in the upper part of Table 3), reveals that farmers with income from mainly milk or forestry production would lose while farmers in all other sectors would gain by having separate mutual funds according to sector. For the milk farms, this may seem unexpected given the results in Figure 4 above. However, though the average risk of an IL30 is smaller in the milk sector than in other sectors, milk farms are larger than other farms. Total public costs of the IST would be virtually unaffected.

The results above were obtained using farm level data and defining income as GFI. As our previous results suggest that income risks are sensitive to how incomes are defined, Table 4 show the outcomes when using individual income from farming and household earnings. Given our previous results, we would expect much smaller effects in both cases.

Table 4 about here

As can be seen, this is also what happens. Expected incomes are of course much lower overall than when income is measured by GFI as GFI does not account for depreciation, rents, interest payments, and costs of hired labour. But this merely illustrates that GFI is of limited interest for entrepreneurial incentives. More interesting is that, volatility (the CV) is much lower for personal- (more than 60 percent) and household incomes (more than 70 percent) than for GFI. As a result, farmers' premiums and the public costs of the IST are also smaller than in Table 3. In fact, with GFI as income proxy, the risk is so high that the farmer's premium amounts to about 5 percent of his expected income without IST payment. When using individual farm income, on the other hand, the risk reduction offered by the provisions in the tax system reduces the farmer's premium to about 2 percent of the expected income without IST payment. Finally, referring to Figure 8 above, using individual farm income as target for the IST would substantially reduce the annual variations in its public costs.

Discussion

Our results when using gross value added as proxy for income, suggest that income risks for Swedish farmers and SSEs are of about the same magnitude. Thus, providing farmers with subsidised income insurance complementing CAP supports is hard to motivate on grounds of overall resource allocation efficiency.

However, the annual variation in risk is somewhat larger for farmers. This implies that the public costs of the IST also would be subject to substantial annual variation. This would lead to yearly fluctuations in the Swedish RDP budget, which would be problematic (see Figure 9). The annual variations in the costs of the IST, in addition to the differences in risk exposure between MS found in previous studies which would lead to income transfers between MS, probably explains why the IST has been placed in the RDP and not in Pillar 1 of the CAP.

We find higher income risks for Swedish farmers than the studies by the EU Commission because our sample includes a larger share of farms in small economic size classes. This might simply be because a given absolute loss constitutes a larger share of the income the smaller the income. Alternatively, small farms could be more risk exposed because their possibilities for managing risk by diversifying production are smaller. It is noteworthy that farms that are small in physical terms but have high incomes, also face large risks. Hence, it could be that they are more specialised than other farms but our data does not allow testing the hypothesis.

More importantly, our results also show that income risks are substantially lower, and have less annual variation, when income is measured by individual farm income, household farm income or household earnings. This illustrates how sensitive the risk is to how income is defined and, as a result, also the costs of the IST. It could be argued that individual- or household farm income is more relevant for entrepreneurial incentives than farm value added. However, though information on individual income is available for Sweden, it is not the case for most other MS. Accordingly, MS may be restricted to use the income proxies available in the FADN (GFI, FNVA, and FFI) which makes the cost unnecessarily high. This further reduces the case for the IST; by utilising provisions in the tax system, farmers can reduce the risk and its annual variation quite substantially. If, as according to OECD (2009), these opportunities exist in most MS, the IST appears to have little to offer.

The effects on incomes and the costs of the IST are estimated assuming that there would be no problems of adverse selection or moral hazard. Adverse selection could be minimised by making membership in the mutual fund(s) compulsory while moral hazard is usually tackled through deductibles. The IST does include a deductible since it only compensates for 70 percent of the income loss. However, as noted by other authors, the incentives to limit losses are weakened since the compensation will only be paid if the loss is at least 30 percent of the farmer’s three-year average income. Actually, the system encourages farms near the IL30 threshold to marginally increase losses because expected income increases substantially when passing the threshold (as the IST compensates up to the three-year-average and not only to the IL30 threshold). We are not convinced that the suggestion by Pigeon et al (2012), i.e. making compensation conditional on a threshold loss for a group of farmers in addition to own loss, would improve the situation as all farmers face the same incentives.

Alternatively, moral hazard may be reduced through peer pressure. Peer pressure will be more efficient the lower the cost of monitoring behaviour, that is, it is likely to be more effective the smaller the group to be monitored. On the other hand, a larger group could increase the possibilities for risk balancing. Accordingly, to find the optimal size for the mutual funds, there is a trade-off between reducing monitoring costs and facilitating risk balancing that complicates the solution.

As to introducing the IST because of concerns about farmers’ living standard, we have, as noted previously shown that individual gross incomes in the Swedish agricultural sector are lower than in the Swedish economy at large. However, if the comparison is done with disposable income, the difference all but disappears (Nordin and Höjgård 2018). The situation may be different in other MS but it would most likely be more effective to address the problem by a means tested income support rather than by income insurance directed at farmers in general.

Thus, it seems to us that, for Sweden, and other MS where the tax system provides opportunities to reduce income variations, the IST has little to offer given its present construction. This, and the fact that it competes for funding with other measures in the RDP, most likely explains the limited interest for the IST among MS.

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Appendix

At the farm/firm level we have longitudinal data covering *N* farms over *T* years (i.e. from 2001 to 2015) and, at the individual level, longitudinal data for *I* individuals over *Π* years (from 1997 to 2015). However, as we need data for a three-year period to compute the income loss that triggers compensations from the IST, *E*(*Y*) and CV_Y are estimated as averages for the period 2004-2015 (i.e. from *t=3* to *T*) when using farm level data, and for 2000-2015 (from *π+3* to *Π*) when using individual level data. Thus, *without* the IST, and using the farm level data as an example:

$$E(Y) = \frac{\sum_{n=1}^{N}\sum_{t=3}^{T} Y_{n,t}}{(T-3)\times N}, \qquad \sigma_Y = \frac{\sum_{n=1}^{N} \sigma_{Yn}}{N}, \quad \text{and} \quad CV_Y = \frac{\sigma_Y}{E(Y)} \tag{1}$$

$Y_{n,t}$ is the observed income (with or without CAP subsidies and income from OGA) of farm *n* in year *t*, σ_Y is the standard deviation in income for all farms during the period from *t=3* to *T*, and σ_{Yn} is the standard deviation in income for farm *n* (within farm standard deviation) for the period from *t=3* to *T* estimated as: $\sigma_{Yn} = \sqrt{\sum_{t=3}^{T}\left[Y_{n,t} - E(Y_n)\right]^2 \Big/ (T-4)}$ where *E*(Y_n) is farm *n*'s average income during the period *t=3* to *T*.

To get the expected income *with* the IST, we deduct that part of the premium that the farmers have to pay (*FP*) from, and add payments from the IST (*ISTB*) to their observed farming incomes. The farmer's part of the IST-premium is assumed[14] to equal 35 percent of the average IST payment per farm for the period 2001-2015. The *ISTB* is assumed to equal 70 percent of the expected income loss for farms with losses of at least 30 percent. Thus, *with* the IST, and using the farm level data as an example, we define:

$$\Upsilon_{n,t} = X_{n,t} + d_{n,t} ISTB_{n,t} - FP_n \tag{2a}$$

$$ISTB_{n,t} = \max\left[0.7\times\left(\bar{X}_{n,t} - X_{n,t}\right), 0\right] \quad \text{if} \quad \frac{X_{n,t}}{\bar{X}_{n,t}} \le 0.7, \text{ else} = 0 \tag{2b}$$

$$FP_n = 0.35\times\frac{\sum_{n=1}^{N}\sum_{t=3}^{T} ISTB_{n,t}}{(T-3)\times N} \tag{2c}$$

Where $\Upsilon_{n,t}$ is farm *n*'s income in year *t* given the IST. $X_{n,t}$ is either GFI, GFI without CAP subsidies, or GFI including income from OGA for farm *n* in the year *t*. $d_{n,t}$ is a dummy variable taking the

[14] Following article 39 in Regulation (EU) No. 1305/2013.

value 1 if $X_{n,t} \big/ \bar{X}_{n,t} \leq 0.7$ and 0 otherwise. $\bar{X}_{n,t} = \sum_{\tau=t-3}^{3} X_{n,\tau} \big/ 3$ is farm *n*'s average income for the three previous years in year *τ*). *FP_n*, finally, is farm n's part of the annual IST-premium estimated as 35 percent of the expected annual IST-payments for all farms during the period *t=3* to *T*.

Accordingly, *with* the IST, expected income *E*(Υ), standard deviation σ_{Υ}, and coefficient of variation CV_{Υ}, are estimated as:

$$E(\Upsilon) = \frac{\sum_{n=1}^{N} \sum_{t=3}^{T} \Upsilon_{n,t}}{(T-3) \times N}, \qquad \sigma_{\Upsilon} = \frac{\sum_{n=1}^{N} \sigma_{\Upsilon n}}{N}, \quad \text{and} \quad CV_{\Upsilon} = \frac{\sigma_{\Upsilon}}{E(\Upsilon)} \tag{2d}$$

Finally, we estimate the annual expected public payments for the IST in three ways. First, we estimate the expected annual public payment per farm, *E*(*ISTB*). Second, the expected annual public payment per farm for farms with IL30, *E*(*ISTB* if *IL30*) and, third, the expected total public annual cost, *E*(*C*). That is, again using the farm level data as example:

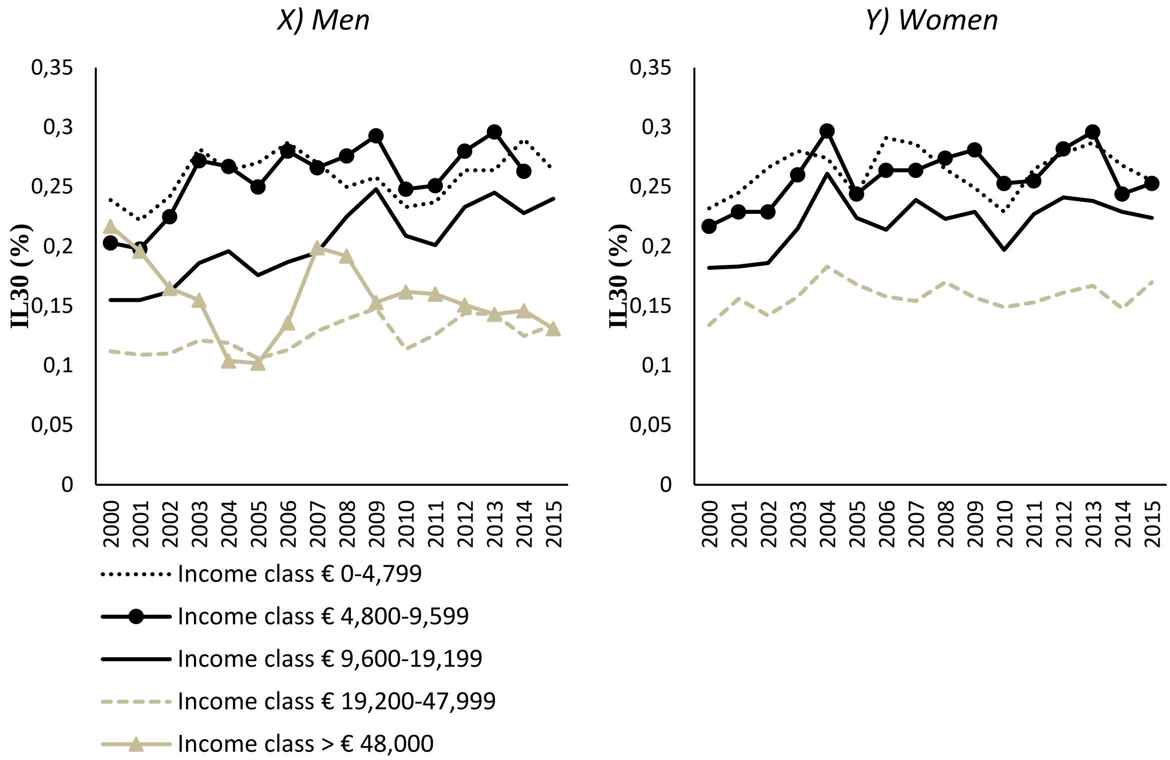
$$E(ISTB) = 0.65 \times \frac{\sum_{n=1}^{N} \sum_{t=3}^{T} d_{n,t} 0.7 \left(\bar{X}_{n,t} - X_{n,t} \right)}{(T-3) \times N} \tag{3a}$$

$$E(ISTB \,|\, IL30) = 0.65 \times \frac{\sum_{n=1}^{N} \sum_{t=3}^{T} d_{n,t} 0.7 \left(\bar{X}_{n,t} - X_{n,t} \right)}{(T-3) \times M} \tag{3b}$$

$$E(C) = 0.65 \times \frac{\sum_{n=1}^{N} \sum_{t=3}^{T} d_{n,t} 0.7 \left(\bar{X}_{n,t} - X_{n.t} \right)}{(T-3)} \tag{3c}$$

Where $d_{n,t}$ is a dummy variable defined as above, and *M* is the number of farms fulfilling the condition that $X_{n,t} \big/ \bar{X}_{n,t} \leq 0.7$.

The only differences when we use the individual level data are the income concepts (where we use personal, household, and disposable household income instead of GFI), the annual number of observations (larger when using individual data), and the time period (longer when using individual data).



Note: For women there are to few observations to report results for size class > € 48,000

Figure AX and AY. Probability of experiencing an income loss exceeding 30 percent of the (three-year) average income (IL30) for different income groups and separately for men and women.

Tables and Figures

Table 1. Summary of studies reviewed.

Study	Variable of interest	Data	Period	Countries or Regions	Income definition	Risk measure	Results
EU Commission, 2009	Risk and Compensation	FADN	1998-2006	EU-15	FNVA	Risk of IL30	Annual risk of IL30 EU-15 (%): 24 – 29 Highest/Lowest by MS (%): 35 (Denmark) / 18 (Belgium) Highest/Lowest by sector (%): 35 (Granivore) / 18 (Milk) Risk decreasing with economic size of farm Compensation per year (billion €) 8.3 – 11.0
De May et al., 2014	Risk and Strategic behaviour	FADN	1995-2008	EU-15	NOI[1]	CV[2]	CV EU-15 for 1995-2008: 0.33 Highest/Lowest by MS: 0.38 (Spain and Portugal) / 0.26 (Belgium) Evidence of strategic behaviour
Hill and Bradley 2015	Risk under different income definitions	FADN	2004-2012	EU-25	FNVA and FFI	CV	FNVA, highest/Lowest by MS: 0.57 (Slovakia / 0.05 (Greece) FNVA, highest/Lowest by sector: 0.20 (Granivore) / 0.07 (Horticulture) FFI, highest/Lowest by MS: 6.11 (Denmark / 0.06 (Greece) FFI, highest/Lowest by sector: 0.24 (Granivore) / 0.08 (Other perm. crops) Risk highest for smallest farms, then decreasing with economic size
EU Commission, 2017b and c	Risk and Compensation	FADN	2007-2013	EU-25	FNVA	Risk of IL30	Annual risk of IL30 EU-25 (%): 21 – 43 Highest/Lowest by MS (%): 43 (Cyprus) / 24 (Belgium) Highest/Lowest by sector (%): 34 (Permanent crop) / 22 (Milk) Risk decreasing with economic size of farm Compensation in "most expensive" year (billion €): 22
Pigeon et al., 2012	Risk and Compensation	FADN	1997-2007	Wallonia, Be	FNVA	Risk of IL30	Annual risk (%): 0 – 13 (Crop), 2 – 9 (Dairy), 8 – 12 (Cattle) Comp. (million €): 0 – 5.65 (Crop), 1.78 – 6.72 (Dairy), 2.58 – 4.73 (Cattle)
Pérez-Blanco et al., 2014	Farmers WTP for insurance	National	1998-2012	Emilia Romagna, It	GVM[3]	N.a.	Average WTP for region: 4 % of exp. GVM without insurance WTP in most risk exposed parts: 20 % of exp. GVM without insurance
Castañeda-Vera and Garrido, 2017	Expected income, P5-income[4], Risk, and CE[5]	Regional	1995-2015	Valladolid, Es	GFI without direct pay-ments and P5	CV	Exp. inc.: 84 – 94 (crop ins.), 117 – 127 (IST), 222 - 232 (direct payments) P5-inc.: -56 – (-)110 (crop ins,), 44 – 39 (IST), 82 – 28 (direct payments) CV: 1.54 – 2.22 (crop ins.), 0.60 – 0.58 (IST), 0.47 – 0.62 (direct payments) CE: 54 (crop ins.), 97 – 104 (IST), 192 – 192 (direct payments)
Trestini et al., 2018	Risk under different income definitions, sensitivity to farm characteristics	FADN	2008-2014	Veneto and Lombardy, It	GFI	Risk of IL30	Risk (income = GFI minus costs of hired labour): 8.2 % Risk (income = GFI minus cost of hired labour/utilised area): 12.9 % Risk (income = GFI minus cost of hired labour/livestock unit): 16.5 %

[1] NOI (Net Operating Income) is total revenues minus costs of variable inputs, that is, it corresponds to GFI in the FADN.
[2] CV (Coefficient of Variation) is defined as the standard deviation divided by the mean. Thus it accounts for the "risk" of gains as well as losses. The definition may make it sensitive to the number of observations.
[3] GVM (Gross Variable Margin) is total sales revenues plus subsidies, minus costs of variable inputs, i.e. it is equal to GFI.
[4] The authors define P5 as the income for which there is only a five percent probability of falling below.
[5] The CE (Certainty Equivalent) is the income, received with certainty that is considered giving the same utility as the uncertain expected income from farming.

Table 2A. Descriptive statistics farm and SSE level data (averages for the period 2001-2015).

	Farms			SSEs		
Variable	*Mean*	*St. Dev*	*Max*	*Mean*	*St.Dev*	*Max*
No. of employees	.26	2.04	479	*.38*	.66	2
Sole proprietorship firms	95%	.24	1	56%	.50	1
Rev. from market sales, €	21 785	100 298	15.6 mil.	39 764	391 845	381.1 mil.
Rev. incl. subsidies, €	38 957	111 848	15.7 mil.			
Rev. incl. subs. and OGA, €	44 695	159 518	139.8 mil.			
Total no. of enterprises	46 163			370 585		
In:	*No.*	*%*	*Mean income*	*No.*	*%*	*Mean income*
Size class € ≤0	10 104	21.9	-5 355	40 958	11.1	-15 610
Size class € 0-4 799	7 175	15.5	2 156	51 796	14.0	2 193
Size class € 4 800-9 599	4 538	9.8	7 030	40 041	10.8	7 102
Size class € 9 600-19 199	5 589	12.1	13 970	56 512	15.1	14 082
Size class € 19 200-47 999	8 507	18.4	31 545	85 790	23.2	31 739
Size class € 48 000-199 999	6 832	14.8	75 025	70 135	18.9	74 656
Size class ≥ € 120 000	3 420	7.4	250 928	25 352	6.8	364 509

Economic size classes constructed using GFI as in the EUROSTAT, see: http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:European_size_unit_(ESU).

Table 2B. Descriptive statistics individual level data for farmers (averages for the period 2001-2015).

Variable	*Male operators*		*Female operators*	
Total number of farmers	30 719		6 567	
in	*No.*	*%*	*No.*	*%*
Income class € 0-4 799	2 926	9.5	1 272	19.4
Income class € 4 800-9 599	4 222	13.7	1 424	21.6
Income class € 9 600-19 199	9 439	30.7	2 191	33.3
Income class € 19 200-47 999	13 742	44.7	1 641	25.0
Income class € 48 000-199 999	380	1.2	38	0.6
Income class ≥ € 120 000	10	0.03	1	0.02
Median income from work	*All Swedish men 20-65 years old*		*All Swedish women 20-65 years old*	
€	31 434		23 385	

Income classes constructed using individual incomes from farming, including subsidies and work related transfers, not deducting personal taxes.
Median income from work based on data from Statistics Sweden and the Swedish Central Bank.

Table 3. Expected income, E(Y), standard deviation, σ_Y, and coefficient of variation, CV_Y, farmers' premiums, expected public costs, E(C), standard deviation, σ_C, and coefficient of variation, CV_V, of the IST estimated with data on farm gross incomes (GFI) 2001-2015

All farms, income defined as	**No IST**			**With IST**			**Farmer's premium**	**IST payments**		**Public costs of IST**
	E(Y)	**σ_Y**	**CV_Y**	**E(Y)**	**σ_Y**	**CV_Y**		**E(IST)**	**E(IST if IL30)**	**E(C)**
GFI excluding CAP pillar 1 supports	28 146	50 542	1.80	31 780	44 574	1.40	1 957	5 592	14 399	167.8 million
GFI	38 957	52 209	1.34	42 077	44 917	1.07	1 712	4 892	14 061	146.8 million
GFI plus income from OGA	44 695	60 065	1.34	47 849	54 531	1.14	1 705	4 872	14 871	146.2 million
Farms according to sector, income defined as GFI	**No IST**			**With IST**			**Farmer's premium**	**IST payments**		**Public costs of IST**
	E(Y)	**σ_Y**	**CV_Y**	**E(Y)**	**σ_Y**	**CV_Y**		**E(IST)**	**E(IST if IL30)**	**E(C)**
Crops	35 851	59 686	1.66	38 916	51 101	1.31	1 652	4 721	13 372	42.8 million
Milk	87 411	49 615	0.57	91 411	43 262	0.47	2 148	6 136	25 130	20.5 million
Meat	34 160	48 008	1.41	37 155	44 268	1.19	1 629	4 651	13 603	28.7 million
Mixed	32 549	39 496	1.21	35 441	31 403	0.87	1 562	4 463	12 434	32.1 million
Forestry	21 737	45 637	2.10	25 224	41 109	1.63	1 856	5 302	12 455	19.5 million
Advisory Services	47 544	46 261	0.97	50 465	43 147	0.85	1 519	4 341	15 214	1.2 million

Table 4. Expected income, E(Y), standard deviation, σ_Y, and coefficient of variation, CV_Y, and expected public costs, E(C), standard deviation, σ_C, and coefficient of variation, CV_V, of the IST estimated with data on individual incomes 1998-2015

All farmers, income defined as	**No IST**			**With IST**			**Farmer's premium**	**IST payments**		**Public costs of IST**
	E(Y)	**σ_Y**	**CV_Y**	**E(Y)**	**σ_Y**	**CV_Y**		**E(IST)**	**E(IST if IL30)**	**E(C)**
Individual farm income	18 689	8 616	0.46	19 453	7 761	0.40	412	1 176	6 348	28.5 million
Individual earnings (farm income + OGA)	21 518	8 749	0.41	22 160	8 080	0.36	346	987	6 718	23.9 million
Household earnings (farm income + OGA)	39 732	15 158	0.38	41 025	13 877	0.34	649	1 989	12 952	48.2 million

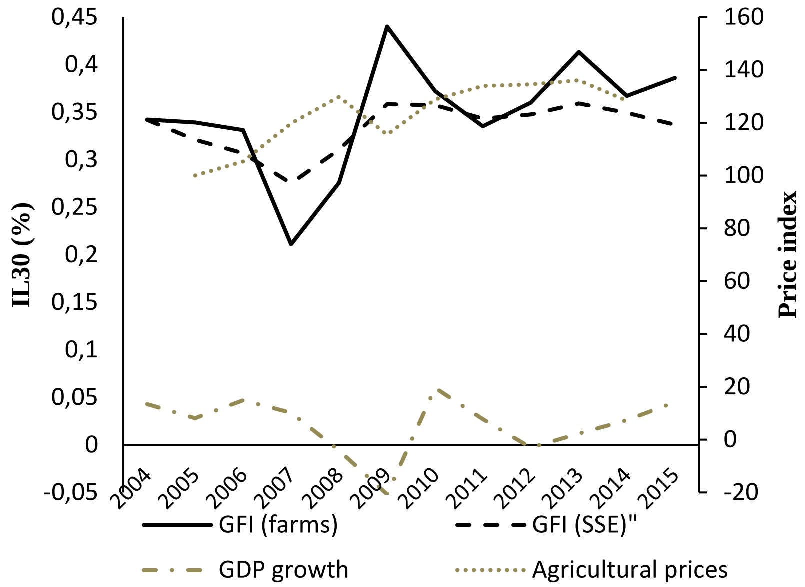


Figure 1. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30).

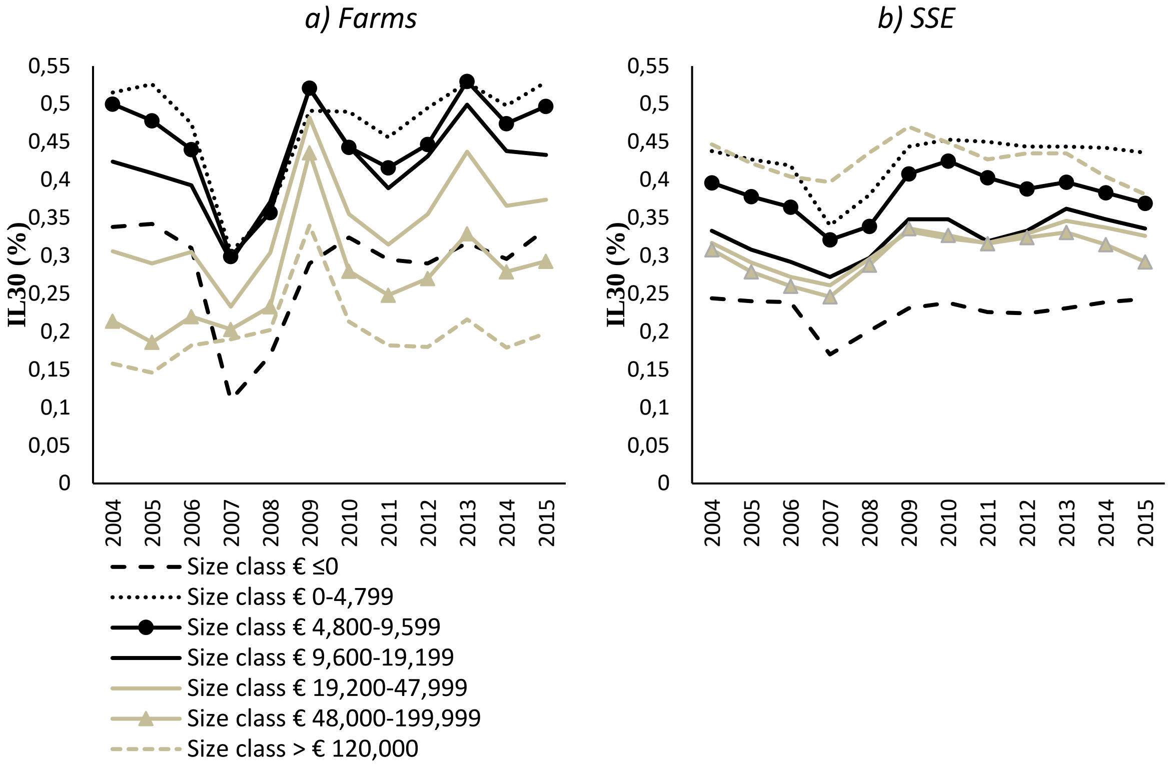


Figure 2a and 2b. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) for different size classes.

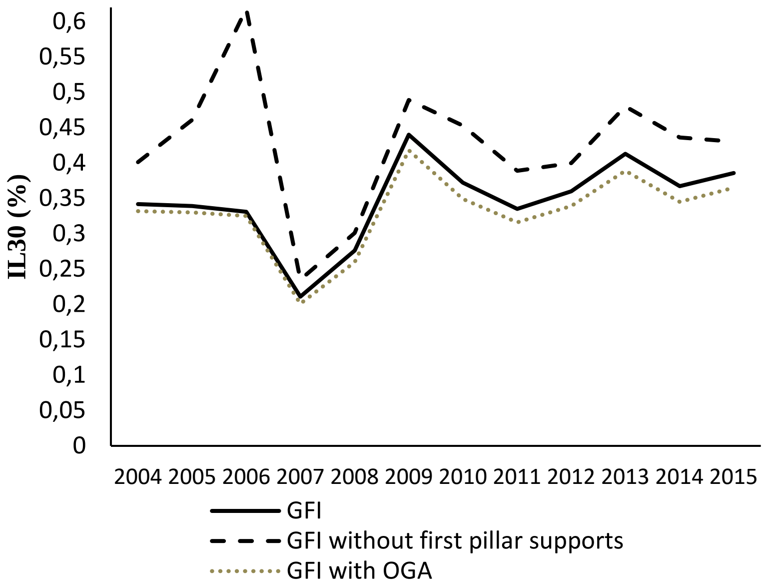


Figure 3. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) when excluding subsidies and including OGA.

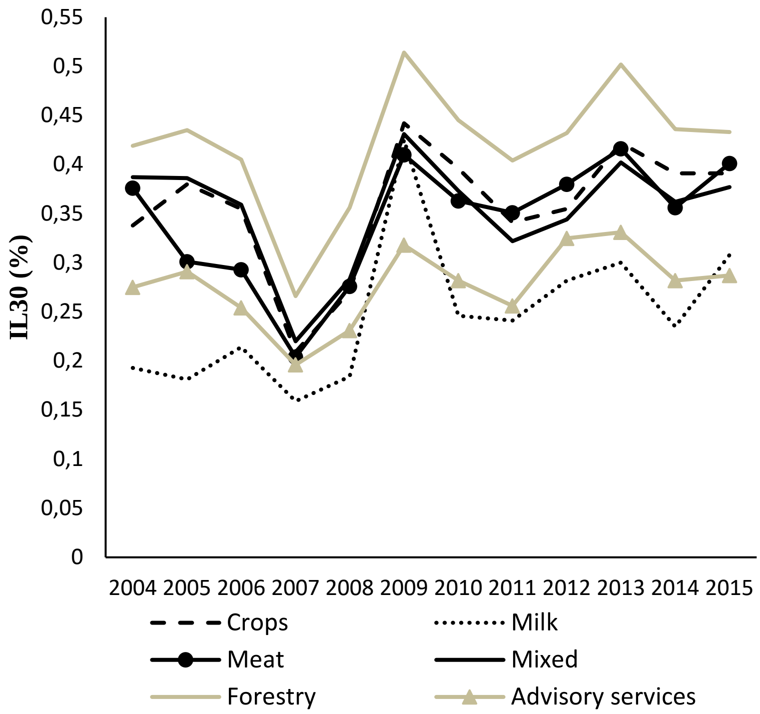


Figure 4. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) for different sectors.

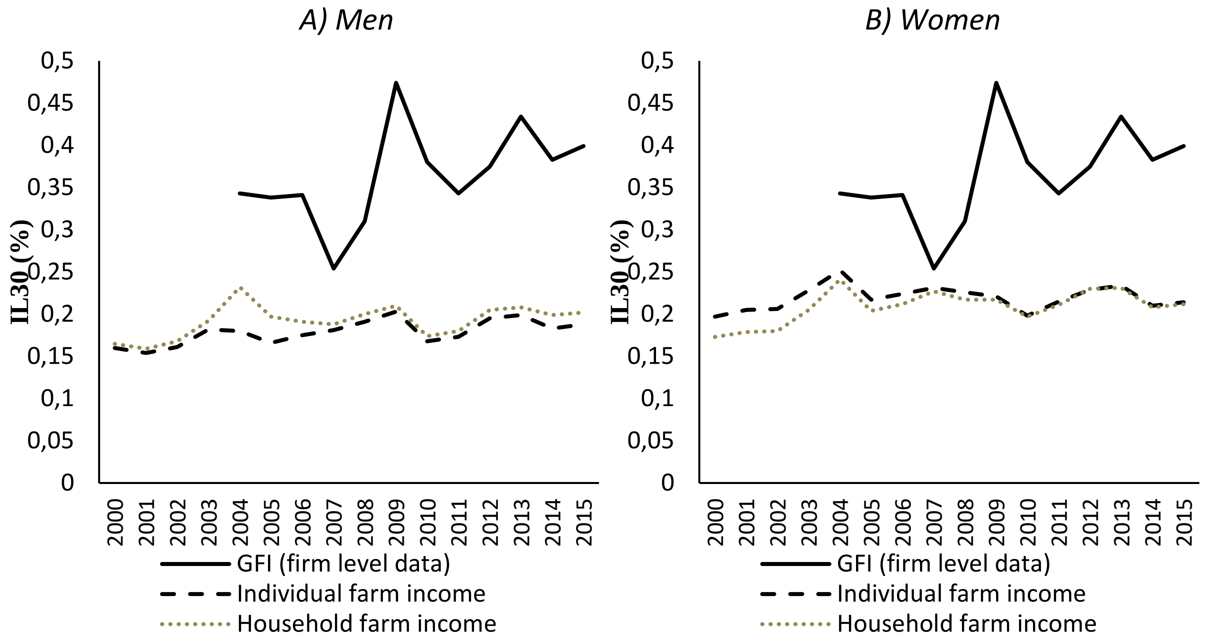


Figure 5A and 5B. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) for men and women. For GFI (firm level data) and individual- and household income.

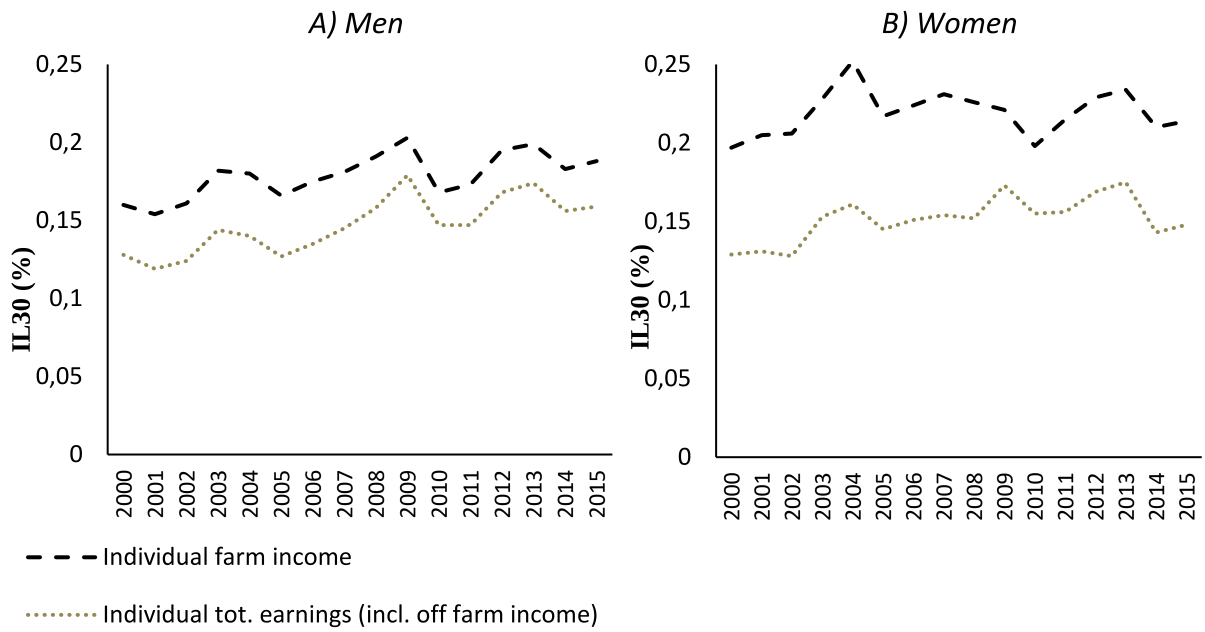


Figure 6A and 6B. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) for men and women. For individual farm income and individual total earnings.

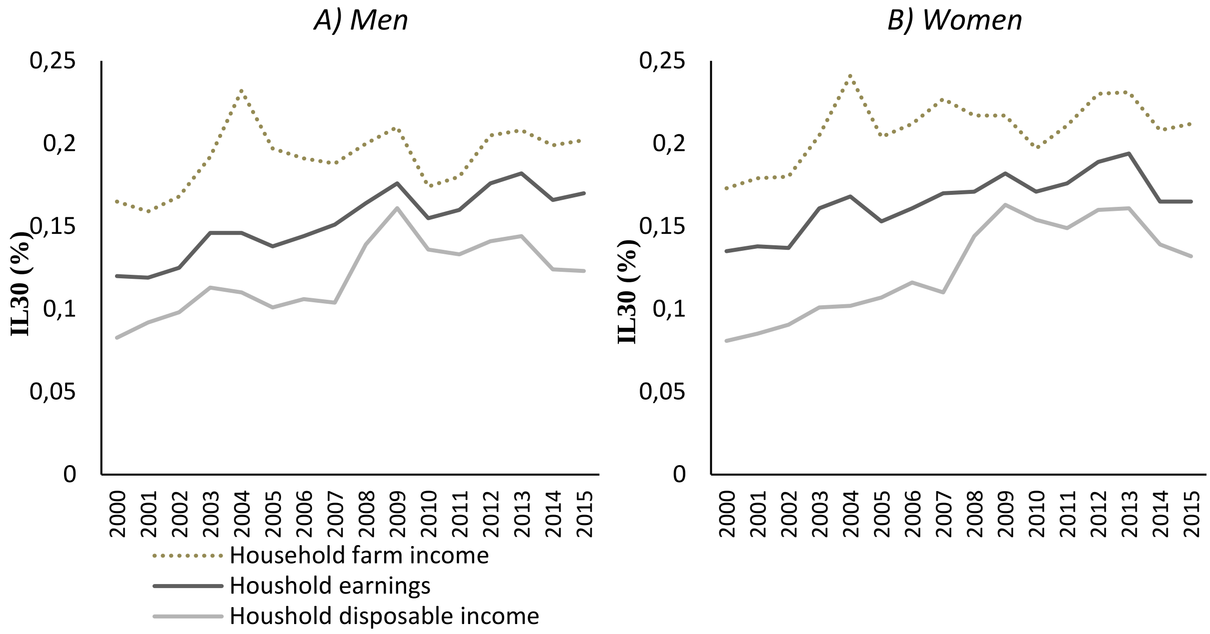


Figure 7A and 7B. Probability of experiencing an income loss exceeding 30 percent of (three-year) average income (IL30) for men and women. For household farm income, household earnings and household disposable income.

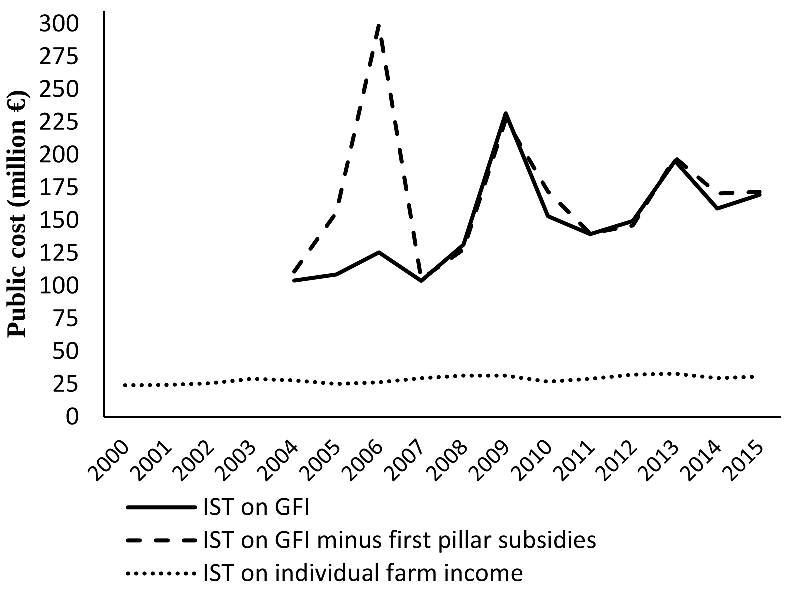


Figure 8. Annual variation in public costs of the IST given different definitions of income

About AgriFood Economics Centre

AgriFood Economics Centre provides economic expertise in the fields of food, agriculture, fishing and rural development. The Centre is a cooperation for applied research between the Swedish University of Agricultural Sciences (SLU) and Lund University. The aim is to supply government bodies with a solid scientific foundation supporting strategic and long-term policy choices.

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