

Macroeconomic impacts of the U.S. farm policy: a second best assessment

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Abstract:

The U.S. farm policy has progressively changed in recent years, with greater reliance on subsidized risk management programs to the detriment of direct payments. Many agricultural economists consider that this policy shift is unwarranted, leading to greater market distortions. We develop two economic models focused on the U.S. agricultural sector and isolate the coverage effects provided by subsidized insurance programs. We find that the welfare effects of subsidized insurance programs are dramatically modified once we recognize the risk sharing properties of these programs. Our simulated market effects on the U.S. cereal markets are consistent with currently available econometric evidence.

1. Introduction: context, literature review and objectives

The U.S. has a long tradition of public intervention in the farming sector. This public intervention pursues many objectives, such as the support of farm income and sustainable farming. It involves many instruments, such as trade instruments defined at the market level and insurance programs defined at the farm level. This public intervention has evolved with the adoption of new farm bills every five or six years. Generally, farm price supports and supply controls were the major instruments introduced after the Great Depression in the 1930s. This instrumentation continued until the mid-1980s. Then, a greater market orientation was adopted, culminating with the Federal Agricultural Improvement and Reform (FAIR) Act of 1996. Supply control measures were progressively removed, price support levels decreased and direct payments were introduced. This “decoupled” or “freedom to farm” period did not last many years, however. In the late 1990s, risk management programs were accentuated with countercyclical payments designed to cope with price risks, crop insurance with production risks and revenue insurance with both type of risks. The last farm bill adopted in 2014 confirms this trend by reinforcing these programs and terminating the direct payments.

This evolution of the instruments in the farm bills has generated many debates and economic analyses. A widespread view among agricultural economists is that “like many of its recent predecessors, and perhaps to an even greater degree, the 2014 farm bill ...will almost certainly reduce the economic welfare of the average U.S. citizen” (Goodwin and Smith, 2015). Indeed, it is widely believed that the previous direct payments distort market signals less than the current risk management programs. Our purpose with this paper is to contribute to this debate by offering an empirical assessment of the relative macroeconomic efficiencies of different policy instruments. We show that the macroeconomic welfare impacts of these instruments greatly depend on the economic tools developed to perform the assessments. As expected, the introduction of market failures/policy distortions matter: if we exclude these imperfections, then removing the policy instruments is welfare improving. When we include them, we can simply obtain the opposite conclusion.

While there is still some debate on the efficiency of previous policy instruments (see Kirwan and Roberts 2016 on the capitalization of direct payments), a large body of agricultural economic literature has recently developed on the impacts of the growing and subsidized insurance programs. For the next decade, the estimated annual public expenditures on crop insurance programs are much greater than those on income support and conservation programs (\$8.9, 5.6 and 5.8 billion, respectively). This literature can be divided in three themes. The first theme focuses on farmer demand for insurance products. This demand has long been modest in arable crop farming. Before the 1980s, when the federal government mostly subsidized the administrative costs, the insured acreage was less than 20 percent of the cropped acreage. The 1980 Federal Crop Insurance Act increased subsidies to 30 percent of premiums. As expected, farmer participation increased but remained lower than 50 percent. This participation is currently greater than 80 percent thanks to the 1994 and 2000 insurance reforms that increased the premium subsidies to approximately two-thirds of expected indemnities. In other words, when farmers enroll in insurance programs, they can expect to receive on average twice the amount of premiums they pay. Despite these economic incentives, some farmers still do not participate in insurance programs. One major explanation explored in the literature is that all farmers are not always offered fair insurance premiums for two reasons. First, the Risk Management Agency (RMA), a division of the USA department of agriculture, defines the insurance products using individual and county level data. However, U.S. farmers face different production conditions and are not exposed to the same idiosyncratic risks (Claassen and Just, 2009). Accordingly, there is a first potential informational challenge when accounting for yield

heterogeneity. Second, the production risks that farmers face may change over time. If this is the case, a critical statistical challenge is knowing whether the technical change affects all moments of the crop yield distribution (Tolhurst and Kert, 2014). These two informational challenges lead to the ex post observation of geographic misratings (Woodard et al., 2012). Some cross subsidizations thus result among farmers, explaining the need for significant subsidies to reach the policy objective of increased participation. To save some public funds while still protecting farm income, new insurance products or new rating procedures have been proposed (Gerlt et al. 2015, Ramirez and Shonkwiler, 2017). These proposals balance the costs of collecting precise data and the benefits of a better targeting.

The second theme addresses the production and risk management decisions of U.S. farmers. In particular, the land use and crop choice impacts of crop insurance programs have been the subject of many econometric studies (recent references include Walters et al. 2012, Goodwin and Smith, 2013, Claassen et al., 2016, Weber et al., 2016, Yu et al., 2016). As usual, econometric results differ among studies because of different econometric models (for instance, with or without cross market effects), econometric procedures (for instance, tackling endogeneity issues of crop insurance decisions) and data (for instance, farm level or aggregate data). In a general way, these studies find limited positive impacts on land use (less than 1 percent) and more significant impacts on crop choices (a 3–5 percent change in crop acreage for some regions is possible). They also find that the subsidized crop insurance programs affect crop acreage decisions by a profit effect (i.e., increasing the expected return of insured crops) and a coverage effect (i.e., reducing the variance of returns). Insurance programs reduce the variability of net farm incomes by providing indemnities only in case of losses greater than the deductibles. Thus, the econometric studies find that U.S. farmers value this risk reduction property of insurance programs and remain risk averse despite the many risk management solutions available to them. Some econometric studies also examine farmers' other production decisions (input uses and yield objectives) and the environmental consequences. Cornaggia (2013) estimates positive impacts on crop yields (close to 1 percent for corn and soybeans) of the exogenous introduction of subsidized insurance programs. Without developing a fully structural econometric model with an explicit production function, this author econometrically estimates that this positive impact on crop yield can be explained by relaxed financial constraints: banks lend to insured farmers at more favorable terms, allowing them to finance productivity-enhancing investments. Weber et al (2016) go further in the production technology by estimating the impacts of subsidized insurance programs on fertilizer and pesticide uses and production value per acre. These authors find small positive effects on input uses and larger effects on production values. Their interpretation is similar to that of Cornaggia: insurance programs may encourage farmers to invest more in productivity-enhancing capital goods. From these production decisions, some studies infer the environmental effects using biophysical models: they generally find limited negative impacts on several environmental indicators. Other econometric studies analyze the risk management decisions of U.S. farmers with and without insurance programs (Ifft *et al.*, 2015; Farrin *et al.*, 2016). They generally find statistically significant impacts on financial decisions (savings, debts) that depend on initial wealth. Insurance and savings can be substitute strategies for the average farmer, while they are complementary for low-income farmers. Credit constrained farmers may not purchase insurance programs, as certain premium expenditures deliver only uncertain future benefits (Du et al., 2016). Overall, these econometric studies confirm small positive impacts on production due to subsidized insurance programs and some impacts on other risk management strategies due to both a transfer/profit effect and a risk reduction/coverage effect.

The third theme addresses the market impacts and macroeconomic efficiency of crop insurance programs. The leakage of subsidies to the insurance industry, composed of insurance agents, insurance companies and reinsurers, has always been a major concern for policy makers. In addition to premium subsidies perceived by farmers, some public money is also spent to cover Administrative and Operation (A&O) expenditures of the insurance industry and to finance part of underwriting losses. By contrast, the insurance industry keeps a greater share of underwriting gains by an optimal choice of reinsurance programs (between so-called commercial funds and assigned risk funds that differ in risk retention levels). Smith *et al.* (2016) find that over the period from 2000 to 2009, the public support perceived by the insurance industry was greater than the support given to farmers through subsidized premiums. That period was characterized by a loss ratio of 0.8. Thus, the premiums were not fair ex post, and the insurance industry benefited from significant underwriting gains. They also benefited from significant A&O subsidies that were fixed by the RMA. Indeed, the delivery of insurance products was not competitive, as the insurance suppliers cannot define their own insurance products, nor they can price it. The price of insurance services is fixed by the RMA as a proportion of premiums. With increasing crop prices in the mid-2000s, the A&O values were highest in 2008 (more than 2 billion US\$). They were not determined by the production cost of insurance services and were likely to generate rents. The policy makers accounted for this possibility (in the 2008 farm bill and the Standard Reinsurance Agreement-SRA negotiated in 2010) by lowering and capping the proportion of premiums going to cover A&O expenses. Since 2010, the A&O receipts have decreased, and the U.S. has experienced loss ratios greater than one. Hence, the recent leakage to the insurance industry is much lower than it was previously (Glauber, 2016). According to the U.S. Government Accountability Office (GAO, 2009), the purpose of the insurance regulators with the SRA was to prevent industry consolidation that may have reduced competition in the long run to the detriment of farmers. There are indeed few insurance companies but many independent insurance agents delivering insurance products to farmers. Smith *et al.* (2016) estimate that, over the period 2002–2008, a large share of rents accrued to these agents. As recognized by the GAO (2009) and Glauber (2016), it is quite difficult to identify those rents, as agents may provide rebates, for instance, by cross-subsidizing other insurance products purchased by farmers (such as property and casualty insurances). Therefore, one cannot exclude that competition finally exists across insurance providers through non crop insurance markets. In that case, the distortionary effects of insurance programs on farmer decisions can be greater than those induced by the premium subsidies, and leakage to the insurance industry may be lower on average. Econometric evidence of this potential leakage to the insurance industry is lacking due to data issues. By contrast, land price and rental rates are more readily available to econometrically measure the potential leakage to landowners. Ifft *et al.* (2015) gather many databases on land prices, farm payments and other land characteristics and perform many econometric estimations to address potential endogeneity of payments. These authors find in all estimated models that premium subsidies did not influence land prices over the period from 2000 to 2006. The impact of disaster payments, which decrease following the increase of insurance subsidies (Deryugina and Kirwan, 2016 explore the causality between the two programs), is not statistically robust. Overall, we do not yet have econometric evidence that the insurance program benefits are partly captured by farm input suppliers. On the output side, aforementioned micro-econometric studies find that the subsidized insurance programs slightly encourage farm production through both acreage and yield effects. They thus potentially benefit consumers of agricultural products. We are not aware of any econometric study trying to identify the output price effects of insurance programs. More generally, we are not aware of the recent macroeconomic analysis assessing the farm bills and their different policy instruments. The exception is provided by Lusk (2015), using a national level, Partial Equilibrium (PE) model to link the supply of disaggregate

farm commodities with final consumer demands. This author simulates the removal of premium and A&O subsidies for the years 2012 to 2014 and finds significant price effects: wheat and corn market prices increase by 7.9 and 4.7 percent, respectively. While of the same nature, these price effects are much larger than those simulated by Young et al. (2001) for the 2001–2010 period simply because the subsidy levels were much lower. Both studies confirm that the domestic and foreign consumers of agricultural products currently benefit from the insurance programs. Lusk even reports that the positive welfare effects for consumers are larger than the welfare gains of producers (and their input suppliers). However, the sum of these welfare gains is lower than the cost supported by the U.S. taxpayers. For instance, in 2013, when subsidies amounted to \$8 billion, the world welfare decreased by approximately \$0.9 billion, and U.S. welfare by about \$1.9 billion.

This unique normative macroeconomic study supports the aforementioned widespread view of the global inefficiency of the US farm policy. However, it is based on debatable assumptions. The PE model used does not capture any potential market failure, such as the informational issues previously mentioned (when the RMA rates insurance products with noisy information or when banks do not lend to credit-constrained farmers). The only modeled distortion is represented by the crop insurance subsidies. Accordingly, it is no surprise that the removal of this unique distortion improves welfare. Moreover, insurance subsidies (both premium and A&O) are modeled as simple subsidies coupled to production. In other words, only the transfer/profit effects of these subsidies are measured. The coverage or risk reduction effects are ignored, despite recent econometric evidence revealing that U.S. farmers are risk averse and value a reduction of the volatility of their income. In that context, our objective is to revisit this macroeconomic assessment by introducing both the profit and coverage effect of subsidized insurance programs.

Our objective requires the development of a macroeconomic model that can capture the risk attitude of U.S. farmers, more generally, the different risk management strategies that farmers can rely on as well as ideally the different market imperfections that characterize our economies. This is obviously a tremendous, not to say impossible, task. However, between the two extremes of “no and all imperfections”, there is room for improving policy assessment. A simple way is provided by Okrent and Alston (2012), who use the same PE model as Lusk. These authors add an ex post assessment of obesity welfare effects, assuming that economic agents do not care about these externalities. This simple approach cannot be used in our case, as farmers value the risk reduction properties of insurance programs and change their production decisions accordingly.

We thus develop a new economic tool with an explicit modeling of the behavior of economic agents and some policy distortions. We choose to start from the GTAP model (Hertel, 1997), which is a world Computable General Equilibrium (CGE) model detailing many farm sectors. By measuring all economic flows between agents, for instance between farmers, input suppliers and final consumers, a CGE model can potentially capture all economic behaviors. The GTAP model is a static CGE model ignoring stochastic aspects, such as the explicit measurement of farmers’ risk premiums. In this regard, it is close to the PE model used by Lusk. However, it captures many policy distortions, including all policy instruments of the farm bills, such as the previous direct payments and trade instruments, and policy instruments in other countries. By using first this static CGE model, we try to replicate Lusk’ analysis, examining the sensitivity of results to the existence of other policy distortions. More importantly, this static CGE model serves as a benchmark to a more elaborated version where farmers’ risk attitude is introduced. We make three important changes in the model. We first introduce dynamics to capture the fact that a risky event is a future event. We then introduce the farm household that has many possibilities to smooth consumption levels (Pope et al., 2011). We finally model explicitly the agricultural insurance market, in particular, farmers’ demand of

subsidized insurance products. In this way, we are able to introduce in the normative analysis the risk reduction properties of insurance programs. As expected, we show that the welfare effects of subsidized insurance programs heavily depend on the remaining risk aversion of farmers. By contrast, the welfare effects of direct payments are less sensitive to this assumption, as these payments are not state contingent.

2. Modeling frameworks

We first give a general description of the GTAP model and then detail the different modifications introduced to perform a more consistent welfare analysis of the US farm policy instruments, in particular, insurance programs.

2.1. The static GTAP CGE model

The GTAP model is a relatively standard multi-region CGE model where consumers are assumed to maximize their utility, factor owners their revenue. This model employs the simplistic assumptions that there is perfect competition in all commodity and factor markets, that flexible prices ensure market equilibrium and that investment are saving-driven. Commodities are differentiated by origin, allowing the modeling of bilateral international trade flows. This GTAP framework is implemented using data organized in Social Accounting Matrices (SAM) per region capturing economic flows during a given year and exogenous substitution/price/income elasticities. The GTAP model is only one version among the many CGE models that rely on the GTAP database and that have been used to analyze a variety of issues, including farm domestic and trade policies (one recent application is provided by Urban et al., 2016).

On the farm supply side, it should be underlined that the modeled agent is not one farmer who may own different primary factors (capital and land in addition to his own human capital and labor force) and decide production variables. Rather, the approach is activity-based with a distinction made according the different primary factor owners. More precisely, it is assumed that there is a representative landowner in each region who allocates his land asset over different farm and non-farm activities each year. This allocation depends on the land return provided by each activity and is technically implemented by (nested) Constant Elasticity of Transformation (CET) mobility functions, which capture in a synthetic way the heterogeneity of the land asset and land market regulations. In the same vein, there is a representative labor supplier (both skilled and unskilled) in each region, allocating his labor force and human capital to different activities in response to their labor returns each year. The logic is the same for the representative physical capital owner, which can be a domestic or a foreign household. The primary factor returns generated by the different activities are constrained by the market and policy environment and the technological relationships that link outputs to inputs and primary factors of production. These technologies are usually mono-product, exhibit constant returns to scale and are specified through nested Constant Elasticity of Substitution (CES) technologies defined over variable inputs and primary factors of production.

This activity-based agricultural supply modeling exhibits desirable features, such as the use of activity-based input–output matrices that are compiled by national statistical institutions. Compared to the reduced form approach of many PE models, a CGE approach explicitly represents the production technology implemented by farmers and thus the productive role of each input. However, this modeling also exhibits some weaknesses. First, this static approach assumes that the regional households (more precisely primary factor owners) know the true market prices of

commodities and the true primary factor returns when they determine their factor allocation. The lag between production decisions and commodity selling on the market is not recognized, preventing the real modeling of the dynamic and stochastic dimensions. Second, this static activity-based supply modeling does not allow for the explicit modeling of farmers' attitude towards risk. Farmers and other producers are not explicitly identified, but they are aggregated with other households, and only regional welfare effects are computed. Third, the insurance products purchased by farmers play the same role in the production technology as inputs such as fertilizers, seeds or chemicals. It does not recognize that farmers pay insurance premiums because they expect production indemnities in case of economic losses. Finally, it supposes that we are able to measure all (gross and net of taxes) commodity uses and primary factor returns by all farming activities. This can be problematic when activities are highly detailed (such as the distinction of wheat and coarse grains in the cereal sector). The determination of primary factor returns also requires some critical assumptions because farming is still performed by some family farms owing physical capital and land. Their net farm income is composed of many primary factor returns. Moreover, farm direct payments that are given independently of activities are arbitrarily distributed across the primary factor returns. These data assumptions are obviously critical and widely debated in world trade debates (Urban et al., 2016). By default, the GTAP database proposes that the U.S. direct payments are distributed in equal proportions to land, labor and capital in all farm sectors. By default, crop insurance subsidies are assumed equivalent to land subsidies. It is up to the modeler to change these assumptions and to shift for instance the latter insurance subsidies as output subsidies. In that case, we can mimic the PE modeling approaches previously adopted by Young et al. and Lusk.

To sum up, the main differences of this static GTAP model with the PE models are the number of policy distortions that are captured and the macroeconomic closure rules (i.e., that all economic agents' budgets are balanced). None of these models acknowledge the risk reduction effect offered by insurance programs. The results between these models may also differ because of calibrated price elasticities. It is straightforward to change the elasticities, and we mostly rely on the GTAP-Agr elasticities that were chosen to better capture certain structural features of world agricultural markets (Keeney and Hertel, 2005).

1.2. A dynamic stochastic CGE model with insurance programs

We introduce three main changes to the previous CGE model: dynamics following previous efforts by Boussard et al. (2006), the farm household following previous efforts by Hanson and Somwaru (2003) and finally insurance demand by farmers following the OECD (2005). Our modeling contribution is to consistently introduce them in a single framework.

The static GTAP approach supposes that economic agents automatically adjust to economic incentives, for instance with workers and capital goods departing from less profitable activities. This makes sense in a steady state perspective. In reality, factors may take time to move following shocks. This can be captured by restraining factor movements technically by fixing at the limit a zero elasticity in the CET mobility function (see for instance, Keeney and Hertel, 2009). In such case, we obtain short-run (yearly) impacts compared to medium/long-run effects. We do so for an aggregate factor composed of physical capital and human capital that we assume to be fixed in the short run per activity. By creating a fixed factor, we identify a farmer who owns this aggregate factor and makes production decisions. His return for managing the farm is the residual income defined as market receipts plus subsidies less input factor expenditures. For the moment, we assume that the farmer's objective is to maximize income. We also need to consider that for most productive

activities, inputs and primary factors of production are engaged before the production is realized. This is particularly true in farming where arable crop producers first determine their land use and seed application, then apply variable inputs over the plant growing period such as fertilizers and pesticides and finally harvest the crop and market it (possibly selling directly on the market or storing before selling). This time lag between production decisions and production marketing implies that farmers must base their decisions on expected prices. During this time lag, exogenous stochastic events (climate/pest events) may make observed production different from expected production and effective prices different from expected prices. This time lag has already been implemented in PE models such the Aglink Cosimo (OECD, 2006) or CGE models (Boussard et al., 2006). We follow these examples and assume that one year/campaign can be divided in two periods. In the first period that can be labeled the production period, farmers equipped with their physical capital determine their production, input and primary factor levels given their expectations of state-contingent productive shocks and commodity/labor prices (labor is used all along the production campaign, such as during harvesting). However, we assume that the land use and rental rate are negotiated with the landowner at the beginning of the production campaign. Most rented land in the U.S. is under fixed contracts. Hence, in the first period of a given year, we determine the expected output level, the true input use, primary factor use (land and labor) by the farmers, parts of the land allocation by the landowner and the equilibrium land return for these dynamic activities. In the second period of the given year, which can be labeled the marketing period, these variables become predetermined in the static CGE model, and market price and residual capital return are determined. They may differ from values expected by farmers because of the stochastic productivity shocks that occur between the two periods. Our division of one year/campaign into two periods is obviously a simplification, as farmers may learn about stochastic events during the campaign and adjust their production decisions accordingly. This simplification prevents us from considering the potential moral hazard issue when insurance programs will be introduced (Yu and Wu, 2016).

The previous changes introduce a short-run dynamic into the modeling. We now introduce the farm household. Of the three possible approaches explained by Keeney and Hertel (2005), we favor the most complete one as already implemented by Hanson and Somwaru (2003). That is, we depart from the representative regional household assumption and assume there are two types of households: farm and non-farm. Each household optimizes separately, and they interact through factor and product markets. This distinction allows specifying the risk attitudes of farm households (eventually their risk aversion) that may differ from the risk attitudes of other households. Moreover, this approach potentially allows for the capturing different risk management strategies that farm households may mobilize to smooth their consumption levels (Pope et al., 2011). These strategies include short-term production decisions, long-term investment/saving decisions, off-farm labor decisions, contracting with intermediaries (Du et al., 2015) or input suppliers (Kuethe and Paulson, 2014), and insurance contracts. If one wants to consistently compare the efficiencies of these strategies, the distinction of farm/non-farm households is recommended. The implementation of this differentiated household approach requires the largest amount of additional data; most of them are not easily accessible. The implementation of this approach also requires the largest number of additional parameters, notably on the risk preferences and perceptions by farmers. Risk (and time) preferences have been extensively investigated with different methods. For instance, when examining insurance purchase decisions, Babcock (2015) and Du et al. (2016) question the relevance of the traditional expected utility approach. It seems accepted that farm household preferences are concave and thus exhibit risk aversion. In face of these implementation issues, we are thus constrained to either spend a lifetime project to gather these data and parameters or to perform conditional economic analysis. In this paper, we focus on the subsidized insurance strategy thanks to

the many data available from the RMA. We also follow many simulation studies (for instance Miao et al., 2016) by specifying expected utility maximizers. Concretely, we assume that the farm household maximizes its expected utility during the production period by an optimal choice of input/factor uses, participation in insurance programs (see below) and state contingent commodity consumptions. We will vary the risk aversion parameter. We assume that the investment, off-farm labor and marketing contracts decisions are fixed. In particular, we assume that their investment remains equal to an exogenous depreciation of the capital stocks. Introducing the investment strategies to cope with short-term volatilities require the development of a stochastic dynamic programming model that is left for future research. These production variables are then introduced as predetermined variables in the CGE model. The latter is solved with different state contingent productivity shocks. It again determines contingent market prices, residual capital return and farm household final consumptions.

The last main change relates to the crop insurance. Crop insurance used by farmers does not directly influence the biological process of arable crops. It is a financial decision. Farmers determine the optimal use of insurance products in terms of insured acreage and coverage levels before the realization of stochastic events. They engage themselves to pay premiums (net of subsidies) to the insurance industry. They receive indemnities in case of observed losses greater than deductibles. The U.S. arable crop farmers are currently offered a variety of insurance products that differ in many aspects. They can cover yield versus revenue losses (with/without harvest price exclusion) with different levels of coverage (from 50 to 90 percent) at different unit levels (enterprise vs basic vs optional). The subsidy levels also differ across these products (from 100 percent for catastrophic level to 35 percent). There is great heterogeneity across the U.S. cropping conditions, leading to the observation of varying participation in these insurance products. Because we start from a macroeconomic CGE approach with representative/aggregate agents, it is impossible to nicely reflect this heterogeneity. One possibility could be to disaggregate U.S. data into regional/state data, which is left for future research. We focus on the insurance product that has been most purchased by the U.S. farmers in recent years: revenue insurance at the 85 percent coverage level. By restraining insurance products, we follow the OECD (2005) by modeling the insured acreage decision only. This decision obviously interacts with other decisions of the farm household. In particular, we assume that farm households cannot speculate on insurance in the sense that they cannot insure more than their cropped areas. Their optimal insured acreage depends on their risk aversion: if they are risk neutral, they do not value the risk reduction properties of insurance and fully insure their cropped acreage only if it is profitable (positive net expected indemnities). In this instance, insurance becomes similar to a land subsidy. This is the current assumption in the GTAP database. If farm households are risk averse, they can insure part of their cropped acreage, even if the insurance products are not subsidized. We introduce the insured acreage demand in the farm household program defined in the production period. We assume that the supply of insurance products is perfectly elastic. This is indeed the logic of current legislation: the insurance industry cannot refuse the distribution of RMA-defined insurance products to farmers. The farm household model solved in the first period now defines the expected output, the true input/factor uses, the insured acreage and the premiums to be paid to the insurance industry. These variables are again introduced as predetermined variables in the second period CGE model. Again, the latter is solved with different state contingent productivity shocks. We hence obtain contingent market prices, residual capital return and farm household final consumptions and net indemnities paid by the insurance industry to the farm household. For instance, if a severe negative productivity shock materializes, the insurance industry pays ex post indemnities to the farm household that can be larger than the collected premiums. In that case, the return to the insurance industry is lower. By assuming only two types of household, then the non-farm household income is also lower. This affects its economic welfare. In

contrast, if there is no negative productivity shock, the insurance industry benefits from underwriting gains that are transmitted to non-farm households in our modeling framework.

The three main changes introduced to the GTAP CGE model deliver new state contingent market results. They will depend in particular on the calibrated risk aversion parameter (see below). To assess the normative efficiency of public policies, what remains is to compute the welfare effects. In a static CGE model, this is usually done with the equivalent variation for the regional household that is straightforward to compute (a difference of closed-form expenditure functions). With our dynamic and stochastic approach with two types of households, a distinction must be made between ex ante and ex post welfare effects (Just et al., 2005). We compute the ex ante equivalent variation for farm and non-farm households. This is slightly less trivial when one assumes risk aversion because there is no closed-form solution. We solve a nonlinear equation involving indirect utility functions defined over contingent states.

3. Economic data and behavioral parameters

We rely on the latest GTAP database to measure the economic flows for the year 2011. With regard to the U.S. crop insurance market, this year is not exceptional. The loss ratio over all commodities (including cotton) is approximately 0.9, which is the average loss ratio over the period 2001–2015.

This database covers 140 countries and 57 commodities. The usual practice is to aggregate them to ease the mathematical resolution. We retain 3 countries, namely, the U.S., the European Union and the Rest of the World. The purpose of the two other countries is simply to check that we do not make computational mistakes (the Walras law). We retain 9 commodities/activities, namely, cereals (an aggregate of rice, wheat and coarse grains), oilseeds, other crops, live animals, food, manufacture, insurance, trade and transport and other services. We concentrate on cereals and ignore the diversification strategy. Some farmers simultaneously produce cereals, oilseeds and even livestock products for risk management purposes, but possibly also for agronomic reasons or labor management. This again is left for future research.

The construction of the GTAP database requires many assumptions, partly because input-output tables are not regularly updated; products are not highly disaggregated, and value added is not split between all primary factors. We make two data corrections to the U.S. data that are introduced in our two CGE frameworks. The U.S. data in the latest GTAP database are updates from the 1992 input–output tables. That is, input output coefficients measured in 1992 by the Bureau of Economic Analysis are applied to 2011 production values. Without surprise, the insurance expenditures by the cereal sector do not fit with the RMA data. In fact, the input–output table reports the premium expenditures net of ex post indemnities. In other words, the input–output table reports the ex post observed contingent state. With this accounting rule, for some years (such as 2012 with a severe drought), the insurance expenditures by some sectors can be negative (insurance expenditures cover crop insurance but also activity based insurance on building, machines or stocks). According to the RMA data, the premiums paid on insured cereal acreage amounted to \$6904 million in 2011. Farm households received \$4252 million of premium subsidies. Ex post indemnities amounted to \$5525 million. The net gain for farmers is thus \$2873 million ex post. Before the subsidies, the cost of participating in the insurance programs is \$1379 million. This corresponds to underwriting gains captured by the insurance industry. Because the year 2011 was not exceptional, we make the simplifying assumption that these ex post gains just cover the expected expenditures of the insurance industry for delivering insurance programs. These gains represent 20 percent of premiums, which is close to the proportion for determining A&O values. One may object that the intention of

the RMA when rating insurance products is that premiums should be fair and farmers should not pay these A&O expenditures. However, from 2001 to 2010, the average loss ratio was 0.8. We cannot exclude the possibility that farmers, when paying their premiums, believe that part of the premium is used to cover A&O expenditures. They are ready to pay these additional expenditures because they receive some subsidies. In other words, we assume a loading factor of 20 percent.

We also modify the distribution of the US cereal value added across the returns to primary factors. This distribution determines in particular the return to farm labor and is directly related to the long-lasting debate on the “farm problem” (Gardner, 1992; Key et al., 2017). In the GTAP database, these returns are derived from econometric estimates of medium-run U.S. price supply responses where risk attitudes are ignored. Furthermore, the farm capital is assumed to be mobile, and the only fixed factor is family labor (Ball, 1988). The returns to land, labor and capital are all close to 15 percent of production values. If we keep this distribution and assume that the capital is the only fixed factor, we end up with negative consumption levels when the revenue shock is larger than 15 percent. According to the USDA data, the net U.S. farm income over the period 2002–2011 is approximately 24 percent of production values. We increase the capital return in the U.S. cereal sector to this percentage to the detriment of the labor return. The capital factor in this sector now comprises both capital and farm household labor that are both considered fixed in the short run. It is then possible to simulate a revenue shock of up to 24 percent without getting negative consumption levels.

These two data modifications are applied to our two CGE models. To implement the dynamic stochastic CGE model with insurance and the farm household, additional data are needed. Key et al. (2017) report that off-farm income can be very significant for some farm households, contributing to 85 percent of the household income. However, for commercial farms, this share is much lower (approximately 25 percent). We introduce this additional income to the farm household composition. However, farm households spend part of their income for farm investment. This should be deducted from the income that remains for household consumption. These investment expenditures are quite volatile, suggesting that farmers can use this strategy to smooth consumption levels. We do not explore this issue. Thus, we rely on the smoother depreciation values of approximately 30 percent of net farm income. By default, we assume that off-farm income and investment expenditures are fixed and are initially equal. A sensitivity analysis will be performed on these data assumption. Having determined the total final expenditures, we assume that farmers’ consumption pattern is identical to the consumption pattern of non-farm households.

To implement the dynamic stochastic CGE model, we also need to specify the risk preferences of the farm household, the distribution of expected price and productivity shocks as perceived by the farm household. We first calibrate the productivity shocks as follows. Like Ramirez and Shonkwiler (2017), we assume that economic agents rely on 10 contingent states and first specify normal distribution (we will adopt a lognormal in a sensitivity analysis). We assume that the standard error of this normal distribution is 0.25. The mean of this normal distribution is calibrated to reproduce observed indemnities. That is, we solve our second period CGE model 10 times with productive shocks and predetermined U.S. cereal productions. We compute ex post the net indemnities paid by the insurance industry to the farmers. Because we consider revenue insurance, these indemnities depend on the simulated prices. These indemnities also depend on the insured acreages and total liabilities. As mentioned in the introduction, there is a great heterogeneity of production risks across U.S. farmers that cannot be perfectly captured in a macroeconomic model. We assume that up to 85 percent of cropped acreage can be insured at the 85 coverage level and that initially this constraint is binding.

We use these simulated prices to determine the initial price and productivity shocks expected by farmers. We simplify the analysis by ignoring productive shocks in the rest of the world or on other markets. By using these values, we implicitly assume that farmers have initially rational expectations, which are the same as those delivered by the CGE model. Plugging the expected values in the first period farm household model ensures that it reproduces the observed input decisions made by the U.S. cereal farmers in 2011. When we will simulate policy scenarios, we will have the possibility to vary these assumptions.

We finally need to specify the risk attitude of our U.S. farm household. We consider two values. First, this farm household is not risk averse at all. It buys the insurance product only because of the subsidy effect. The preferences over all final goods are governed by a simple Cobb–Douglas utility function. A linear expenditure system with commitments was also tested without significantly changing the results. Second, this farm household still exhibits risk aversion in the initial year despite the existence of subsidized risk products. That is, it is ready to pay a remaining risk premium to face less residual economic risk. The calibration of this initial risk premium and its evolution are critical. We simplify the analysis by assuming a power utility function (compared to the less parsimonious prospect theory) and thus specify only one parameter. Miao et al. (2016) suggest calibrating the risk aversion parameter following the device of Babcock et al (1993) on the “gamble size”. That is, the risk premium is initially fixed at 10 percent of the standard deviation of farm income. We take a more conservative value of 5 percent because we capture more risk management decisions in our framework. This risk premium is initially counted in the residual capital return. Thus, we separate the two components in the calibration phase using the constant return to scale assumption of the production function (Femenia et al., 2010).

4. Simulations

In the recent years, the U.S. farm policy has departed from direct payments in favor of subsidized risk management programs, in particular, insurance programs. Both programs were in operation in 2011. We successively simulate below the market and welfare effects of the removal of these two programs using our two CGE frameworks. When we use the static CGE model, we make our analysis comparable to previous simulation studies by assuming that the premium subsidies are coupled to production. We also assume with this model that the U.S. farm household will no longer purchase insurance if not subsidized. When we use our preferred dynamic and stochastic CGE model, premium subsidies are logically linked to the insurance expenditures. This model must be solved for different random draws of a series of 10 productivity shocks. The results are averaged afterwards. Below we report results for one random draw to simplify the analysis of results. To prove the robustness of the analysis, we will report the results with a different random distribution in the sensitivity analysis.

4.1. Impacts of removing insurance subsidies

The upper part of Table 1 reports the market effects of this scenario on selected variables. The lower part reports the welfare effects. The first column gives the result when using the static CGE model. The results are standard: the removal of coupled subsidies leads to a decrease of U.S. cereal production. This creates a deficit on the world market. The U.S. market price increases, dampening the initial decrease of the U.S. production. At the new equilibrium, the US market price is 0.4 percent higher, and the U.S. cereal production 1.7 percent lower. The U.S. cereal cropped acreage decreases by 1 percent, which favors other crop production (the U.S. oilseed production increases by 0.2

percent). The removal of insurance subsidies is partly shared by landowners: the rental rate of cereal land decreases by 5.7 percent. The value added generated by the U.S. cereal sector decreases. However, the U.S. economy saves insurance subsidies and insurance loading costs. Overall, the U.S. welfare increases by \$1.4 billion. This scenario leads to a decrease of U.S. exports of cereals. Consequently, the economies in the RoW suffer from the price increases: their welfare decreases by nearly \$0.3 billion. The world welfare increases by \$1.1 billion. Our market results are qualitatively similar to those obtained by Young et al. and more recently by Lusk. They empirically differ because of data and calibrated elasticities. Our welfare results look like those obtained by Lusk but are slightly different. We obtain global welfare gains only because we remove insurance loading costs. The sole removal of insurance subsidies, while maintaining useless insurance loading costs, leads to a global welfare loss of \$0.8 billion (and a 3.6 percent decrease of the U.S. cereal production). This is mostly explained by the increased policy distortions (ad valorem tariffs) that prevail in the RoW. These first results already signal that defining a welfare increasing policy reform is not trivial.

The second column of Table 1 reports the results of the same policy experiment when we use the dynamic and stochastic CGE model with risk neutral farm household. The expected production now decreases by 4 percent. This impact is higher than it was previously, partly because we assume here that U.S. farm households do not react to the price increase (this will be taken into account in the sensitivity analysis). The average (ex post) U.S. market price now increases by 1.4 percent. The U.S. cereal acreage decreases by 1.6 percent and the U.S. cereal yield by 2.4 percent. This is partly explained by the less expensive land input (the rental rate decreases by 8.4 percent) compared to other inputs (the price of manufactured goods, including fertilizers and chemicals, does not change). Unsurprisingly, we find that the U.S. farm household no longer insures its cropped acreage. The initial insurance demand was only motivated by a profit effect. This effect disappears with the removal of these insurance subsidies and maintained insurance loading costs. In terms of welfare, we report the ex ante equivalent variation measures. We find that the U.S. farm household loses from this scenario (\$0.6 billion). However, we still find that the U.S. economy enjoys welfare gains thanks to reduced subsidies and now useless insurance loading costs. The global ex ante welfare increases by \$0.7 billion. This is slightly less than the ex post welfare gain obtained with the previous static CGE model. This is partly explained by the price misperceptions of economic agents (see below).

The third column reports the results when we use the dynamic and stochastic CGE model with risk-averse farm households. The expected production now decreases by 7.4 percent, with cereal acreage decreasing by 3 percent and yield by 4.4 percent. The production decrease is 3.4 percent higher than the previous result. Our simulated coverage/risk sharing effect on production provided by the subsidized insurance programs is hence close to the profit effect. This is similar to the OECD simulation results (OECD, 2005) and in line with recent econometric evidence supporting the important coverage effect (Yu et al., 2016). More debatable is the yield effect. We find that it decreases by 4.4 percent compared to a 2.4 percent decrease when we exclude risk aversion. This larger yield effect is partly explained by the evolution of the land rental rate: it now decreases by 15 percent (compared to 8.4 percent). Quite debatable is the result of insured acreages. We find that farmers insure 73.2 percent of insurable acreage (hence 62 percent of cropped acreage). This is much higher than the insured acreage observed in the 1980s. However, the situations are not fully comparable. We focus here on revenue insurance, not on yield insurance. Furthermore, we make the simplifying assumption that economic agents cannot manage price risks on future markets. The results can be different if other risk management strategies (and their respective costs) are introduced in the analysis (see OECD, 2005). In terms of ex ante welfare effects, we again find that the U.S. farm households lose from this policy scenario. Even if the ex post prices increase, they

produce less and generate less value added. Now we find that the U.S. economy no longer gains: the U.S. ex ante welfare decreases by as much as \$0.9 billion. This is explained by the reduced U.S. production of cereals and the fact that insurance products are still used by farmers. Hence, insurance production costs are not totally saved. The economies in the RoW suffer more (\$0.8 billion). We finally find that the global economy suffers a welfare loss following the removal of premium subsidies (by \$1.7 billion).

4.2. Impacts of removing direct payments

In a theoretical first best world with complete contingent markets, no frictions and policy distortions, a direct payment to a fixed factor is decoupled from production decisions (Chambers and Voica, 2016). In other cases, it is impossible to know a priori the magnitude of production impacts of these direct payments. We simulate the removal of direct payments provided to cereal producers with our two CGE models.

The modeling of market/welfare effects of direct payments provided to farmers remains debated (Urban et al., 2016; Boulanger and Philippidis, 2015). In the standard GTAP approach, these direct payments are split arbitrarily into farm activities and primary factor returns. The modeler has the choice to modify this allocation. For instance, if we assume that all direct payments are allocated to the fixed factor (capital in our case), then the removal of these payments has no market impacts. We only get a transfer between non-farm and farm households. However, if we assume that part of these payments is diluted in mobile factors, then we can expect production effects. The degree of capitalization of direct payments into the land price (rental or buying prices) remains controversial because of frictions on the land market in particular (Kirwan and Roberts, 2015). We do not model these frictions. Rather, we test whether the market and welfare impacts of direct payments are similar across our two CGE models, conditional on the initial modeling of these direct payments. Table 2 reports the results of this policy experiment.

Let us start again with the static CGE model (first column). The removal of U.S. direct payments (precisely those payments attached to land and labor used in the cereal sector) induces a decrease of the U.S. cereal production because of a reduction of both cropped acreage and expected yield. We again find a small increase of the U.S. cereal market price and a decrease of the land rental rate. The welfare effects are negative because of policy distortions in other activities.

When we use our CGE models with farm households, the market results of this policy experiment are rather similar. Precisely, the U.S. expected production of cereals decreases by 1.27 percent without risk aversion and by 1.34 percent with risk aversion. The difference corresponds to a so-called wealth effect. Compared to the static CGE model, we obtain slightly larger production and price effects because we assume that the U.S. farm household makes price expectation errors in the short run. We also find that the U.S. farm household fully insures insurable acreage. Interestingly, we find that the risk attitude of U.S. farmers does not matter much when assessing the welfare effects of direct payments: the global welfare losses are quite similar (\$0.3 billion). Conditional on the initial modeling of U.S. direct payments in the GTAP framework, we find that these direct payments mostly generate profit effects, limited wealth effects and no coverage/risk sharing effects.

4.3. Sensitivity analysis

We already recognize that our dynamic and stochastic CGE with farm households is based on many simplifying assumptions in addition to those of the static CGE model. We found previously that the market and welfare impacts of premium subsidies depend on the modeling choice. We now test whether these differences are sensitive to three modeling assumptions.

The first test focuses on the price expectation by the U.S. farmers. Thus far, we assume that the U.S. farm household does not anticipate that the decrease of its expected production level will induce a market price increase. This is a short-run view that is less likely in the medium/long run. We now assume that the U.S. farm household is able to partly anticipate this price increase: by 1 percent without risk aversion, by 2 percent with the risk aversion. Selected results are reported in Table 3 (that must be compared to Table 1). As expected, we find different market effects. For instance, assuming a risk-averse farm household, the expected U.S. cereal production decreases by 5.3 percent following the removal of premium subsidies (compared to 7.4 percent in the central case). The magnitude of welfare effects also differs. The U.S. farm households lose more in that case (\$1.6 billion compared to \$0.6 billion) because the simulated market prices increase less (on average 1.8 percent compared to 2.6 percent). Above all, the global welfare results remain highly sensitive to the risk aversion assumption. Removing the premium subsidies is welfare improving (decreasing) when the U.S. farm household is risk neutral (averse).

The second test focuses on the composition of the farm household income. Thus far, we assume that the initial off-farm income receipts equal the initial capital replacement expenditures. We now assume that the initial capital replacement expenditures are null, that the initial off-farm income receipts represent 25 percent of the farm household income. We assume that this “exogenous” income is fixed (to be precise, in a CGE model, prices are endogenous; we just fix the quantity of off-farm labor). With this exogenous income, the farm household risk premium is initially different. We recalibrate the risk aversion parameter such that this risk premium represents 5 percent of the standard deviation of the farm household income. Selected results of the premium subsidy scenarios are reported in Table 4. If the farm household is risk neutral, the market and welfare effects are exactly equal to those obtained earlier. This is expected because the U.S. farm household’s decision does not depend on this wealth. When we assume risk aversion, the market impacts are again similar to the previous ones. However, the welfare effects are slightly different. The loss of the U.S. farm household is less important (\$0.05 billion compared to \$0.6 billion in the central case). The reason is the insurance decision. We find a significant decrease of insured acreage to 35 percent of cropped acreage. In other words, we find that the price sensitivity of the demand for insurance products depends on the extent of total economic risks faced by farmers. We also find that the global welfare losses are less important (\$1.2 billion compared to \$1.7 billion).

The third test focuses on the distribution of productive shocks. Thus far, we assume a normal distribution for the productivity shocks and then simulate the CGE model to get the initial price distribution, supposing that the U.S. economic agents (the farmer, the insurance industry, and the RMA) perfectly know the initial distribution. Many efforts have been devoted to identifying the true distribution of crop yields and in particular to improving the efficiency of rating procedures. Of the numerous alternative distributions, we adopt a log normal distribution in this sensitivity analysis. We adopt the same calibration procedure (we adjust the mean to replicate ex post indemnities from revenue insurance), maintaining 10 contingent states. The adoption of this lognormal distribution leads to less dispersed indemnities, compared to the normal distribution: 7 contingent states lead to indemnities (compared to 6 with the normal distribution). The coefficient of variation of net

indemnities perceived by the U.S. farm households is 1.6 (compared to 2.0). Maximum indemnities remain large (\$12.6 billion) but less than those with the normal distribution (\$15.5 billion). The effects of the removal of premium subsidies are reported in Table 5. Market results do not differ much compared to the central case results. The impacts on expected production are slightly lower because there are few extremely negative contingent states that the risk-averse farm household wants to avoid. Interestingly, we find that the risk-averse U.S. farm household no longer loses from the policy shock. This is partly explained by the reduction of insured acreages to 48 percent of insurable acreage (hence 41 percent of cropped acreage). However, the global welfare effects remain quite robust: from positive without risk aversion to negative with risk aversion.

5. Concluding comments

The U.S. farm policy has progressively changed in recent years, with greater reliance on subsidized risk management programs to the detriment of direct payments. Many agricultural economists consider that this policy shift is unwarranted, leading to greater market distortions. While there are many econometric studies identifying the production and management responses of farmers to these policy instruments, few efforts assess the macroeconomic and efficiency impacts of the U.S. farm bills. In this paper, we partially fill this gap, recognizing that any macroeconomic evaluation tool requires a mass of critical assumptions. We develop two CGE models focused on the U.S. agricultural sector, with and without risk-averse farm households. This allows us explicitly capture the coverage effects provided by subsidized insurance programs in addition to the profit effects. We find that the welfare effects of subsidized insurance programs are dramatically modified once we recognize the risk sharing properties of these programs. By contrast, the welfare effects of direct payments remain independent of the risk attitude of farm households.

It is no surprise that the modeling assumptions can critically influence the results. For instance, assuming incomplete contingent markets and unequal initial marginal rates of substitution between producers and consumers, Innes (1990) defines optimal price support programs in a static partial equilibrium framework. More recently, Gouel (2013) defines optimal public storage policy in a similar, but dynamic, partial equilibrium framework. In this paper, we obtain qualitatively similar results on the subsidized U.S. revenue insurance programs, starting from a widely used CGE framework.

Our analysis relies on many assumptions that prevent us from being definitive on the absolute efficiency of subsidized insurance programs. In particular, we do not include the various risk management strategies that farm households can develop with other economic agents (futures or marketing contracts), on the farm (crop diversification) or off of the farm (off-farm employment), or over time (investment/saving decisions) or that the farm household can expect (disaster payments). Doing so requires the measurement of their relative costs and benefits in terms of risk sharing. We also do not include other potential market failures, such as informational issues or non-market environmental effects. In this paper, we focus on the prominent subsidized insurance programs that are extensively debated and relatively well documented. In the forthcoming U.S. farm policy debate, the risk sharing property of subsidized insurance programs should not be omitted, as this empirical paper demonstrates.

References

- Babcock B., Choi E.K., Feinerman E. (1993).** Risk and Probability Premiums for CARA utility functions. *Journal of Agricultural and Resources Economics*, 18(1): 17-24
- Babcock B. (2015).** Using cumulative prospect theory to explain anomalous crop insurance coverage choice. *American Journal of Agricultural Economics*, 97(5): 1371-1384
- Ball E. (1988).** Modelling Supply Response in a Multiproduct Framework. *American Journal of Agricultural Economics*, 70(4): 813-825
- Boulanger P., Philippidis G. (2015).** The EU budget battle : Assessing the trade and welfare impacts of CAP budgetary reform *Food Policy*, 51: 119-130
- Boussard J.M., Gerard F., Piketty M.G., Ayouz M., Voituriez T. (2006).** Endogenous risk and long run effects of liberalization in a global analysis framework. *Economic modelling*, 23(3): 457-475
- Chambers R.G., Voica D.C. (2016).** “Decoupled” Farm Program Payments Are Really Decoupled: The Theory. *American Journal of Agricultural Economics*
- Claassen R., Just R.E. (2009).** Heterogeneity and distributional form of farm-level yields. *American Journal of Agricultural Economics*, 91(1): 144-160
- Claassen R., Langpap C., Wu J. (2016).** Impacts of Federal Crop Insurance on Land Use and Environmental Quality. *American Journal of Agricultural Economics*
- Cornaggia J. (2013).** Does risk management matter? Evidence from the U.S. agricultural industry. *Journal of Financial Economics*, 109: 419-440
- Du X., Ifft J., Lu L., Zilberman D. (2015).** Marketing Contracts and Crop Insurance. *American Journal of Agricultural Economics*, 97(5): 1360-1370
- Du X., Feng H., Hennessy D.A. (2016).** Rationality of Choices in Subsidized Crop Insurance Markets. *American Journal of Agricultural Economics*
- Deruygina T., Kirwan B. (2016).** Does The Samaritan’s Dilemma Matter? Evidence From U.S. Agriculture. Working paper.
- Farrin K., Miranda M.J., O’Donoghue E. (2016).** How Do Time and Money Affect Agricultural Insurance Uptake ? A New Approach to Farm Risk Management Analysis. USDA ERS Report 212, 34 p.
- Femenia F., Gohin A., Carpentier A. (2010).** The decoupling of farm programs. Revisiting the wealth effects. *American Journal of Agricultural Economics*, 92(3): 836-848
- Gardner B. L. (1992).** Changing Economic Perspectives on the Farm Problem. *Journal of Economic Literature*, 30(1): 62-101
- GAO. (2009).** Crop Insurance: Opportunities Exist to Reduce the Costs of Administering the Program. Report GAO-09-445.
- Gerlt S., Thompson W., Miller D.J. (2014).** Exploiting the Relationship between Farm-Level Yields and County Level Yields for Applied Analysis. *Journal of Agricultural and Resource Economics*, 39(2): 253-270
- Glauber J. (2016).** Crop Insurance and Private Sector Delivery. Reassessing the Public-Private Partnership. Working paper.
- Goodwin B.K., Smith V.H. (2013).** What harm is done by subsidizing crop insurance ? *American Journal of Agricultural Economics*, 95(2): 489-497
- Goodwin B.K., Smith V.H. (2015).** The 2014 Farm Bill. An Economic Welfare Disaster or Triumph? In Smith V. The Economic Welfare and Trade Relations Implications of the 2014 Farm Bill. 10 p.

- Gouel C. (2013).** Optimal food price stabilisation policy. *European Economic Review*, 57: 118-134
- Hanson K., Somwaru A. (2003).** Distribution Effects of U.S. Farm Commodity Programs: Accounting for Farm and Non-Farm Households. Working paper.
- Hertel T.W. (1997).** *Global Trade Analysis. Modeling and Applications*. Cambridge University Press. 403 p.
- Ifft J.E., Kuethe T., Morehart M. (2015).** The impact of decoupled payments on U.S. cropland values. *Agricultural Economics*, 46: 643-652
- Ifft J.E., Kuethe T., Morehart M. (2015).** Does federal crop insurance lead to higher farm debt use? Evidence from the Agricultural Resource Management Survey (ARMS). *Agricultural Finance Review*, 75(3): 349-367
- Innes R. (1990).** Government Target Price Intervention in Economies with Incomplete Markets. *The Quarterly Journal of Economics*, 105(4), 1035-1052
- Just R.E., Hueth D.L., Schmitz A. (2005).** *The Welfare Economics of Public Policy. A Practical Approach to Project and Policy Evaluation*. Edward Elgar Publishing, 688 p.
- Keeney R., Hertel T. (2005).** GTAP-Agr: A Framework for Assessing the Implications of Multilateral Changes in Agricultural Policies. GTAP Technical Paper 24, 60 p.
- Key N., Prager D., Burns C. (2017).** Farm Household Income Volatility: An Analysis Using Panel Data From A National Survey. USDA ERS Report 226, 43 p.
- Kirwan B., Roberts M. (2016).** Who really benefits from agricultural subsidies ? Evidence from field level data. *American Journal of Agricultural Economics*,
- Kuethe T., Paulson N.D. (2014).** Crop Insurance Use and Land Rental Agreements. Working paper.
- Lusk J.L. (2017).** Distributional effects of crop insurance subsidies. *Applied Economic Perspectives and Policy*, 39(1): 1-15.
- Miao R., Hennessy D., Feng H. (2016).** The effects of crop insurance subsidies and sodsaver on land use change. *Journal of Agricultural and Resource Economics*, 41(2): 247-265
- OECD (2005).** The impact on production incentives of different risk reducing policies. AGR/CA/APM(2004)16/FINAL, 36p.
- Okrent A.M., Alston J. (2012).** The Effects of Farm Commodity and Retail Food Policies on Obesity and Economic Welfare in the United States. *American Journal of Agricultural Economics*, 94(3): 611-646
- Pope R.D., Lafrance J.T., Just R.E. (2011).** Agricultural Arbitrage and Risk Preferences. *Journal of Econometrics*, 162(1): 35-43
- Ramirez O., Shonkwiler J.S. (2017).** A probabilistic model of the crop insurance purchase decision. *Journal of Agricultural and Resource Economics*, 42(1): 10-26
- Smith V., Glauber J., Dismukes R. (2016).** Rent Dispersion in the US Agricultural Insurance Industry. Working paper
- Tolhurst T.N., Ker A.P. (2014)** On Technological Change in Crop Yields. *American Journal of Agricultural Economics*, 97(1): 137-158
- Urban K., Jensen H.G., Brockmeier M. (2016).** How decoupled is the Single Farm Payment and does it matter for international trade ? *Food Policy*, 59: 126-138
- Urban K., Boysen O., Brockmeier M., Engelbert T., Jensen H.G., Narayanan B.G. (2016).** Analysing the trade effects of the Transatlantic Trade and Investment Partnership between the EU and the US: Do we need to care about agricultural domestic support? Working paper.

Walters C.G., Shumway C.R., Chouinard H.H., Wandschneider P.R. (2012). Crop insurance, land allocation and the environment. *Journal of Agricultural and Resource Economics*, 37(2): 301-320

Weber J., Key N., O'Donoghue E. (2016). Does Federal Crop Insurance Make Environmental Externalities from Agriculture Worse? *Journal of the Association of Environmental and Resource Economists*, 3(3): 707-742

Woodard J.D., Schnitkey G.D., Sherrick B., Lozano Gracia N., Anselin L. (2012). A Spatial Econometric Analysis of Loss Experience in the US Crop insurance Program. *The Journal of Risk and Insurance*, 79(1), 261-285

Young E., Vandever M.L., Schnepf R.D. (2001). Production and price impacts of US crop insurance programs. *American Journal of Agricultural Economics*, 83(5): 1196-1203

Yu J., Smith A., Sumner D. (2016). The effects of the premium subsidies in the US federal crop insurance program on crop acreage. Working paper

Yu J., Wu J. (2016). Welfare Effects of Publicly Subsidized Crop Insurance Programs: The Sufficient Statistics Approach. Working paper.

Table 1. Market and Welfare Impacts of the removal of premium subsidies (in deviation from the baseline)

Model	Static EGC	Dynamic and stochastic EGC No risk aversion	Dynamic and stochastic EGC risk aversion
Cereal Market effects (%)			
Expected U.S production	-1.7	-4.0	-7.4
U.S. acreage	0.4	1.4	2.6
Average U.S. price	-1.0	-1.6	-3.0
Rental rate of land	-5.7	-8.4	-15.0
Share of insured acreage	--	0	73.2
Welfare Effects (\$million)			
Farm household	--	-554	-586
Total U.S. economy	1399	1190	-876
Row economies	-287	-436	786
Total	1112	754	-1662

Table 2. Market and Welfare Impacts of the removal of direct payments (in deviation from the baseline)

Model	Static EGC	Dynamic and stochastic EGC No risk aversion	Dynamic and stochastic EGC risk aversion
Cereal Market effects (%)			
Expected U.S production	-0.7	-1.3	-1.3
U.S. acreage	0.2	0.4	0.4
Average U.S. price	-0.4	-0.7	-0.7
Rental rate of land	-2.9	-3.7	-3.8
Share of insured acreage	--	100	100
Welfare Effects (\$million)			
Farm household	--	-442	-397
Total U.S. economy	-45	-207	-198
Row economies	-100	-104	-111
Total	-145	-311	-309

Table 3. Sensitivity of impacts following the removal of premium subsidies to price expectations by the farm household (in deviation from the baseline)

Model	Dynamic and stochastic EGC No risk aversion	Dynamic and stochastic EGC risk aversion
Cereal Market effects (%)		
Expected U.S production	-3.0	-5.3
Average U.S. price	1.0	1.8
Share of insured acreage	0	73.6
Welfare Effects (\$million)		
Farm household	-1137	-1577
Total welfare	927	-1103

Table 4. Sensitivity of results following the removal of premium subsidies to off farm income (in deviation from the baseline)

Model	Dynamic and stochastic EGC No risk aversion	Dynamic and stochastic EGC risk aversion
Cereal Market effects (%)		
Expected U.S production	-4.0	-7.4
Average U.S. price	1.4	2.6
Share of insured acreage	0	40
Welfare Effects (\$million)		
Farm household	-553	-51
Total welfare	754	-1161

Table 5. Sensitivity of results following the removal of premium subsidies to the distribution of TFP shocks (in deviation from the baseline)

Model	Dynamic and stochastic EGC No risk aversion	Dynamic and stochastic EGC risk aversion
Cereal Market effects (%)		
Expected U.S production	-2.9	-6.8
Average U.S. price	0.9	2.3
Share of insured acreage	0	48
Welfare Effects (\$million)		
Farm household	-929	62
Total welfare	1099	-769