Politique Agricole Commune et Stabilisation des Revenus et Marchés Agricoles Européens

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Sommaire

Introduction Générale

Les politiques agricoles menées, depuis le milieu du 20ème siècle, dans la plupart des pays développés ont eu pour premier objectif de soutenir le revenu des agriculteurs. Pour ce faire, les instruments de marchés initialement instaurés visaient à maintenir les prix agricoles à un niveau stable et constant sur les marchés intérieurs de ces pays. Malheureusement, si ces objectifs ont été atteints, l'application des politiques de soutien des prix a généré des coûts très importants pour les pays protecteurs, et a surtout entraîné une déstabilisation, accompagnée d'une baisse, des prix mondiaux (Tyers et Anderson, 1992). Ce phénomène est notamment lié aux subventions à l'exportation et protection à l'importation variables que ces pays ont du mettre en place pour protéger leurs prix nationaux. C'est pourquoi, sous la pression de la communauté internationale, l'Union Européenne (UE) a, dès 1992, commencé à modifier son système de soutien à l'agriculture en remplaçant, par exemple, une partie du soutien direct des prix par des aides à l'hectare (voir Butault et al. (2004) pour un historique complet de la Politique Agricole Commune (PAC) européenne). Ces aides ont toutefois aussi des effets sur la production, et par conséquent sur les prix, même si ceux-ci sont plus limités. Ainsi, dans sa réforme de la PAC de 2003, l'UE a mis en place un système dont le principe repose sur des aides attribuées sous forme d'une prime unique, calculée par exploitation en fonction d'une référence historique et versée qu'il y ait ou non production. Ce processus de découplage des aides vise donc à remplacer des subventions étroitement liées aux rendements et aux prix agricoles par des subventions indépendantes des conditions de marché. Les aides découplées ont théoriquement moins d'effets distorsifs sur la production, les prix et les échanges et s'inscrivent, de ce fait, dans les mesures autorisées par l'Organisation Mondiale de Commerce (OMC) visant à favoriser la libéralisation des marchés. Le découplage des aides a été renforcé lors du bilan de santé de la PAC en 2008, et il est fort probable que la part des subventions agricoles européennes aujourd'hui encore liées à la production ou aux prix soit fortement réduite, voire totalement supprimée, lors de la prochaine réforme de la PAC en 2013.

Cette évolution des instruments de la PAC, si elle s'opère toujours avec l'objectif de soutien des revenus, interroge toutefois sur son aspect stabilisation des marchés et revenus agricoles. Les aides directes européennes étant de plus en plus déconnectées de la production et des conditions de marché, les niveaux des prix d'intervention étant toujours plus bas, le risque existe en effet potentiellement pour les producteurs agricoles d'être confrontés à des fluctuations des prix de marché plus importantes que par le passé, et par suite à une plus grande fluctuation des recettes et profits tirés des activités de production. En contrepartie, les aides directes contribuent de plus en plus à la formation des revenus agricoles et procurent, à politique inchangée, une source fixe et sûre de revenu. L'effet net sur la volatilité des revenus agricoles et sur l'utilité des producteurs agricoles, généralement considérés comme averses au risque, est donc théoriquement ambigu et nécessite des analyses empiriques. Face à cette éventuelle variabilité accrue des prix agricoles et en anticipation d'une possible évolution (à la baisse) du niveau des aides directes, les acteurs agricoles français insistent aujourd'hui sur le maintien d'un volet gestion des risques dans la PAC. C'est dans cet esprit que sont soutenus publiquement de nouveaux systèmes permettant de gérer les risques (aide au stockage privé, assurance, provisions fiscales, épargne subventionnée, ...). Cette évolution observée en France se retrouve globalement dans les autres pays européens à des degrés divers selon les instruments, et suscite évidemment de nombreuses interrogations. Tout particulièrement, se pose la question des effets des nouveaux instruments de gestion des risques sur les décisions des producteurs (décisions de souscription aux nouveaux systèmes par exemple, mais également décisions de choix et de volume de production), et par suite la question des effets induits sur les marchés et leur acceptabilité internationale si ces instruments impliquent un certain soutien public.

L'évolution de la PAC vers des instruments de gestion des risques est peu analysée par les modèles économiques de marchés qui sont pour la plupart déterministes. L'enjeu principal de cette thèse est donc d'introduire de l'incertitude dans ces modèles pour pouvoir évaluer ces nouveaux instruments. Il s'agit notamment d'apprécier dans quelle mesure ces instruments ont un effet sur les productions et les marchés. Or, la modélisation macro-économique avec prise en compte de l'incertain est confrontée à de nombreux défis méthodologiques.

Un premier défi méthodologique est lié au fait que l'activité agricole est confrontée à de multiples sources de risques, les plus fréquemment mentionnés étant les risques prix des produits et des inputs et les risques de production. Il faut bien évidemment, avant d'évaluer les effets des instruments de gestion des risques, mesurer ces risques et leur perception par les agents économiques. Une première approche, qui est d'ailleurs la seule solution possible dans les travaux économétriques d'identification des comportements des producteurs, consiste à s'appuyer sur les séries passées, de prix par exemple. Ceci soulève plusieurs difficultés. D'une part, cela ne reconnaît pas le fait que la volatilité de ces séries évolue avec le temps, et ce même en dehors de tout changement significatif de politique agricole (Goodwin et Ker, 2002). Surtout, cela ne prend pas explicitement en compte les évolutions récentes des politiques agricoles. Masters et Garcia (2010), par exemple, ont montrer empiriquement qu'il existait un lien entre les politiques commerciales mises en place et variabilité des prix agricoles dans les pays concernés. L'approche proposée dans cette thèse consiste plutôt à simuler la volatilité qui pourraient survenir sur les marchés dans l'avenir, suivant en cela les premiers travaux menés par Hertel et ses collègues de l'université de Purdue (Hertel et al., 2005) avec le modèle d'Equilibre Général Calculable (EGC) GTAP [1]. L'idée principale est d'introduire des chocs exogènes de production dans les différentes régions du monde spécifiées dans la modélisation. L'intérêt de la modélisation en EGC est ici double. Elle offre en effet la possibilité de mesurer, d'une part la volatilité des marchés sous différents

1. Le projet GTAP (Global Trade Analysis Project) a débuté en 1993 à l'université de Purdue. Il bénéficie aujourd'hui de collaborations du monde entier et a pour but d'améliorer l'analyse en équilibre général de questions économiques globales. Les travaux menés dans le cadre de ce projet portent sur le développement des modèles d'EGC, mais également sur l'amélioration des bases de données utilisées par ces modèles

scénarios d'évolution des politiques agricoles et commerciales, et d'autre part la volatilité des revenus agricoles dans les différents secteurs, ce qui est une condition préalable à l'étude des instruments spécifiques de gestion des risques. Pour ces raisons, la version agricole du modèle GTAP, très utilisée dans les débats internationaux sur les politiques agricoles, constitue le point de départ des modèles développés dans cette thèse. Ces modèles serviront à simuler la volatilité des prix et des revenus agricoles européens pouvant apparaître à l'avenir, suite à des réformes. Dans une vision progressive du travail, l'accent sera ici porté aux secteurs des grandes cultures.

Un second défi méthodologique réside dans le fait que les impacts des instruments publics de gestion des risques vont dépendre, en plus de l'ampleur éventuelle des risques, du comportement des acteurs vis-à-vis de ceux-ci. Ces comportements sont aujourd'hui très imparfaitement pris en compte dans les modèles de simulation, si ce n'est complètement ignorés dans la majorité des recherches. L'un des objectifs de la thèse est donc de combler ce vide. La théorie du comportement vis-à-vis du risque est généralement considérée comme bien établie mais sa mise en oeuvre est extrêmement délicate, notamment à cause de problèmes de disponibilités de données micro-économiques. Par exemple, les données sur la richesse des agents sont difficiles à collecter, ce qui contrarie notoirement l'identification de leurs degrés d'aversion au risque. En fait, en économie de la production agricole, les difficultés sont d'identifier simultanément ces degrés d'aversion au risque, les technologies de production et les anticipations des producteurs. Face à cette difficulté qui ne pourra être résolue, au mieux, qu'à moyen terme car il importe de disposer de données sur période assez longue (Just, 2003), nous avons choisi dans cette thèse de nous focaliser sur la question des anticipations et de tester par simulations différentes structures pour les anticipations des agents économiques en les intégrant dans les modélisations en EGC.

Enfin, un troisième défi méthodologique est de modéliser les instruments spécifiques de gestion des risques qui peuvent être envisagés et les réactions des agents vis à vis de ceux-ci. Si, dans les modèles de producteur, il est possible d'introduire ces instruments, il est en revanche nettement plus difficile d'étudier les interactions entre les différents types d'instruments mis en oeuvre, ainsi que leurs impacts sur l'ensemble des marchés avec ce type de modèle. Les modèles développés dans cette thèse nous permettent de palier à ces difficultés en offrant la possibilité d'intégrer ces instruments de gestion des risques dans une modélisation en EGC dynamique. Nous nous intéressons en particulier ici à un type d'instrument privé sur lequel les politiques publiques peuvent intervenir : le stockage.

Cette thèse sur articles est structurée en trois parties, chaque partie comportant deux chapitres (deux articles).

La première partie est consacrée à la présentation du contexte de la thèse. Un premier article (Chapitre 1) définit les enjeux liés au rôle des politiques agricoles dans la stabilisation des revenus et des marchés agricoles. Cet article passe en revue les différents arguments présents dans la littérature concernant, d'une part l'évaluation du risque de marché en agriculture et de son impact économique, d'autre part les forces et faiblesses des instruments privés de gestion du risque, et enfin la nécessité d'une intervention publique visant à stabiliser les revenus agricoles. Cette revue de littérature fait tout d'abord ressortir un certain nombre de controverses sur la quantification des risques agricoles et sur l'efficacité des instruments privés de gestion du risque. Il apparaît également que la définition d'une éventuelle intervention publique pour stabiliser les marchés et revenus agricoles en Europe est loin d'être tranchée. Des travaux de modélisation intégrant notamment les caractéristiques spécifiques des risques agricoles sont donc utiles pour éclairer la décision publique et nourrir les futurs débats sur l'évolution de la PAC. En termes politiques, la question centrale est finalement de connaitre le degré d'incomplétude des marchés. Cela nécessite de développer des cadres d'analyse plus sophistiqués que ceux actuellement disponibles, intégrant notamment de la dynamique et traitant du problème des anticipations. C'est ce à quoi nous nous attachons dans cette thèse en construisant un modèle possédant un certain nombre de caractéristiques nécessaires à l'étude de l'impact des politiques en univers incertain. Ce modèle dynamique intégrant différentes formes d'anticipation est développé à partir du modèle d'EGC statique GTAP AGR. Ce dernier est une version du modèle GTAP adaptée plus particulièrement à l'analyse des politiques agricoles, toutefois la façon dont les instruments de la PAC y sont représentés est discutable. Ce point fait l'objet du second article de la première partie (Chapitre 2). Dans cet article nous mettons en effet en évidence les limites du modèle GTAP AGR concernant la calibration et la modélisation de certains instruments spécifiques de la PAC. Nous nous intéressons ainsi, par exemple, à la représentation des droits de douanes et subventions à l'exportation variables dans ce modèle. Ces deux éléments clé du soutien des prix européens ne sont en fait pas correctement pris en compte dans la version "standard" du modèle : ils sont modélisés comme de simples instruments *ad valorem*, ce qui ne tient pas compte de leur fonction de soutien des prix européens. Après avoir modifié la représentation de la PAC dans le modèle GTAP AGR, nous conduisons donc des simulations afin de tester la robustesse des évaluations passées à la représentation de cette politique complexe. Ces nouvelles simulations révèlent qu'une calibration et une modélisation plus justes de la PAC peuvent conduire à des résultats très différents en termes d'implication politique que ceux simuler habituellement à l'aide de modèles d'EGC tels que celui-ci, et ce avant même d'introduire de la dynamique dans le modèle. Les améliorations apportées ici au modèle GTAP AGR seront également intégrées à notre modélisation lors des simulations politiques conduites dans la troisième partie de la thèse.

Ayant décrit le contexte et les enjeux de la thèse, une seconde partie est consacrée aux aspects de modélisation et au développement du modèle d'EGC dynamique à partir duquel seront conduites les simulations politiques. Ainsi, le premier article de cette partie (Chapitre 3) décrit comment nous avons développé, à partir du modèle statique GTAP AGR, un modèle d'EGC dynamique capable de prendre en compte différents types d'anticipations, quelles soient parfaites ou adaptatives, voire naïves. De plus, et contrairement à la plupart des modèles d'EGC dynamiques existant qui adoptent une approche récursive, notre modèle intègre la dimension inter temporelle des décisions des agents économiques. Ce modèle nous permet ainsi d'évaluer la robustesse des résultats obtenus à partir de modèles statiques à la modélisation cohérente des comportements dynamiques et à la spécification des anticipations de prix. En nous focalisant sur le scenario d'une libéralisation complète des marchés des grandes cultures dans les pays développés, nous trouvons que les résultats statiques disponibles actuellement sont relativement robustes aux spécifications dynamiques, et ce pour la plupart des schémas d'anticipation. Des fluctuations de marchés endogènes, liées aux erreurs d'anticipation des agents, peuvent apparaitre suite à la libéralisation, elles sont toutefois limitées par de nombreux effets de rétroaction que permet de prendre en compte la modélisation en équilibre général. Nous disposons donc d'un cadre de modélisation propice à la simulation de la volatilité sur les marchés agricoles, tant dans son aspect exogène (lié à des chocs d'offre par exemple), qu'endogène (lié aux erreurs d'anticipation). Pour simuler les effets d'instruments de gestion des risques sur cette volatilité, il convient également de représenter ces instruments dans le modèle. C'est l'objet du deuxième article de cette partie (Chapitre 4) dans lequel nous nous intéressons plus précisément à l'un de ces instruments : le stockage. Les comportements des stockeurs privés, basés sur des arbitrages inter temporels, jouent en effet un rôle important dans la dynamique des prix. La plupart des études économiques s'intéressant à ce sujet ont montré que ces comportements permettaient de stabiliser les marchés. Cependant, ces études posent toutes l'hypothèse d'anticipations rationnelles et se concentrent donc exclusivement sur l'aspect exogène de la volatilité. Or, il est parfois avancé que des comportements spéculatifs non rationnels pourraient en fait avoir tendance à déstabiliser les prix. Dans cet article nous intégrons donc, de façon endogène, des comportements de stockage privés à notre modèle d'EGC dynamique. Les résultats de nos simulations montrent que, même lorsque les spéculateurs ont des anticipations imparfaites, leurs comportements tendent à réduire la volatilité sur les marchés agricoles, sauf dans quelques cas extrêmes où les stockeurs sont plus “naïfs” que les autres agents, ce qui parait peu réaliste.

Le modèle développé dans la seconde partie est utilisé dans la troisième partie de la thèse pour répondre à notre problématique de départ et évaluer, d'une part l'impact des réformes de la PAC sur la volatilité des marchés agricoles, et d'autre part l'effet d'un nouvel instrument potentiel de gestion des risques : une subvention du stockage privé. Dans un premier article (Chapitre 5), nous nous intéressons à la façon même dont les politiques agricoles peuvent être réformées. En effet, les analyses économiques des politiques agricoles se concentrent en général sur les effets de long terme et les aspects dynamiques transitionnels sont négligés. Dans cet article nous simulons, à l'aide de notre modèle d'EGC dynamique, un scenario de réforme de la Politique Agricole Commune. Nous nous intéressons à la même réforme, mise en place de façon abrupte ou de façon progressive. Nous résultats montrent que, si les agents économiques sont capables de parfaitement anticiper les impacts de la réforme, étaler l'implémentation de la réforme dans le temps n'est jamais optimal. D'un autre côté, si les agents ajustent progressivement leurs anticipations en fonction de l'information qu'ils reçoivent, une réforme progressive peut, dans certains cas, améliorer le bien être. Une telle réforme permet en fait de minimiser les coûts d'ajustement. Ainsi, une mise en oeuvre progressive, et non abrupte, des futures réformes de la PAC permettra de limiter l'augmentation du risque sur les marchés agricoles qu'elle risque d'engendrer. Enfin, le second article de cette troisième partie (Chapitre 6) reprend plusieurs éléments décrits précédemment : nous simulons les effets d'une subvention au stockage privé sur la volatilité des marchés agricoles ; volatilité accrue suite à une réforme (progressive) de la PAC comprenant notamment la suppression du soutien des prix agricoles. En effet, comme nous l'avons montré dans le Chapitre 4, les comportements des stockeurs privés tendent à réduire la volatilité sur les marchés agricoles, que celle-ci soit de source exogène ou endogène. On pourrait donc, à première vue, penser qu'encourager l'activité de stockage en subvention le stockage privé, constitue une solution à la déstabilisation des marchés induite par la réforme. Nos résultats montrent que ce n'est pas si évident. En effet, même si les résultats que nous obtenons ici confirment, d'une part la déstabilisation des marchés européens induite par la suppression de la PAC dans les secteurs des grandes cultures, et d'autre part l'effet stabilisateur du stockage compétitif, la mise en place d'une aide publique, certes assez rudimentaire, visant à encourager ce stockage vient en fait "brouiller" les signaux de marché envoyés aux producteurs agricoles et a, de ce fait, un effet déstabilisateur sur les marchés agricoles.

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Première partie

Définition du contexte et des enjeux de la thèse

Chapitre 1 Faut-il une intervention publique pour stabiliser les marchés agricoles ? Revue des arguments et des questions non résolues [1]

Résumé

La stabilisation des revenus et marchés agricoles est, avec le soutien des revenus des agriculteurs, l'un des objectifs initiaux de la Politique Agricole Commune (PAC). Les mécanismes d'intervention ont longtemps permis de viser ces deux objectifs simultanément. Toutefois, les réformes successives de la PAC ont progressivement réduit les niveaux de ces instruments de gestion de marché au bénéfice de l'instauration d'aides de plus en plus découplées de la production et des prix. Cette évolution des instruments de la PAC interroge sur son aspect stabilisation des marchés. Se pose alors la question de savoir si la mise en oeuvre de nouveaux systèmes permettant de gérer des situations risquées (assurance, marchés à terme, contrats d'option, crédits, stockage, ...) doit être facilitée par la puissance publique. Cet article passe en revue différentes questions présentes dans la littérature concernant, d'une part l'évaluation du risque de marché en agriculture et de son impact économique, d'autre part les forces et faiblesses des instruments privés de gestion du risque, et enfin la nécessité d'une intervention publique visant à stabiliser les revenus agricoles. Nous soulignons en conclusion les questions non résolues qui devront être étudiées par la suite pour traiter la question de l'optimalité, ou non, de l'intervention publique.

1. Cet article, co écrit avec Alexandre Gohin, est accepté pour publication dans la Revue d'Etudes en Agriculture et Environnement/Review of Agricultural and Environmental Studies

Introduction

La faible réaction au prix de la demande de biens agricoles, couplée à la rigidité de l'offre à court terme, rend les marchés agricoles particulièrement volatiles : le moindre choc d'offre ou de demande entraîne une variation de prix de forte amplitude. Ce phénomène, appelé effet King, fait l'objet d'un consensus dans la littérature économique (Butault et Le Mouël, 2004). C'est pourquoi la stabilisation des marchés agricoles est, avec le soutien des revenus des producteurs, l'un des objectifs des politiques agricoles menées depuis le milieu du 20ème siècle, et notamment de la Politique Agricole Commune (PAC) de l'Union Européenne (UE).

Pour répondre à cet objectif de stabilisation, les instruments politiques mis en place initialement visaient à maintenir les prix à un niveau stable et constant sur les marchés intérieurs. En Europe, les prix étaient garantis aux producteurs grâce à un mécanisme d'intervention : en cas de chute des prix, des quantités de biens étaient retirées du marché pour limiter la baisse, puis stockées. Elles étaient ensuite replacées sur le marché quand les prix augmentaient ou exportées. Ce mécanisme nécessitait simultanément la mise en place d'un prélèvement variable sur les importations et de subventions à l'exportation (restitutions variables) afin de maintenir les prix à l'exportation au niveau des prix mondiaux.

Cependant l'application des politiques de soutien des prix a progressivement généré des coûts importants pour l'UE et a surtout déstabilisé les marchés extérieurs, tout en exerçant une pression à la baisse sur les prix mondiaux. Le risque a en fait été transféré du marché européen vers le marché mondial, ce qui a été souligné à plusieurs reprises par plusieurs études (Anderson, 1992; Tyers et Anderson, 1992). Ainsi, pour des raisons budgétaires et sous la pression de la communauté internationale, l'UE a, dès 1992, commencé à modifier son système de soutien à l'agriculture en remplaçant, par exemple, une partie du soutien direct des prix par des aides à l'hectare. Ce processus s'est poursuivi avec les réformes suivantes de 1999 (Agenda 2000), de 2003 (réforme à mi parcours) et 2008 (bilan de santé). Les nouveaux paiements à l'hectare augmentent les niveaux moyens de revenu agricole et par ce biais diminuent leur coefficient de variation. Par ce mécanisme qualifié d'effet richesse, ces paiements directs favorisent la production agricole (Femenia et al., 2010) et par suite tendent également à déstabiliser les marchés.

Cette évolution de la PAC vers moins de régulations directes des marchés agricoles soulève naturellement de nombreuses interrogations, notamment en France. A titre d'exemple, Mazier (2003) considère que ce processus de découplage est problématique car le marché est incapable d'assurer une bonne régulation dans le domaine agricole. Il faudrait donc, selon lui, reconnaître l'exception agricole et revenir aux principes rooseveltiens de soutien des prix. Toutefois, les producteurs ont d'ores et déjà à leur disposition un certain nombre d'instruments privés leur permettant de gérer le risque auquel ils font face. Parmi les instruments les plus fréquemment évoqués dans la littérature, on notera le stockage, le marché du crédit, les contrats d'assurances, les marchés à terme et les contrats d'option. Ces différents outils sont toutefois encore peu utilisés aujourd'hui en Europe, d'une part parce les mesures de soutien des prix appliquées jusque là ne les rendaient pas nécessaires, et d'autre part parce qu'ils peuvent présenter certaines limites. Les politiques publiques de gestion du risque peuvent alors corriger ces limites. Selon Cafiero et al. (2007), elles peuvent agir sur trois leviers principaux : réduire les effets des sinistres éventuels par des politiques préventives, atténuer les effets des sinistres subis par les agriculteurs par des politiques *ex post*, et enfin accroître les capacités de gestion du risque des agriculteurs. Plus particulièrement, les pouvoirs publics peuvent être impliqués de différentes façons dans ce troisième objectif : en réduisant les coûts des assurances (subventions des primes, réduction des coûts de transaction, réassurance, mise à disposition d'information sur les risques, augmentation de la compétition dans le secteur des assurances, offre directe d'assurance), en fournissant un cadre légal pour les marchés d'instruments financiers (marché à terme, options), en réduisant le coût de la gestion des risques par les agriculteurs eux mêmes (épargne subventionnée, accès aux crédits), ou encore en facilitant les transferts d'information. Mais, comme c'est le cas dès qu'il s'agit d'intervention publique, on peut s'interroger sur les effets de telles mesures, sur leur efficacité, leurs impacts potentiels sur les décisions des producteurs et leur acceptabilité internationale.

L'objectif de cet article est de passer en revue les arguments économiques sur l'opportunité d'une intervention publique et d'identifier dans ces débats les questions scientifiquement non résolues. Une première partie est consacrée à une discussion méthodologique sur les sources de risques et des débats sur leurs quantifications. Dans une seconde partie, nous passons en revue les instruments de marché dont peuvent disposer les acteurs pour gérer les risques agricoles. Nous considérons successivement le stockage, les marchés à terme et contrats d'options, les assurances et le marché du crédit en soulignant leurs attraits et limites. Ceci nous amène logiquement, dans une troisième partie, à nous interroger sur la nécessité d'une intervention publique visant à stabiliser les revenus agricoles à travers des instruments de gestion de marché, et à présenter les modalités et les conséquences éventuelles de cette intervention. Enfin, nous concluons sur les résultats déjà acquis et également les questions scientifiques non résolues qui méritent d'être approfondies.

1.1 Les risques en agriculture : sources et quantifications

1.1.1 Les sources

Les prix, marchés et revenus agricoles sont volatiles, et cette volatilité peut s'expliquer par deux types de phénomènes. Pour de nombreux auteurs, les fluctuations des prix agricoles sont d'abord liées à des chocs d'offre et de demande (Moschini et Hennessy, 2001). Il existe en effet un délai entre les décisions de production des agriculteurs et leurs récoltes ; de ce fait l'offre de produits agricoles peut difficilement s'ajuster aux changements de prix, elle est donc rigide à court terme. D'autre part, les produits agricoles sont des produits de base et la demande pour ce type de biens réagit peu aux variations de prix : elle est inélastique. Il en résulte que ce sont les prix qui vont le plus réagir aux chocs éventuels. Ainsi, par exemple, une baisse de l'offre liée à un alea climatique va entraîner une hausse de prix. C'est ce qu'on appelle l'effet de King. La production agricole étant exposée à de nombreux risques tels que les intempéries ou les épidémies, ce type de chocs exogènes est relativement fréquent et entraîne donc d'importantes fluctuations de prix. Les chocs de demande peuvent eux aussi être importants, particulièrement dans le cas de produits destinés au marché international.

Un second phénomène cette fois lié au fonctionnement, ou plutôt au dysfonctionnement, du marché peut contribuer à accentuer les fluctuations de prix. Il est du au décalage entre les décisions de production et les récoltes, et à la possibilité qu'ont les agriculteurs de se tromper quand ils anticipent leur futur prix de vente pour prendre leurs décisions. Le modèle du Cobweb (Ezekiel, 1938) propose une première formalisation de ce processus. Dans ce modèle les anticipations des producteurs sont naïves, c'est-à-dire qu'ils considèrent que le prix au moment de la récolte sera égal au prix de la période passée. Ainsi, si, suite à un aléa climatique par exemple, le prix à la période initiale est supérieur au prix d'équilibre, les producteurs vont anticiper que le prix sera aussi élevé à la période suivante et produire plus que la quantité demandée. La demande étant inélastique, le prix à la seconde période va s'ajuster à la baisse et sera inférieur au prix d'équilibre. A la troisième période les producteurs vont donc anticiper un prix bas et produire peu, ce qui va finalement induire une hausse de prix, et ainsi de suite. Selon la forme des fonctions d'offre et de demande et la valeur de leurs paramètres, ce phénomène peut conduire à une convergence du prix vers un prix d'équilibre ou au contraire à une divergence perpétuelle, c'est-à-dire à des fluctuations cycliques induites par le fonctionnement du marché (Mahé, 1977). Cette théorie est aujourd'hui assez peu fréquemment appliquée dans les modèles économiques sur le risque, notamment à cause des problèmes de convergence qu'elle induit (Chavas et Klemme, 1986). Boussard (1996) montre cependant qu'en introduisant les comportements des producteurs face au risque les prix fluctuent autour du prix optimal sans trop s'en éloigner. De plus, l'hypothèse d'anticipations naïves posée dans le Cobweb est très restrictive. En effet, même si elles ne sont pas rationnelles, les anticipations de prix des agriculteurs sont certainement plus élaborées et se basent sur un ensemble d'informations, et non uniquement sur un prix passé (Chavas, 1999).

1.1.2 Débats sur l'importance des risques

Si la nature des sources de risque affectant l'agriculture est peu débattue, leur importance relative est en revanche très disputée. Nous présentons ci-dessous les débats autour de la mesure statistique de ces risques, du comportement des acteurs vis-à-vis de ces risques (aversion au risque) et de la nature de leurs anticipations.

Mesure statistique des risques

La façon de mesurer les risques est évidemment un point crucial dans ces débats. L'importance des risques a longtemps été capturée par la variance ou encore le coefficient de variation des séries associées. Dans le cas d'une variable aléatoire suivant une loi normale, ces mesures suffisent en effet à caractériser l'événement incertain. Par contre, cela n'est plus le cas si les distributions ne suivent pas une loi normale. De nombreuses recherches ont cherché à identifier les distributions de probabilité des rendements et des prix agricoles (voir par exemple Goodwin et Ker (2002) ou encore OECD (2009a). De manière générale, les résultats montrent que la loi log normale capture mieux ces aléas que la loi normale. Ce résultat dépend toutefois de l'échelle d'agrégation retenue, notamment pour les rendements. Par ailleurs la loi log normale n'est pas non plus très pertinente notamment lorsqu'il y a des événements peu probables.

D'autres indicateurs, caractérisant cette fois plutôt les évènements extrêmes en queue de distribution, s'avèrent alors pertinents. Le coefficient d'asymétrie, qui est le moment centré d'ordre trois, permet d'évaluer le décalage, à gauche ou à droite, d'une distribution. Par exemple, une distribution de prix présentant un coefficient d'asymétrie positif est décalée vers la gauche, ce qui signifie que des pics de prix de très forte amplitude apparaissent épisodiquement, même si cela est peu fréquent. Ce type d'épisode peut être problématique, pour les ménages les plus pauvres tout d'abord, mais aussi pour les producteurs qui, s'ils anticipent que ce type de hausse perdurera dans le temps, peuvent investir et se trouver en situation de surendettement quand les prix retrouvent leur niveau "normal".

Les risques peuvent également être mesurés par la VaR (Value at Risk) qui est un critère très utilisé pour les choix de portefeuille en finance. La VaR est utilisée pour caractériser les pertes possibles des agents : il s'agit de la probabilité de perdre un certain montant au bout d'un certain temps. Ainsi, plus la VaR est faible, moins le risque de pertes à un horizon donné est élevé. Comme le soulignent Manfredo et Leuthold (1999), la VaR pourrait donc avoir plusieurs applications dans les secteurs agricoles ; elle pourrait notamment être utilisée comme guide dans la gestion des risques : en estimant les pertes maximum possibles sur un certain horizon les agriculteurs peuvent choisir de se couvrir ou non, sur les marché à terme par exemple. Avec ces indicateurs, on centre donc la discussion sur les événements défavorables pour un acteur donné sans prendre en compte qu'il peut rencontrer des situations qui lui sont favorables. Au-delà du choix des indicateurs et de leur signification, une autre difficulté avec la mesure statistique des risques provient du fait que celle ci évolue généralement au cours du temps. Ceci peut s'expliquer notamment parce que la série en question a une tendance et/ou un comportement cyclique. Il convient alors d'extraire ces phénomènes potentiellement connus par les acteurs pour vraiment mesurer les risques. Logiquement des débats existent sur la capacité des acteurs à identifier ce qu'il est possible d'anticiper de ce qui ne l'est pas. Par exemple, Modelina et al. (2004) s'appuient sur des modèles de séries temporelles pour estimer la volatilité des prix non anticipée par les agents. Il apparait que cette volatilité "résiduelle" est nettement moins élevée que celle mesurée par le coefficient de variation sur les données de base. Par suite, ces auteurs ne considèrent pas la question des risques en agriculture comme une très grande problématique.

Soulignons enfin que, bien qu'on cherche le plus souvent à quantifier les risques de prix ou de rendements, c'est la stabilité de leurs revenus qui importe le plus aux agents. Or, les fluctuations de prix, lorsqu'elles compensent les fluctuations d'offre ou de demande, peuvent contribuer à stabiliser les revenus. Cette forme d'assurance revenu, liée à la corrélation négative entre production et prix, dépend toutefois du degré d'ouverture des marchés. En effet, plus les marchés sont ouverts et moins les prix sont corrélés aux quantités produites localement. Ensuite, les agriculteurs peuvent produire plusieurs types de biens dont les revenus, bien qu'individuellement instables, sont globalement stables (Newbery et Stiglitz, 1981). Les conséquences d'une stabilisation des prix sur la variabilité du revenu sont donc ambigües. Glauber et al. (1989) montrent d'ailleurs que de nombreux programmes dont l'objectif est de stabiliser les prix agricoles vont en fait déstabiliser le revenu des agriculteurs. Anderson et al. (1977) montrent que les conséquences d'une stabilisation des prix sur la stabilité du revenu dépendent énormément de l'élasticité prix de la demande : ils trouvent que si celle-ci est supérieure à 0.5, une déstabilisation des prix conduira à une déstabilisation des revenus. En d'autres termes, il existe également un débat quant à la variable aléatoire qui mérite *in fine* d'être analysée.

Aversion au risque

L'aversion des agents vis-à-vis du risque est un paramètre crucial pour l'évaluation des effets d'une politique publique visant à réduire les risques. L'hypothèse d'une aversion des producteurs agricoles vis-à-vis du risque fait quasiment l'objet d'un consensus dans la littérature. Cette aversion au risque conduit les agriculteurs à produire une quantité de biens telle que leur coût marginal s'égalise, non pas au prix auquel ils anticipent vendre leur bien, mais à ce prix plus une prime de risque, ce qui fait baisser l'offre agricole. L'aversion au risque des producteurs tient donc un rôle très important dans les pertes de bien être liées à la volatilité des prix.

Si l'aversion au risque des agriculteurs est rarement remise en cause, le niveau de cette aversion et son évolution en fonction de différents paramètres, la richesse des producteurs notamment, font débat. De nombreuses études montrent d'ailleurs que les préférences face au risque sont hétérogènes, même à l'intérieur de groupes d'agriculteurs relativement homogènes (Moschini et Hennessy, 2001). On trouve ainsi dans la littérature des valeurs allant du simple au quintuple pour le coefficient d'aversion au risque des agriculteurs. Pour Just et Peterson (2003) les niveaux d'aversion au risque très élevés qui peuvent ressortir de données observées s'expliqueraient en fait par l'omission de certaines variables qui modifient la perception du risque qu'ont les agriculteurs, leurs comportements en apparence très "prudents" ne seraient donc pas liés à une forte aversion au risque mais au fait qu'ils perçoivent un risque plus important qu'il ne l'est en réalité. Ceci nous amènera à souligner l'importance d'un autre aspect du comportement des producteurs en situation d'incertitude : celui de leurs anticipations. D'autre part, Lence (2009) soutient que les données dont nous disposons en agriculture ne permettent pas d'identifier simultanément les paramètres technologiques et les structures d'aversion au risque. Or les hypothèses posées sur la façon dont l'aversion au risque des producteurs évolue avec leur richesse peuvent jouer un rôle dans l'analyse des effets des politiques agricoles. En effet, comme le montrent Femenia et al. (2010), si cette aversion est décroissante avec la richesse, les aides découplées peuvent finalement avoir un impact sur les décisions de production des agriculteurs. Si elles sont capitalisées dans la valeur de l'exploitation agricole, ces aides viennent en effet accroitre la richesse des producteurs qui deviennent alors moins averses au risque.

Ce problème de mesure de l'aversion au risque n'est pas spécifique aux producteurs agricoles. L'aversion au risque des transformateurs ou encore des acteurs participant aux marchés à terme est également cruciale et mal connue. A titre d'exemple, les stockeurs achètent des biens quand les prix sont bas, ce qui atténue leur baisse, les stockent puis les revendent quand les prix augmentent, ce qui atténue la hausse. Ce mécanisme de stockage peut donc contribuer à limiter la volatilité des prix (Deaton et Laroque, 1992). Ces agents sont généralement reconnus comme faiblement averses ou neutres au risque, voire risquophiles, mais certaines études ont montré qu'ils pouvaient eux aussi présenter une certaine aversion au risque (Frechette, 1999; Turnovsky et Campbell, 1985). La modélisation de leurs comportements, et de ce fait l'évaluation des performances du stockage compétitif ou encore des marchés futurs pour la gestion du risque, sont conditionnées par cette aversion au risque, ce qui montre bien une nouvelle fois l'importance des hypothèses sur le comportement des agents.

Nature des anticipations

L'importance des risques en agriculture dépend également de la perception qu'en ont les acteurs. Là encore des débats importants existent entre les tenants des anticipations dites rationnelles et ceux qui s'y opposent. Ces débats portent à la fois sur l'espérance de la variable aléatoire sous jacente et sur la dispersion autour de cette espérance.

Une grande majorité de travaux portent sur les anticipations des espérances de prix par les différents acteurs. On peut les classer en trois grands groupes : les anticipations naïves, quasi rationnelles et rationnelles (Chavas, 1999). L'hypothèse d'anticipations naïves consiste à considérer que les producteurs anticipent que le prix de l'année suivante sera égal au prix de l'année en cours. Cette hypothèse est à la base du modèle du Cobweb évoqué plus haut et qui explique la génération des fluctuations de prix par le biais de dysfonctionnements du marché. Elle est toutefois souvent critiquée et de nombreux auteurs optent plutôt pour une hypothèse d'anticipations rationnelles, c'est-à-dire basées sur une connaissance du marché identique à celle du modélisateur (Muth, 1961; Wright, 2001; Williams et Wright, 1991; Pratt et Blake, 2007). Pour Nerlove et Bessler (2001) l'hypothèse d'anticipations rationnelles est le plus souvent posée car il n'y a pas d'autre hypothèse théoriquement acceptable quand on utilise un modèle de comportement agrégé. Pourtant, certains auteurs soutiennent que bien que l'hypothèse d'anticipations naïves ne soit pas correcte, celles-ci ne sont pas non plus rationnelles, en raison des coûts d'acquisition et de traitement de l'information (Just et Rausser, 2002). Une autre forme d'anticipations semble en fait plus en adéquation avec le comportement des agriculteurs et l'information dont ils disposent. Il s'agit des anticipations quasi rationnelles (Nerlove et Fornari, 1998), c'est-à-dire basées partiellement sur l'information passée. Chavas (1999) conclut dans son étude que les anticipations quasi rationnelles sont majoritaires dans la population et cela vient de la capacité de chaque agent à collecter et traiter l'information et des coûts qui en découlent. Il utilise ainsi des anticipations basées sur des estimations de séries temporelles. Frechette (1999) également soutient que certains traders forment leurs anticipations sur la base des informations passées. Il s'agit des chartistes qui optent pour ce type d'anticipations car, même si elles sont biaisées, elles sont plus simples et moins coûteuses que les anticipations rationnelles. Ces agents considèrent donc que le coût supplémentaire des anticipations rationnelles est plus important que la perte liée au biais induit par l'approximation quasi rationnelle.

Ces travaux économétriques sur la nature des anticipations supposent cependant que les acteurs sont neutres au risque. Ces travaux négligent donc les anticipations sur la distribution des variables aléatoires. D'autres travaux, notamment à partir d'enquêtes élicitant les probabilités perçues par les acteurs, tendent également à s'éloigner du cas des anticipations rationnelles. Plus précisément, les variances subjectives sont généralement plus faibles que les variances impliquées par les marchés à terme (OECD, 2009a). De même, la perception de situations catastrophiques est très subjective.

1.2 Les mécanismes privés de gestion des risques

Face à des situations risquées, les agents économiques averses au risque ont de multiples possibilités pour atténuer les conséquences négatives de ces risques. Nous présentons ici quelques instruments privés de gestion des risques, leurs propriétés et leurs éventuelles limites. Nous centrons la discussion sur le stockage, les marchés du futur (contrats à terme, contrats d'options), les assurances et les marchés du crédit. Cette discussion ne doit pas occulter que les agriculteurs peuvent aussi diversifier leurs portefeuilles d'activités pour gérer leurs risques de revenu. Le degré de diversification des producteurs explique d'ailleurs pour partie l'utilisation ou non de ces autres mécanismes privés de gestion des risques (Cole et Kirwan, 2009). Toutefois cette stratégie est relativement peu étudiée et n'est donc pas incluse dans cette section.

1.2.1 Le stockage

L'activité de stockage, basée sur un arbitrage inter temporel de la part des stockeurs, permet de réduire la volatilité des prix. Il permet en fait aux producteurs de partager les risques avec les stockeurs. Le stockage contribue donc à réduire la variance des prix et rend leur distribution asymétrique car les baisses de prix sont atténuées mais de fortes hausses peuvent apparaitre en cas de rupture de stocks (Williams et Wright, 1991). Cette asymétrie assure en quelque sorte un prix minimum aux producteurs. Cette remarque illustre l'importance de prendre en compte le coefficient d'asymétrie dans les analyses, ce qui est rarement le cas. De plus, la demande de stocks qui vient s'ajouter à la demande de consommation permet de réduire l'inélasticité de la demande globale, et donc de compenser cette caractéristique des biens agricoles génératrice de volatilité des prix.

Le stockage privé participe à la stabilisation des prix nationaux et internationaux (Makki et al., 1996). Cependant, il ne permet pas d'éviter des périodes de prix très élevés, et ceci peut nuire au bien être des consommateurs. D'autre part, plusieurs produits, comme les fruits et légumes par exemple, ne sont pas stockables, le stockage seul ne peut donc permettre de stabiliser l'ensemble des marchés agricoles. Anderson (1992) montre de plus que la stabilisation des marchés est très sensible au coût de stockage : une augmentation de 5% des stocks liée à une diminution des coûts de stockage entraîne une baisse de 24% de la volatilité des prix alors que l'effet sur le prix moyen est nettement plus modéré (1% de baisse). La rationalité des stockeurs joue également un rôle important : on peut s'interroger sur la quantité d'information dont ils disposent pour prendre leurs décisions d'achat ou de vente et sur la façon dont ils traitent cette information. En effet, si les stockeurs ne sont pas suffisamment informés, ou s'ils ne tirent pas partie de toute l'information dont ils disposent pour anticiper les prix, le mécanisme de lissage des prix évoqué plus haut risque d'être affecté. Certaines études évoquent même la possible déstabilisation des marchés induite par les comportements non rationnels des stockeurs (Ravallion, 1987). Ceci nous renvoie à l'importance d'une modélisation correcte des anticipations pour évaluer l'efficacité des instruments de stabilisation des prix.

1.2.2 Les marchés à termes et contrats d'options

Les marchés à termes et les contrats d'options sont encore peu utilisés en Europe, entre autres parce que la relative stabilité de prix garantie par la PAC rendait les instruments de stabilisation des prix inutiles (Cafiero et al., 2007). C'est en fait l'existence d'une aversion au risque qui génère à la fois l'utilité des marchés à terme et les prix sur ces marchés (Boussard, 2001).

Le marché à terme est une place financière qui met en relation acheteurs et vendeurs. Il définit un prix d'échange pour une certaine quantité de produit à une date future : ce prix est obtenu grâce à la confrontation de l'offre et de la demande anticipées par les participants. Son organisation et son fonctionnement sont décrits à travers quatre éléments clés : la place de la transaction, son objet, les opérateurs et le système d'échange (Cordier, 1984). Le principe de fonctionnement en est le suivant : un contrat à terme est signé à une date donnée et engage le vendeur à vendre, à une certaine échéance, une certaine quantité de produit à un certain prix, fixés à la signature du contrat, à un acheteur qui lui aussi s'engage à acheter la quantité fixée au prix fixé. On appelle "terme" le délai entre la signature du contrat et son échéance. Ainsi le producteur agricole qui signe un contrat de vente à terme s'assure de vendre tout ou partie de sa récolte ou de ses stocks à un prix certain. En pratique, il est rare que la vente se concrétise réellement (contrairement aux contrats de marché) car, avant l'échéance, au moment de la récolte ou au terme de son stockage, l'agriculteur va vendre sa production à son partenaire commercial au prix de marché courant, appelé prix spot. En parallèle, il déboucle sa position sur le marché à terme en rachetant son ou ses contrats ce qui le libère de l'engagement de livraison.

Le principe des contrats d'option est le même que celui des marchés à terme sauf qu'il n'y a, à terme, qu'un droit et non une obligation d'acheter ou de vendre et que l'option a un coût : la prime. Ainsi, si le prix spot est supérieur au prix à terme, le producteur agricole peut vendre sa récolte au prix spot et ne perdra que le coût de la prime d'option.

Le premier avantage de ces contrats est la protection contre le risque de prix (Mahul, 2002). On distingue en effet deux types d'intervenants sur les marchés à termes : d'une part les agents, comme les producteurs agricoles, qui souhaitent se couvrir et assurer leur revenu futur, et d'autre part les spéculateurs qui sont prêts à prendre le risque de perdre de l'argent pour avoir la possibilité d'en gagner. Ainsi, même si le prix de marché baisse, l'agriculteur percevra le prix fixé au départ. Les marchés à terme et contrats d'option permettent aux agriculteurs d'assurer leur prix et constituent pour les spéculateurs une possibilité de bénéficier d'une éventuelle hausse des cours sans stocker physiquement la marchandise, ce qui limite leurs coûts. Les marché à terme sont donc, comme l'explique Keynes, un endroit où les risques sont réalloués entre producteurs et spéculateurs : ils permettent aux agents présentant une aversion au risque de s'en décharger sur les agents qui acceptent de la supporter en contrepartie d'une prime de risque.

Un autre atout de ces contrats est que, normalement, plus on se rapproche du terme du contrat, plus le prix spot est proche du prix à terme. Les marchés à terme apportent donc de l'information aux agents sur le prix futur et cette information peut être utilisée pour améliorer leurs anticipations.

Cependant ces marchés à terme souffrent de quelques limites. Tout d'abord, ces marchés ne sont pas disponibles pour toutes les activités agricoles et toutes les campagnes futures. Ensuite, même lorsqu'ils existent, les acteurs supportent de (faibles) coûts de transaction et surtout font face à des risques de base qui peuvent être selon les produits importants. Le risque de base est donné par la différence entre le prix spot et le prix à terme. Cette base peut être liée à l'hétérogénéité des anticipations des agents (Frechette, 1999). Lorsque le prix spot est supérieur au prix à terme, on parle de déport (backwardation en anglais). Selon Carter et Revoredo Giha (2007) ce phénomène existe toujours et s'explique entre autres par les coûts de transaction et l'aversion au risque des producteurs qui font que les spéculateurs demandent un prix supérieur au prix spot. Par ailleurs, de nombreux travaux montrent que dans un cas idéal sans imperfections de marchés, l'ouverture de ces marchés à terme est bénéfique pour la société dans son ensemble mais souvent au détriment des producteurs (Turnovsky et Campbell, 1985; Lence, 2009). En effet, ces contrats permettent aux producteurs de se couvrir contre les risques prix, ce qui les incite à produire plus. Ceci se traduit *in fine* par une baisse des prix moyens favorable aux consommateurs mais défavorables aux producteurs. L'effet total de la baisse du prix moyen et de la baisse de la variance du prix au niveau du producteur est souvent négatif pour ce dernier. Enfin, de nombreux auteurs s'interrogent sur les effets de la spéculation sur la stabilité des marchés. La manipulation de ces marchés par les spéculateurs est souvent dénoncée. Il existe en effet des travaux théoriques (voir par exemple Stein (1987)) qui montre que ces marchés à terme peuvent déstabiliser les marchés physiques et être Pareto inefficace. La raison est implicitement toujours liée à la formation des anticipations des acteurs. Selon cet auteur, les spéculateurs utilisent des informations différentes des autres acteurs pour déterminer leur positions, ce qui crée du bruit sur ces marchés et distord l'allocation des ressources. L'impact de cette spéculation est aujourd'hui vivement débattu suite à la forte hausse des prix agricoles de 2007/2008 suivie d'une forte baisse. Selon les détracteurs de la spéculation, ces mouvements de prix ne s'expliquent pas seulement par des variations d'offre ou de demande, dues par exemple à l'émergence des biocarburants ou au changement climatique, mais par un accroissement de la spéculation et de l'intervention d'investisseurs financiers sur les marchés à terme (Robles et al., 2009). Cette intervention aurait selon ces auteurs contribué à augmenter les prix à terme et les prix spots. Toutefois cette analyse est critiquée notamment par Wright (2009) ou encore Irwin et Sanders (2010). Les critiques portent sur l'utilisation du test controversé de Granger pour prouver que les prix à terme influencent les prix réels.

Ces limites potentielles des marchés à terme expliquent peut être que certains producteurs leur préfèrent les contrats de gré à gré proposés par des coopératives à partir de fonds mutualisés et sans risque de base (Bielza et al., 2007). Ce type de contrat, par lequel le producteur s'engage à vendre sa marchandise à un prix donné à la coopérative, débouche obligatoirement sur la livraison de marchandises au prix défini préalablement et ne génère pas de spéculation. Les coûts de transaction sont cependant plus élevés pour ces contrats de gré à gré car, contrairement aux marchés à terme, ils ne sont pas standardisés et, les opérateurs étant moins nombreux, le risque supporté par chacun d'eux est plus important (Cordier, 1984).

1.2.3 Les assurances

L'assurance est une stratégie de partage du risque : la compagnie d'assurance met en commun les risques de nombreux clients et fixe les primes en fonction de ses informations sur les risques encourus (Hardaker et al., 1997). Du point de vue des agriculteurs, l'assurance n'est attractive que pour les personnes averses au risque. Au niveau de son fonctionnement l'assurance présente certaines similarités avec les contrats d'options car, contrairement aux contrats à terme où le producteur peut perdre la différence entre prix spot et prix à terme sur la quantité contractualisée, elle permet une cession du risque et l'agriculteur paie uniquement et de façon certaine une prime de risque.

Les assurances actuellement proposées aux agriculteurs européens par des compagnies privées sont peu nombreuses et celles qui existent concernent des risques très spécifiques comme l'assurance grêle. Ceci s'explique par la nature même des risques en agriculture. En effet, les risques, de manière générale, peuvent être définis selon deux critères (Cordier, 2008) : ils peuvent être indépendants ou systémiques et normaux ou catastrophiques ; un risque est indépendant s'il n'affecte qu'un nombre restreint d'agents, ou, au contraire, systémique s'il affecte un grand nombre d'agents en même temps ; un risque est dit normal si les pertes qu'il engendre sont de faible amplitude, ou, au contraire catastrophique si ces pertes sont très importantes. Or l'assurance ne peut intervenir que pour des risques quasiment indépendants et dont les pertes ne sont pas catastrophiques. Selon Cordier (2008), les risques normaux peuvent en effet être gérés directement par les agents grâce à la constitution de provisions utilisables en cas d'aléas. Le risque de grêle entre effectivement dans cette catégorie ; en revanche, une grande majorité des risques agricoles ont la particularité d'être systémiques : ils touchent un grand nombre de producteurs et sont de forte amplitude (toute une région est généralement touchée par des aléas climatiques). Ces risques sont donc difficilement assurables par les compagnies privées, et s'ils l'étaient les primes d'assurance seraient prohibitives. Une solution éventuelle à ce problème réside dans le recours aux marchés financiers pour la réassurance des risques systémiques (Cordier et Guinvarch, 2002) : les marchés des capitaux servent dans ce cas de sources de financement *ex post* et *ex ante*. Les principaux avantages de cette forme de réassurance sont que les risques climatiques ne sont pas corrélés aux fluctuations de marché, les marchés financiers fournissent beaucoup plus de capital que nécessaire à l'industrie de l'assurance, le capital privé élimine le besoin d'implication du gouvernement (voir plus loin) et les investisseurs peuvent choisir un type particulier d'exposition au risque et le montant de cette exposition (Miranda et Vedenov, 2001).

Un autre problème posé aux assureurs réside dans l'asymétrie d'information (les agriculteurs disposent de plus d'information sur leur production que les assureurs), ce qui génère des problèmes d'anti-sélection (seuls les producteurs présentant le plus de risque s'assurent) et d'aléa moral (la souscription entraîne une modification de comportement de l'agriculteur qui prend alors plus de risque). Outre une meilleure collecte de l'information, une solution fréquemment évoquée dans la littérature (Mahul, 1998; Barnett, 1999; Glauber, 2004) pour contourner ce type de problème réside dans le recours à des contrats dont l'indemnité est basée sur un index, c'est-à-dire une variable exogène indépendante des actions des producteurs et observable par les deux parties. Comme ils sont basés sur un index tel que niveau de pluie ou la récolte dans une région ils évitent les problèmes de hasard moral et sont transparents ce qui incitent les investisseurs à s'engager. Les contrats d'option sur index climatique proposés sur les marchés financiers seraient ainsi de nouveaux instruments de transfert des risques catastrophiques et apparaissent comme une alternative aux programmes de réassurance. Par exemple, s'il existait des contrats d'options sur le niveau de pluie dans une région, l'option put protègerait contre des niveaux de pluie trop bas (si le niveau de pluie est trop faible, l'option est exercée et l'assuré reçoit un paiement d'autant plus important que la différence entre le niveau de pluie réel et celui de l'option est grand) et l'option call contre des niveaux de pluie trop élevés. Le problème des index est que, comme ils sont basés sur un critère agrégé, ils peuvent conduire à un risque de base élevé. Aussi, il est nécessaire de bien évaluer et mettre en place ces index afin que la balance, entre d'un côté aléa moral, et de l'autre transparence et simplicité mais risque de base, soit bien équilibrée (Miranda et Vedenov, 2001). Il y a donc là pour les assureurs un arbitrage à faire entre risque de base et aléa moral, les instruments sans risque de base étant préférés par les agriculteurs (Bielza et al., 2007).

1.2.4 L'épargne et le crédit

Au même titre que la souscription d'une assurance permet aux producteurs de partager leurs risques avec l'assureur, le financement de l'exploitation agricole constitue une autre stratégie de partage du risque, avec le banquier cette fois. Le ratio dettes sur fonds propres, appelé levier financier, est un instrument clé pour la décision d'emprunt : il permet de déterminer, pour chaque exploitation, le niveau de dettes optimale en fonction des taux d'intérêt, à condition toutefois de connaître les préférences de l'agriculteur et ses anticipations de revenu (Hardaker et al., 1997). Une prise en compte adéquate des caractéristiques du comportement des acteurs apparait donc encore une fois essentielle.

Grâce au crédit, les gains résultant de périodes de prix élevés sont épargnés pour des périodes futures de plus faible revenu et des emprunts peuvent être contractés en prévision de gains futurs lorsque les prix sont trop bas. Ce mécanisme permet aux agriculteurs de gérer les fluctuations de prix entre deux périodes (Just, 2003). Il permet de plus de séparer temporellement la consommation de la collecte des revenus (Anderson, 1992).

Il existe cependant certains obstacles au marché du crédit qui rejoignent d'ailleurs ceux de l'assurance : les prêteurs ont une information imparfaite. Ce type de problèmes peut être résolu grâce à l'expertise et l'expérience des institutions financières qui disposent aujourd'hui de moyens de collecte d'information très développés. Il ne faut d'autre part pas négliger le fait que trop de crédits pourraient entrainer des taux de faillites très élevés (Anderson, 1992). C'est d'ailleurs ce qui a été observé aux Etats-Unis dans les années 80 : les années 70 ont connu une forte expansion de la demande de biens agricoles qui a poussé les agriculteurs à investir et donc à emprunter massivement, ce qui a entrainé une hausse des taux d'intérêt et la faillite dans les années 80 de milliers d'exploitations trop endettées (Just, 2003). Enfin, comme le souligne Hardaker et al. (1997), les pertes liées à des catastrophes peuvent conduire au non remboursement des emprunts souscrits par les producteurs agricoles et donc causer des problèmes aux banques.

1.3 Nécessité et modalités de l'intervention publique

Les producteurs agricoles ont donc à leur disposition un certain nombre d'instruments de marché pour gérer leurs risques de production, de prix et de revenu. Si leur faible développement en Europe n'est pas suffisant pour justifier l'intervention publique, leur fonctionnement peut se heurter à certains problèmes. Ainsi l'intervention de spéculateurs sur les marchés à terme, tout comme sur le stockage, peut temporairement déstabiliser les marchés. Les assurances, quant à elles, ne peuvent pas une gestion efficace de tous les risques de production en agriculture, la solution de l'utilisation d'options sur index se heurte aux mêmes difficultés que les contrats d'options "classiques", à savoir la présence éventuelle d'un risque de base. Enfin, les crédits bancaires peuvent également être une solution de partage des risques, mais encore une fois les problèmes d'asymétrie d'information empêchent un développement complet de ces marchés. Aussi la question d'une intervention publique, dans son principe même et dans sa forme, mérite d'être posée.

1.3.1 Faut-il intervenir ?

Selon les deux théorèmes de l'économie du bien être, l'équilibre concurrentiel est, sous certaines conditions, efficace au sens de Pareto et un optimum de Pareto peut être obtenu par un équilibre de marché. Cela implique que laisser faire le marché conduit à une situation optimale pour l'ensemble des acteurs et que l'intervention de la puissance publique n'est pas souhaitable. Cependant, ces théorèmes reposent sur un certain nombre d'hypothèses, notamment celle de la complétude des marchés (Varian, 1992). Or, comme nous l'avons vu, celle-ci n'est pas vérifiée pour les marchés de gestion des risques agricoles. Les marchés à terme, notamment, n'existent pas pour tous les produits agricoles. Les assurances ne couvrent pas non plus tous les types de risques, notamment les risques systémiques. La question centrale qui se pose alors est de savoir si ces marchés sont simplement absents car, en raison de l'intervention publique, ils ne sont pour l'instant pas nécessaires ; ou si au contraire il existe un réel problème d'incomplétude des marchés de gestion des risques justifiant l'intervention publique.

Sur le plan théorique, cette question centrale ne fait pas débat. Par contre, elle reste non résolue sur le plan empirique depuis de nombreuses années. Ainsi Timmer (1989) s'intéresse déjà à ce problème sans proposer de solutions politiques. Il suggère surtout quelques pistes de développement des modèles économiques afin d'y apporter des réponses. Ses préconisations portent notamment sur l'utilisation de modèles d'équilibre général dynamiques permettant d'intégrer les décisions d'investissement des agriculteurs. Ces décisions sont en effet fortement influencées par les risques futurs auxquels ils anticipent faire face. Timmer souligne également à ce sujet le manque de connaissances sur la façon dont les acteurs traitent l'information et forment leurs anticipations. Or, celles-ci conditionnent les décisions, d'investissement notamment, et sont elles même sensibles à la stabilité des marchés. Ainsi, un environnement stable a un impact positif sur les anticipations de long terme, et de ce fait sur l'efficacité des marchés. Vingt après, l'OCDE (OECD, 2009b) fait le même constat d'incomplétude des marchés de gestion du risque liée aux problèmes d'information. En effet, comme nous l'avons évoqué, l'asymétrie d'information peut conduire à des problèmes d'anti sélection et d'aléa moral. La puissance publique a alors un rôle à jouer pour faciliter la diffusion de l'information et aider ainsi à la correction des défaillances de marchés et au développement des contrats d'assurance et des marchés de gestion des risques agricoles. Toutefois, comme le souligne également l'OCDE, il est aussi possible que l'information soit asymétrique entre gouvernement et citoyens, conduisant alors à des problèmes de "défaillance politique".

La question, évoquée par Timmer, des anticipations et implicitement du traitement de l'information nous ramène à celle de la volatilité endogène des marchés évoquée en première partie. Une amélioration de l'information permettrait en effet de réduire cette volatilité, si tant est elle qu'elle existe. Pour l'OCDE (2009b) ce n'est pas le cas car les acteurs ne peuvent pas se tromper indéfiniment et répéter leurs erreurs d'anticipations dans le long terme. Effectivement de nombreuses analyses sur la gestion des risques considèrent un état stationnaire pertinent à long terme (par exemple Lence et Hayes (2002)). Cela n'est pas contradictoire avec le fait qu'à court terme les agents peuvent apprendre progressivement du développement des marchés et améliorer leurs anticipations. Cette question de l'apprentissage est aujourd'hui encore peu étudiée dans les analyses des risques agricoles et commence à être prise en compte dans les analyses macro-économiques (voir Gouel (2010) ou McKibbin et Tan (2009)). Une autre question non résolue à ce jour est celle de la définition des risques catastrophiques. Tous les auteurs s'accordent en effet à dire que l'intervention publique est justifiée pour ce type de risque car leur importance est telle qu'ils ne peuvent pas être gérés par les agriculteurs ou par le marché seuls (voir par exemple Cafiero et al. (2007), OECD (2009b)). Toutefois, il n'existe pas de définition précise des risques catastrophiques, concernant par exemple leur amplitude ou leur fréquence. Ce problème de définition peut d'ailleurs être considéré comme une source de risque de nature politique, les acteurs ignorant à quel moment la politique interviendra.

Terminons enfin par souligner que l'intervention publique est encore plus justifiable lorsque, au-delà de l'incomplétude des marchés, se conjuguent d'autres défaillances de marché (tels que pouvoir de marchés ou l'existence d'effets externes) ou encore lorsque des politiques agricoles distorsives sont mises en place par d'autres pays.

1.3.2 Comment intervenir ?

Même si un certain nombre questions restent encore en suspend aujourd'hui, comme nous l'avons vu, le principe d'une intervention publique pour le partage d'information, comme pour la prise en charge des risques catastrophiques, semble faire l'objet d'un consensus dans la littérature économique.

Il existe toutefois d'autres préconisations, souvent plus contestées, portant de façon spécifique sur certains instruments de gestion des risques évoqués en deuxième partie. Nous nous intéressons ici à trois types de solutions (concernant le stockage, les marchés à terme et les assurances), sachant que d'autres travaux se sont aussi intéressés aux interventions publiques possibles sur le marché du crédit ou à travers des politiques fiscales et sociales.

Sur le stockage ?

Le stockage peut permettre de réduire la volatilité des prix mais la spéculation de la part d'organismes privés présente certains dangers pour le bien être des agents. Une solution éventuelle à ce problème réside dans la mise en place de stocks tampons : la puissance publique constitue des stocks en période de prix bas pour les remettre sur le marché lorsque les prix remontent. Ce mécanisme induit une diminution des variations de prix qui sont finalement une condition nécessaire au stockage privé, il n'y aurait donc à terme plus de stockage privé (Glauber et al., 1989). C'est d'ailleurs ce que trouvent Lence et Hayes (2002) dans leur étude sur la réforme de la politique agricole américaine de 1996 (le FAIR Act) : lorsque le système de stockage public, qui existait avant la réforme, est supprimé le stockage privé devient plus actif et la volatilité des prix agricoles ne change quasiment pas, ceci vient du fait qu'avant la réforme le stockage public se substituait au stockage privé. Ce type de mesure peut également avoir un fort impact sur les décisions de productions des agriculteurs et s'avérer distorsive. Srinivasan et Jha (2001) montrent dans une étude basée sur le cas du blé et du riz en Inde, qu'en termes de rapport réduction du risque/coût public, une politique de stabilisation des marchés par des instruments tels que des subventions à l'exportation et des taxes à l'importation est préférable à une stabilisation par des stocks tampons. Ces résultats s'expliquent notamment par le fait que régulièrement les stocks de riz arrivent à épuisement et la capacité maximale de stockage du blé est atteinte.

Une autre façon d'intervenir au niveau des stocks serait de faciliter le stockage privé, en subventionnant par exemple les coûts de maintenance des stocks, et ainsi encourager l'utilisation de cet instrument de stabilisation des marchés. Ce type de programme présente l'avantage d'être plus flexible dans son ajustement aux phénomènes stochastiques que ne le sont les aides directes (Glauber et al., 1989), mais la question de son impact sur l'action des spéculateurs mériterait d'être considérée avec attention.

Sur les marchés à terme ?

Le risque de base pose problème sur les marchés futurs, Bielza et al. (2007) considèrent même que ce risque, conjugué aux coûts de fonctionnement, font que les marchés à termes ne sont pas une solution intéressante pour la gestion des risques. Aujourd'hui le rôle de l'Etat sur ces marchés se limite à en assurer le bon fonctionnement en fournissant un cadre légal (Bureau et Witzke, 2007), ce qui peut contribuer à rassurer les agents et les inciter à participer, mais ne permet pas de résoudre les problèmes éventuels liés à la spéculation évoqués précédemment. Aussi, Turnovsky et Campbell (1985) suggèrent de compenser les producteurs pour les inciter à vendre à terme et de compenser les pertes qui peuvent être liées à la spéculation. Robles et al. (2009), quant à eux, proposent de créer une réserve internationale virtuelle destinée à intervenir sur les marchés à terme lorsque la spéculation fait monter les prix à terme au dessus d'un certain niveau de façon à décourager les spéculateurs et à donner un signal de prix raisonnable à l'ensemble des agents.

Sur les assurances ?

Les trois problèmes majeurs auxquels doivent faire face les compagnies privées pour assurer les risques agricoles sont l'anti-sélection, l'aléa moral, tous deux liés à l'asymétrie d'information, et le caractère souvent systémique des risques en agriculture.

Le rôle de l'Etat peut être de fournir des informations pour répondre aux problèmes d'aléa moral, d'inciter, voire d'obliger, les agriculteurs à s'assurer pour éviter l'anti-sélection ou encore de proposer des réassurances aux compagnies privées dans le cas de risque systémique ou catastrophique.

L'obligation d'assurance existe actuellement dans certains pays tels que le Japon et le Mexique, ou encore la Grèce et Chypre pour le cas européen. En s'appuyant sur le cas du Japon et du Mexique, Hardaker et al. (1997) montrent que ce type d'action ne conduit pas à des résultats satisfaisants car, même si elle permet de résoudre les problèmes d'anti-sélection, elle en engendre d'autres : les compagnies d'assurance ne sont pas incitées à fixer leurs primes au niveau le plus juste et les agriculteurs sont incités à produire les biens pour lesquels il y a assurance et non les autres. Une autre façon d'inciter les producteurs à s'assurer est de subventionner leurs primes d'assurance. En effet, pour Bielza et al. (2007) par exemple, sans subvention les agriculteurs ne souscrivent pas d'assurance. Dans son rapport de 2005, la Commission Européenne (European Commission, 2005) suggère donc la mise en place de subventions des primes d'assurance sur les récoltes de façon à encourager leur souscription (Cafiero et al., 2007). Ce système permettrait de garantir un certain niveau de revenu aux producteurs agricoles.

Ce type d'instrument existe aux Etats-Unis depuis 1938 sous la forme d'assurance sur les récoltes et a subi plusieurs réformes au cours des dernières années. Le principe est de subventionner une partie des primes d'assurance des agriculteurs pour les inciter à couvrir leur récolte, et, depuis 1996, leur revenu. L'Etat prend également en charge une partie des frais de gestion supportés par les assureurs privés et leur propose des réassurances pour les inciter à assurer des risques agricoles dont l'ampleur est généralement importante. L'efficacité de ces subventions est pourtant limitée. En effet, depuis la mise en place de ce système, censé remplacer le versement d'aides exceptionnelles de l'Etat, le montant de ces dernières n'a quasiment pas baissé (Young et al., 2001). De plus, ces programmes enregistrent encore aujourd'hui de faibles taux de participation et leurs performances actuarielles (rapport entre les indemnités versées par les assureurs et les primes qu'ils perçoivent) sont faibles (2.50$ dépensés pour 1$ de primes payées selon Hardaker et al. (1997)), même si la situation s'est quelque peu améliorée ces dernières années. En effet, au départ les indemnités étaient basées sur des rendements individuels alors que le taux de prime était basé sur des rendements agrégés (par comté), donc les agriculteurs qui avaient des rendements individuels inférieurs à ceux du comté s'assuraient et pas ceux qui avaient des rendements supérieurs (asymétrie d'information : seuls les agriculteurs connaissent leurs rendements individuels). Par remédier à ces problèmes le taux de prime a été calculé sur le rendement historique de chaque agriculteur. Les problèmes qui persistent sont, selon Coble et Knight (2002) et Just et al. (1999), toujours liés à l'anti-sélection et à l'aléa moral. La subvention des primes est aussi sujette à controverse car le marché des assurances peut être monopolistique et dans ce cas la subvention ne bénéficierait pas à l'assuré mais à l'assureur (Babcock, 2007). De plus, les subventions des assurances présentent une faible efficacité de transfert (Anton et Giner, 2005) ce qui vient nuancer leur impact positif sur le bien être des producteurs. Ce propos va dans le sens de Young et al. (2001) qui montrent, dans le cas des céréales, que la subvention des primes crée une incitation à produire plus, et, quand la quantité de terre est limitée, l'agriculteur modifie la part de chaque culture en fonction des effets de l'assurance sur les retours nets. Comme la demande de céréales est inélastique, l'augmentation de la production engendrera un déclin plus fort des prix, entrainant une réduction du revenu de marché. Cette baisse de revenu pourrait en partie annuler les bénéfices du transfert de revenu des subventions d'assurance. Glauber (2004) montre toutefois que, certes le système de subvention des primes proposé aux Etats Unis est moins efficace que des transferts directs, mais qu'il est de toute évidence moins distorsif. En ce qui concerne la réassurance éventuelle proposée par l'état aux compagnies privées. Cafiero et al. (2007) soulignent que les risques systémiques sont difficiles à assurer et cela peut provoquer une faillite du marché de l'assurance même avec réassurance et que dans tous les cas la réassurance nationale devrait être envisagée comme une alternative et non un complément aux primes d'assurance.

Conclusion

L'évolution de la PAC vers un système d'aides de plus en plus découplées au détriment des mécanismes de soutien des prix remet en cause son rôle initial de stabilisation des marchés agricoles. Ces aides directes sont par ailleurs très certainement amenées à évoluer dans leur niveau et modalités de versement.

Ceci devrait amener les agriculteurs européens, s'ils sont effectivement averses au risque, à se tourner vers d'autres instruments pour gérer la volatilité de leur revenu. Aussi les instruments privés de gestion des risques présents aujourd'hui sur le marché sont amenés à être de plus en plus utilisés. Tous ces instruments présentent néanmoins certaines limites essentiellement dues à l'asymétrie d'information (problèmes d'anti-sélection et d'aléa moral) ainsi qu'à la nature souvent systémique des risques agricoles. Cette dernière caractéristique implique qu'ils sont difficilement assurables par des compagnies privées, à moins d'utiliser les contrats d'option basés sur index (climatique par exemple) pour se couvrir. Une autre difficulté de ces instruments vient de la nature des anticipations que doivent formuler les différents acteurs utilisant ces outils (producteurs, assureurs, stockeurs, banquiers). La formulation de ces anticipations impose des coûts d'acquisition et d'exploitation d'informations qui sont susceptibles d'être plus élevés à court terme qu'à long terme.

Cette évolution de la PAC vient donc relancer le débat, déjà ancien, sur la nécessité d'une intervention publique pour stabiliser les marchés agricoles. Dans cet article, nous avons listé un ensemble large de questions scientifiques non résolues sur cette problématique. Des controverses existent toujours sur la quantification des risques agricoles, sur l'efficacité relative des instruments privés ou encore sur le degré d'incomplétude des marchés justifiant l'intervention publique.

Aussi il est nécessaire de développer de nouveaux cadres d'analyse enrichis par la prise en compte de la dynamique, des problèmes liés à la formation des anticipations (à tout le moins à court terme), ou encore de l'existence de multiples stratégies de gestion des risques. Plus généralement, pour être pertinents, les cadres d'analyse traitant de l'optimalité des politiques agricoles doivent être développés en considérant davantage les différentes imperfections de marché.

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Chapitre 2 On the European Responsibility in the Agricultural Multilateral Trade Negotiations: Modelling the Impacts of the Common Agricultural Policy [1]

Résumé

Les négociations commerciales du cycle de Doha sont actuellement dans une impasse sur les questions de commerce agricole. L'Union Européenne (UE), notamment, est pressée par ses partenaires commerciaux d'ouvrir d'avantage ses marchés agricoles. Les évaluations économiques conduites jusqu'ici concluent en effet unanimement qu'une ouverture significative des marchés agricoles est nécessaire pour que le cycle de Doha aboutisse à des résultats satisfaisants en terme de bien être. Dans cet article, nous conduisons de nouvelles évaluations pour identifier de façon précise la contribution de la Politique Agricole Commune (PAC) Européenne et pour étudier la robustesse de ces évaluations à la représentation de cette politique complexe. En utilisant les mêmes spécifications que les principales études passées, nos premières simulations montrent que l'UE est la principale responsable et qu'une libéralisation des marchés Européens engendrerait des gains significatifs pour les pays en développement. Cependant, quand nous conduisons les mêmes simulations en calibrant et en modélisant de façon plus adéquate les instruments de la PAC, les gains générés par une libéralisation en UE sont considérablement réduits.

1. Cet article, co écrit avec Alexandre Gohin, est paru dans The World Economy (2009) 32(10):1434-1460

Introduction

Even though agricultural negotiations started one year before the official launch of the Doha Round in 2001, the current World Trade Organization (WTO) talks are still stalled over agricultural trade. Negotiations were even suspended in July 2006 by the WTO Director Pascal Lamy, who considered that the positions on agriculture were too far apart for an agreement to emerge, independently of discussions on other subjects. In fact, three key issues remained unsettled at that period: the level of reduction of (i) tariffs on industrial products, (ii) tariffs on agricultural products, and finally (iii) agricultural domestic subsidies. Pascal Lamy has clarified further the current negotiation difficulties by suggesting that this triangle of issues corresponds to a triangle of members: "The European Union (EU) needs to do more on agricultural tariffs ; the United States (US) needs to do more on reducing agricultural subsidies, and the G-20 group of countries needs to do more on industrial tariffs". Without ignoring the complexity of nonagricultural negotiations, this presentation thus puts huge responsibility on both the US and the EU for the failure up to now to achieve the successful development round initially promised to developing countries, and especially to the least developed countries.

Economic evaluations of the gains of a successful Doha Round provide valuable inputs for illuminating this debate on agricultural trade policy. Using different datasets and economic models, these evaluations unanimously conclude that most of the gains will come from a reduction of tariffs on agricultural products (Diao et al., 2001; Hoekman et al., 2004; Anderson et al., 2006; Hertel and Keeney, 2004). Most recent estimates suggest that the potential contribution to global economic gains from removing agricultural domestic subsidies is less than one-tenth of that from removing agricultural tariffs. A complete liberalisation of agricultural trade is obviously not a realistic scenario discussed at the WTO but the relative importance of market access still remains with a scenario for discussion. This scenario is defined as an equal proportional reduction of agricultural tariffs, domestic subsidies and export subsidies (Tangermann, 2005; OECD, 2006). This major impact of the market access pillar can be explained by the fact that export subsidies are quite modest in value terms and that domestic instruments are less trade distorting than tariffs and other market access instruments.

There is also consensus in the economic literature on the fact that agricultural tariffs and (amber and blue box) domestic subsidies' ceilings must be cut substantially before some genuine reductions of trade distortions can occur. This reflects the present gaps between applied tariffs and subsidies and binding commitments. Moreover, allowing a small percentage of tariff lines to be treated as sensitive and thus to be subject to lesser cuts will considerably shrink the welfare gains of a successful Doha Round (Jean et al., 2006) [2].

Viewing these economic assessments in the political context apportions most of the blame to the EU, which conditionally offers to reduce its agricultural subsidies and tariffs only if a significant number of tariff lines can be designated as sensitive. Moreover, these evaluations minimise the progress made by the EU with the recent Common Agricultural Policy (CAP) reforms (including the reform of the sugar regime) which try mainly to reduce export subsidies and reshape domestic support (from blue to green box). In this context, the objectives of this paper are twofold: first, to measure the real contributions of the EU farm policy on global welfare gains, and second, to test the sensitivity of these gains to the modelling and data assumptions used to represent the complex EU CAP.

With respect to the first objective, recent economic evaluations overwhelmingly use the last Global Trade Analysis Project (GTAP 6) database calibrated on the year 2001. They focus on the impacts of agricultural liberalisation in developed countries (as a whole) on the welfare of developing countries. Surprisingly, we have not been able to find a recent study disentangling the impacts of the agricultural policies of each major developed country [3]. Hence the relative importance of the

2. Economic evaluations also reveal that the welfare effects are evenly distributed among developing countries, with some possibly experiencing losses from liberalisation. In this paper, we focus mostly on the contribution of different developed countries on the group of all developing countries.

3. Such distinction across countries has been done in previous studies using the former GTAP

market access pillar obtained in available economic analysis cannot be attributed only to the EU but may be the result of market protection in other developed countries as well (such as those of the G-10 group of net food importers with heavily protected agricultural sectors). It is thus highly critical to calculate the contributions of main participants and not to rely on the oversimplified presentation made by the WTO director Pascal Lamy. In this paper, we take a careful look at the agricultural policy of three major developed players, namely the EU, the US and Japan.

With respect to the second objective, agricultural policies around the world are so complex that global modelling inevitably involves some simplifying modelling assumptions. Modellers then rely on sensitivity analysis to check the robustness of their results. To date, Valenzuela et al. (2008) show that the welfare gains of a completely free trade scenario (including non-agricultural products) simulated with the GTAP framework are only sensitive to the so-called Armington trade elasticities and are nearly independent of macroeconomic closures. On the other hand, the modelling of the way agricultural policy instruments operate as well as the exact level of these policy instruments has not been tested so far. In this paper, we investigate the calibration and representation of EU CAP instruments in the GTAP framework as they have already been challenged on many grounds. From the policy arena, the European Commission (2006) argues that this global trade model does not adequately represent the working of EU domestic support

5 database calibrated on the year 1997 (Diao et al., 2001; Tokarick, 2005). Unfortunately, comparisons of model results reveal that the initial database critically influences outcomes. As an example, Yu and Jensen (2005) found using the GTAP 5 database that removing EU export subsidies decreases world welfare by US$ 1 billion while Hertel and Keeney (2004) found the opposite result from a very similar experiment (removing all export subsidies) with the GTAP 6 database. Such large differences reflect the evolution of market conditions and policies between 1997 and 2001 as well as a better representation of these agricultural policies in the database. In particular, there is wide recognition that the last GTAP 6 database substantially improves on the measurement of market access instruments thanks to the MAcMap database developed by the Centre dÉtudes Prospectives et d' Informations Internationales (CEPII) and the International Trade Centre (ITC) (Bouet et al., 2006). This last version now includes non-reciprocal trade preferences in protection data and thus allows a better analysis of the issues of preference erosion. Given the trade preferences granted by the EU and discussed at length in the trade talks, it is thus important to use this last database when assessing the effects of its agricultural policy.

prices which have been reduced during the last decade (and hence underscore the domestic support pillar). Furthermore, it does not correctly measure trade protection due to an incorrect definition of products (and hence it overvalues the need to substantially cut tariffs). On the academic front, there is also much published research which questions the way the CAP is represented in the GTAP framework. In particular, Lips and Rieder (2005) and Frandsen et al. (2003) demonstrate the substantial impacts of the EU milk and sugar production quotas which are not identified in the standard versions of the GTAP database and model. van Meijl and van Tongeren (2002) also modify the way EU support prices are modelled in this framework, while Gohin (2006) calls into question the modelling of direct payments which have progressively been increased to compensate for price support decreases. In this paper, we will progressively introduce these alternative specifications in order to check the robustness of the impacts of EU agricultural policy instruments. In addition, we will pay particular attention to data involving EU agriculture that have been gathered using assumptions which may significantly influence policy measurement (Bouet et al., 2006).

Using the same specifications as in previous major studies, our first simulations reveal that EU agricultural policy has a major impact on the welfare gains that developing countries as a whole may reap from a successful Doha Round. Moreover, a major cut in EU agricultural tariffs is needed for these welfare gains to materialise, while the removal of EU agricultural (export and domestic) subsidies has a more limited and negative welfare impact on these developing countries. On the other hand, developing countries do not gain much from the dismantling of Japan and US farm policy. All these first results thus confirm the predominant role that the EU has in the current Doha Round.

However, these simulation outcomes change significantly when we adopt a more relevant calibration and modelling of the CAP instruments. Specifically, when we introduce EU agricultural production control measures, model alternatively the working of the support price regime and direct payments, and correct the initial level of policy instruments and for the bias in trade elasticities, two main results emerge. First, the impact of the EU farm policy on developing countries is considerably reduced. Second, the relative contributions of the export competition and domestic support pillars greatly expand to the detriment of the EU market access pillar. These alternative results then suggest that the EU' s conditional offer at the WTO and the recent CAP reforms are far from being insignificant. They also imply that the EU must not be charged with the full responsibility for the current deadlock in the trade talks. In addition, economic modellers bear a major responsibility in correctly fuelling the policy debate by improving the representation of complex agricultural policies.

This paper is organised as follows. In section 2.1,webriefly present the GTAP AGR framework which is the main economic toolkit to evaluate Doha Round scenarios. In section 2.2, we use this framework to assess the impacts of successively removing export competition, domestic support and market access measures of three main players: the EU, the US and Japan. In section 2.3, we detail the results obtained in the case of EU liberalisation in order to understand them and reveal the critical modelling assumptions. In section 2.4, we present our modifications to the database and model specifications in order to represent better the extent and working of the CAP. We then simulate the same experiments and contrast these new results with the standard framework. Last section concludes.

2.1 The GTAP AGR framework

The GTAP framework consists of a detailed database representing world economic flows and a computable general equilibrium (CGE) model for the simulation of policy scenarios. In this paper, we rely on (a copy of) [4] the GTAP AGR version

4. In fact, we start from the GTAPinGAMS version developed by Rutherford (1998) which differs from the standard GTAP model on two main points. First is the macroeconomic closure (balance of savings investment and public budget) but, as Valenzuela et al. (2008) demonstrate, this has very few impacts on trade simulation results. Second is the representation of household preferences with a Cobb-Douglas function rather than a Constant Difference of Elasticities (CDE) demand system. This difference has many more consequences in terms of price elasticities and,

sion explained in Keeney and Hertel (2005) because it includes the most detailed specification of the farm and food sectors.

Without being as flexible as partial equilibrium (PE) models in the definition of sectors and policy instruments, the GTAP AGR framework is a natural candidate to explore our issues. In particular, it captures the effects revealed by PE models (Gohin and Moschini, 2006). Moreover, this framework is clearly prominent in trade policy analysis. Finally, all farm and food products are relatively well represented in the database. Using the GTAP 6 database calibrated on the 2001 economic flows, the GTAP AGR version has been defined for 19 farm and food products and 10 other products and services. In this paper, we aggregate the 85 countries in the original database into 10 regions because we are not interested in the impacts on each developing country: we only distinguish "major" developing players in agricultural markets (China, India and the pairing Argentina/Brazil). As is well known, the aggregation level matters for the simulation of trade reforms because the more aggregated the model is, the more tariff peaks are diluted in the aggregation process. The 10-region version is, nevertheless, sufficient for our objectives because we get very similar global effects to those in other analyses.

In terms of agricultural policy instruments discussed at the WTO, the GTAP AGR framework explicitly models some instruments pertaining to the three pillars of the negotiations. As far as the export competition pillar is concerned, direct export subsidies are simply introduced as a wedge between domestic and free on board (fob) export prices. Their levels are calibrated with the export subsidies notified at the WTO for the 2001 base period. As far as the domestic support pillar is concerned, direct subsidies paid by the taxpayers of the amber, blue and green boxes are also introduced as price wedges in the output supply, intermediate input demand and primary factor demand functions. Their levels are calibrated using the OECD's Producer Support Estimates (PSEs) and transparent classification

accordingly, we change this specification towards a Linear Expenditure System (LES) calibrated with the CDE income elasticities. On this "LES GTAPinGAMS" version, we then introduce all changes explained in Keeney and Hertel (2005) to get this copy of the GTAP AGR version. Implementation of the alternative modelling of CAP instruments is easier with the GAMS software.

criteria. As far as the market access pillar is concerned, all measures pertaining to one given trade flow are represented by a single *ad valorem* tariff which is included as the difference between the cost, insurance, freight (cif) import and the domestic market prices. The levels of import tariffs are sourced from the MAcMap database maintained by the CEPII with many additional assumptions required to (i) deal with non-tariff barriers, (ii) convert specific tariffs into *ad valorem* ones, and finally (iii) aggregate HS six-digit tariff lines to the productlevel definition of GTAP AGR.

If far from perfect, one should begin to acknowledge the formidable task in compiling all this information with input-output tables into a CGE-consistent format (balanced social accounting matrix). Above all, the transparency in the database building and model implementation gives one the opportunity to test that framework. But before running simulations with this standard framework, some preliminary comments on agricultural policy modelling are made.

First, it is well known that the EU is the main user of direct export subsidies while other developed countries use more indirect measures to promote their exports (export credits, state trading, foreign aid, rules of origin, etc.). The exclusive inclusion of direct export subsidies thus biases the evaluation against both the EU and the relative importance of the export competition pillar. On the other hand, the modelling of other export instruments is far from simple and will not be done in this paper, whose focus is the EU farm policy. Second, this standard framework does not recognise either the different supply control measures European farmers face (set-aside obligations on arable crops, production quotas on sugar and milk, beef premia quotas) or the environmental conditions attached to direct payments. If the latter are quite difficult to represent in global models, the former have already been studied and may have significant impacts on results. Third, the modelling of market access instruments is kept to a minimum with only one *ad valorem* tariff equivalent of all measures. Even if this is perfectly calibrated at the initial point, this misses the intricate working of the tariff rate quotas which play a significant role in agricultural market access and trade talks. Again this may have significant impacts on trade reform results.

2.2 Contributions of the farm policies of main developed countries with the standard GTAP AGR framework

2.2.1 Definition of experiments

Most analyses on the Doha Round using the GTAP AGR framework start from the 2001 economic database without including the liberalising efforts of the EU already adopted (such as the sugar reform in 2006) or presently negotiated (such as the EPA and EBA trade agreements). Moreover, they do not introduce the recent changes observed in the world markets of energy and food products. Finally, they usually consider a radical scenario of full removal of all distortions as a benchmark. This is clearly far from the options being negotiated in the Doha Round. However, we still examine such a scenario using the 2001 reference point firstly in order to compare our results to available ones, and secondly to provide an indication of the maximum impacts one could expect from the Doha negotiations.

The structure of the GTAP AGR framework is such that it is possible to successively simulate the effects of removing instruments of each pillar. Two initial remarks are in order here. First, that possibility does not mean that there are no interactions between all instruments. In the results below, we report the impacts of each pillar as well as the impacts of all pillars considered simultaneously. Second, that possibility suggests that one country may grant export subsidies without the need to protect its own market from re-exportation of these quantities. This may puzzle EU policy-makers who deliver export subsidies to tariff-protected goods only. In fact the Armington trade specification technically allows for this possibility since imported goods are supposed to be different from exported goods. But this may not correspond to the working of the EU support price regimes (European Commission, 2006). This issue will be tackled in the alternative specifications that we propose in Section 5.

In this section we successively simulate the removal of (i) export competition measures, (ii) domestic support measures, (iii) market access measures, and (iv) all these instruments in three developed countries (the EU, the US and Japan). We also simulate the full removal of the EU agricultural policy and allow two GTAP products (beef and sugar) to be designated as sensitive where tariff reduction is assumed to be null. We then repeat this for Japan with rice and sugar designated as sensitive. These experiments illustrate the issue of sensitive products which are mostly defended by these countries and often blamed for stalling the Doha Round.

2.2.2 Effects of Farm Policies of all Developped Countries

We first compare our results on welfare (measured by the equivalent variation) with previous results to ensure the validity of the model. The first row of Table 2.1 reports the results obtained by Hertel and Keeney (2006) and the results of our comparable scenario are in the second row. Focusing on the global impacts on the world, developed and developing groups, it appears that we are able to reproduce previous results. The market access pillar has a major effect in total welfare gains.

Although the "contrasting fortunes" of developing countries in the present Doha Round have been extensively analysed in the economic literature, there has been much less discussion of the impacts on each developed country. Our results show that Japan (as a net food importer) will lose from an agreement restricted to export and domestic subsidies. More surprising is the absence of significant positive effects on EU welfare of a liberalisation of market access instruments in all developed countries. This is because the EU is a large player in the world market and thus benefits from an optimal tariff. Equally surprising is the distribution of welfare gains across developed countries: Japan will reap most of these gains (50% of world welfare gains and 62% of developed countries' gains).

Table 2.1 – Welfare Impacts of Agricultural Liberlisation in Developed Countries (Equivalent variation in income, 2001 US$ million)

Liberalisation in \ Impacts on	EU	US	Japan	Other Developed	Total Developed	Brazil/ Argentina	China	India	Other Developing	Total Developing	World
Hertel and Keeney											
All developed											
Export subsidies					2554	99	-78	13	-1545	-1511	1043
Domestic Support			Not Available		2450	1152	-428	72	-437	359	2809
Market Access					31811	4746	1141	409	5688	11984	43795
Total					36815	5997	635	494	3706	10832	47647
All developed											
Export subsidies	2469	-113	-536	370	2190	107	-103	18	-1721	-1699	489
Domestic Support	4091	2184	-661	548	6161	751	-522	42	-1065	-794	5370
Market Access	193	1613	24376	2537	28719	4479	2106	632	4980	12197	40919
Total	6829	3856	23246	3495	37426	5530	1748	834	2067	10179	47606
EU + US + Japan											
Export subsidies	2469	-113	-536	370	2190	107	-103	18	-1721	-1699	489
Domestic Support	4130	2174	-637	485	6152	739	-513	37	-1016	-753	5400
Market Access	295	786	24265	2336	27682	4461	2114	635	5081	12291	39974
Total	6750	3061	23149	3191	36151	5498	1765	831	2177	10271	46424
EU15											
Export subsidies	2479	-118	-510	353	2204	103	-95	18	-1689	-1663	542
Domestic Support	4658	89	-81	191	4857	328	-87	-8	-54	179	5038
Market Access	-363	356	-449	1075	619	4407	98	788	4226	9519	10141
Total	6139	298	-1084	1556	6909	5080	-133	951	2326	8224	15135
Total with sensitive pds	3550	369	-1016	1645	4548	1580	121	-14	1010	2697	
US											
Export subsidies	-21	2	-19	8	-30	1	-6	0	-26	-31	-61
Domestic Support	-552	1991	-850	257	846	357 -438	39	-1040	1082	235	
Market Access	21	-551	19	182	-329	175	-5	-7	239	402	7
Total	-554	1431	-858	449	468	532	-444	31	-829	-710	-243
Japan											
Export subsidies	0	0	0	0	0	0	0	0	0	0	0
Domestic Support	-16	21	310	24	339	8	9	3	43	63	402
Market Access	859	995	24638	1130	27622	-111	2094	-168	549	2364	29988
Total	795	1012	24781	1155	27743	-99	2088	-164	479	2304	30048
Total with sensitivity pds	4	1289	763	1038	3094	19	157	-26	320	470	3563

2.2.3 Effects of the different agricultural policies

It is no surprise that dismantling the EU, US and Japanese agricultural policies generates most of the global welfare gains (97.5%). This is because other developed countries have limited subsidies/tariffs and/or are much smaller in agricultural world markets. Among these three major actors, the elimination of the Japanese agricultural policy contributes to 63% of total welfare gains, followed by the EU CAP (32%) while global welfare slightly decreases with the elimination of the (2001) US farm bill. Most important is the fact that developing countries as a group enjoy most of their welfare gains when the EU removes the CAP (81%). On the other hand, they lose from the US farm bill elimination including all domestic subsidies (one leg of the "Lamy triangle of issues"). Finally, Japanese liberalisation mainly benefits Japanese consumers and more marginally the developing countries. The responsibility of the EU in the current WTO impasse appears even greater when we introduce sensitive products which are explicit in the conditional EU offer. Allowing the EU to select two sensitive GTAP products decreases developing countriesẃelfare gains by 67%.

On the basis of the results discussed so far, the political message would be that the EU bears a major responsibility for the current impasse in the agricultural trade talks since it does not want to really open its agricultural markets to developing countries. On the other hand, these countries have no gains to expect from a US liberalisation of domestic subsidies. Thus the US cannot be held responsible for the current deadlock. The worst scenario for developing countries would even be that the Doha Round concludes with a removal of direct export subsidies only, which is to date the only concrete (but conditional) achievement !

2.2.4 Qualifications

Given the strong political overtones of these figures, a more careful analysis is recommended. In this subsection we focus the discussion on some impacts of the US farm policy. The EU case will be analysed in length later. Furthermore, the explanation of these impacts already reveals several interesting modelling challenges for the simulation of the CAP instruments.

We find that world welfare decreases when the US removes its export subsidies. The welfare decomposition reveals that this has nothing to do with Armington-based terms-of-trade effects on non-agricultural products, as discussed in Tangermann (2005). In fact, US export subsidies are initially concentrated on dairy products and their elimination decreases US dairy exports. They are then partly substituted by increased EU exports which benefit from a fixed unitary subsidy in the standard GTAP AGR framework. Thus the "US distortion" is replaced by an "EU distortion" which explains part of the EU and global welfare decreases in this scenario. Even if these figures are of a small magnitude, they reveal the incorrect modelling of the EU support price regime. The EU would have reduced the unitary export subsidy in the present case. There is a second reason for this negative global welfare effect which also questions another assumption in the modelling of agricultural policy instruments. The elimination of US dairy export subsidies leads to a slight rise in world prices registered at all borders. The fixed *ad valorem* tariff equivalents of all market access measures then apply to these increased world prices. Accordingly, the unitary protection level on dairy products increases and, given the already high initial level, it finally creates more distortion effects. These results again demonstrate that the standard GTAP AGR framework does not recognise the true nature of agricultural protection with a majority of specific tariffs. The removal of US import tariffs has limited effects even in the sugar and milk sectors. A quick look at the initial database suffices to understand this result. US initial import tariffs on sugar and milk products are quite low (25% and 18%, respectively, on average), at least compared to the EU ones (110% and 38%, respectively). These levels are nevertheless in contradiction with those from the OECD PSE database. According to this latter, the consumer nominal protection coefficients (NPCs) amount to 2.4 for the EU sugar sector and 2.9 for the US one [5]. In the case of the milk sector, the figures are 1.4 for the EU and 1.8 for

5. The consumer NPC measures the ratio between the domestic price paid by consumers and

the US. This calibration of policy measurement obviously has a major impact on simulation results.

2.3 Impacts of and on the European Union agricultural sectors

So far the analysis has been conducted without considering the different agricultural sectors and markets. In this section we go deeper in the analysis of CAP effects by simulating the effects of policy instruments in the main agricultural sectors and analysing the effects on the corresponding EU markets. Thus this section has two main purposes. One is to better understand previous EU results. The second is to go deeper in the analysis of the way the modelling of CAP instruments affects the results.

2.3.1 The contributions of the different Common Market Organisations

We first analyse the welfare consequences of each pillar on six major sectors. Results are reported in Table 2.2. Full liberalisation of the EU arable crops increases world welfare by US$1.3 billion, including US$0.3 billion for developing countries only. As expected, the removal of the corresponding export subsidies and import tariffs has a limited effect due to their small initial amounts. The effect of the removal of the arable crop direct payments is more important (US$0.9 billion). This welfare gain is quite limited compared to the initial level of these payments (a US$17 billion). In very general terms, the main reason for this is that these direct payments are reasonably uniform across farm sectors – and above all total land is fixed. Accordingly, they work as a subsidy to a fixed factor and thus do not alter input allocations and market equilibriums. However, Gohin (2006) challenges this approach which implicitly assumes that these payments are already capitalised in

the border price. It is thus an indicator of the protection given by the market access instruments. The figures above pertain to the year 2001 and are roughly similar when we take the average over the years 1999-2003 to account for world market price volatility (as well as exchange rates).

land values. This implicit assumption is contradicted by observed statistics on land values and rental rates.

The impacts of EU sugar policy instruments are more troubling and interesting to detail. First, their export subsidies have nearly no effects. Second, current EU sugar import tariffs marginally penalise Brazil and Argentina while significantly hurting the welfare of our other developing countries group (which includes preference-receiving ACP [African, Caribbean, Pacific] countries). A quick look at the initial database allows these two results to be understood. EU sugar export subsidies are low in the database (US$172 million) compared to EC statistics (US$1 billion in 2001, averaging US$1.2 billion over 2000-02). Such a large difference comes from (i) the very bad statistics on the sugar trade that need to be reconciled (Gehlhar, 2006) and (ii) the very intricate EU sugar policy. On this last point, the EU reports much lower export subsidies to the WTO because a significant part of them is paid for the re-exportation of ACP sugar. Furthermore, Brazil does not reap most of the gains of the opening of the EU sugar market for two reasons. One is the CES-based Armington approach of trade which tends to fix exporter shares (Brown, 1987). As Brazil has a very limited share at the start, this approach with limited substitution elasticity tends to constrain its expansion. The second factor is the data representing the EU sugar import tariffs. According to the GTAP 6 database, Brazilian sugar is heavily taxed by the EU (175%), but ACP sugar is too (117%). If the first figure is not unexpected, the latter is. Where does it come from ? Bouet et al. (2006) explain the conversion of all market access instruments into one *ad valorem* tariff equivalent. When doing this, they notably use a reference group concept to convert specific tariffs into ad valorem ones with an "unbiased" world price. Basically, they consider that bilateral unit values should not be used during this conversion process because they are endogenous and/or badly measured. They propose using different, more robust and exogenous, world prices defined on reference groups. As these authors themselves recognise, this methodology is not perfect and in the EU sugar case is quite misleading.

To explain this, let us first simplify by ignoring the additional issue of binding/ non-binding tariff rate quotas. ACP sugar exports to the EU are subject to lower (on average) specific tariffs and these countries are able to capture quota rents. The corresponding bilateral trade value is much higher than the unit value of sugar traded among other countries. But these ACP-specific tariffs are divided by a reference group price which is much lower than the "rent-included" bilateral value. Accordingly, this conversion overestimates the *ad valorem* equivalent of the specific tariff for these countries. This overestimated tariff is then applied to the true bilateral values in the GTAP 6 database. This implies that ACP sugar is sold on the EU market at a price much higher than the EU intervention sugar price.

To summarise up to this point, the *ad valorem* tariff equivalent of the specific tariff is computed with one given price and is introduced into the database with another price, so accounting for the high protection on the sugar coming from ACP countries. In reality, the protection of the EU sugar market is even more complex due to the tariff rate quota. This policy instrument introduces a discontinuity in the marginal tariff which is not acknowledged with one ad valorem tariff equivalent. So far this issue is resolved by maximising the tariff in the sense that out-of-quota tariffs are assumed when imports approach the quota level. This assumption is correct in a simulation which will lead to an increase of these imports. However, when we remove that instrument, the marginal tariff is not the out-of-quota tariff but the smaller in-quota tariff. This is the second reason why EU tariffs on ACP sugar are so high. More generally, this problem of measuring the true protection level of multiple trade instruments applies not only to the EU sugar case but to other products as well.

Table 2.2 – Welfare Impacts of Agricultural Liberlisation in Developed Countries (Equivalent variation in income, 2001 US$ million)

Liberalisation in EU15 \ Impacts on	EU	US	Japan	Other Developed	Total Developed	Brazil/ Argentina	China	India	Other Developing	Total Developing	World
Arable crops											
Export subsidies	326	-3	-35	56	344	18	-21	6	-293	-290	55
Domestic Support	633	63	-102	98	698	308	-101	8	-25	190	890
Market Access	39	107	-61	7	92	107	365	-24	-110	338	430
Total 911	171	-202	159	1039	443	443	228	-5	-378	288	1328
Sugar											
Export subsidies	116	-4	-19	4	97	14	-3	1	-53	-41	57
Domestic Support	7	0	0	0	7	0	0	0	2	2	8
Market Access	946	51	-28	13	982	105	-53	-3	1212	1261	2242
Total	1086	46	-51	18	1099	122	-57	-2	1150	1213	2313
Dairy											
Export subsidies	713	-108	-178	202	629	23	-54	-2	-498	-531	99
Domestic Support	155	-4	-8	19	162	-5	-3	-1	-30	-39	123
Market Access	-925	31	-245	1074	-65	31	-106	-17	413	321	255
Total	-221	-73	-431	1307	581	55	-167	-20	-78	-210	370
Beef											
Export subsidies	913	33	-40	60	966	17	-7	9	-237	-218	747
Domestic Support	3365	24	22	86	3497	47	12	-10	32	81	3578
Market Access	2220	-127	-20	-83	1990	3447	-213	822	254	4300	6300
Total	4588	-111	-51	12	4438	3953	-237	983	125	4824	9261
Other animals											
Export subsidies	-34	34	-159	38	-121	22	3	0	-160	-135	-255
Domestic Support	-34	4 -10	7	-33	2	0	-1	-3	-2	-34	
Market Access	-1063	93	-58	35	-993	638	-78	2	746	1308	315
Total	-1156	135	-229	82	-1168	666	-76	2	586	1178	9

continued on next page

Table 2.2 continued

Liberalisation in EU15 \ Impacts on	EU	US	Japan	Other Developed	Total Developed	Brazil/ Argentina	China	India	Other Developing	Total Developing	World
Fruits and vegetables											
Export subsidies	27	-6	-4	0	17	0	1	-1	-50	-50	-33
Domestic Support	-52	-1	-3	3	-53	2	1	-1	16	18	-34
Market Access	-812	-62	-37	6	-905	29	126	-12	839	982	76
Total	-883	-70	-46	9 -990	32	129	-13	814	962	-29	
Others											
Export subsidies	345	-68	-63	-15	199	6	-11	5	-367	-367	-168
Domestic Support	0	0	0	0	0	0	0	0	0	0	0
Market Access	-1471	259	-40	99	-1153	477	16	14	890	1397	244
Total	-1117	191	-104	84	-946	483	5	19	519	1026	79
EU15											
Export subsidies	2479	-118	-510	353	2204	103	-95	18	-1689	-1663	542
Domestic Support	4658	89	-81	191	4857	328	-87	-8	-54	179	5038
Market Access	-363	356	-449	1075	619	4407	98	788	4226	9519	10141
Total	6139	298	-1084	1556	6909	5080	*133	951	2326	8224	15135

Notes: In each row of this table, we remove policy instruments only for the relevant commodities/sectors. The arable crops sector includes wheat, rice, other grains, oilseeds, fibres and other crops. Sugar includes sugar beet and sugar. Dairy includes milk and dairy products. Beef includes cattle and beef. The other animals sector includes other animal products and other meats. Finally the residual (Others) includes fats, other food, beverages and tobacco.

The EU liberalisation of the beef sector gives most of the welfare effects in each pillar. The suppression of the EU beef domestic subsidy leads to significant global welfare gains that are mainly harvested by the EU. These subsidies are lower than arable crops ones (US$9.6 billion compared to US$17 billion). The standard framework thus suggests that they are more distorting. In fact, they are modelled as a capital subsidy and capital is perfectly mobile across farm sectors and imperfectly mobile between farm and non-farm sectors. By contrast, land is imperfectly mobile across farm sectors and not mobile at all with non-agricultural sectors. Accordingly, beef domestic subsidies attract more resources in the sector than do arable crop subsidies. The production-distorting effect of this capital subsidy is, on the other hand, limited by the production technology which assumes that capital, labour, land and feed ingredients are net substitutes. Such a specification implies in particular that farmers use technologies which are intensive in capital (suckling cows) and extensive in land, labour and feed ingredients. Unfortunately this does not recognise that the CAP limits the number of animals per hectare. Moreover, the numbers of animals eligible for the payments are also limited. Gohin (2006) again shows that modelling the latter constraint substantially challenges the results. Opening the EU beef market appears to be the most useful option for developing countries. If the gains of Brazil and Argentina are not unexpected, the welfare effect on India is more curious because the EU did not import at all from this region according to EU trade statistics (COMEXT). Again the initial database and its protection data explain this effect.

2.3.2 The effects on EU markets

In this subsection we analyse the impacts on EU markets of each pillar. In order to save space, Table 2.3 reports the impacts of removing, first, export competition measures on all EU agricultural sectors, second domestic subsidies, third import tariffs, and finally all instruments. In this table, we also report the initial values of domestic production, consumption, total EU exports and total EU imports. In

CGE models, prices are usually calibrated to one and thus values initially correspond to quantities. The import values include the tariffs while the export ones represent the domestic values before the application of export subsidies.

Before analysing these impacts, two remarks are in order. First, the trade values are considerable. For instance, EU wheat exports represent 39% of domestic production and imports 37% of consumption. This results from the fact that trade values include EU intra-trade. Self-imports are usually maintained during the GTAP country aggregation process. Accordingly, trade between EU members is supposed to be exports/imports and these quantities are introduced in the lower Armington nest. Second, these initial data suggest that the EU is a net importer of sugar in 2001. If we remove EU intra trade, exports account for only 2.3% of EU sugar production. As already underlined, this low figure comes from the difficulty of resolving trade statistics over all countries (Gehlhar, 2006). Unfortunately, this is likely to bias downward the influence of the export competition pillar on this sector.

As expected, EU agricultural production and exports generally decrease following the removal of CAP instruments while imports increase. Impacts on producer prices are also quite limited. This is quite usual with CGE models with constant returns to scale production technologies and a significant degree of mobility of inputs across sectors. These results reveal that the standard framework does not include production quotas. For instance, in the milk sector, it is very unlikely that a 0.5% reduction of milk producer price will translate to a 5% decrease of EU milk production because the vast majority of studies (e.g. Lips and Rieder (2005)) on the EU milk sector conclude that significant quota rents exist.

The last two columns of Table 2.3 report the impacts on land use and yields for major crop activities. The removal of domestic support measures has very strong impacts on land use and yields per hectare. However, econometric evidence so far does not support such results. For instance, Sckokai and Anton (2005) were unable to find significant effects of arable crop direct payments on yields. One possible explanation is that the standard framework is based on large substitution possibilities between land and other inputs. As Gohin (2006) shows empirically, the way the arable crop direct payments are modelled also has a substantial bearing on the yield impacts. This is important per se and also when one considers the EU set-aside obligation. One may anticipate that removing this set-aside obligation has very limited market effects because additional cultivated land will be compensated by large yield decreases.

The last result we want to underline is the decrease in EU imports when the EU removes export subsidies. Figures in Table 2.3 are admittedly small due to EU intratrade. But imports originating from non-EU countries decrease more significantly. As the European Commission (2006) underlines, this does not reflect the EU market price support regime where imports are subject to tariff rate quotas and the EU simultaneously reduces import tariffs and intervention prices in order to maintain preferences.

Table 2.3 – Market Impacts of Liberalisation in EU Agricultural Sectors, (Initial values in US$ million and impacts in %)

Impacts on	Production	Consumption	Exports	Imports	Producer Price	Land Uses	Yields
Wheat	10272	9922	4004	3654	1		
Export subsidies	-5.1	-0.9	-12.9	-2.3	-1.3	-0.9	-4.2
Domestic Support	-4.2	-0.3	-8.3	1.6	2.6	-22.3	18.2
Market Access	4.4	-2.6	13.6	-4.6	-2.9	2.1	2.3
Full liberalisation	-6.0	-4.1	-10.5	-5.9	-1.9	-21.3	15.3
Other grains	11464	11024	3130	2690	1		
Export subsidies	-5.7	-1.1	-18.4	-1.5	-1.4	-1.2	-4.6
Domestic support	-1.5	-0.8	-3.0	-0.1	2.6	-21.0	19.2
Market access	-2.9	-3.4	0.8	-0.9	-3.7	-0.7	-2.2
Full liberalisation	-10.6	-5.5	-22.0	-2.9	-2.9	-22.3	11.7
Oilseeds	5665	9971	941	5247	1		
Export subsidies	1.3	-0.2	3.4	-1.2	-0.8	1.6	-0.3
Domestic support	-34.7	-3.3	-60.9	22.8	30.5	-23.7	-11.0
Market access	6.7	-2.1	19.5	-7.7	-3.1	2.8	3.8
Full liberalisation	-29.9	-6.1	-50.3	11.9	25.4	-19.6	-9.2
Sugar/Sugarbeet	19654	21981	1373	3700	1		
Export subsidies	-2.6	-0.8	-30.0	-1.6	-0.3	0.3	-2.3
Domestic support	0.5	0.1	2.3	-0.1	-0.7	15.5	-15.0
Market access	-38.6	-4.0	-49.3	235.7	-4.3	-12.0	-17.2
Full liberalisation	-41.1	-5.0	-88.4	227.0	-5.1	2.0	-33.1
Dairy products/Milk	110546	106474	21527	17455	1		
Export subsidies	-5.0	-0.5	-24.1	-1.0	-0.5		
Domestic support	0.2	0.9	0.4	0	-0.1		
Market access	-6.6	-0.4	-13.6	23.7	-2.2		
Full liberalisation	-12.4	-0.9	-41.0	20.8	-2.8		
Beef/Cattle	61698	63513	7741	9556	1		
Export subsidies	-3.0	-0.2	-23.9	-1.1	-0.4		
Domestic support	-3.9	-1.2	-14.2	5.7	5.4		
Market access	-27.3	-0.2	-50.9	160.5	-3.1		
Full liberalisation	-35.4	-1.6	-86.3	181.5	1.5		
Other meats/Animals	97376	96642	16792	16058	1		
Export subsidies	-1.3	-0.2	-7.3	-0.6	-0.3		
Domestic support	0.2	0.4	0.7	-0.2	-0.2		
Market access	-4.6	-0.5	-9.9	15.0	-2.0		
Full liberalisation	-5.7	-0.6	-17.2	13.1	-2.5		
Fruit and vegetables	45718	57048	15999	27329	1		
Export subsidies	0.5	0	0.5	-0.7	-1.0		
Domestic support	4.1	0.6	6.6	-1.6	-4.6		
Market access	-5.2	0.3	-7.9	4.5	-4.8		
Full liberalisation	-0.4	0.8	-0.7	1.8	-10.0		

2.3.3 Interim Summary

In the previous section, the analysis of global welfare effects already raises several issues regarding the modelling of trade and domestic policy instruments with fixed price wedges. This section analyses in depth the welfare impacts of the CAP as well as the impacts on EU markets. This analysis also reveals new questions on both the modelling of some policy instruments (such as the conditions attached to the direct payments or the production quotas) and the calibration of trade flows and policy instruments (such as the measurement of the true protection given by the quite complex tariff rate quota). Even if this is quite long, such a diagnostic is very important in understanding global figures and messages as well as for testing them with alternative specifications (Tangermann, 2005). This is the purpose of the next section.

2.4 Sensitivity analysis in the modelling and calibration of the CAP instruments

The purpose of this section is to measure the extent to which the modelling choices questioned above influence the results. We consider in turn: (i) the issue concerning the measurements of market protection and export support (for sugar), (ii) the introduction of production control measures, (iii) the acknowledgment of tariff rate quotas, (iv) the interaction among EU trade policy instruments due to the intervention price regime, and (v) the modelling of direct payments. We will focus the analysis on four main sectors (arable crops, beef, dairy and sugar) where there is sufficient published research to support our sensitivity analysis. Before proceeding, we consider the issue of EU self-imports in order to conduct the subsequent analysis on EU external trade and not EU total trade.

2.4.1 Self-Imports

The GTAP database distinguishes 87 countries among which all 15 EU members (in 2001) appear. When the EU15 aggregate is built, the EU intra-trade flows must be considered, as this must be done for other country aggregation. The basic modelling option explicitly maintains these flows, notably because import values are higher than export values due to the additional transport costs. This modelling choice has already been discussed and, like Rutherford (2006), we remove them and allocate the associated linked transport costs directly to the expenditure of domestic consumers.

The comparison of the first two rows of Table 2.4 illustrates the significant impact of the EU intra-trade modelling choice. When we remove all CAP instruments in the four main sectors (arable crops, beef, dairy and sugar), world welfare increases by US$14.3 billion with the standard approach and by US$11.9 billion with the new treatment of EU intra-trade. In fact the major difference resides in the effect of market access instruments. World welfare gains decrease from US$9.3 billion to US$6.7 billion. This reduction is mostly felt by the EU and Brazil/Argentina. The logic of these results is relatively simple. In the standard modelling, the self-imports are (CES) nested with imports from outside the EU in the second-stage Armington trade modelling. The resulting import composite then substitutes with domestic products in the first-stage Armington trade modelling. The substitution elasticities in the second nest are twice those of the first nest. When we remove EU intra-trade, we basically introduce these flows in the domestic demand. Accordingly, the substitution facilities between non-EU imports and domestic products are lower in the alternative. By extension, welfare effects are lower because these trade elasticities have very large impacts on the welfare effects of trade liberalisation (Valenzuela et al., 2008). These effects are quantitatively important in the beef sector where there is significant EU intra-trade ; hence the significant reduction of welfare gains by Brazil/Argentina. In the rest of the paper, we keep this alternative modelling of self-imports, so that EU import price elasticities are dealt with on a level playing field.

2.4.2 Protection data and export subsidies

The impacts of policy instruments obviously depend on their initial amount. In the previous section, we underlined that in the initial database, the values of sugar exports and sugar export subsidies are considerably lower than statistics from EU sources. We also questioned the conversion of specific tariffs into ad valorem ones when there are simultaneously tariff rate quotas, and EU cif import prices are significantly higher than other cif prices.

Correcting data of CGE-supporting social accounting matrix (SAM) is not a trivial task because market equilibrium must always be satisfied. In case of the sugar export values, we proceed as follows. We first increase the export values of sugar from the EU to the Rest of the World (ROW) aggregate by US$1,206 million based on COMTRADE values. We decrease by the same amount the value of the EU sugar private consumption. In order to maintain the same EU final expenditures and trade figures over all agricultural products, we assume the opposite changes for the "other foods" product (exports are decreased and private consumption is increased). These first changes ensure that the EU SAM is still balanced. Again opposite changes need to be done for the SAM of the ROW. As far as the sugar export subsidies are concerned, we increase their amount by US$753 million based on FEOGA (Fonds Européen dÓrientation et de Garantie Agricole) expenditures. We decrease by a similar amount the EU private consumption of sugar.

As far as the protection data are concerned, we focus on the sugar and beef sectors because they generate most of the welfare effects. As stated earlier, the conversion of specific tariffs is done with a reference group price (Bouet et al., 2006) and the resulting *ad valorem* tariff is applied on the much higher bilateral price in the case of sugar exported from the ROW to the EU. In this subsection, we assume that the true marginal tariff (in fact the out-of-quota tariff) is correctly computed and then we simply scale back the *ad valorem* tariff to reflect the difference between the reference group price and the bilateral price. In practical terms we reduce the *ad valorem* tariff imposed by the EU on ACP sugar from 114% in the initial database to 44.5%. This represents a US$829 million reduction on import tariffs which is compensated for by a similar reduction in the EU private consumption of sugar in order to balance the SAM for the EU.

The reference group price is also much lower than the beef bilateral price involving the EU. Accordingly, we perform the same computations in order to correct the import tariff imposed by the EU on beef from Brazil/Argentina: we scale back the *ad valorem* tariff by 36%, from 88% to 56%.

In the same way, the *ad valorem* tariff imposed by the EU on beef from the ROW is reduced from 53% to 35%. Finally, we suppress the *ad valorem* tariff imposed by the EU on Indian beef because there have been absolutely.

It comes as no surprise that different data lead to different results. The results with this new modification are reported in the third row of 2.4. It appears that the removal of export subsidies is more welfare improving and essentially to the benefit of the EU. By contrast, the removal of tariffs is less welfare enhancing, both for developed countries and developing countries. At this stage, the removal of EU tariffs is still the major welfare-enhancing scenario for developing countries but the magnitude of the gains is considerably reduced, from US$6.2 billion to US$2.6 billion. In terms of world welfare, the contribution of the market access pillar relative to the whole CAP also decreases significantly, from 65% (9.3/14.3) to 32% (2.8/8.8).

Table 2.4 – Sensitivity of Welfare Effects of Removing EU Agricultural Policy Instruments to Modelling Choices (Equivalent variation in income, 2001 US$ million)

Modelling Choice \ Impacts on	EU	US	Japan	Other Developed	Total Developed	Brazil/ Argentina	China	India	Other Developing	Total Developing	World
Initial modelling											
Export subsidies	2115	-79	-277	327	2086	74	-87	14	-1098	-1097	989
Domestic Support	4605	87	-74	189	4806	331	-89	-6	-55	180	4986
Market Access	2425	60	-344	978	3118	3611	3	774	1775	6164	9282
Total	7881	25	-717	1421	8610	4345	-213	938	634	5704	14314
Self-imports											
Export subsidies	1871	-20	-274	354	1931	99	-71	21	-891	-841	1090
Domestic support	4354	98	-79	184	4557	291	-63	6	73	307	4865
Market access	1299	237	-138	376	1774	2512	185	496	1794	4988	6762
Total	6308	295	-503	892	6992	3194	22	633	1052	4901	11893
Data											
Export subsidies	2378	-1	-287	374	2465	154	-77	29	-811	-704	1761
Domestic support	4252	98	-79	184	4455	289	-63	6	71	303	4757
Market access	-231	186	-130	375	201	1793	239	-8	604	2627	2828
Total	5593	270	-498	902	6267	2440	71	33	-16	2528	8795
Production quotas											
Export subsidies	1713	0	-210	291	1794	96	-67	13	-957	-915	879
Domestic support	4509	96	-70	176	4711	280	-62	3	64	285	4996
Market access	-927	186	-60	280	-521	1715	254	-19	589	2539	2018
Total	5048	249	-395	736	5637	2241	91	7	-301	2038	7675
Tariff rate quotas											
Export subsidies	1950	1	-203	287	2035	87	-65	12	-958	-924	1112
Domestic support	4408	96	-70	176	4610	281	-62	3	63	285	4895
Market access	-274	187	-76	347	184	632	323	-20	61	996	1181
Total	5484	262	-386	792	6152	1031	168	4	-663	540	6693
Intervention regime											
Export subsidies	2186	6	-204	324	2312	292	-67	25	-1027	-777	1536
Market access	-261	173	-125	316	103	409	299	-21	170	857	959
Direct Payments											
Export subsidies	1979	18	-181	277	2093	308	-68	23	-1011	-748	1345
Domestic support	3453	116	-148	244	3665	341	-83	18	-61	215	3879
Market access	-347	183	-113	301	24	323	290	-22	131	722	746
Total	4589	281	-474	870	5266	1073	144	16	-791	422	5709

2.4.3 Production quotas

The development of EU milk and sugar production has been constrained for decades by production quotas which are not introduced in the standard framework. However, these production quotas are very important instruments of the EU milk and sugar policies. The main difficulty in introducing these instruments is to determine the level of the associated quota rents. Based on van Meijl and van Tongeren (2002), Frandsen et al. (2003) and Lips and Rieder (2005), we assume that the unit quota rents represent 20% of initial producer prices in both sectors. We simultaneously reduce the values of other factors of production used in these sectors (labour and capital) using their initial shares. Our introduction of production quotas is made in a complementary fashion, i.e. the quota regimes are endogenous.

The introduction of these production quotas is illustrated in the fourth row of Table 2.4. It appears that the main effect is to significantly reduce the world welfare gains of an export subsidies removal scenario from US$1.7 billion to US$0.9 billion. This reduction is mainly experienced by the EU-equivalent variation (from US$2.4 billion to US$1.7 billion), simply because prices must significantly decrease in these two sectors before resource allocation (and hence welfare) changes. The impact of the market access pillar is also significantly reduced from US$2.8 billion to US$2 billion at the world level. Again, the main welfare loser is the EU because these two farm sectors resist liberalisation better.

2.4.4 Tariff Rate Quotas

The protection of EU agricultural markets is characterised by the predominance of tariff rate quotas (TRQs). Again if the modelling of such instrument is well known, its practical implementation is challenging. The main reason for this is that TRQs are defined at tariff lines while economic models are usually defined on product aggregates due to the availability of data. Accordingly the aggregation must acknowledge the discontinuity involved in the TRQs. Another important reason is that this instrument generates rents and their distribution between importers and exporters should be identified.

In the standard framework, the default assumptions are to use the out-of-quota tariff when imports approach the quota level and to implicitly affect the quota rent to the importer. This last assumption is very crucial as it implies that export prices by foreign countries to the EU are equal to their true production costs. Accordingly, these foreign producers are not able to export the same quantities to the EU if their export prices decrease slightly. The assumption is supported by the analysis of Tangermann (2005) who concludes that importers in developed countries are likely to capture these rents. In this paper, we will adopt this assumption but, as the European Commission (2006), we suspect that additional work on the measurement of true production costs would be useful here. However, we examine the assumption that the marginal tariff equals the out-of-quota tariff when imports reach the quota level. Our concern can be explained simply using the sugar case. The application of the out-of-quota tariff to the bilateral cif import price between the ACP and the EU leads to a domestic price of imports much higher than the EU market price. These imports are in fact taxed at a much lower rate. In order to compute our true marginal tariff, we proceed as follows. We first compute the maximum entry price by multiplying the reference price by the initial *ad valorem* tariff rate. We then assume that the marginal tariff is given by the difference between this maximum entry price and the bilateral price. With these assumptions, the tariff rate imposed by the EU on ACP sugar becomes zero while the tariff rate on beef imported from Brazil/Argentina is reduced to 23.5%. We thus reduce again the level of tariff of the GTAP database to reflect the lower in-quota tariff which applies on higher bilateral trade values.

The results of the new modification are reported in the fifth row of 2.4. As expected, the world welfare effect of removing the EU tariff protection is again much lower (from US$2 to US$1.2 billion). The ROW country group now does not significantly benefit from this experiment.

2.4.5 The intervention price regime

So far we have measured the impacts of each pillar independently of the interactions between instruments thanks to the Armington trade modelling. EC (2006) questions the absence of articulation between tariffs and export subsidies in the representation of EU price support regimes. In the academic literature, there is recognition that these two instruments are linked. van Meijl and van Tongeren (2002), in particular, assume that a reduction in market price support implies a simultaneous decrease of export subsidies and import tariffs. In the cereal sectors, these two policy instruments are made endogenous and are linked to the exogenous intervention prices and threshold prices, respectively. As the evolution of these two latter prices are practically linked (due to the "155 per cent" rule), it is thus clear that the removal of export subsidies is linked to a reduction of tariffs. In other sectors (notably beef), these authors also assume that the reduction in support prices is reflected in exogenous lower import tariffs and exogenous lower export subsidies. Unfortunately the precise relationship is unclear in that publication.

Regarding the EU support price regimes and the links between tariffs and export subsidies, our understanding is as follows. When the EU simultaneously grants export subsidies and imports significant quantities in one given market, the imports are preferential and motivated by historical relationship (butter) and/or as a development policy tool (sugar). Thus the EU wants to maintain these trade flows and will reduce, if necessary, the import tariffs in case of market changes. On this basis we assume that the removal of export subsidies scenario should be accompanied by a reduction of tariff rates such that total imports are maintained in the corresponding agricultural sector. The impacts of removing market access instruments should in that case be computed as the difference between the simultaneous removal of both instruments and the new export subsidies scenario.

The results of this new decomposition are given in the sixth row of 2.4. The contribution of the export competition pillar now increases from US$1.1 billion to US$1.5 billion because we simultaneously reduce import tariffs on sugar (by 100%)

and dairy products (by 24%). The additional welfare gain is mostly reaped by the EU and Brazil/Argentina. By definition, the contribution of the "remaining" market access pillar is lower. In the initial setting, the market access pillar contributes 65% of the world welfare gain generated by the EU liberalisation. In our new setting, it contributes only 14% and, moreover, the absolute level decreases by 90% (from US$9.3 billion to US$1 billion). By contrast, the contribution of the export competition pillar increases from 7% to 23%.

2.4.6 The modelling of direct payments

The fact that massive direct payments have limited welfare consequences puzzles many observers. Global models are criticised for their inability to represent the different channels (wealth, dynamic, efficiency effects) by which these direct payments influence country production and ultimately trade (for instance, Roberts and Gunning-Trant (2007)). If these critics are justified theoretically, there is to date no published research showing major impacts of the direct payments through these channels (Bhaskar and Beghin, 2007). On the other hand, Gohin (2006) questions the usual modelling of EU direct payments in currently available models and tests alternative specifications. The first point is that these models assume that arable crop direct payments are fully capitalised in land values. Comparison with land rental rates shows that this assumption is untenable. This author reconciles these figures by assuming that arable crop direct payments are partly land subsidies, partly labour/capital subsidies. The second point is that these models implicitly assume that beef direct payments are fully coupled and accordingly do not recognise the different constraints associated with these payments. Their introduction on the different categories of animals significantly alter the production and trade effects ofEUbeef direct payments.

In this last sensitivity analysis we basically implement the alternative specifications developed by Gohin (2006) in the GTAP AGR framework. As far as the arable crop sectors are concerned, we reduce the initial level of land subsidies and introduce subsidies on labour and capital uses. We maintain the total level of direct payments but the distribution across factors is done according to the factors shares in the value-added. This implies that when we remove these direct payments, we remove the land subsidies and the labour and capital subsidies as well. We also increase the land endowment (by 5%) to reflect the set-aside policy linked to these direct payments. As far as the cattle sector is concerned, the GTAP product disaggregation is not sufficiently detailed to reproduce the different beef premiums and attached constraints. As underlined earlier, the initial modelling overstates the impacts of these payments by considering them as a capital subsidy (since capital is a substitute for other factors in the cattle production technology, including the more fixed land factor). In our alternative modelling, we consider that these direct payments are output subsidies. We also introduce a production quota to reflect the different constraints on suckling herds. Based on the simulation results of Gohin (2006), we assume that the associated quota rent is half the cattle direct premiums.

These last changes obviously significantly alter the welfare effects of the domestic support pillar. World welfare gains decrease from US$4.9 billion to US$3.9 billion. This reduction of welfare gains is mainly supported by the EU. In fact there are two opposite forces. The modifications made on the arable crop direct payments make them initially more distortionary because resource allocation of primary factors across sectors changes more significantly. On the other hand, the introduction of the beef premium constraints makes them much less distortionary. The impacts of the two other pillars are slightly reduced.

Conclusion

The present round of multilateral trade negotiations is still stalled over agricultural trade. The EU is pressed by its trading partners to open its agricultural markets. Economic evaluations of trade liberalisation scenarios unanimously conclude that substantial market opening is required for a successful (welfareimproving) Doha Round. In this paper, we perform new evaluations to identify precisely the contributions of the CAP and to examine the robustness of these evaluations to the representation of this complex policy. Using standard approaches, our first simulations show that the EU has a major responsibility in delivering significant gains to developing countries. However, when we conduct the same experiments with a more relevant calibration and modelling of the CAP instruments, the potential gains and their distribution are significantly modified: world welfare gains decrease by 60% and the contribution of the market access pillar decreases by 52% (from 65% to 13%). For developing countries, the reduction of their welfare gains due to a CAP dismantling is even more significant (92.5%).

We are reluctant to draw too general policy conclusions from these simulations because they are based on modelling assumptions which could be improved and we just wish to demonstrate that available results are not really robust. In this paper, we only modify some data measuring the support given by the CAP and the way these policy instruments are modelled. We do not modify the (CES-based) trade elasticities which are well known to have significant impacts.

However, if political decisions are to be influenced by available economic evaluations, our empirical analysis allows us to conclude that the current focus in the Doha Round on EU agricultural market access is misplaced. This statement has already been expressed in general terms by Charlton and Stiglitz (2005), for instance. Our contribution in this paper is to demonstrate empirically this point by using and improving a widely used economic tool.

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Deuxième partie

Modélisation dynamique en Equilibre Général Calculable

Chapitre 3 Dynamic modelling of agricultural policies: the role of expectation schemes [1]

Résumé

Les effets, très discutés, de la libéralisation du commerce agricole sont la plupart du temps simulés à l'aide de modèles statiques. Notre objectif principal dans cet article est d'évaluer la robustesse de ces résultats statiques à la modélisation cohérente des comportements dynamiques et à la spécification des anticipations de prix. En nous focalisant sur le scenario d'une libéralisation complète de certains marchés agricoles dans les pays développés, nous trouvons que les résultats statiques disponibles actuellement sont relativement robustes aux spécifications dynamiques, et ce pour la plupart des schémas d'anticipation. Des fluctuations de marchés endogènes, liées aux erreurs d'anticipation des agents, peuvent apparaitre suite à la réforme lorsque les agents ont des anticipations imparfaites. Ces fluctuations sont toutefois limitées par de nombreux effets de rétroaction révélés par notre modélisation en équilibre général.

1. Une version courte de cet article, co écrit avec Alexandre Gohin, est en révision dans Economic Modelling

Introduction

Agricultural liberalization is generally a major bone of contention in both bilateral and multilateral trade negotiations. Many economic analyses evaluating the impacts of various trade liberalisation scenarios are now available. On the one hand, some studies using complex computable general equilibrium (CGE) models find that the agricultural trade liberalisation will improve the world welfare with benefits shared by most countries (for instance, Anderson et al. (2006) with the Linkage model of the World Bank ; OECD (2006) with the GTAP-PEM of the OECD ; Hertel and Keeney (2006) with the GTAP model of the Purdue University, Fontagné et al. (2005) with the Mirage model of the CEPII). On the other hand, other studies question these results and policy recommendations arguing that they rely on implausible modelling assumptions, such as the choice of trade elasticities, the modelling of trade policy instruments or the modelling of labour market imperfections (for instance, Ackerman (2005) ; Taylor and von Armin (2007) ; Polaski (2006)).

The specification of dynamic economic behaviours in these CGE models is also disputed. In their survey, Piermartini and Teh (2005) observe that dynamic CGE models tend to estimate larger gains compared to comparative static models. According to these authors, this comes from the fact that these dynamic models take into account the subsequent increase in the rate of investment and the diffusion of technical change following trade opening. Bouet (2008) argues that the diffusion of technical change, more precisely the relation between total factor productivity and trade openness, is the key factor in the larger effects simulated with dynamic models. Unfortunately the way in which this relation has been introduced in CGE models lacks micro-economic foundations and *in fine* may artificially increase welfare effects of agricultural trade liberalisation (Bouet, 2008). Moreover, the dynamic CGE models used to simulate the effects of agricultural trade liberalisation adopt a simple recursive structure: they are built as a succession of static CGE models mainly linked by a jumping variable. Typically the stock of physical capital is updated by the net investment of previous period. The major drawback of these recursive dynamic CGE models is that they do not guarantee time-consistent economic behaviours (Nordas et al., 2006). Typically investments by firms (or savings by households) are specified with *ad hoc* functions and thus do not derive from well-behaved inter temporal optimisation programs. In these latter consistent programs, firms decide their investment levels subject to price and factor return expectations. So the investment effect justifying larger dynamic effects also lacks solid macro economic foundations. Finally, these static or dynamic recursive CGE models do not recognize one critical feature of agricultural production: the time lag between production decisions and harvests, which implies that farmers have to base their production decision on expected rather than on observed market prices.

Our major objective in this paper is to evaluate the robustness of simulation results of agricultural trade liberalisation to the consistent modelling of dynamic behaviours and to the linked specification of price/return expectations.

This joint issue of dynamics and expectations is widely neglected in the large CGE literature simulating the impacts of agricultural policies. The exception are Boussard et al. (2004) and Boussard et al. (2006) who compare an *ad hoc* dynamic recursive CGE model with a model where farmers and investors have naïve price/return expectations. They find that these two versions lead to very different dynamic results and *in fine* to different policy conclusions. In this paper we extend these works in several directions. First, we test different expectation schemes (from naïve to fully rational) and not only the extreme naïve one because econometric analysis on farmers' behaviour generally concludes that farmers have quasi rational price expectations (Chavas, 1999, 2000; Nerlove and Bessler, 2001). Second, our benchmark is a static CGE model widely used to assess agricultural trade liberalisation rather than an *ad hoc* dynamic recursive one. By the way this will allow us to clarify the differences between static and dynamic appraisals of agricultural policy. Third, Boussard et al. (2004) and Boussard et al. (2006) mostly focus on the nature of farmers' price expectation for production decisions. In this paper we also pay attention to the nature of price expectations for saving and investment decisions. A final distinctive feature of our analysis is the specification of land market clearing mechanisms. Due to the lag between production decisions and harvest, farmers engage some inputs (mainly land) in the production process without perfectly knowing their output price. Equally landowners allocate part of their land to farmers without perfect knowledge of the returns provided by alternative land-using activities. Some policy regulations on land uses/returns may provide some frictions on this land market. Accordingly we will test the sensitivity of results to the return expectations by both actors operating on land markets and to the eventual existence of land policy regulations.

In this paper we simulate the impacts of a full trade liberalisation of arable crop markets by developed countries. This radical scenario is often analysed as a benchmark of more realistic scenarios. Our main results are as follows. First, the static and rational dynamic models lead to very similar results. Accordingly, dynamic modelling by itself is not sufficient to generate higher or lower gains from agricultural trade liberalisation. Second, the specification of price/return expectations in general matters a lot. When the expectations by all economic agents come close to naïve ones, we obtain a diverging cobweb model with the standard elasticities. On the other hand, with more econometrically founded adaptive price expectations, market results still do not reach limit points but stay nevertheless close to static results. Third, the specification of factor return expectations by landowners (when allocating land) or by farmers (when investing in physical capital) also matters a lot. In particular, if farmers have different price expectations when deciding production for the next period and investment for all future years, then we again obtain a diverging cobweb model. This outcome also appears when landowners allocate their land on (policy-oriented) imperfect expectations rather on the current return offered by farmers. Accordingly all these results suggest that it is critical to incorporate the different decisions (production, investment, land allocation) and associated expectations of the actors (farmers, factor owners) operating on farm markets in dynamic models. These multiple dimensions are usually ignored in dynamic partial equilibrium models (for instance, Goeree and Hommes (2000)). This also suggests that some policy interventions (on the land market) may prevent the interplay of market forces and *in fine* they may be destabilising. Fourth all these results are obviously dependent on the form of supply and demand functions and on the calibrated price elasticities. Parameters of CGE models are usually calibrated with long-run supply elasticities. As expected, reducing the values of these supply elasticities to reasonable short-run ones reduce the occurrence of diverging cobweb models.

The remaining of the article is organised as follows. In the next section, we briefly describe the general structure of current CGE models used to simulate the effects of agricultural policies. We focus the discussion on the specification of dynamic variables (investments, savings). In section 3.2, we explain the passing from a static CGE model to a dynamic model with rational (or perfect foresight) expectations. In particular we consistently derive production, investment and saving decisions from well behaved inter temporal optimisation programs. In the section 3.3, we introduce imperfect price and return expectations by the different agents. We detail the closure rules we specify to ensure that all profits are distributed, that product and factor markets clear and that macro-economic identities are satisfied. Section 3.4 is dedicated to simulation results obtained with the different modelling versions. Finally we conclude

3.1 CGE modelling of agricultural policies: current specifications of dynamic variables

If, by definition, no models can serve for all purposes, it is fair to admit that CGE models are now more and more widely used to assess public policies in general, and agricultural policies in particular. The development of richer databases with better representation of agricultural/food sectors and policy instruments certainly contributes to make them more realistic than those used ten years ago. While improved databases supporting these models are always welcome, their technical specifications progressively become the focus of debates. In this section, we first give the main equations structuring current CGE models. Then we discuss how dynamic variables (investment, savings) are specified in both static and recursive dynamic CGE models used to assess agricultural policies.

3.1.1 Basic structure

The basic structure underlying current CGE models for agricultural policy assessment can be summarised by the following seventeen equations:

$$L_{ir} = L_{ir}\left(Y_{ir}, WL_{ir}, WK_{ir}, WT_{ir}\right) \ \perp L_{ir} \tag{3.1}$$

$$K_{ir} = K_{ir}\left(Y_{ir}, WL_{ir}, WK_{ir}, WT_{ir}\right) \ \perp K_{ir} \tag{3.2}$$

$$T_{ir} = T_{ir}\left(Y_{ir}, WL_{ir}, WK_{ir}, WT_{ir}\right) \ \perp T_{ir} \tag{3.3}$$

$$P_{ir}Y_{ir} = WL_{ir}L_{ir} + WK_{ir}K_{ir} + WT_{ir}T_{ir} \ \perp Y_{ir} \tag{3.4}$$

$$L_{ir} = L_{ir}\left(\overline{L}_r, WL_{ir}, WL_{jr}\right) \ \perp WL_{ir} \tag{3.5}$$

$$K_{ir} = K_{ir}\left(\overline{K}_r, WK_{ir}, WK_{jr}\right) \ \perp WK_{ir} \tag{3.6}$$

$$T_{ir} = T_{ir}\left(\overline{T}_r, WT_{ir}, WT_{jr}\right) \ \perp WT_{ir} \tag{3.7}$$

$$Q_{ir} = Q_{ir}\left(E_r, P_{ir}, P_{jr}\right) \ \perp Q_{ir} \tag{3.8}$$

$$I_{ir} = I_{ir}\left(I_r, P_{ir}, P_{jr}\right) \ \perp I_{ir} \tag{3.9}$$

$$M_{ir} = M_{ir}\left(PW_{ir}, PW_{jr}\right) \ \perp M_{ir} \tag{3.10}$$

$$P_{ir} = PW_{i,r}\left(1 + tm_{ir}\right) \ \perp PW_{ir} \tag{3.11}$$

$$Q_{ir} + I_{ir} = Y_{ir} + M_{ir} \ \perp P_{ir} \tag{3.12}$$

$$S_r = S_r\left(.\right) \ \perp S_r \tag{3.13}$$

$$I_r = I_r\left(.\right) \ \perp I_r \tag{3.14}$$

$$E_r = \sum_i \left(\begin{array}{l} WL_{ir}L_{ir} + WK_{ir}K_{ir} \\ +WT_{ir}T_{ir} + tm_{ir}PWM_{ir}M_{ir} \end{array} \right) + B_r \ \perp E_r \tag{3.15}$$

$$B_r = \sum_i PWM_{ir} M_{ir} \perp B_r \tag{3.16}$$

$$I_r = S_r \tag{3.17}$$

With the following notations:

index

i, j : product

r : region

endogenous variables

Y_{ir} : production

L_{ir} : labour

K_{ir} : capital

T_{ir} : land

WL_{ir} : labour return

WK_{ir} : capital return

WT_{ir} : land return

Q_{ir} : consomption

M_{ir} : net imports

I_{ir} : investment

P_{ir} : domestic price

PW_{ir} : import price

PI_{ir} : price of investment

E_r : income

B_r : capital account imbalance

S_r : total savings

I_r : total investment

exogenous variables

$\overline{L}_r$: labour stock

tm_{ir} : tariffs

$\overline{T}_r$: land stock

The first fourth equations determine the supply side of the economy. Labour (Equation 3.1), capital (Equation 3.2) and land (Equation 3.3) demands are derived from static cost minimisation problems by firms:

$$\min cost_{ir} = WL_{ir}L_{i,r} + WK_{ir}K_{ir} + WT_{ir}T_{ir}$$

$$s.t. \quad Y_{ir} = Y_{ir}\left(L_{ir}, K_{ir}, T_{ir}\right)$$

The CES (Constant Elasticity of Substitution) functional form is usually used to specify the production or dual cost functions. Implicit in this specification is that the capital is, at least partly, mobile between sectors. Output levels are determined by the zero profit condition (Equation 3.4). The next three equations (Equations 3.5 to 3.7) determine the supply of factors to activities as a function of total factor availability and return by activities. The CET (Constant Elasticity of Transformation) functional form is usually used to implement these equations (with the limited case of perfect mobility). Following equations specify final demand by household (Equation 3.8), investment demand per commodity as a function of total investment (Equation 3.9), foreign supply of products in a reduced form to simplify the presentation (Equation 3.10), the relation between domestic and foreign prices (Equation 3.11), equilibrium on product markets (Equation 3.12). Domestic saving and investment are for the moment specified in general ways and will be discussed below (Equations 3.13 and 3.14). Finally, the last three equations are macro-economic conditions defining the national income (Equation 3.15), ensuring the balance of payments (Equation 3.16), and the balance between savings and investments (Equation 3.17).

In this stylised static CGE model, agricultural policies are captured by the tariffs imposed on imports.

3.1.2 Specification of investment and saving dynamic decisions

The choice of a closure rule which ensures that saving equals investment has long been an important issue in static CGE models. As Dewatripont and Michel

(1987) note, this closure problem arises because of the dynamic nature of the economy, reflected in the possibility for economic agents to invest or save. Different solutions reflecting modeller's view have been implemented. We discuss the solutions adopted in the four prominent CGE models mentioned in the introduction.

In the static version of the GTAP model and the GTAP-PEM model, saving is a fixed proportion of domestic income. This specification is motivated by the work of Lluch (1973) and Howe (1975) showing that, under the assumptions of static price (and inflation) expectations and a Stone Geary instantaneous utility function, saving is a fixed proportion of the supernumerary income. Then a world bank collects savings from all countries and allocates world saving to regional investments according to expected regional capital returns. These expected capital returns decline with investments according to an *ad hoc* log-log specification and do not depend on expected good prices. This is equivalent to assume static output price expectations in investment decisions.

In the recursive dynamic CGE models, saving and investment specifications are hardly more complex. In fact most of the dynamics occurs outside of the model proper, i.e. in between solutions. The main exception is the capital accumulation function. In the Mirage CGE model, regional savings are also assumed to be fixed proportions of regional incomes for each simulated year. These savings are yearly allocated to investments in different sectors and different regions according to current capital returns. This is thus slightly different from previous specifications. The Mirage one assumes that end-of-the-year simulated capital returns will prevail in the next period (so a naïve expectation). In the previous CGE models, observed capital returns at the beginning of the year (before the implementation of the policy shock) are used as capital return expectations for the next period (so a myopic expectation).

Finally, in the Linkage CGE model, agents are assumed to be myopic and to base their decisions on static expectations about prices. More precisely regional savings represent fixed shares of regional incomes. Regional investment is set residually to balance with domestic and foreign savings, the latter being determined from an exogenous current account surplus or deficit.

To sum up, both static and dynamic recursive CGE models used to assess agricultural policies implicitly specify potentially restrictive expectations scheme for investment and saving decisions. They mostly assume static (myopic) price/return expectations and thus do not recognize the effects of policy shocks on these dynamic decisions. Moreover they do not recognize the lag between (planting) production decisions and (harvesting) output marketing and thus also neglect the expectations associated with this dynamic as well.

3.2 Dynamic CGE modelling of agricultural policies with rational expectations

Many researches have already analysed the joint impacts of dynamics and price expectations on CGE results. For instance, Rutherford and Tarr (2003) show with a CGE model applied to a small open economy that the static and dynamic rational expectation versions lead to the same results. Bye (2000) also finds similar results from the rational expectation version of his dynamic CGE model, and from a version where investors have imperfect expectations,. By contrast, Thissen and Lensink (2001) or Ballard (1987) find that their results differ considerably between the rational expectation version and the adaptive expectation version of their respective dynamic CGE models. These results suggest that the issue of dynamics and expectations is case specific, depends on the nature of contemplated scenarios and how imperfect are adaptive price expectations.

In this section we explain how we build a dynamic rational CGE model from the static CGE model described in section 3.1. We first describe the dynamic behaviour of producers, then the dynamic behaviour of consumers and finally define the macro-economic closure rules and steady state conditions. We basically keep the same notations and add a time index t.

3.2.1 Dynamic modelling of producer behaviour with rational expectations

As usual we assume that firms choose, at each time period, the optimal levels of labour and land and make investment decisions to maximise the value of the firm. We furthermore assume that firms, and more generally all agents, face the same certain world interest rate. This is equivalent to assume an efficient world financial capital market. Such an assumption makes sense in the perfect foresight setting of this section. This implies in particular that the financial structure of firms does not matter. However, to facilitate the comparison with the imperfect expectation case, we assume that firms finance all investment outlays by retaining profits so that the number of equities issued by the private sector remains unchanged. It should be added that this assumption fits well with the structure of farm capital mostly owned by farmers (Barry and Robison, 2001).

On the other hand, we assume that investment is subject to rising marginal costs of installation and that physical capital, once installed, is fixed (Chavas, 1994; McKibbin and Wilcoxen, 1999). Accordingly the equation determining the mobility of capital is dropped (Equation 3.6). The decision problem of firms then becomes:

$$\max \pi_{ir} = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^{t} \left(\hat{P}_{irt} Y_{irt} - \hat{W}L_{irt} L_{irt} - \hat{W}T_{irt} T_{irt} - \hat{P}I_{irt} \left(1 + \aleph_{irt}\right) I_{irt}\right)$$

$$s.t. \quad Y_{irt} = Y_{irt}\left(L_{irt}, K_{irt}, T_{irt}\right)$$

$$s.t. \quad K_{irt+1} = K_{irt}\left(1 - \delta_{irt}\right) + I_{irt}$$

$$s.t. \quad K_{ir0} = \bar{K}_{ir0}$$

Expected output prices and factor returns (with a hat) are now specified, δ_{irt} is the depreciation rate of capital and $\aleph_{irt}$ the unit cost of capital installation. We adopt the Uzawa's specification:

$$\aleph_{irt} = \frac{\phi_{ir}}{2} \frac{I_{irt}}{K_{irt}}$$

This producer decision problem can be solved in two steps. In the first step, we can solve the optimal production, land and labour decisions given expected output prices, expected factor returns and installed capital:

$$\max \hat{W}K_{irt}K_{irt} = \hat{P}_{irt}Y_{irt} - \hat{W}L_{irt}L_{irt} - \hat{W}T_{irt}T_{irt}$$

$$s.t. \quad Y_{irt} = Y_{irt}\left(L_{irt}, K_{irt}, T_{irt}\right)$$

$$s.t. \quad K_{irt} = \bar{K}_{irt}$$

This leads to equations very similar to Equations 3.1 to 3.4, the exception being that the capital derived demand equation (Equation 3.2) implicitly determines the residual expected capital return. In the second step, we determine the optimal investment and capital formation per period:

$$\max \pi_{ir} = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^{t} \left(\hat{W}K_{irt}K_{irt} - \hat{P}I_{irt}\left(1+\aleph_{irt}\right)I_{irt}\right)$$

$$s.t. \quad K_{irt+1} = K_{irt}\left(1-\delta_{irt}\right) + I_{irt}$$

$$s.t. \quad K_{ir0} = \bar{K}_{ir0}$$

Equations 3.6 and 3.9 are then replaced by the first order conditions of this second step:

$$K_{irt+1} = K_{irt}\left(1-\delta_{irt}\right) + I_{irt} \quad ; \quad K_{ir0} = \bar{K}_{ir0} \perp \quad K_{irt} \tag{3.18}$$

$$\left.\begin{array}{l} \hat{W}K_{irt+1} + \left(1-\delta_{irt}\right)\hat{P}I_{irt+1}\left(\phi_{ir}\frac{I_{irt+1}}{K_{irt+1}} + 1\right) \\ = \left(1+r\right)\hat{P}I_{irt}\left(\phi_{ir}\frac{I_{irt}}{K_{irt}} + 1\right) - \frac{\phi_{ir}}{2}\hat{P}I_{irt+1}\left(\frac{I_{irt+1}}{K_{irt+1}}\right)^{2} \end{array}\right\} \perp \quad I_{irt} \tag{3.19}$$

$$I_{rt} = \sum_{i} \hat{P}I_{irt}I_{irt} \perp \quad I_{rt} \tag{3.20}$$

Equation 3.18 reproduces the dynamic of capital accumulation. Equation 3.19 implicitly determines the optimal investment by firms and Equation 3.20 simply aggregates investment at the regional level. To facilitate the interpretation of Equation 3.19, let's first assume that installation costs are null ($\phi_{ir} = 0$). The right hand side is then the marginal cost of investment in period t evaluated in period

$t + 1$. The left hand side is the marginal revenue of this investment: it equals the next period expected capital returns and the next period expected price of (the depreciated) investment good. When installation costs are positive, then the marginal cost and revenue of present investment are augmented by these costs. The last term of this equation takes into account that this installation cost decreases with the capital stock, hence investing today will decrease the installation cost of next-period investment.

The crucial point here is that optimal investment decisions depend on the expected prices of the investment good and the expected capital returns. The latter depend on the expected prices of outputs and the expected returns to other production factors. Accordingly if an agricultural policy scenario leads to some expected changes in output prices and capital returns, farmers will react by modifying their investment decisions (as well as their periodic production and input decisions). This will have subsequent impacts on future production and markets. Their expectations thus may have dramatic real impacts if they are not self-fulfilling. In the rational (or perfect foresight) case, the assumption is that all individuals have all information necessary to compute the future output prices and factor returns. In other words, their expectations are consistent with the model specification. This suggests that expected prices and returns can be simply replaced by simulated values in previous equations. Hence the lag between production decisions and harvest does not matter.

3.2.2 Dynamic modelling of consumer behaviour with rational expectations

We also adopt the standard assumption that households allocate their income to consumption goods and savings in order to maximise an inter temporal utility function. As usual we assume that this utility function is additively separable with a preference for present consumption over future consumption. Households face an inter temporal budget constraint because they have the possibility to save/borrow without risk at the world interest rate. This budget constraint ensures that the discounted value of future consumptions does not exceed the discounted value of future incomes. Due to the absence of liquidity constraints, this constraint can also be defined as a sequence of recursive equations of motion on wealth (Pereira and Shoven, 1988). We adopt this specification as it will ease later the specification of household imperfect expectations.

More formally, the decision problem of the household is given by:

$$\max \quad U_r = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^t U_r\left(Q_{irt}\right) = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho}\right)^t \log\left(Q_{rt}\left(Q_{irt}\right)\right)$$

$$\begin{aligned} s.t. \quad \hat{W}_{rt+1} - \hat{W}_{rt} &= r\hat{D}_{rt} + \sum_i \left(\begin{array}{l} \hat{W}L_{irt}\hat{L}_{irt} + \hat{W}T_{irt}\hat{T}_{irt} + \hat{\pi}_{irt} \\ +\hat{t}m_{irt}\hat{P}WM_{irt}\hat{M}_{irt} - \hat{P}_{irt}Q_{irt} \end{array} \right) \\ &= r\hat{W}_{rt} + \sum_i \left(\begin{array}{l} \hat{W}L_{irt}\hat{L}_{irt} + \hat{W}T_{irt}\hat{T}_{irt} \\ +\hat{t}m_{irt}\hat{P}WM_{irt}\hat{M}_{irt} - \hat{P}_{irt}Q_{irt} \end{array} \right) \\ &= \hat{D}Y_{rt} - \sum_i \hat{P}_{irt}Q_{irt} \end{aligned}$$

$$s.t. \quad W_{r0} = \bar{W}_{r0}$$

ρ is the rate of time preference, D the net foreign assets held by the domestic household (positive or negative), W the domestic household wealth which is the sum of domestic assets and net foreign assets, DY the distributed income. This dynamic decision problem is much more complex that the dynamic producer decision problem because the household must anticipate much more variables (mostly determining future income). The definition of the wealth accumulation equation deserves some explanation. The first terms of the right hand side represent the current income to domestic household: it equals the interest earning of foreign assets, the current labour and land returns, the profits distributed by firms and the tariff receipts. This definition of current income is different from the static one where we introduce the gross capital returns in place of profits (see Equation 3.13). If we add the total investment outlays by firms on the right hand side, then we can get total regional saving:

$$
\begin{aligned}
S_{rt} &= r\hat{D}_{rt} + \sum_i \left(\begin{array}{l} \hat{W}L_{irt}\hat{L}_{irt} + \hat{W}T_{irt}\hat{T}_{irt} + \hat{\pi}_{irt} + \hat{P}I_{irt}\left(1 + \hat{\aleph}_{irt}\right)\hat{I}_{irt} \\ +\hat{t}m_{irt}\hat{P}WM_{irt}\hat{M}_{irt} - \hat{P}_{irt}Q_{irt} \end{array} \right) \\
&= r\hat{D}_{rt} + \sum_i \left(\begin{array}{l} \hat{W}L_{irt}\hat{L}_{irt} + \hat{W}K_{irt}\hat{K}_{irt} + \hat{W}T_{irt}\hat{T}_{irt} \\ +\hat{t}m_{irt}\hat{P}WM_{irt}\hat{M}_{irt} - \hat{P}_{irt}Q_{irt} \end{array} \right) \\
&= \hat{E}_{rt} - \sum_i \hat{P}_{irt}Q_{irt}
\end{aligned}
$$

Accordingly, if we are able to determine the consumption expenditure from the household decision problem, then national saving is determined by this last equation. We can solve this household inter temporal program in two steps thanks to the time separability assumption. In the first step, we can determine the periodic optimal good consumption given expected consumer prices and optimal consumption expenditure. This leads to an equation very similar to Equation 3.8, the income variable being substituted by the optimal consumption expenditure. In the second step, we determine the optimal saving and consumption expenditure. Equation 3.13 is replaced by the following first order condition:

$$
\hat{E}_{rt+1} - S_{rt+1} = \hat{P}C_{rt+1}Q_{rt+1} = \left(\frac{1+r}{1+\rho}\right)\hat{P}C_{rt}Q_{rt} = \left(\frac{1+r}{1+\rho}\right)\left(\hat{E}_{rt} - S_{rt}\right) \perp \quad S_{rt} \tag{3.21}
$$

$\hat{P}C_{rt}$ is the expected composite consumer price, and Q_{rt} the composite consumption good. Again we only get an implicit equation determining the optimal evolution of consumption expenditure and saving in function of expected consumer prices and expected incomes. For instance, if the household expects a change in the composite consumer price, then it will modify its saving and consumption decisions. This will in turn alter market equilibriums, prices and future household decisions. If the policy shock affects a small sector like the farm sector in developed countries, then we do not expect textita priori that the issue of price and return expectations will significantly influence these macro-economic saving/consumption expenditure levels. This issue may be more severe for economies more dependent on their farm sector.

3.2.3 Macro-economic closures and steady state solutions

From the initial static CGE model, so far we mainly modify the equations determining capital supply (Equation 3.6 to 3.18), investment by firms (Equation 3.9 to 3.19), regional investment (Equation 3.14 to 3.20) and regional saving (Equation 3.13 to 3.21). In passing we also slightly redefine the current income by replacing the capital account imbalance (equal to the opposite of the current account imbalance) by the earning of foreign assets (first term of Equation 3.22) so that the dynamics of foreign assets accumulation is taken into account:

$$\hat{E}_{rt} = r\hat{D}_{rt} + \sum_i \begin{pmatrix} \hat{W}L_{irt}\hat{L}_{irt} + \hat{W}K_{irt}\hat{K}_{irt} + \hat{W}T_{irt}\hat{T}_{irt} \\ +\hat{t}m_{irt}\hat{P}WM_{irt}\hat{M}_{irt} \end{pmatrix} \perp \quad \hat{E}_{rt} \qquad (3.22)$$

To clarify, the two specifications in Equations 3.15 and 3.22 are equivalent if the interests on foreign assets always equal the current account imbalance. This condition makes sense in the long run, steady state, solution because one country can not indefinitely accumulate foreign assets or debts. However the specification 3.22 allows specifying the dynamic of foreign assets/debts which is given by:

$$D_{rt+1} - D_{rt} = rD_{rt} - B_{rt} \quad ; \quad D_{r0} = \bar{D}_{r0} \perp D_{rt} \qquad (3.23)$$

This equation is a macro-economic identity satisfied at each period. Expectations enter this equation through the capital/trade account imbalance. In static CGE models different rules concerning current/capital account imbalances can be specified reflecting modellers' view. For instance, in the standard static version of the GTAP model, the current account imbalance is endogenous while fixed at the observed initial level in the Linkage model. This obviously implies different effects on the real exchange rate and current income (see Equation 3.22). By extension this also implies different saving decisions and has important implications on farm-dependent economies. But the macro-economic closure of these static CGE models is still ensured due to the fact that investment, either regional or world, is driven by saving.

In dynamic CGE models, different "trade" rules consistent with the assumption on the financial capital markets are possible as well. The rules will also have some real impacts. On the other hand, if expectations by all economic agents are fully rational, then we can show that global savings equal global investment (see Appendix 3.A). This is indeed intuitive: since economic agents have full rationality, households necessarily know investment levels by firms and thus adjust their consumption and saving decisions so as to finance these investments.

Solving an infinite horizon dynamic CGE model imposes the modeller to define steady state conditions at some future terminal period. The equations determining investment (Equations 3.18 and 3.19) and saving (Equation 3.21) relates current decision to next period decision given expected prices and returns. As usual, we assume that in steady state investment equals capital depreciation, that the household wealth does not grow and that foreign debts/assets are stable as well. All these relations are consistent with the macro-economic identities. In fact this also implies that regional saving equals regional investment.

3.3 Dynamic CGE modelling of agricultural policies with imperfect expectations

The previous section makes clear that different price and factor returns expectations are formulated by all economic agents. In the rational expectation case, the assumption is that all economic agents are fully rational. In this section we consider the other polar case where no economic agents have full information on the evolution of the global economy and thus have imperfect expectations on prices, factor returns and future interest rates as well. This bounded rationality of economic agents is justified by the positive and significant cost of obtaining and processing market information (see for instance, Brock and Hommes (1997)). Before detailing agents' behaviour and macro-economic closures with imperfect expectations, it is worth stressing that, by definition, expected values are equal to the "true" future values in the fully rational dynamic CGE model. This implies that at the first period consumers and producers base their decisions on the "true" future market prices. Decisions taken during the second period rely on the same future market prices. Thereby there is no need to re-evaluate the model for each period: the solution computed in the first period corresponds to the optimal choice for the following periods (Ginsburgh and Keyzer, 1997). This need to solve the model for all periods simultaneously can lead to some computational issues (Dixon et al., 2005). On the other hand, in the imperfect expectation case, producers and consumers base their decision on expected prices which are not necessarily the true future market prices. Thus if during the second period they realize that their first period expectations were wrong, they will modify their expectations concerning the future periods and revise their production/investment/saving plans. Thereby the model has to be evaluated at each period and only the results for the on going period matter because they will be used to form the next period expectations and to give new starting conditions for the following period (new stock of capital, household wealth and country net debt). The model is thus iteratively solved, period by period, even if at each period agents define plans for many years.

3.3.1 Dynamic modelling of producer behaviour under imperfect expectation

In addition to the formulation of expectation schemes on prices, factor returns and interest rate, two main changes are introduced in the inter temporal program of the producer. First we consider that firms optimize their investment over a finite horizon rather than indefinitely because they have limited knowledge about output price, capital returns and interest rate in the far future. In other words, we assume that firms consider that, at some date, their investments will equal their capital depreciation. Indeed this firm steady state condition may never appear because firms periodically revise their plans but this formulation defines the current optimal investment plan for firms, including the current investment. We also assume that firms perfectly know the current price of the investment good when they invest, i.e. when they buy it. To be complete, this corresponds to the following decision problem:

$$\max \pi_{ir0} = \sum_{t=0}^{T} \left(\frac{1}{1+\hat{r}}\right)^{t} \left(\hat{W}K_{irt}K_{irt} - \hat{P}I_{irt}\left(1+\aleph_{irt}\right).I_{irt}\right)$$

$$s.t. \quad K_{irt+1} = K_{irt}\left(1-\delta_{irt}\right) + I_{irt}$$

$$s.t. \quad K_{ir0} = \bar{K}_{ir0}$$

$$s.t. \quad I_{irT} = \delta_{irT}K_{irT}$$

$$s.t. \quad \hat{P}I_{ir0} = PI_{ir0}$$

First order conditions of this problem are exactly given by equations 3.18 and 3.19. The only difference (except the formulation of expectation) is the introduction of a terminal/ steady state condition stating that firms do not expect to indefinitely grow or contract. The solution of this program is a firm investment plan which depends on the expected capital returns and expected price of investment goods. It mainly gives the current investment which will affect current market equilibrium. The investment levels planned for future periods may indeed be revised in the next period if the firm expectations do not materialize. Finally we note that firms need to anticipate over T periods the price of investment goods, their capital returns and the interest rate. Only the current price of the investment good is perfectly known when firms purchase it. The second modification concerns the intra temporal production and input decisions and intends to capture the time lag between production decisions and harvests. This modification applies to some activities only and this does matter with imperfect expectations. All the "cobweb" literature focuses on the production decision of firms but, to our knowledge, pays little attention to the input decisions. In our CGE setting both decisions are modelled, forcing us to classify inputs according to their introduction in the production process. In this article we focus on the arable crop markets where the one-year decision fits well with the annual periodicity of CGE models.

We assume that arable crop farmers decide their acreage choice given expected output prices and expected input prices (only labour in this theoretical section;

in the empirical section, we also include fertilizers, pesticides, ...). On the other hand, we assume that they can observe the current price of the land they decide to use. In other words, farmers pay their land input to landowners once they use it. Their intra temporal decision problem is thus:

$$\max \hat{W}K_{irt}K_{irt} = \hat{P}_{irt}Y_{irt} - \hat{W}L_{irt}.L_{irt} - WT_{irt}T_{irt}$$

$$s.t. \quad Y_{irt} = Y_{irt}\left(L_{irt}, K_{irt}, T_{irt}\right)$$

$$s.t. \quad K_{irt} = \bar{K}_{irt}$$

From this problem, we derive the optimal production, labour and land demands:

$$L_{irt} = L_{irt}\left(\hat{P}_{irt}, \hat{W}L_{irt}, K_{irt}, WT_{i,r}\right) \ \perp L_{ir} \tag{3.24}$$

$$T_{irt} = T_{irt}\left(\hat{P}_{irt}, \hat{W}L_{irt}, K_{irt}, WT_{i,r}\right) \ \perp T_{ir} \tag{3.25}$$

$$Y_{irt} = Y_{irt}\left(L_{irt}, K_{irt}, T_{irt}\right) \ \perp \quad Y_{irt} \tag{3.26}$$

Because some activities are asking some land before other activities, landowners must decide to offer land to activities before knowing the land returns that other activities may offer. Accordingly landowners must allocate part of their land with imperfect information. Indeed the landowner has two decision periods: one at the "beginning" of the year where some lands are allocated to arable crop activities given expected land returns by other activities ; one at the "end" of the year to allocate remaining lands given observed land returns offered by other activities. Again this issue does not appear with the full rational case. The decision problem of the landowner at the beginning of the period is given by:

$$\max \sum_{j} \hat{W}T_{jrt}T_{jrt}$$

$$s.t. \quad \bar{T}_{rt} = T_{rt}\left(T_{jrt}\right)$$

$$s.t. \quad \hat{W}T_{irt} = WT_{irt} \quad i \in ac$$

The problem at the end of the period is:

$$\max \sum_{j \notin ac} WT_{jrt} T_{jrt}$$

$$s.t. \quad \bar{T}_{rt} = T_{rt}\left(T_{jrt}\right)$$

$$s.t. \quad T_{irt} = T^*_{irt} \quad i \in ac$$

ac stands for the arable crop activities and T^*_{irt} the allocation of land to arable crop activities in the beginning of the year. These two problems give new land supply functions:

$$\left.\begin{array}{l} T_{irt} = T_{irt}\left(\bar{T}_{rt}, WT_{irt}, \hat{W}T_{jrt}\right) \;\; i \in ac, j \notin ac \\ T_{jrt} = T_{jrt}\left(\bar{T}_{rt}, T_{irt}, WT_{jrt}\right) \;\; i \in ac, j \notin ac \end{array}\right\} \perp T_{ir} \tag{3.27}$$

Anticipating the simulation results, some may object at this point that the land markets are heavily regulated in some developed countries with some price and/or quantity restrictions. Indeed price regulations provide information to both landowners and farmers who thus have better information on land returns, if not the true one as modelled here. However this price regulation may prevent some cost adjustment by farmers and hence leads to subsequent large production effects. The potential stabilising or destabilising effect of one stylised land price regulation will be explored in the simulation section.

Implementing these new equations describing the behaviour of arable crop farmers and landowners modify the resolution of the model. In fact we first solve these equations to determine optimal production, land use and variable input uses by farmers given expected prices/returns and installed capital. In this first step we also determine land returns paid by the arable crop activities. Then in a second step we plug these results in the full CGE model (and remove the corresponding equations). The full CGE model will determine the current prices of arable crop products and the observed capital return will be determined residually. This full CGE model also determines the optimal investment plans by all agents and hence the availability of capital stock for next period.

3.3.2 Dynamic modelling of consumer behaviour under imperfect expectation

In a similar way we consider that the household optimizes its consumption and saving plans over a finite horizon rather than indefinitely because it has limited knowledge about the evolution of distributed income, consumer prices and interest rates. We consider that, after some dates, the household anticipates that the consumption expenditure equals the annual distributed income (Devarajan, 2001). Focusing on the "upper-stage" consumption/saving decisions, this decision problem is defined by:

$$\max \quad U_r = \sum_{t=0}^{T} \left(\frac{1}{1+\rho}\right)^t \log\left(Q_{rt}\right)$$

$$s.t. \quad \hat{W}_{rt+1} - \hat{W}_{rt} = \hat{D}Y_{rt} - \hat{P}C_{rt}Q_{rt}$$

$$s.t. \quad \hat{D}Y_{rT} = \hat{P}C_{rT}Q_{rT}$$

$$s.t. \quad W_{r0} = \bar{W}_{r0}$$

Solving this problem leads to the necessary first order conditions 3.21 and the additional terminal condition stating that the consumption expenditure equals the distributed income in the long run. Combining these two sets of conditions leads to:

$$PC_{r0}Q_{r0} = \hat{P}C_{rT}Q_{rT}\left(\frac{1+\rho}{1+\hat{r}}\right)^T = \hat{D}Y_{rT}\left(\frac{1+\rho}{1+\hat{r}}\right)^T$$

The current consumption expenditure thus depends on the expected distributed income in the long run and on the expected interest rate (to simplify notations, we assume here a constant expected interest rate over the projection period like the time preference parameter). The current total regional saving is then given by:

$$\begin{aligned} S_{r0} = E_{r0} - P_{r0}Q_{r0} &= E_{r0} - \hat{D}Y_{rT}\left(\frac{1+\rho}{1+\hat{r}}\right)^T \\ &= E_{r0} - \left(\hat{E}_{rT} - \hat{P}I_{rT}\left(1+\hat{\aleph}_{rT}\right)\hat{I}_{rT}\right)\left(\frac{1+\rho}{1+\hat{r}}\right)^T \end{aligned} \tag{3.28}$$

In other words, the current total regional saving depends on the current total income, the expected level of distributed income in the long run and the expected evolution of the interest rate. In many static or dynamic recursive CGE model, saving is a fixed proportion of total income. We see from this Equation 3.28 that this implies particular price and income expectations from households.

3.3.3 Macro economic closures under imperfect expectation

Household saving and firm investment decisions are made completely apart in the imperfect expectation setting. Whatever the specifications of the expectation schemes are, there is a chance that a country net foreign debt accumulates over the years, possibly leading to some correcting macro-economic policy (for instance, fiscal policy, see Devarajan and Go (1998)). There is also a great chance that they do not *de facto* ensure that investment equals saving at the world level. We thus need a new equilibrium mechanism ensuring this equality between investment and saving. We adopt a classical closure assuming that the current world interest rate is endogenous and that asset markets are perfectly integrated across regions. This endogenous interest rate at least appears in the current investment, whatever the expectation schemes. For instance, if total savings are lower than total investments, then the current interest rate increases such as to reduce investment and restore the equilibrium at the world level.

3.4 Simulations

Having detailed the main differences between static and consistent dynamic CGE models with different expectations schemes, we are now in a good position to assess the robustness of simulation results on agricultural policies to the joint issue of dynamics and expectations. We implement these different versions using the inescapable GTAP database (we use the version six calibrated on the 2001 economic flows) and the different elasticities (substitution elasticities between inputs at the production side, factor mobility elasticities, "Armington" trade elasticities and price/income demand elasticity) usually used in agricultural policy assessments (Keeney and Hertel, 2005). As usual we reduce the dimensions of the model by aggregating some regions and products. We retain 26 commodities keeping all farm and food products and 3 regions (the European Union (EU), the United States (US) and the Rest of the World (RoW)) in order to reduce computation time in the dynamic rational expectation case. All these information are sufficient to calibrate the static CGE model. In order to calibrate the dynamic versions, with rational or imperfect expectations, we need additional information. Basically we follow Devarajan and Go (1998) assuming that the initial point is a steady state and the initial interest rate/preference parameter/unit capital installation cost all equal 5%.

As usual we consider a rather extreme agricultural policy scenario: we assume that the EU and the US remove all their trade barriers on arable crop products (export subsidies and import tariffs on wheat, coarse grains and oilseeds). On the other hand, we assume that the RoW keeps all farm policy instruments at initial levels. Furthermore we do not change policy instruments on other farm and food products.

3.4.1 Results from the static model

Impacts on selected commodities from the static CGE model are provided in Table 3.1. As expected, we find that the EU production of cereals declines, by 6% for wheat, and by 6.9% for coarse grains. Basically removing trade barriers puts downward pressure on the EU domestic prices. We find limited price decreases, by 0.9% for wheat and 1% for coarse grains. Ex-post supply elasticities are thus considerable as usual in static CGE models because production factors are quite mobile. In fact we mainly observe a decrease of land returns paid by cereals activities (by 12%) leading to some reallocation to other activities. In particular the EU oilseed production slightly increases (by 0.6%) as this European sector is not initially protected by trade measures. We equally observe a slight increase (by 0.2%) of the European cattle production. In addition to the reallocation of land, this sector benefits from the decrease of cereal prices.

By contrast, the US and RoW productions of cereals expand (by less than 1%) because these sectors initially receive less protection than the EU sectors[2]. They even experience a slight increase of domestic price (around 0.2%) because they enjoy greater demands for their products. Finally impacts on US and RoW productions of oilseeds and cattle are again of the opposite sign, i.e. these productions decrease because land is attracted in the cereal sectors and the cereals are slightly more expensive.

TABLE 3.1 – Impacts of agricultural trade liberalisation from the static CGE model (in % with respect to the initial 2001 point)

	EU		US		RoW	
	Production	Price	Production	Price	Production	Price
Wheat	-6.0	-0.9	0.9	0.3	0.7	0.2
Coarse grains	-6.9	-1.0	0.6	0.2	0.7	0.2
Oilseeds	0.6	-0.3	-0.2	0	0	0
Cattle	0.2	-0.4	-0.1	0.1	-0.1	0.1

3.4.2 Results from the dynamic rational expectation model

In a dynamic model, we inevitably need to first establish a baseline before contemplating the effects of a policy scenario. In order to make results comparable to the previous static ones, we assume in the baseline no exogenous growth, more generally no changes in exogenous variables from the initial period until the steady state solution. So the baseline is simply a replication of the 2001 economic flows over the projection period. Below we report the results for a 15 years time hori-

2. More precisely the US protection on arable crops is lower than the EU ones in the initial GTAP database, partly because all U.S. trade measures are not included in this database (like food aid, export credit; more on this point can be found in Gohin and Levert, 2006) while the levels of EU agricultural policy instruments tend to be overestimated (more on this point can be found in Femenia and Gohin (2009).

zon. We perform the same experiment using a 20 years time horizon. Results are qualitatively similar because, as we will see, there is a rapid convergence to the steady state solution.

Before analysing results, we finally mention that in a dynamic model the timing of policy shocks can be specified as well. For example, we can investigate the effects of a rapid versus a slow trade liberalisation. Due to our crude baseline for this paper, we also specify a very crude implementation of the trade liberalisation shock. We assume that it is accomplished in the third year of our projection period (the motivation is provided below).

We find that in the steady state impacts on selected commodities are exactly equal to those obtained with the static CGE model. While the move from a static CGE model to a dynamic rational expectation one is rather complex and the resolution of the latter is much longer (few seconds for the static CGE model, one hour for the latter using the same computer), this may appear disappointing. In fact this result is not particularly surprising because a consistent dynamic rational expectation CGE model mainly gives micro-economic foundations to the saving and investment decisions. But these macro-economic decisions were not fundamentally modified in our policy experiment because agriculture is a small sector in developed countries. Moreover the sectoral impacts simulated by the static CGE model were also quite limited because land returns, rather capital returns, capture much of the shock. Finally this result has already been obtained by Rutherford and Tarr (2003) who simulate larger trade policy shocks (see also Devarajan (2001)).

Put in another way, this gives confidence on the long run impacts simulated by static CGE models, once one admits the rational expectation hypothesis. With respect to the debate on agricultural policy and the potential benefits of trade liberalisation, we thus find that dynamic modelling with rational expectations is not sufficient to generate larger, positive or negative, effects than the simple static approach (assuming away "*ad hoc*" productivity effects from trade opening).

Yet this does not mean that dynamic modelling with rational expectations is not worthwhile. For instance this provides the transition path from one to another steady state. Figure 3.1 provides the percentage evolution of the European production and price of wheat following trade liberalisation. We fully implement the trade liberalisation in the third year ("2003"). It is interesting to note that one year before the shock European wheat producers already start decreasing their production (by 0.4%). In fact investment in the European wheat sector decreases in the first two years by nearly 20%, so that the capital stock in this sector adjusts downwards. Consequently the European price temporary increases (by 0.2%). This suggests that the timing of trade liberalisation, more precisely its early announcement, matters in that rational expectation case because producers (more generally economic agents) already adjust to future market conditions. From a policy perspective, this also suggests that, in this rational expectation setting, the impacts of anticipated shocks can already be smoothed by economic agents.

Nevertheless Figure 3.1 also shows that the major effect occurs during the year of liberalization. For instance, the European production of wheat already declines by 5% in this first "liberal" period compared to 6% in the steady state. This suggests that, even if the dynamic of capital accumulation takes time, most production adjustments occur with the optimal combination of intra temporal variable inputs (fertilizers, pesticides, labour and land). In other words, short run price supply elasticities are still consequent (around 5) and much larger than those usually adopted in partial equilibrium models focused on agriculture (around 0.5). This is so because first substitution elasticities in production technologies are unchanged and second capital returns are a modest production cost in the initial GTAP database. From a modelling perspective, this suggests that fixing the annual capital stock alone is not sufficient to get more econometrically founded short run price elasticities. Either substitution elasticities or the mobility of other factors (such as land or labour) must be reduced in order to get more realistic supply response.

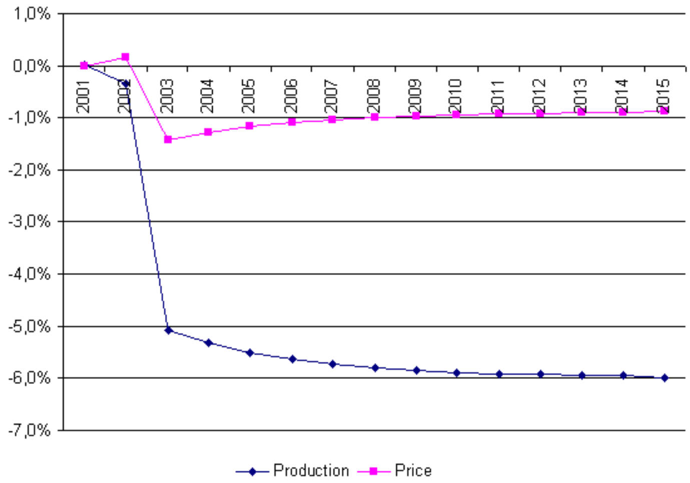

FIGURE 3.1 – Evolution of the European production and price of wheat under the rational expectation assumption(percentage change compared to the baseline)

3.4.3 Results from the dynamic imperfect expectation model

Implementing the dynamic imperfect expectation model also requires to determine the expectations on output prices, input prices, factor returns and the interest formulated by firms, factor owners and households. In this paper, we consider different variants on the arable crop farmer expectations when they decide their next period production levels, on the landowner expectations when they decide their land allocation and on the firm expectations when they plan their investment. On the other hand, we maintain the same assumptions regarding household expectations concerning future distributed income and economic agents concerning future interest rate. In practical terms, we adopt the usual specification that current saving is a fixed proportion of current total income. In other words, we assume that consumers expect that their terminal distributed income is proportional to the current total income (see equation 3.28). As regard to the future interest rate, we simply assume that all agents expect that the current interest will prevail in the future (so naïve interest rate expectation).

The exact nature of price expectations formulated by arable crop farmers is quite disputed in the economic literature. In a nutshell, the rational expectation assumption is made most of the time because it is elegant and consistent with other modelling specifications. This implicitly assumes that the information is costless. On the other hand, some recognize that collecting and processing information is costly: if these costs are high, adaptive and even naïve expectations can in fact be rational and there is an optimal use/search of information (Just and Rausser, 2002). Unfortunately this use of information is difficult to measure. It should be added that the econometric identification of farmers' expectations is made even more complex when there are public interventions on farm markets. To prevent these two issues, Chavas (1999) and Chavas (2000) performs econometric estimations on the price expectations by non-subsidized U.S. livestock farmers and thus exploit the dynamics of animal production to reveal the use of information. He finds that most farmers exhibit quasi rational expectations. On this ground, we assume that, in a "liberal" world, arable crop farmers would formulate their price expectations for the next period using past price information. We slightly simplify the analysis by assuming that arable crop farmers have Nerlovian (adaptive) price expectation scheme for next period prices:

$$\hat{P}_{irt} = \hat{P}_{irt-1} + \alpha \left(P_{irt-1} - \hat{P}_{irt-1} \right) = \alpha P_{irt-1} + (1-\alpha)\, \hat{P}_{irt-1}$$

with $\quad 0 \leq \alpha \leq 1$

The α parameter is the weight given to the previous period market price compared to all the earlier ones. In fact the lowest this parameter is, the greatest quantity of past information is taken into account. At the extreme, if this parameter equals zero, then we end up with static price expectations. At the opposite, if this parameter equals one, we end up with naïve price expectations. We report below the results of our policy experiment using different values for this parameter. In the central case, we assume that this parameter equals 1/3.

In a CGE model we also need to specify the nature of firms' expectations on input prices, factor returns, price of investment goods for their variable input and investment decisions. In the standard case, we also assume adaptive expectations with the same weighting parameter α. We also need to specify the nature of landowners' expectations on land returns in order to allocate part of their lands to some activities (see section 3.3.1). Again, adaptive expectations with the similar weighting parameter are assumed in the standard case.

Below we focus the discussion on the European impacts as they are the most contrasted. We first discuss results with the assumption of the same weighting parameter in all decisions. Then we analyse the sensitivity of results to the weighting parameter, moving from the naïve case to nearly static expectations. Third we present results when we assume different expectation schemes by firms when they invest. Fourth we examine the issue of landowner expectations. Finally we examine the sensitivity of the results to substitution (supply) elasticities.

Standard case

Figure 3.2 provides the results for the European wheat market from agricultural trade liberalisation under imperfect expectations. We also report the previous results obtained with rational expectations. The first point to note is that the results do not converge to a steady point after 12 years of liberalisation (recall that we implement the trade liberalisation in the third year). We solve the same model over 30 years and the model still does not reach a steady point. On the other hand, we never see a diverging system: the European wheat price changes from the baseline are always comprised between minus 5% and 3% and the European wheat production changes are bounded between minus 8% and 4%. In fact Figure 3.2 shows that these dynamic imperfect expectation results move around the dynamic rational expectation results and thus also around the static results.

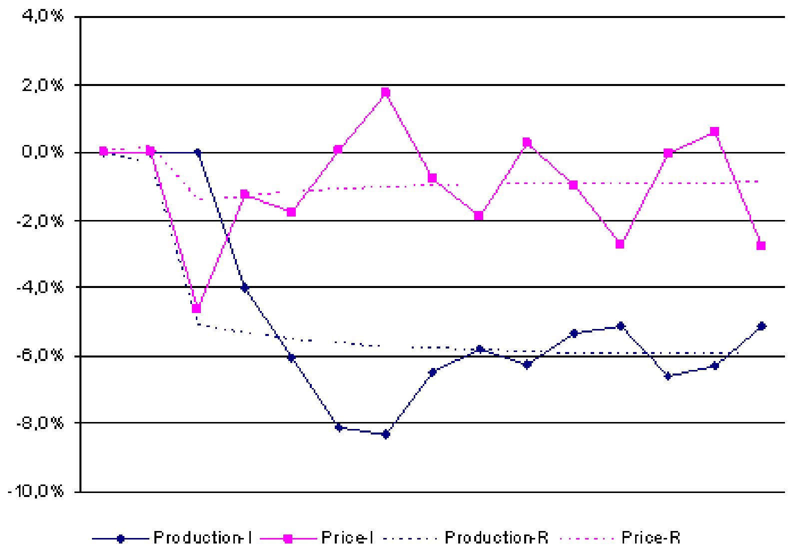

FIGURE 3.2 – Evolution of the European production and price of wheat under the imperfect and rational expectation cases(percentage change compared to the baseline)

Figure 3.3 provides the same information on the European coarse grains market. From this figure, we can better observe that every two years, the imperfect expectations results are higher (and then lower) than the corresponding rational ones. In both figures, we observe that the impacts of the policy shock obtained with imperfect expectations are much more severe. In particular the European price of coarse grains decreases by as much as 10% in the third year, compared to 2% in the rational expectation case. This is so because farmers do not anticipate the forthcoming price decrease and thus maintain their production levels during the first three years. By contrast, in the rational case, they already decrease production in the second year (investment in the first year).

From a policy perspective, these results suggest that the price fluctuations on agricultural markets generated by the agricultural trade liberalisation are "endogenous", i.e. generated because of imperfect expectations by agents. This price fluctuation around the steady state remains however limited, by at most 4% for both cereals.

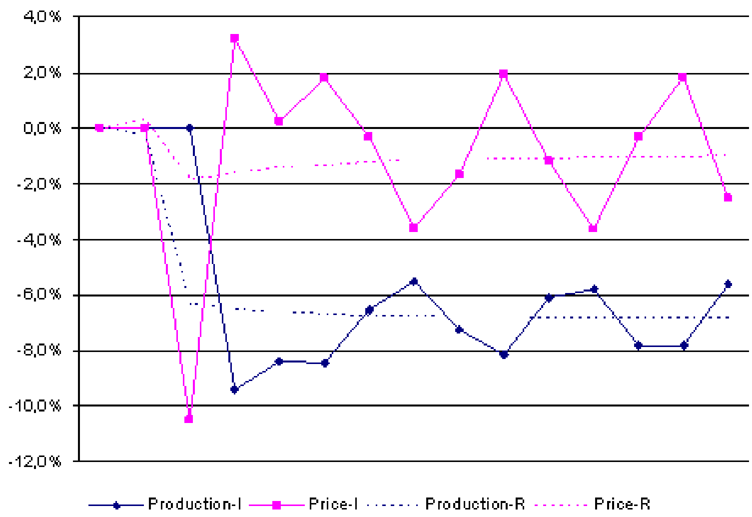

FIGURE 3.3 – of the European production and price of coarse grains under the imperfect and rational expectation cases (percentage change compared to the baseline)

Sensitivity to the historical weighting parameter

In both the CGE literature (for instance Ballard (1987)) and the "cobweb" one (for instance, Hommes (1994), the α historical weighting parameter is shown to have significant impacts on market dynamics. Basically the divergence of the system is more likely when this parameter gets close to one (which is in fact the case in the basic cobweb model with naïve expectation). In this sensitivity analysis we vary this parameter from 0.1 (nearly myopic) to 1 (completely naïve) for all dynamic decisions (next year production, investment, land allocation).

Figures 3.4 to 3.7 give the results of this sensitivity analysis. It appears first that when we assume naïve expectations, the dynamic simulated by the imperfect rational model quickly diverges. In particular we find that the European corn market price decreases by as much as 60% three years after the shock (Figure 3.7). The wheat price also significantly decreases (by 25%, Figure 3.5). We stop the resolution of the model as we then encounter some productions and prices going to zero. So using “standard” (but very high) CGE elasticities and naïve expectations leads to a diverging system and crazy endogenous fluctuations. On the other hand we observe that the dynamic is much more smoothed when agents slowly react to price news. Let’s focus on the case when alpha equals one half. We find that the system is not diverging after 15 years. More precisely, the price and quantity fluctuations on the wheat market are growing over time while those on the coarse grains are contracting.

From a modelling perspective, this suggests that it is useful to introduce cross market relationships as they tend to modify supply and demand curves and reduce the occurrence of diverging dynamic system. From a policy perspective, this result suggests that before implementing sectoral policy (in this example on wheat) policy makers should be aware of the feedback effects from other production sectors.

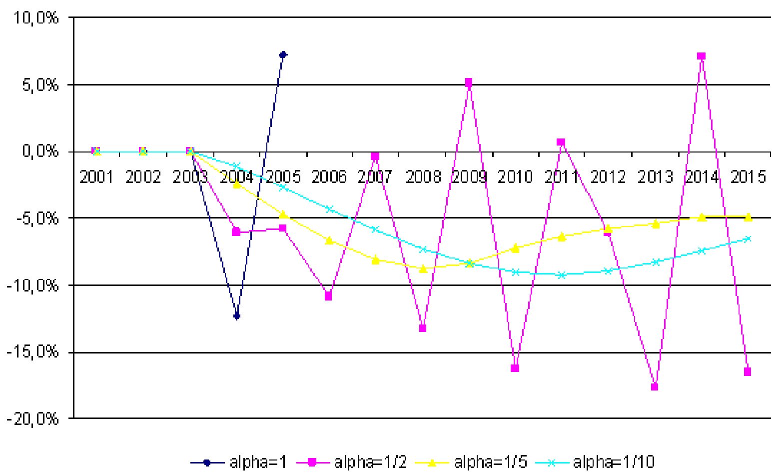

FIGURE 3.4 – Evolution of the European production of wheat under the different imperfect expectations assumptions (percentage change compared to the baseline)

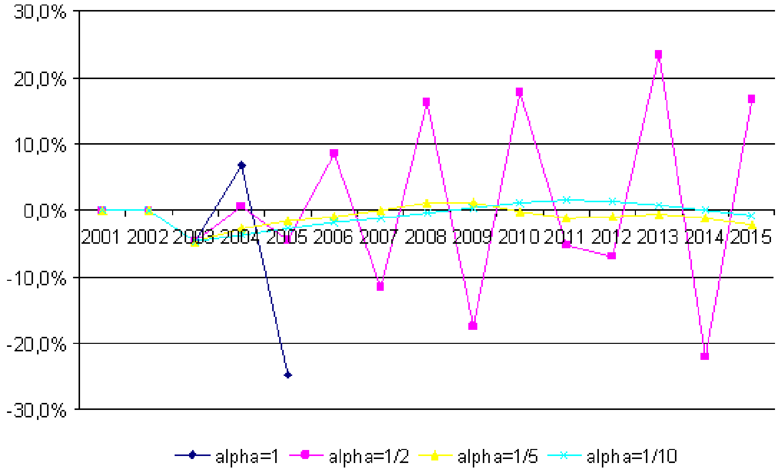

FIGURE 3.5 – Evolution of the European price of wheat under the different imperfect expectations assumptions (percentage change compared to the baseline)

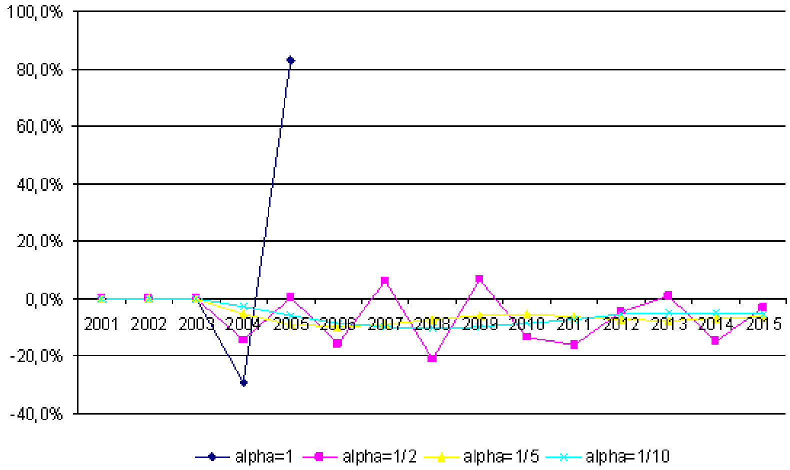

FIGURE 3.6 – Evolution of the European production of coarse grains under the different imperfect expectations assumptions (percentage change compared to the baseline)

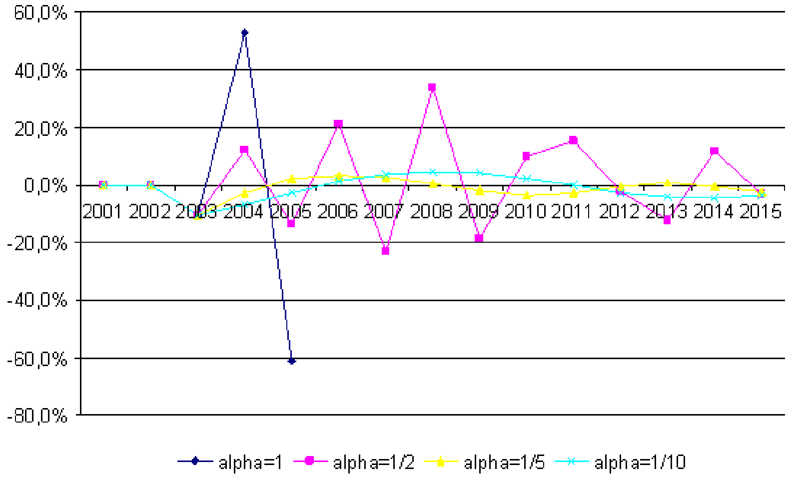

FIGURE 3.7 – Evolution of the European price of coarse grains under the different imperfect expectations assumptions (percentage change compared to the baseline)

Sensitivity to expectations for investment

In the dynamic modelling with imperfect expectations, firms define each year an investment plan for future years. We need expectations on the future capital returns and future price of investment goods in order to compute this plan. So far we adopt the same expectations as for the next period production. Here we consider another case usually implicitly adopted by the cobweb literature. We assume that the capital is fixed over all projection periods. This is equivalent to assume static expectations for investment purposes. We adopt this assumption for all firms. On the other hand, we maintain standard expectation assumptions on intra temporal decisions. Results for the European wheat market are reported in Figure 3.8. We observe that the dynamic of the model diverges. More precisely we end up with a zero price solution in the year “2015”, so the model stops running. We observe that the fluctuations of quantity and price grow over time. By contrast, these fluctuations were bounded in the standard case (see Figure 3.2).

The mechanism at work is the following. In the first two years following the trade liberalisation ("2003" and "2004"), impacts are similar because the capital used in production has still not changed. In the third year ("2005"), the capital stock decreases in the standard case because producers start reducing their investment in the previous year ("2004"). So the production is going down and price slightly recovers in this third period. For instance, the European wheat production decreases by 6.1% (compared to the baseline) and the price only decreases by 1.7%. They are in fact close to the final steady state solution we get from the dynamic rational expectation model. By contrast, the production decrease in "2005" is lower in the fixed investment setting (by 3.8%), so the wheat price remains low (3.2%). This greater supply level (compared to the steady state solution) we get in the third year following trade liberalisation induces a diverging cobweb.

A graphical analysis may help to clarify this mechanism. In Figure 3.9, the supply curve is fixed and the demand curve shift inwards following trade liberalisation. In the third year, production increases compared to the initial point, leading to a diverging cobweb. By contrast, in Figure 3.10 the supply curve shifts during the third period because producers already reduce their investment. So production in the third year no longer expands (compared to the initial point), leading to a converging cobweb model.

To our knowledge, this feedback mechanism occurring from investment and capital accumulation on the cobweb dynamic is seldom acknowledged, if not simply omitted. This is so because most of this literature relies on partial equilibrium analysis, ignoring firm production costs and the different possibility firms have to respond to price shocks. From a modelling point of view, the CGE setting used in this paper thus reveals new feedback mechanisms preventing diverging dynamics. From a policy perspective this again suggests that some (input) market forces prevent large endogenous market fluctuations.

FIGURE 3.8 – Evolution of the European production and price of wheat under the imperfect expectation case with fixed investment (percentage change compared to the baseline)

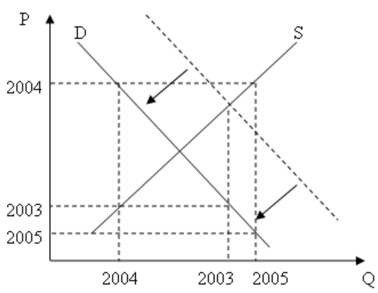

FIGURE 3.9 – The market dynamic without investment changes

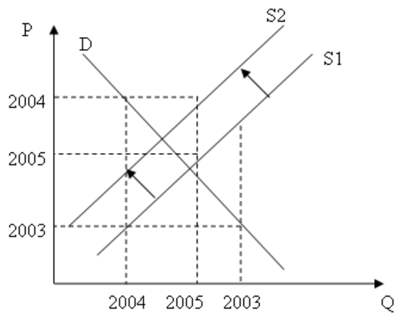

FIGURE 3.10 – The market dynamic with investment changes

Sensitivity to landowner expectations

The lag between production decisions and harvest is often advanced as an agricultural specificity. While true, this lag also exists in other sectors. In this section, we focus on landowner expectations and the interference of land price regulations. Because landowners allocate part of their land to some activities before knowing returns provided by alternative activities, they have to formulate expectation scheme as well. Up to now we assume that the land returns paid by arable crop farmers to landowners adjust to ensure the equilibrium between their demand and landowner supply.

In this sensitivity analysis, we assume that the land supply to arable crop activities is perfectly price elastic and that the landowner believes that farmers may offer for the current year a moving average of previous land returns. In other words, landowners anticipate that arable crop farmers are able to pay previous land rents and if not, they will allocate their lands to other activities. This assumption intends to capture some regulations existing on land leasing in some countries (like France) where unit land rents are computed using past prices rather than as an equilibrium.

Results for the European coarse grains market are reported in Figure 3.11. Again we find a diverging dynamic system and the resolution of the system stops seven years after the trade liberalisation shock. The intuition of this result is similar to the one we just identify with investment. By "fixing" land returns, supply curves do not shift, leading to a diverging cobweb. By contrast, once we allow the current land returns to adjust, then the supply curve shifts outwards in case of expected price decrease (and conversely). This prevents the divergence of the dynamic system.

The modelling implication is again that a CGE setting reveals more adjustment mechanisms. From a policy perspective, this result suggests that some badly designed public interventions may indeed prevent optimal adjustment of the markets, leading to crazy endogenous market fluctuations.

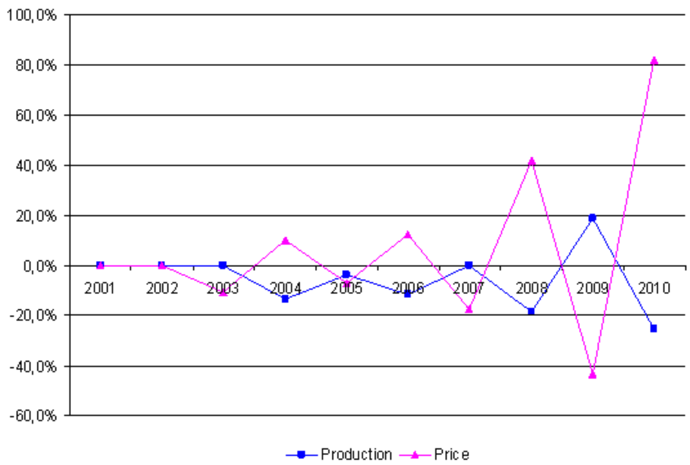

FIGURE 3.11 – Evolution of the European production and price of coarse grains under the imperfect expectation case with "fixed" land returns (percentage change compared to the baseline)

Sensitivity to substitution elasticities

When we adopt extreme expectation schemes and remove some market adjustments (on investment, on land returns), we encounter cases of diverging cobwebs. It is well know that this divergence mostly depends on the ratio of supply and demand elasticities. In a CGE model, supply elasticities derive from assumptions on substitution elasticities and the mobility of factors. We have already seen that moving from a static to a dynamic rational expectation model, where capital is fixed per period, slightly reduces the price elasticity of supply (see Section 3.4.2). With our imperfect expectation standard framework, short run supply elasticities are also lower because we further take into account the limited mobility of land, but still remain quite high compared to standard values used in agricultural partial equilibrium models. For instance, the European price elasticity of wheat equals 2.9.

In a last experiment, we reduce by half the substitution elasticities implemented in European arable crop technologies (the substitution elasticity between production factors and intermediate inputs). So the *ex ante* supply price elasticities also decrease by half (to 1.5 for the European wheat production). Figure 3.12 reports the evolution of wheat price and production with standard and reduced elasticities. In this figure, we assume that alpha equals one half in order to better show the impacts. As expected, fluctuations of price and quantity, as well as the occurrence of diverging cobweb, are reduced. This result is in sharp contrast with static models where, once we reduce supply elasticities, we usually get larger price effects and lower quantity effects. Here we get both reduced price and quantity effects. The implication of this last result is that the endogenous fluctuations of price and quantity do not increase by lowering supply elasticities to standard values.

FIGURE 3.12 – Sensitivity to supply elasticities of the evolution of the European production and price of wheat under the imperfect expectation case (percentage change compared to the baseline)

Conclusion

Most of the CGE models used today to assess the effects of agricultural policies are static, or are said to be dynamic, but don't really take the inter temporal investment and saving decisions of economic agents into account. To our knowledge, agricultural policies have not been analysed with consistent dynamic CGE models and various expectation schemes. The nature of expectation schemes by farmers and more generally by all economic agents has already been extensively discussed in the economic literature. The rational expectation assumption is widely used for its consistency with other modelling specifications but does not recognize the costs associated with the collection and the processing of market information. If this information is too costly, then agents may have simpler expectation scheme, possibly leading to diverging cobweb models. This endogeneity of market risk is one argument often mentioned in favour of a public intervention to stabilize agricultural markets. In light of policy debates on agricultural trade liberalisation, it is thus crucial to know if, by introducing dynamics and expectations in the CGE models used to assess agricultural policies, we end up with significant endogenous market risks or if the static results are quite robust to these specifications.

In that objective, we start from the usual static CGE approach and build dynamic CGE models with rational and imperfect expectations. We assess a complete agricultural trade liberalisation scenario by developed countries. What comes out of these simulations is that the dynamic model with rational expectations leads to the same results as the static model: markets evolve linearly toward a steady state which corresponds to the static situation after the shock. On the other hand, under the imperfect expectations assumption our trade policy scenario leads to endogenous market fluctuations. These fluctuations are all the more important that expectations take account of few past information and can even become higher and higher with time which leads to diverging dynamic systems if expectations are naïve. However the occurrence of divergence and the extent of endogenous fluctuations are seriously reduced with less extreme expectation schemes and more reasonable calibration of supply elasticities. Our CGE approach also reveals that many feedback effects, from competing sectors, from investment decisions and from (land) variable input markets, also reduce the occurrence and extent of endogenous market fluctuations generated from imperfect expectations. In other words, even if information is costly and agents form imperfect expectations, the consequences of these “bad” decisions are absorbed through the adjustment of the many related markets.

We are quite reluctant to draw too general policy recommendations from these results because the developed models still rest on simplifying assumptions. For instance, we assume perfect financial capital markets, we exclude risk aversion of economic agents, we focus the analysis on arable crop markets only, we omit the possibly smoothing role of storage, the existence of exogenous risks and of some policy instruments (public stocks for instance). All these extensions undoubtedly constitute an interesting and promising research agenda. In the meantime, our results give some interesting clues to the current agricultural policy debate. Static market effects simulated by current models are rather robust to the dynamic modelling of agricultural policies and to most expectation schemes. Endogenous market fluctuations do exist but are limited through many feedback effects. All agricultural policy design, should it finally be direct market intervention or more simply the provision of information, should acknowledge the existence of these tempering effects.

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3.A Equality between global savings and global investment in the rational expectation case : Proof

The purpose of this appendix is to show that world investment automatically equals world saving if agents are fully rational. Plugging Equations 3.23 and 3.16 in 3.22, we obtain:

$$E_{rt} = D_{rt+1} - Drt + \sum_i \left(WL_{irt}L_{irt} + WK_{irt}K_{irt} + WT_{irt}T_{irt} + (1 + tmirt)\, PWM_{irt}M_{irt} \right)$$

Using equations 3.4 and 3.11, the right hand term simplifies to:

$$E_{rt} = D_{rt+1} - Drt + \sum_i \left(P_{irt}Y_{irt} + P_{irt}M_{irt} \right)$$

Next we use 3.21 and 3.12 to get:

$$S_{rt} + \sum_i P_{irt}Q_{irt} + P_{irt}I_{irt}$$

Dropping consumption expenditure, this equation simply states that domestic saving equal domestic investment plus net investment in foreign countries. At the world level, total foreign assets/debts vanish, so we finally get:

$$\sum_r S_r t = S_t = \sum_r \sum_i P_{irt}I_{irt} = I_t$$

Chapitre 4 Impacts of Stockholding Behaviour on Agricultural Market Volatility: A Dynamic Computable General Equilibrium Approach [1]

Résumé

Dans le contexte actuel de libéralisation des marchés agricoles, on s'intéresse de plus en plus aux instruments privés de gestion des risques tels que le stockage. La littérature économique s'est déjà largement intéressée aux effets du stockage. Toutefois les études passées ne prennent pas en compte les liens existants entre les décisions des agents économiques dans leur dimension inter temporelle. De plus, une grande majorité d'entre elles se contente d'étudier les effets du stockage sur une volatilité des prix due à des chocs exogènes et pose l'hypothèse d'anticipations rationnelles. Pourtant, c'est souvent l'aspect endogène du risque, lié aux erreurs d'anticipation des agents, qui a été utilisé pour justifier l'intervention sur les marchés agricoles. Dans cet article nous développons un modèle d'Equilibre Général Calculable intégrant ces caractéristiques. Ce cadre d'analyse permet de simuler la façon dont des erreurs d'anticipations, initialement dues à un choc exogène, peuvent se propager dans le temps et à travers les différents secteurs de l'économie. Les résultats des premières simulations conduites à l'aide de ce modèle montrent en outre que, même lorsque les spéculateurs ont des anticipations imparfaites, les comportements de stockage tendent à réduire la volatilité sur les marchés agricoles.

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Introduction

One of the objectives of the European Common Agricultural Policy (CAP) when it was introduced was to ensure the stability of agricultural incomes in the European Union (EU). A system of public instruments was used to control the quantities of agricultural products supplied on European markets and thus to guarantee stable agricultural prices and incomes. In 1992, the EU started to replace this price support scheme by a system of payments more decoupled from production and prices. This decoupling of farm payments was reinforced by the 2003 CAP reform and, as shown by the 2008 Health Check, is likely to be continued in the future. Yet, as revealed notably by Chavas and Kim (2006), abolishing a price-support program leads to increasing price volatility.

Thus the successive reforms of the CAP lead us to question its price-stabilizing role. Some private instruments could, however, be used by European agricultural producers to manage their price risk but they have not so far been extensively used, principally because of the existence of public instruments (Anderson, 1992). Private storage is one of these instruments. Indeed, stockholding behaviour allows for intertemporal arbitrage (Anderson, 1992): When prices are low the demand for stocks is high, and when prices rise the quantities stored are put back onto the market, which mitigates the rise. This mechanism was formerly used by the European Union to stabilize market prices through public stockholdings. In fact, this public storage substituted speculative stockholdings (Lence and Hayes, 2002). One can thus presume that private storage will be used more and more on European markets, which raises the question of its effect on agricultural market volatility. One does indeed wonder if, and if so to what extent, the use of storage will make it possible to mitigate the increase of market volatility induced by the evolution of the CAP. The economic literature identifies two kinds of phenomenon explaining the volatility of agricultural market prices: volatility can be due to exogenous random shocks like climatic hazards and price fluctuations can also be endogenous, that is to say linked to market functioning and to expectation errors from economic agents. Indeed, in agricultural sectors there is a time-lag between production decisions and harvests. This time lag implies that producers have to base their decisions on expected rather than on observed market prices, and their possible expectation errors can induce price fluctuations. This phenomenon was formalised by Ezekiel (1938) in his Cobweb theorem. Both of these two sources of volatility are linked in the sense that economic agents can sometime make mistakes, because exogenous shocks occur between production decisions and harvests, which generates price fluctuations and if they are not rational these fluctuations will spread over time. Whereas the impacts of stockholding behaviour on exogenous price volatility have been quite widely studied in the economic literature (Williams and Wright, 1991; Deaton and Laroque, 1992), the studies dealing with their effects on endogenous volatility are much rarer, even though non-rational speculative behaviour of private stockholders is sometimes said to destabilize markets (see Ravallion (1987) for instance). In fact, we have not been able to find more than one paper that addresses the issue of modelling stockholding behaviour in an imperfect expectation framework (Mitra and Boussard, 2008).

Furthermore, none of the aforementioned works are conducted in a general equilibrium framework, typically because existing Computable General Equilibrium (CGE) models do not incorporate stockholding behaviour. However, the impacts of market stabilization may be borne by different economic agents, like producers and consumers, and are not limited to the regions and sectors directly concerned by the stabilization scheme (Newbery and Stiglitz, 1981).Moreover, in a market economy, prices result from several decisions taken by economic agents acting on several markets that are potentially linked. So the decisions of several agents, including stockholders, can in fact influence producers' or consumers' expectations if these expectations are not perfect but based on past information only. Taking account of all these relationships, as a CGE model can, becomes crucial when one focuses on the effects of storage on price risk. One of the reasons why CGE models do not include stockholding behaviour is that most of them were not originally aimed at simulating short-run policy effects (Hertel et al., 2005). As a matter of fact, these models are generally not fully dynamic (Femenia and Gohin, 2009). The purpose of this article is to tackle this issue by introducing stockholding behaviour in a dynamic CGE model able to take account of agricultural price volatility.

The model we construct here has several characteristics that allow the integration of these different elements. First, we depart from a widely used general equilibrium framework: the GTAP model and database (Hertel, 1997). Then, we rely on the work of Femenia and Gohin (2009) to create a dynamic model that takes intertemporal decisions of economic agents into account. These intertemporal decisions are based on imperfect expectations, which enables us to represent the endogenous aspect of market volatility, the exogenous part being introduced via exogenous shocks. Finally, private stockholding behaviour is introduced into the model. In addition to being conducted in a general equilibrium, our work differs essentially from the previous work dealing with storage and endogenous volatility by specifying the intertemporal behaviour of all economic agents and by the timing of stockholders' decisions - taken once harvests are put on markets and not simultaneously with production decisions as in Mitra and Boussard (2008). Once we have constructed this model, we run some simulations to study the effects of European wheat storage when exogenous productivity shocks occur in the Rest of the World. These simulations reveal that considering imperfect expectations and taking account of the general equilibrium links between sectors and the intertemporal dimension of the decisions of economic agents can lead to results different from what is commonly found in the economic literature, notably those findings concerning the transmission of market fluctuations between sectors/regions or from prices to production quantities. The remainder of the article is organised as follows: in section 4.1 we describe the characteristics of the model, namely its dynamic characteristics, the way market price volatility is introduced, how private stockholding behaviour is modelled, and finally the execution of the model. Section 4.2 is devoted to the results of the simulations we have conducted and to some sensitivity analyses of these results. These are followed by our conclusions.

4.1 The model

As pointed out by Newbery and Stiglitz (1981), it is worth considering the potential impacts of stockholding behaviour on price volatility in a general equilibrium framework. Indeed, the costs of price instability arising in one sector or one region are not limited to this sector or region, because this instability can be spread over the whole economy. Price stabilization can thus be beneficial to different economic agents in different regions. In this case, stockholders are not isolated and their decisions can influence those of producers and consumers, and vice versa. However, most of the CGE models used today to assess the effects of agricultural policies are not adapted to dealing with price volatility and, a fortiori, with the effects of stockholdings on this volatility, because they are mostly static, are not able to represent the endogenous aspect of price volatility and do not introduce stockholding behaviour. To tackle this issue we create a model capable of taking into account the dynamic evolution of markets and the intertemporal decisions of economic agents. This model is also suited to representing exogenous and endogenous price volatility and includes stockholding behaviour. Our starting point is a version of the widely used GTAP framework (Hertel, 1997), adapted to the study of agricultural markets: the GTAP AGR framework. The main differences between this model and ours are described in the following.

4.1.1 Characteristics of dynamic behaviour

The first concern when dealing with price fluctuations is to model market evolution period by period. This is the reason for relying the work of Femenia and Gohin (2009) who construct a dynamic CGE model based on the GTAP framework. In this model sectoral capital stocks accrue from one period to another in each region:

$$K_{irt+1} = (1 - \delta_{ir})\, K_{irt} + I_{irt},$$

with K the capital stock, I the new investment and δ the depreciation rate of capital, the subsets i, r and t denoting respectively the sector, the region and the time period concerned. Using capital accumulation as a link between periods is quite a common way of introducing dynamics in CGE modelling (see, for instance, the Linkage model from the World Bank or the Mirage model from the CEPII). However, most of the existing dynamic CGE models do not take account of intertemporal decision processes of economic agents and are thus not able to consider the formation of their expectations. As in Femenia and Gohin (2009), this drawback is overcome in our model: investment decisions of producers and saving decisions of households are based on intertemporal arbitrage. Indeed, to take his investment decision the producer seeks to maximize the present value of his firm (Devarajan and Go, 1998), which corresponds to the discounted value of all his expected future profits (capital income) minus his expected future investment costs:

$$\max \pi_{ir} = \sum_t \frac{1}{(1+r)^t} \left(\; wk_{irt} K_{irt} - PI_{irt} \left(1 + \tfrac{\phi}{2} \tfrac{I_{irt}}{K_{irt}}\right) I_{irt} \; \right)$$

$$s.t. \quad K_{irt+1} - K_{irt} = -\delta_{ir} K_{irt} + I_{irt}$$

with r the interest rate, wk the capital income, PI the price of investment and ϕ an adjustment parameter: the term $\frac{\phi}{2}\frac{I}{K}$ represents the adjustment cost of capital (McKibbin and Wilcoxen, 1999). Solving this optimisation problem leads to a condition determining optimal investment in our CGE model:

$$\begin{aligned} & wk_{irt+1} + (1 - \delta_{ir})\, PI_{irt+1} \left(\phi \frac{I_{irt+1}}{K_{irt+1}} + 1\right) = \\ & (1 + r)\, PI_{irt+1} \left(\phi \frac{I_{irt}}{K_{irt}} + 1\right) - \frac{\phi}{2} PI_{irt+1} \frac{I^2_{irt+1}}{K^2_{irt+1}} \end{aligned} \tag{4.1}$$

As we will detail later, because in our model producers have limited knowledge about the output price, capital returns and the interest rate in the distant future, we then assume that they consider that, at some date, their investments will equal their capital depreciation. It means that they expect the economy to reach a steady state from this period. Indeed, this producers' steady-state condition may never appear, because they periodically revise their plans, but this formulation defines the current optimal investment plan for firms, including current investment.

Households also base their saving decisions on an intertemporal trade-off: they spend a part of the income they earn in one period to consume goods, which brings them some utility, and save the remaining part. The part of the income saved in one period will be used later to consume and represents a future utility. So, the representative household in each region seeks to maximize the value of its intertemporal utility, subject to an intertemporal budget constraint:

$$\max U_{rt} = \sum_t \frac{1}{(1+\rho)^t} u\left(Q_{rt}\right)$$

$$s.t. \quad \sum_t \frac{E_{rt}}{(1+r)^t} = \sum_t \frac{1}{(1+r)^t}\left(P_{rt}Q_{rt} + S_{rt}\right)$$

With ρ a time preference parameter (households have a preference for immediate utility), Q the quantity consumed, P the composite consumer price, E the total income (including interest earned from foreign assets, factor returns, distributed profits and tax receipts) and S savings. The first-order condition of this program allows us to determine the evolution of savings:

$$E_{rt} - S_{rt} = \left(\frac{1+\rho}{1+r}\right)\left(E_{rt+1} - S_{rt+1}\right) \tag{4.2}$$

Like producers, households have limited knowledge about prices and income in the distant future; we thus also assume that they consider that the economy will reach a steady state where regional savings equal regional investment at some date. Once again, the steady state expected by households may never be reached but this condition, combined with equation 4.2 enables us to derive saving plans of households and thus current savings.

These different characteristics of agents' intertemporal decisions, combined with a foreign-debt accumulation period by period, are the main features of our model that facilitate the simulation of the dynamic evolution of markets.

4.1.2 Modelling of the volatility of market prices

Two sources of price volatility on agricultural markets are identified in the economic literature (Butault and Le Mouël, 2004): price fluctuations can be due to exogenous stochastic shocks and can also be generated by non-rational market behaviour. These two aspects are introduced in our model. The first part of this section is devoted to the introduction of exogenous disturbances in the model and the second part to the modelling of non-rational behaviour.

Introduction of exogenous stochastic disturbances in the model

Many economists have argued that fluctuations on agricultural markets are essentially due to demand and supply shocks (Moschini and Hennessy, 2001). Indeed, the time lag between production decisions of farmers and their harvests induces a short-term rigidity of agricultural supply that can hardly adjust to market price changes. Furthermore, most agricultural products are staples and demand for these goods is quite inelastic. Because of these two characteristics agricultural markets are very sensitive to market shocks: a supply decrease due to a climatic hazard for instance will result in a large price increase. This phenomenon is formalized by King's law. Yet agricultural production is exposed to several epidemic and climatic risks and these exogenous shocks occur quite frequently, thus generating price fluctuations.

Our purpose here is to introduce random supply shocks in the dynamic model to incorporate exogenous price fluctuations.

In our model, agricultural technology is represented by a nested CES production function. The first nest combines production factors to create value added ; the second combines the aggregate factors with intermediate consumption to produce output:

$$\begin{cases} VA_{irt} = \gamma_{ir} \left(a_{ir} K_{irt}^{\rho_{ir}} + b_{ir} L_{irt}^{\rho_{ir}} + c_{ir} T_{irt}^{\rho_{ir}} \right)^{\frac{1}{\rho_{ir}}} \\ Y_{irt} = \Phi_{ir} \left(\beta_{ir} VA_{irt}^{\theta_{ir}} + (1-\beta_{ir}) IC_{irt}^{\theta_{ir}} \right)^{\frac{1}{\theta_{ir}}} \end{cases} \quad (4.3)$$

With VA the value added, L the labour factor, T the land factor, Y the quantity produced and IC the aggregate intermediate consumption. a, b, c and β are share parameters, ρ and θ determine respectively the degree of substitutability between capital, labour and land and between value added and intermediate consumption. Finally γ and Φ are productivity parameters. Supply shocks are introduced in our model through the productivity parameter Φ . We assume that these shocks can be linked to productivity shocks.

We thus introduce random disturbances ϵ such as $\Phi shock_{ir} = \Phi_{ir}\,(1+\epsilon)$, with $\Phi shock_{ir}$ the "shocked" productivity parameter, and assume that $\epsilon \sim N\left(0, \sigma_{\epsilon}^{2}\right)$, which implies that $\Phi shock_{ir}$ fluctuates around Φ_{ir} with a variance equal to $\sigma^2_{\Phi shock_{ir}} = \Phi^2_{ir}\sigma^2_{\epsilon}$. That is to say that the values calibrated from the GTAP database correspond to average expected values over many years.

Introduction of imperfect expectations

The intertemporal dimension of decision processes in our model implies that agents have to form expectations about the future path of the economy at the time decisions are made. Many studies dealing with uncertainty assume rational expectations (Wright, 2001; Williams and Wright, 1991; Pratt and Blake, 2007), which means that economic agents have the same knowledge as economists about the functioning of markets and that expected prices are those corresponding to the economic model (Muth, 1961). However, processing and collecting information can be costly and it can in fact be more rational for economic agents to form imperfect expectations (Just and Rausser, 2002) and, as formalized by (Ezekiel, 1938) in his famous Cobweb theorem, the non-rationality of farmers can cause expectation errors to spread over time and to induce endogenous fluctuations of market prices. This endogenous price volatility has often been used to justify public interventions in agricultural markets (Boussard et al., 2006). Assuming that farmers have the right information concerning their own productivity (that they know the distribution of the exogenous shocks affecting their production) seems quite obvious. On the other hand, we consider that their expectations about market prices are non-rational and hence incorporate endogenous volatility into our model.

As pointed out by Newbery and Stiglitz (1981), if some farmers have imperfect expectations, private stockholding behaviour can induce serial correlation and make past prices informative. So, even if exogenous productivity shocks are independent over time, the use of past information to form expectations about the future is justified in our case. For that purpose we rely on the work of Nerlove (1958) who proposed a formalisation for adaptive expectations based on past information. These Nerlovian expectations are such that agents take their past expectation errors into account to form their new expectations:

$$\hat{P}_{t+1} = \hat{P}_t + \alpha \left[P_t - \hat{P}_t\right] = \alpha P_t + (1-\alpha)\,\hat{P}_t \tag{4.4}$$

$\hat{P}$ denotes expected prices and P observed market prices, $0 \leq \alpha \leq 1$ can be seen as a measure of the adjustment speed of expectations. In fact the lower α, the slower expectations adjust to market changes. An extreme case of Nerlovian expectation arises when α equals 1: the economic agent only considers the current period to form his expectation for the future. These are called naïve expectations.

4.1.3 Introduction of stockholding behaviour

We focus now on the introduction of stockholding behaviour in our dynamic CGE model. We distinguish between private speculative stockholdings which are held by private stockholders seeking to make profit from price changes and public stockholdings only aimed at stabilizing market prices. To take account of storage, it is first necessary to represent the behaviour of private stockholders, and the first part of this section is devoted to this issue. Then in the third part we explain how a new storage sector is introduced into the model. Finally, we discuss the other elements that have to be introduced into the model to take account of stockholdings.

Determination of stockholding behaviour

A new agent, the stockholder, is introduced into the model. There is one representative stockholder in each region. This agent holds stocks, can sell a part of these stocks or can buy other stocks at the current market price in each period. Let ST be the quantity stored and k the unitary storage cost. A is the quantity bought and V the quantity sold by the stockholder. These bought and sold quantities affect the stocks:

$$\begin{aligned} & ST_{irt} = ST_{irt-1} + A_irt - V_{irt} \\ & or\ ST_{irt} = ST_{irt-1} + \Delta_{irt},\ with,\ \ \Delta_{irt} = A_{irt} - V_{irt} \end{aligned} \tag{4.5}$$

The stockholder seeks to maximize his intertemporal profit which corresponds to the discounted sum of his sales minus his purchases and the storage costs. His program can thus be expressed as:

$$\max \sum_t \frac{1}{(1+r)^t} \sum_i \left(-\hat{P}_{irt}\Delta_{irt} - k_{rt}ST_{irt}\right)$$
$$s.t. \quad ST_{irt} = ST_{irt-1} + \Delta_{irt}$$

Solving this optimisation program leads to the conditions:

$$P_{irt} + k_{rt} = \frac{\hat{P}_{irt+1}}{(1+r)} \tag{4.6}$$

We find here the standard relationship explaining stockholding behaviour (wil91): if the cost of buying goods at time t and storing them during one period is less than the (discounted) price at which these goods can be sold at time $t+1$ ($P_{irt} + k_{rt} < \frac{\hat{P}_{irt+1}}{(1+r)}$), then stockholders will buy goods, thus increasing the current prices until $P_{irt} + k_{rt} = \frac{\hat{P}_{irt+1}}{(1+r)}$. On the contrary, if $P_{irt} + k_{rt} > \frac{\hat{P}_{irt+1}}{(1+r)}$ then stockholders will sell their stocks, thus lowering current market prices until $P_{irt} + k_{rt} = \frac{\hat{P}_{irt+1}}{(1+r)}$ or until their stocks are null, in which case the market is in equilibrium even if $P_{irt} + k_{rt} > \frac{\hat{P}_{irt+1}}{(1+r)}$. These considerations allow us to explain why stockholding behaviour is able to mitigate market price volatility.

Creation of a storage service sector

Storing a commodity generates costs paid by private or public stockholders and made up, for instance, by the rent of grain silos and the wages of workers who carry out stock handling. In order to determine these factor incomes, we introduce a storage service sector in our model. This sector uses labour and capital factors which are combined through a Constant Elasticity of Substitution (CES) function to produce the service good. The optimisation problem of producers in this sector can thus be written as:

$$\min \; wl_{STrt} L_{STrt} + wk_{STrt} K_{STrt}$$

$$s.t. \quad Y_{STrt} = \chi_r \left(d_r K_{STrt}^{\frac{\varpi_r - 1}{\varpi_r}} + (1 - d_r) L_{STrt}^{\frac{\varpi_r - 1}{\varpi_r}} \right)^{\frac{\varpi_r}{\varpi_r - 1}}$$

$$s.t. \quad Y_{STrt} = \sum_i ST_{irt}$$

$$s.t. \quad K_{STrt} = (1 - \delta_{iST}) K_{STrt-1} + I_{STrt}$$

with Y_{ST} the supply of storage service, L_{ST} and K_{ST} the quantities of labour and capital, wl_{ST} and wk_{ST} their unitary income, d a share parameter, χ a productivity parameter and ϖ the elasticity of substitution between labour and capital.

Solving this program leads to the zero-profit condition:

$$P_{STrt} \sum_i ST_{irt} = wl_{STrt} L_{STrt} + wk_{STrt} K_{STrt} \tag{4.7}$$

Equation 4.6 will allow us to determine the unitary storage costs $k_{rt} = P_{STrt}$.

Furthermore, since the capital stock in this sector, as in other sectors, is subject to adjustment costs, storage capacity in one period is limited even if no storage limit is explicitly imposed.

The specification of this storage service sector differentiates our work from that of Hertel et al. (2005) who also incorporate stockholdings in a CGE model but consider that storage is at no cost and fixed and an exogenous limit to the storage capacity.

Equilibrium conditions

To take stockholding into account in our CGE model, some conditions ensuring market equilibrium have to be modified.

First, the supply and demand of goods for storage modify the equilibrium market prices. So, the market equilibrium conditions determining market prices now include beginning-of-period stocks on the supply side and end-of-period stocks on the demand side.

Then, as in Hertel et al. (2005), private stockholdings are considered in our model as a form of investment and are thus financed by savings. This modifies the equation ensuring the equality between investments and savings at world level and determining the world interest rate [2].

4.1.4 Execution of the model

Our dynamic model is solved period by period, because agents readjust their decisions in each period, and in two steps for each period. This sequencing of the model resolution deserves some explanation.

As we have already mentioned, consumers and producers base their decisions on expected future market prices. Furthermore, contrary to other agents, farmers do not observe market prices at the time they make their production decisions. To take this specific feature of agricultural sectors into account in our model, we solve it in two steps: first, agricultural production decisions are determined, based on farmers' expectations about market prices, and the prices of factors used for agricultural production are adjusted to ensure equilibrium between farmers' demand and factor owners' supply ; the second step puts agricultural quantities produced onto the markets, consumption, savings, investment and stockholdings decisions are taken, and the prices of goods and factors allocated to non-agricultural activities are adjusted so as to ensure market equilibrium. Here our work differs from that of Mitra and Boussard (2008), who are also interested in the effects of stockholdings in the case of imperfect expectations. Indeed, in their work storage is assumed to occur at the time agricultural production decisions are taken and not once harvests are put on the market.

2. See Femenia and Gohin (2009) for more information on closure rules and on the necessity of introducing this endogenous interest rate in the case of imperfect expectations

Thus, if a productivity shock occurs in, say, the first period after agricultural producers have decided how much to produce based on their expectations about the future, the effective realized output quantities would not be equal to what farmers had expected. On the other hand, the other economic agents observe market conditions and thus know current market prices at the time they take their decisions. In the first step determining agricultural production decisions, the model is thus solved with a productivity value equal to $E\left[\Phi shock_{ir}\right] = \Phi_{ir}$, and the outcome corresponds to what agricultural producers plan for the future period and therefore it provides the level of production factors they use. In the second step, the model is solved with the shocked productivity, with the levels of agricultural production factors used being set equal to those determined in the first step and consequently they are exogenous. Agricultural supply is determined by the production function, and the outcome of the model corresponds to what effectively happens on markets, at least for the first period. In the second period, the first step is re-executed taking into account the new levels of stockholdings and capital stocks resulting from the first period and the new expectations of agricultural producers, and the second step is re-executed taking into account the new value of the random productivity parameter, and so on.

4.2 Simulations and results

The main purpose of this article is to construct a fully dynamic general equilibrium model with the aim of assessing the effects of stockholding behaviour on the volatility of agricultural prices and able to take account of the endogenous dimension of this volatility. Having described the structure of this model in the first part, this second part is devoted to the results of some simulations which are conducted for illustrative purposes, in order to have initial insight into the impacts of the model specification on the simulated effects of stockholding behaviour on market volatility.

4.2.1 Definition of simulations

In these simulations we focus on the European wheat sector, which is assumed to be the only sector producing a storable commodity, and study the impacts on this sector of stochastic supply shocks arising in other regions of the world during 25 periods. Assuming that stockholdings only concern one sector and one region in the world is obviously unrealistic, but this assumption is made for better identification of the different simulated effects and thus to make it easier to interpret the results.

Data

To run our simulations, we use the 6th version of the GTAP database calibrated on 2001 economic flows and including tariffs, export subsidies and direct payments for the different regions represented. These data are aggregated to 11 sectors, among which seven are agricultural sectors, and three regions: the European Union (EU), the United States (US) and the Rest of the World (RoW). As mentioned in part 1, we add a new sector producing storage services.

As the GTAP database was initially aimed at being used in a static framework, we need to make some assumptions to calibrate the data for our dynamic model: we posit that the initial interest rate r, the time preference parameter ρ and the unit capital installation cost ϕ are all equal to 5%. Furthermore, we reduce by half the supply price elasticities in the agricultural sectors. The supply price elasticities used in the GTAP model are actually rather high, because this model is aimed at simulating the long-term effects of policy reforms. On the other hand, our dynamic framework is intended to simulate short-term effects, and agricultural supply adjusts less easily, notably to price changes, in the short term. The supply price elasticities are reduced by half by reducing the elasticities of substitition between primary factors and between value added and intermediate consumption in the targeted sectors. Then, as in Femenia and Gohin (2009), we assume that the 2001 initial point is a steady state. This assumption, which facilitates the calibration of the other dynamic parameters, implies that prices are stable and, in fact, that private stockholdings are nil. However, the CES form of the production function in the storage service sector does not allow for zero production. To overcome this issue we also assume that some precautionary wheat stocks, representing 10% of wheat production, are held by the public sector in the European Union. These precautionary stocks are constant over time and thus have no effect on price volatility. Finally, in the standard case, the expectation adjustment parameter α is set to $1/5$. We conduct some sensitivity analyses for this parameter, the results of which are presented in the last part of this section.

Characteristics of market volatility

The price volatility in our models results from production shocks occurring in the Rest of World's wheat sector. These shocks can lead agricultural producers to make mistakes when they anticipate forthcoming prices.

The first step in our simulations is thus to generate the shocks affecting the productivity parameter $\Phi_{wheat,RoW}$. The value of $\Phi_{wheat,RoW}$ calibrated from the GTAP database, and corresponding as we have seen to the mean value of the random parameter $\Phi shock_{wheat,RoW}$, is 1.95.

We recall that $\Phi shock_{ir} = \Phi_{ir}\,(1+\epsilon)$, with $\epsilon \sim N\,(0, \sigma_\epsilon^2)$.

Calibrating the value of σ_ϵ^2 is not a trivial task. Indeed, the data available, like those from the Food and Agriculture Organization (FAO) that have been used by Hertel et al. (2005) to characterize the exogenous production volatility in their model, concern the production quantities or yield, but these data result in fact from producers' decisions, for example, and not only from exogenous shocks. So, as we will see later, the volatility of quantities produced can be much higher than the volatility of productivity shocks, especially when market agents are assumed to have imperfect expectations. For these reasons, in our 'standard' case we set the value of σ_ϵ^2 to 0.9% and then conduct some sensitivity analyses of the results to this value.

The 25 stochastic exogenous shocks are thus generated according to a normal distribution $N\,(0, 0.9\%)$. They are plotted in Figure 4.1 and Table 4.1 presents their main distribution characteristics.

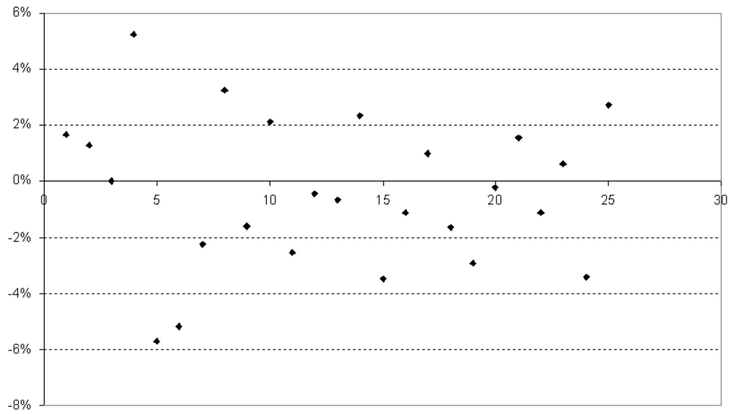

FIGURE 4.1 – Productivity shocks

Table 4.1 below presents the main characteristics of the 25 productivity shocks generated according to the above mentioned distribution.

TABLE 4.1 – Distribution characteristics of productivity shocks

Mean	s.d.[a]	a.c[b]
-0.4%	2.7%	-0.18

[a] standard deviation
[b] autocorrelation

Benchmark results

Before focusing on the impacts of stockholding behaviour, some attention must be paid to the outcome of our dynamic CGE model before the introduction of storage. These results will be used as a benchmark to assess the effects of private storage. The evolution of wheat output in the three regions of the world is represented in Figure 4.2 and the development of the wheat price is illustrated in Figure 4.3.

FIGURE 4.2 – Wheat output (%age change compared to the baseline)

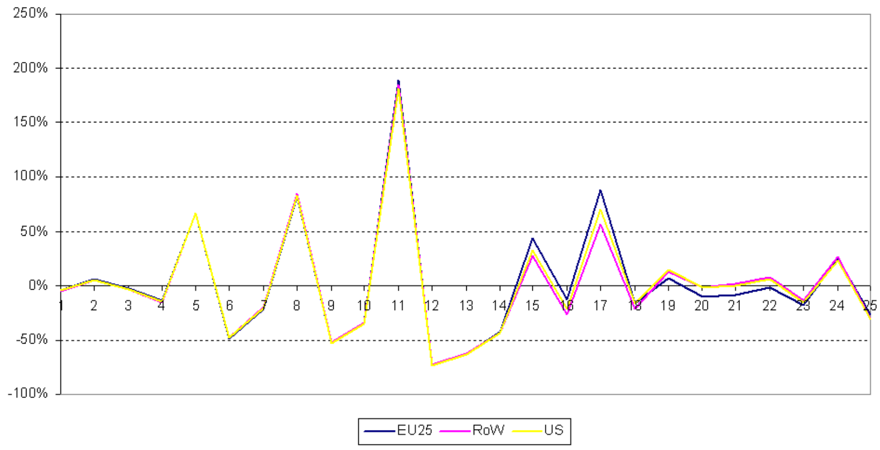

FIGURE 4.3 – Wheat price (%age change compared to the baseline)

The first thing to note is that, even if exogenous productivity shocks occur in the RoW only, wheat production in the EU and the US also fluctuates. The same phenomenon arises for prices: price fluctuations are synchronous. Besides, as illustrated in Table 4.2, wheat prices in all regions are highly correlated. This synchronism is, of course, partly due to trade exchanges between regions but, while this trade could create a dampening in market fluctuations at world level via a risk sharing mechanism if agents were rational, when expectations are imperfect market fluctuations synchronise and are amplified at the world level. This illustrates one important criticism of the liberalisation of agricultural trade (Boussard et al., 2005).

TABLE 4.2 – Correlation between wheat prices

	EU	RoW	US
EU	1.0	1.0	1.0
RoW	1.0	1.0	1.0
US	1.0	1.0	1.0

Thus productivity shocks range from -6% to +6% (see Figure 4.1) but output fluctuations are much more important: a production increase of more than 50% is observed in the RoW in period 12 and a nearly 40% decrease arises in the EU in period 17, as shown in Figure 4.2. The mechanisms explaining these market evolutions are as follows: if in one period a negative productivity shock occurs in the RoW, leading to an increase in the wheat price and the capital income in the wheat sector, in the next period agricultural producers of wheat readjust their price expectation according to the previously observed price increase. They expect a market price higher than the initial price, and so plan to produce more. If positive productivity then occurs, leading to an even larger harvest than producers had expected, the market price of wheat decreases. At the same time, the increase of capital income observed during the previous period leads producers to expect an increase of capital income for the forthcoming periods and so to make new investments, which will lead to an increase in their capital for the third period. This increase of capital stock can result in producers not decreasing their production as much as they should if they expect a price decrease for the future. So the market volatility originating from exogenous productivity shocks is amplified by the linked imperfect price and factor return expectations, and this endogenous aspect can even generate sudden price peaks as in periods 5, 8, 11, 15 and 17 (see Figure 4.3). Indeed, these periods follow periods where positive shock occurs (see Figure 4.1), so wheat producers expect a market price decrease. This price expectation, combined with the fact that investment in previous periods was low and that their capital stock has just decreased, induces them to plan to produce less than they initially intended. Because of a negative productivity shock, the harvest is actually much lower than expected (see Figure 4.2). As wheat demand is quite price inelastic, this large decrease of production is conducive to a very large price increase. Following these peaks, producers readjust their expectations and market prices return to lower levels for the following periods. In the EU and the US, the actual output of producers is equal to what they plan but, as market prices are affected by those of the RoW, this does not prevent them from making expectation errors leading to endogenous price fluctuations. These results illustrate the relative importance of endogenous compared with exogenous market fluctuations. As Table 4.3 clearly demonstrates, exogenous productivity shocks in the RoW wheat sector, characterized by a 2.7% standard deviation, can generate output fluctuations characterized by a standard deviation almost 10 times higher. This reveals the difficulty in calibrating the distribution of productivity shocks based on production data. The standard deviations of prices around 55% for wheat are in accordance with the fluctuations observed in Figure 4.3.

Table 4.3 also shows that other sectors related to wheat are affected in all regions as well, since wheat production is at the mean higher than its initial value, and the mean production of oilseeds and other cereal production is lower at the mean, and this leads to some mean price increases. The cattle and beef sectors are also affected by the fluctuations of grain prices: the mean price increases of grains induce a slight mean increase of cattle and beef prices. Although not as high as in the wheat sector, the standard deviations of output and prices in these sectors are not negligible. So exogenous productivity shocks arising in the RoW wheat sector spread to all regions and to several sectors, generating market fluctuations amplified by the non-rationality of market participants. As a matter of fact, farm income is also influenced by these shocks, even if they occur in only one region and one sector: The standard deviation of farm income change in the wheat sector is equal to 104% in the EU, 86% in the RoW and 35% in the US, and the standard deviation of farm income changes in the other cereals and oilseeds sectors is in the range from 5% to 13% (see Table 4.6).

TABLE 4.3 – Distribution characteristics of output and price changes compared with the initial values

		Output changes		Price changes	
		Mean	S.D.	Mean	S.D.
Wheat	EU	5.1%	19.2%	2.2%	56.7%
	RoW	8.4%	22.0%	1.0%	54.5%
	US	1.9%	14.1%	1.5%	54.5%
Oilseeds	EU	0.5%	2.2%	0.8%	9.4%
	RoW	0.2%	2.0%	0.6%	8.9%
	US	0.3%	1.0%	0.4%	9.1%
Other Cereals	EU	0.4%	1.2%	0.8%	4.7%
	RoW	-0.2%	2.5%	0.4%	7.9%
	US	-0.1%	0.7%	0.3%	5.1%
Cattle	EU	-0.1%	0.2%	0.2%	1.1%
	RoW	0.1%	0.9%	0.1%	2.0%
	US	0.0%	0.5%	0.1%	0.9%
Beef	EU	-0.1%	0.1%	0.0%	0.4%
	RoW	-0.1%	0.6%	0.1%	0.8%
	US	0.0%	0.3%	-0.1%	0.4%

4.2.2 Impacts of stockholding

Having described the outcome of the model without storage, we now consider the impacts on the results of stockholding behaviour in the European wheat sector.

Standard case

In what we call our standard case, we set the historical weighting parameter α to 1/5 for all agents, and the substitution elasticity between labour and capital in the storage service sector is set to 0.8. Some sensitivity analysis of the results to these parameters, as well as to the volatility of production shocks, will be presented in the next parts. Figures 4.4 and 4.5 below represent the fluctuations of wheat output and price when stockholding behaviour is introduced into the model.

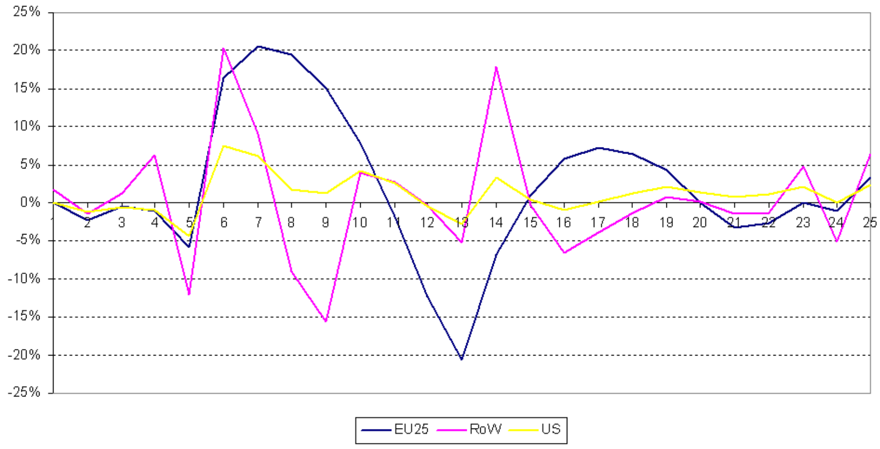

FIGURE 4.4 – Wheat output (%age change compared to the baseline)

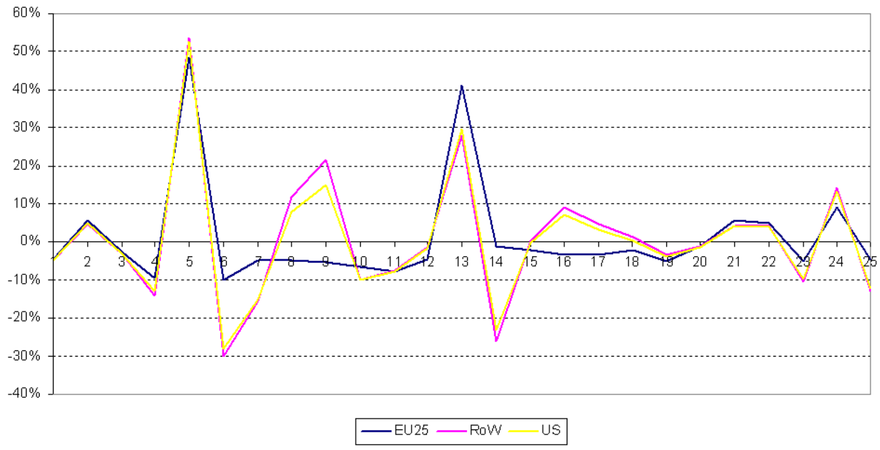

FIGURE 4.5 – Wheat price (%age change compared to the baseline)

We can observe from Figure 4.4 that, compared with the case without stocks, output fluctuations in the wheat sector seem to be slightly smoothed for all regions. But the most interesting result appears in Figure 4.5: here the European wheat price is not synchronized with prices in the RoW and the US. This is also reflected in the correlation between prices shown in Table 4.4: whereas wheat prices in the RoW and in the US are still highly correlated, the correlations between the wheat price in the EU and prices in other regions are reduced by about 25%. Stockholding behaviour, which takes place only in the European wheat sector, tends in fact to "disconnect" the European wheat market from world markets.

TABLE 4.4 – Correlation between wheat prices

	EU	RoW	US
EU	1.0	O.7	0.8
RoW	0.7	1.0	1.0
US	0.8	1.0	1.0

We can also see in Figure 4.5 that price decreases in the European wheat sector are limited but do not totally disappear. They are in fact restrained by the expectations of stockholders concerning the future wheat price and the storage costs. We recall that if stockholders expect a price rise they buy wheat until: $P_{irt} + k_{rt} = \frac{\hat{P}_{irt+1}}{(1+r)}$, which prevents the wheat price from decreasing to less than $\frac{\hat{P}_{irt+1}}{(1+r)} - k_{rt}$. On the other hand, we can still observe some price peaks in the EU, as in other regions. However, these peaks are lower than before the introduction of storage, which can this time be attributed to the liquidation of stocks as illustrated by Figure 4.6.

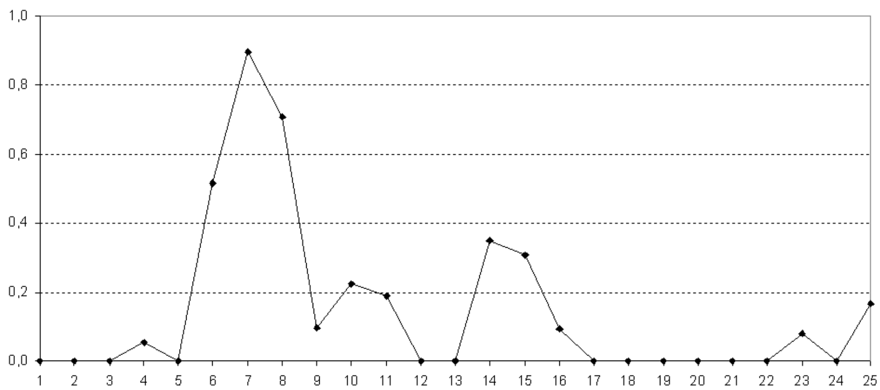

FIGURE 4.6 – Wheat stocks in the EU (in Millions of Tonnes)

Due to the effect of big production shocks on the non-rational behaviour of producers, private stockholding behaviour thus seems to limit the occurrence of price peaks while inducing other peaks through stock disposal. The distribution characteristics of output and price changes in the wheat, oilseeds and other cereals sectors are presented in Table 4.5.

TABLE 4.5 – Distribution characteristics of output and price changes compared with the initial values

		Output changes		Price changes	
		Mean	S.D.	Mean	S.D.
Wheat	EU	2.0%	9.4%	1.0%	14.0%
	RoW	0.5%	8.0%	0.7%	17.2%
	US	1.1%	2.5%	0.4%	16.3%
Oilseeds	EU	-0.3%	0.9%	0.2%	4.0%
	RoW	0.0%	0.8%	0.0%	3.8%
	US	0.0%	0.4%	0.0%	3.9%
Other Cereals	EU	-0.2%	0.5%	0.2%	2.1%
	RoW	0.0%	1.0%	0.0%	3.2%
	US	0.0%	0.3%	0.0%	2.1%
Cattle	EU	-0.1%	0.1%	0.2%	0.4%
	RoW	0.0%	0.3%	0.0%	0.7%
	US	0.0%	0.1%	0.0%	0.4%
Beef	EU	-0.1%	0.1%	0.1%	0.2%
	RoW	0.0%	0.2%	0.0%	0.3%
	US	0.0%	0.1%	0.0%	0.2%

Williams and Wright (1991) point out that, as long as the mean price is endogenous and the responses and feedback of economic agents are taken into account, a stabilization mechanism cannot keep this price unchanged. Our results illustrate their point: compared with the distributions observed prior to the introduction of storage in the model (Table 4.3), mean prices are now lower in all regions and all sectors. In our simulation framework, the mean price decrease is furthermore accentuated by the limitation of the sudden huge price increases attributable to non-rational expectations when storage is not allowed. On the other hand, the effects of stockholding behaviour commonly found in the economic literature are that storage tends to stabilize price and destabilize production citepwil91. While our results suggest that stockholding behaviour effectively limits price fluctuations, particularly in the European wheat sector, output fluctuations are not systematically increased: apart from a slight increase in the RoW cattle sector, output fluctuations decrease in all regions and all sectors in the table. One explanation for the decrease of output fluctuations is that the stabilization of price also allows producers to stabilize their expectations and in consequence to stabilize their production. So, even if stockholding behaviour can play the destabilizing role stated in the economic literature, it also gives rise to an improvement of other agents' expectations, and the two phenomena interact. Moreover, as pointed out by Newbery and Stiglitz (1981), agricultural producers are more concerned with the stability of their income than with price or production stability. Here our results, as presented in Table 4.6, suggest that the introduction of storage is conducive to stabilization of farmers' incomes in all cases, even when their production is destabilized.

TABLE 4.6 – Standard deviation of farm income changes

	Without stockholdings			With stockholdings		
	Wheat	Oilseeds	Other Cereals	Wheat	Oilseeds	Other Cereals
EU	104.4%	11.2%	13.4%	31.71%	4.3%	4.9%
RoW	85.9%	11.1%	11.4%	24.9%	4.8%	4.6%
US	35.1%	13.0%	5.4%	9.2%	5.6%	2.2%

The last point that differs in our results from what is found in the economic literature is that a decrease of price volatility caused by stockholding behaviour is shared by all regions, even though it is more important in the EU. This differs from the view expressed by Tyers and Anderson (1992), who stress a risk sharing between regions. Our findings show that stockholders allow all market agents to improve their expectations and in consequence they decrease the endogenous part of price volatility.

Sensitivity Analysis

The simulations presented above suggest that modelling the effect of stockholding behaviour in a dynamic intertemporal CGE framework that assumes non-rational expectations can lead to results on market risks quite different from those commonly found in the economic literature. Indeed, our results suggest that storage actually induces a stabilization of agricultural prices (and incomes), but does not necessarily destabilize output. Furthermore, we find no evidence of a transmission of price volatility from the sector concerned with stockholding to other sectors or regions. However, in order to run these simulations, some parameters determining the variability of exogenous shocks, the form of stockholders' expectations and the elasticity of storage service supply have been set to arbitrary values. Some sensitivity analyses are now conducted to test the sensitivity of our results to these values.

Sensitivity to the variability of supply shocks

In our standard case the supply shocks implemented in the RoW wheat sector are generated according to a normal distribution with a standard deviation σ_ϵ equal to 3%. We now run other simulations for different values of σ_ϵ, namely 1%, and 4%. We demonstrate in Table 4.7 below the changes in standard deviation of outputs, prices and income induced by the introduction of storage for the different volatilities of exogenous shocks. Regarding these results, it appears that the more volatile the productivity shocks the more the introduction of storage in the model creates stabilization of production, prices and, as a matter of fact, farm income. Actually, this result is not surprising, since moderate productivity shocks, as we have seen, can generate high output and price fluctuations because of the additional volatility arising from the expectation errors of economic agents. In fact, the more volatile productivity shocks are the higher are market fluctuations and the more important are the reductions of expectation errors caused by stockholding behaviour and of fluctuations.

TABLE 4.7 – Changes in standard deviations induced by the introduction of storage in the model

			$\sigma_\epsilon = 1\%$	$\sigma_\epsilon = 3\%$	$\sigma_\epsilon = 4\%$
Prices S.D.	Wheat	EU	-37.5%	-75.4%	-82.6%
		RoW	-25.0%	-68.3%	-71.5%
		US	-27.1%	-70.0%	-73.4%
	Oilseeds	EU	-15.8%	-57.2%	-53.1%
		RoW	-17.3%	-57.3%	-53.2%
		US	-17.4%	-57.0%	-52.9%
	Other Cereals	EU	-20.3%	-55.3%	-50.0%
		RoW	-19.3%	-59.9%	-56.7%
		US	-22.2%	-59.6%	-57.4%
Output S.D.	Wheat	EU	-35.1%	-51.1%	-66.7%
		RoW	-10.1%	-63.7%	-67.1%
		US	-21.8%	-82.0%	-75.0%
	Oilseeds	EU	-0.6%	-60.8%	-62.6%
		RoW	-7.7%	-60.1%	-56.3%
		US	-7.5%	-60.4%	-53.3%
	Other Cereals	EU	8.2%	-60.7%	-63.2%
		RoW	-8.7%	-60.1%	-54.1%
		US	-11.0%	-57.6%	-60.5%
Income S.D.	Wheat	EU	-25.0%	-23.3%	-82.6%
		RoW	-29.3%	-22.4%	-74.8%
		US	-24.3%	-28.2%	-73.2%
	Oilseeds	EU	0.0%	-33.3%	-68.2%
		RoW	-17.2%	-33.6%	-52.7%
		US	-19.4%	-33.7%	-52.9%
	Other Cereals	EU	-16.7%	-36.0%	-77.8%
		RoW	-17.2%	-34.9%	-57.3%
		US	-23.8%	-38.1%	-60.2%

Sensitivity to the expectations of stockholders

In our standard case we consider that stockholders form their expectations in the same way as the other agents in the model: the historical weighting parameter α is set to 1/5 for all of them. However, as shown by Chavas (1999), expectations of economic agents are heterogeneous, and one can presume that speculative stockholders may have expectations different from other agents. We investigate here the impacts of different stockholders' expectation schemes on the volatility of markets. Thus we run some simulations that consider different values for the historical weighting parameter α, namely 1/3, 1/4, 1/10 and 1/50. The changes in standard deviations of price, output and income induced by stockholding behaviour are presented in Table 4.8.

The first thing to note is that, as for $\alpha = 1/5$, the introduction of storage allows prices to stabilize in all regions, for $\alpha = 1/4$, $\alpha = 1/10$ and $\alpha = 1/50$; and the lower *alpha* is, that is to say the more past information is taken into account by stockholders the more the price volatility is reduced by the introduction of storage in the model. Output and farm income fluctuations are also dampened when decreases. In contrast, if stockholders take little account of past information when making their decisions, when $\alpha = 1/3$, their behaviour tends to increase price, output and farm income fluctuations in several sectors and regions. These results confirm what Femenia and Gohin (2009) pointed out in their paper on the role of expectation schemes, namely that the dynamics of markets are smoothed when agents react slowly to price news.

TABLE 4.8 – Changes in standard deviations induced by the introduction of storage in the model

			$\alpha = 1/3$	$\alpha = 1/4$	$\alpha = 1/5$	$\alpha = 1/10$	$\alpha = 1/50$
Prices S.D.	Wheat	EU	-68.7%	-71.1%	-75.4%	-76.19%	-79.28%
		RoW	-65.2%	-65.0%	-68.3%	-67.94%	-67.37%
		US	-66.8%	-66.7%	-70.0%	-69.78%	-69.59%
	Oilseeds	EU	10.6%	-50.9%	-57.2%	-57.52%	-60.10%
		RoW	-2.5%	-51.3%	-57.3%	-57.48%	-60.29%
		US	22.0%	-51.0%	-57.0%	-57.23%	-60.07%
	Other Cereals	EU	5.2%	-49.1%	-55.3%	-55.43%	-55.52%
		RoW	-53.6%	-55.2%	-59.9%	-59.63%	-59.20%
		US	-48.4%	-55.1%	-59.6%	-59.53%	-59.86%
Output S.D.	Wheat	EU	-13.8%	-34.1%	-51.1%	-57.2%	-60.4%
		RoW	-58.6%	-58.7%	-63.7%	-63.3%	-63.5%
		US	-75.7%	-80.0%	-82.0%	-82.2%	-81.4%
	Oilseeds	EU	223.1%	-46.1%	-60.8%	-63.3%	-61.0%
		RoW	-41.6%	-54.1%	-60.1%	-60.3%	-61.4%
		US	63.3%	-52.3%	-60.4%	-60.9%	-61.9%
	Other Cereals	EU	178.4%	-47.6%	-60.7%	-61.3%	-58.4%
		RoW	-44.4%	-55.2%	-60.1%	-59.4%	-56.8%
		US	76.7%	-50.1%	-57.6%	-58.5%	-56.9%
Income S.D.	Wheat	EU	-53.5%	-60.0%	-69.6%	-74.9%	-76.2%
		RoW	-67.7%	-67.3%	-71.0%	-70.8%	-71.0%
		US	-67.7%	-71.2%	-73.9%	-73.8%	-73.2%
	Oilseeds	EU	45.4%	-52.5%	-61.8%	-64.3%	-66.8%
		RoW	10.9%	-50.8%	-56.8%	-57.0%	-60.0%
		US	30.1%	-50.8%	-56.8%	-57.1%	-60.0%
	Other Cereals	EU	-4.3%	-51.9%	-63.6%	-69.3%	-72.0%
		RoW	-50.5%	-55.3%	-59.9%	-59.8%	-59.7%
		US	-32.1%	-55.4%	-60.2%	-60.1%	-60.7%

Conclusion

The successive reforms of the CAP raise the question of its price-stabilizing role, and more and more attention is paid to private risk-managing instruments such as storage. The effects of private storage on market volatility have already been widely studied in the economic literature but hardly any of these previous studies takes account of the links between producers', households' and stockholders' decisions in the way that is possible with a CGE model. Furthermore, there is little consideration of the intertemporal decisions of these agents, which is a drawback when studying the effects of an instrument like storage that allows intertemporal arbitrage. Finally, almost all these studies focus on the effect of stockholding on exogenous price volatility and assume rational expectations, which does not allow for the representation of the endogenous part of risk induced by market mechanisms. Speculative stockholders themselves have sometimes been blamed for increasing the volatility on agricultural markets because of their non-rational behaviour. To address these issues we constructed a dynamic CGE model, taking the intertemporal decisions of economic agents into account, including imperfect expectations and private stockholding behaviour, and then conducted some simulations. These simulations reveal some interesting results which, even if they do not completely contradict the outcome of previous studies, modify some of them. First, our results illustrate the point made by Williams and Wright (1991) that a stabilization scheme cannot keep market prices unchanged: indeed, in our framework, the expectation-improving role of stockholding behaviour tends to limit the occurrence and magnitude of sudden price peaks due to an accumulation of expectation errors from other agents. Price peaks still exist under storage but they are mostly due to a liquidation of stocks, and this tends to decrease market prices. On the other hand, contrary to Mitra and Boussard (2008), we do not find evidence of a systematic destabilizing effect of speculative behaviour on prices. Even stockholders have imperfect expectations about the future. The only case where this destabilizing effect arises is when speculators take past information less into account than other agents when making their decisions, which seems unrealistic. Moreover, we find that the price-stabilizing effects of stockholding behaviour are all the more important when stockholders take full account of past information to form their expectations. In this case some studies, like Williams and Wright (1991), argue that if stockholding behaviour stabilizes prices it also destabilizes production. This is not necessarily the case in our framework: when stabilizing prices, stockholding behaviour also stabilizes producers' expectations and production. In the same way, the improvement of expectations allows market prices to stabilize in other sectors than the sector of the storable commodity (wheat in our simulations). Thus, there is no transfer of volatility between regions or between sectors. Furthermore, we find that stockholding behaviour in the EU tends to stabilize income in each region except, once again, if stockholders take less account of past information than other agents to form their expectations. Furthermore, our results reveal the difficulty in estimating a distribution of exogenous (for instance climatic) production shocks based on production data, especially if market agents are not fully rational, because these data already result from many decisions based on agents' expectations. Finally, we must acknowledge that the simulations presented here are for illustration only: storage applies to the EU wheat sector only and the productivity shocks apply to wheat in the rest of the world. Moreover, we have not taken into account the risk aversion of economic agents that can have an impact on their decisions. Further work should be done to overcome these limitations and to construct a CGE model that studies the effect of a commodity price stabilization program. As pointed out by several authors (Newbery and Stiglitz, 1981; Williams and Wright, 1991; Weaver and Helmberger, 1977), this analysis of commodity price stabilization should take storage activities into account.

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Troisième partie

Simulations des effets de réformes politiques sur la stabilité des marchés agricoles

Chapitre 5 On the optimal implementation of agricultural policy reforms [1]

Résumé

Les analyses économiques des politiques agricoles se concentrent en général sur les effets de long terme et les aspects dynamiques transitionnels sont négligés. Dans cet article nous conduisons une analyse en Equilibre Général Calculable dynamique déterministe. Dans ce modèle, les agents peuvent être supposés avoir des anticipations parfaites ou imparfaites. En utilisant, à titre illustratif, un scenario de réforme de la Politique Agricole Commune, nous simulons cette réforme mise en place de façon abrupte ou de façon progressive. Nous résultats montrent que, si les agents économiques sont capables d'anticiper parfaitement les impacts de la réforme, étaler dans le temps sa mise en place n'est jamais optimal. D'un autre côté, si les agents ajustent progressivement leurs anticipations en fonction de l'information qu'ils reçoivent, nous trouvons des cas où une réforme progressive améliore le bien être. Une telle réforme permet en fait de minimiser les coûts d'ajustement des agents.

1. Cet article, co écrit avec Alexandre Gohin, a été présenté au Symposium de l'IATRC à Stuttgart en Juin 2010

Introduction

Agricultural policies in developed countries have undergone several reforms since their creation. These reforms have almost always been implemented gradually. This is notably the case of the Common Agricultural Policy (CAP) of the European Union (EU): the reduction of support prices begun in 1992 and was reinforced in 1999 and 2003 reforms while the decoupling of farm payments started in 2003 and was pursued with the 2008 Health Check.

This gradual implementation of agricultural policy reforms can first be explained by political considerations. Indeed these reforms are often difficult to agree upon due the opposition of stakeholder including farmers. A gradual reform generally benefits from a better acceptability. Secondly there might be a time lag between the implementation of a reform and agents' adaptation to the new policy because of adjustment costs. Hence reforming gradually may lessen these adjustment costs and may be economically justified. On the other hand, a too long implementation of a reform may ultimately become inefficient if the steady state benefits are postponed too far away and are thus heavily discounted. A quick implementation can also be motivated by other political considerations. Indeed a quick implementation at the beginning of a new administration confers some credibility to its elected members (Haggard and Webb, 1993). Furthermore this allows the new policy to be well embedded and benefits materialize before the end of the mandate and the new elections. Accordingly, governments face both economic and political trade-offs when deciding the implementation of a reform.

To our knowledge, few economic analyses focus on the transition dynamics and thus deal with this issue. Furthermore only a small part of the existing studies specifically addresses agricultural policy issues. Among these is the analysis of Yanagida et al. (1987) who argue that suppressing immediately agricultural price supports in the US is preferable to suppressing them gradually. The reason is that a gradual reform generates cyclical market movements. However this study is based on an econometric model focused on market impacts without any computation of economic welfare effects. On the contrary, using a dynamic Computable General Equilibrium (CGE) framework with static expectations for investment decisions, Levy and van Wijnbergen Levy and van Wijnbergen (1995) argue that a progressive liberalisation of Mexican agriculture is preferable to an immediate reform. Even if an immediate liberalisation induces larger economic gains, the authors prove that gradualism is not very costly while it allows mitigating the welfare losses for the group affected. The analysis of Adams et al. Adams et al. (2001) confirms this trade-off between smoothness and short run efficiency losses. These authors develop a dynamic CGE model on the Danish economy, with static versus perfect expectations, to analyse the implementation of a quota on pig production. They conclude that whether announcement (gradual) or surprise (abrupt) implementation is to be preferred depends on agents' attitude towards risks and how they discount the future. On the other hand, the position of Malakellis (1998) on the optimal timing of a tariff reform for Australia is more definitive. He shows using a dynamic CGE model with perfect expectations that, even if both type of reforms lead to similar long term effects, reforming immediately is better than reforming gradually. The reason is that the economy adjusts more slowly when the reform is progressive: the earlier tariffs on capital goods are suppressed, the earlier allocation efficiency gains are realized. These different studies rely on different models, on different assumptions concerning agents' expectations and inter temporal decisions, and focus on different policy issues. Their results are thus hardly comparable. However their contrasting conclusions show that the issue of the optimal implementation of policy reforms is still open and that several factors can influence it.

In this article we focus on the role played by price and return expectations formed by economic agents. The basic intuition is the following: the more stakeholders are able to correctly anticipate the market effects of the reforms, the more the reforms can be implemented quickly. Adams et al. also express this intuition but do not formally test it. More generally different economic studies have already shown that these expectations can be crucial when evaluating policy reforms (Pereira and Shoven, 1988). In particular Ballard (1987) shows with a dynamic CGE model for the US economy characterized by many distortions, that the implementation of a consumption tax in the US in place of the income tax can generate lower welfare gains if agents perfectly anticipate the future than if they make adaptive expectations. The reason is that the taxation of consumption leads to an increase of capital stock, and if consumers have perfect foresight they expect the induced decrease of capital returns, leading them to reduce their savings before the reform. This, in turns, generates a welfare loss which does not occur if consumers do not anticipate the effect of the reform before its implementation. In the same vein, Thissen and Lensink (2001),using a dynamic CGE model for Egypt, find that a currency devaluation which is perfectly anticipated by economic agents has a negative effect on pre reform investments and production. These negative effects are absent with adaptive expectations. This issue of expectations is not specific to dynamic CGE analyses of macro-economic reforms. For instance, Scandizzo et al. (1983) develop a static partial equilibrium model calibrated on a stylised farm market. These authors find that the welfare gains of a price stabilisation reform are higher the more agents are naïve ; as a matter of fact, most of the gains could be reaped if agents were better informed. This cost of naivety suggests that, if agents are not fully rational and adjust their expectations along with time, a gradual reform is preferable because it allows them to learn and improve their information progressively. If the aforementioned studies provide some insights about the role played by expectations on the optimal implementation of reforms, none of them specifically addresses this issue. In that context, our main objective in this article is to investigate this overlooked issue. We obviously focus on farmers who potentially face major changes from agricultural reforms. In this respect, we develop a dynamic CGE model aimed at simulating the effects of agricultural policy reforms on farm markets and welfare. This dynamic model is developed using different expectations schemes, ranging from perfect foresight to pure naivety. Using this framework, we simulate the effects of a radical reform, namely the total suppression of the CAP in the EU arable crop sectors (cereals and oilseeds). This shock is implemented in one step or implemented gradually (over five years). Our simulation results show that if economic agents have perfect expectations, then delaying the implementation of reforms is never optimal. On the other hand, if agents gradually learn from market developments because of their imperfect expectations, then we find some cases where a progressive implementation of a radical reform is welfare improving while an abrupt implementation may generate significant welfare losses in the short run.

The next part of this article is devoted to a brief description of our dynamic CGE model with a special focus on the links between the form of expectations and the dynamic decisions of the model. The results of the simulations conducted under different assumptions concerning the implementation of the reform and the expectations of economic agents are then presented. We also perform sensitivity analysis of main results to our assumptions on the level of adjustment costs and on the imperfect nature of expectations. Finally we conclude.

5.1 Modelling frameworks

We develop two consistent dynamic CGE models. In the first version agents are assumed to have perfect expectations while the second one they are assumed to have adaptive expectations, the case of naïve and static expectations being particular cases. In a first subsection we present the main characteristics of the perfect expectation version. The necessary changes to the model to switch from the perfect to the adaptive expectations version are then described in a second subsection.

5.1.1 The version with perfect expectations

We start from the static version of the widely used Global Trade Analysis Project (GTAP) model. More precisely, our point of departure is the GTAP-AGR model which offers a detailed representation of the farm and food sectors (Keeney and Hertel, 2005). In this static CGE model, savings by household are a fixed proportion of domestic income. Then a world bank collects savings from all countries and allocates world saving to regional investments according to expected regional capital returns. These expected capital returns decline with investments according to an *ad hoc* log-log specification.

In our dynamic CGE models, we develop alternative specifications of these saving and investment dynamic decisions. They result from consistent micro-economic dynamic optimisation programs. Different expectation schemes by economic agents can be introduced in these programs.

Producers' behaviours

Producers' behaviours result from both intra and inter temporal decisions. At each time period producers maximise capital returns by combining primary factors (capital, labour, and land in the case of agricultural producers) and intermediate consumption through nested CES functions. Land and labour endowments in each region are assumed to be fixed, although they can be reallocated across agricultural sectors or across non agricultural sectors at each period. Capital, once installed in a sector, is assumed to be fixed in the current period. However this sectoral capital stock changes with firms' investment from one period to another, namely:

$$K_{irt+1} = (1 - \delta_{ir})\, K_{irt} + I_{irt}$$

with K_{irt} the capital stock installed in region r and sector i in period t, I_{irt} the new investment made in period t and δ_{ir} the depreciation rate of capital. The optimal investment may be positive or negative. This optimal investment is precisely determined by the inter-temporal dimension of producers' decisions. Producers seek to maximize the present value of their firm (Devarajan and Go, 1998), which corresponds to the discounted value of their expected future profits (capital income) minus their expected future investment costs:

$$\max \quad \pi_{ir} = \sum_{t=1}^{\infty} \frac{1}{(1+r)^t} \left(wk_{irt} K_{irt} - PI_{irt} I_{irt} \left(1 + \frac{\phi_{ir}}{2} \frac{I_{irt}}{K_{irt}} \right) \right)$$

$$s.t. \quad K_{irt+1} = (1 - \delta_{ir}) K_{irt} + I_{irt}$$

With r the interest rate, wk_{irt} the expected capital unitary return, PI_{irt} the expected price of the investment good. The term $\frac{\phi_{ir}}{2} \frac{I_{irt}}{K_{irt}}$ represents the installation cost of capital with ϕ_{ir} a structural parameter (McKibbin and Wilcoxen, 1999). Solving this optimisation problem leads to a condition determining the optimal sectoral investment:

$$\begin{aligned} & wk_{irt+1} + (1 - \delta_{ir}) PI_{irt+1} \left(\phi_{ir} \tfrac{I_{irt+1}}{K_{irt+1}} + 1 \right) \\ & = (1+r) PI_{irt} \left(\phi_{ir} \tfrac{I_{irt}}{K_{irt}} + 1 \right) - \tfrac{\phi_{ir}}{2} PI_{irt+1} \left(\tfrac{I_{irt+1}}{K_{irt+1}} \right)^2 \end{aligned} \tag{5.1}$$

To facilitate the economic interpretation of this implicit equation, let's first assume that the installation cost parameter is null. The right hand side is then the marginal cost of investment in period t evaluated in period t+1. The left hand side is the marginal revenue of this investment: it equals the next period expected capital returns and the next period expected price of the (depreciated) investment good. When installation costs are positive, then the marginal cost and revenue of present investment are augmented by these costs. The last term of this equation takes into account that this installation cost decreases with the capital stock, hence investing today will decrease the installation cost of next-period investment.

This optimal investment decision depends on the expected prices of the investment good and the expected capital returns. The latter depend on the expected prices of outputs and the expected returns to other production factors. Accordingly if an agricultural policy scenario leads to some expected changes in output prices and capital returns, then farmers will react by modifying their investment decisions (and periodic production and input decisions as well). This will have subsequent impacts on future production and markets.

Households' behaviours

Households' decisions can also be decomposed between inter and intra temporal decisions. Households base their savings decisions on an inter-temporal trade-off: they spend a part of the income they earn at one period to consume goods, which brings them some utility, and save the remaining part. The part of the income saved at one period will be used later to consume and represents a future utility. So, the representative household in each region seeks to maximize the value of its inter-temporal utility, which is assumed to be additively separable, subject to the constraint on wealth accumulation:

$$\max U_r = \sum_{t=1}^{\infty} \frac{1}{(1+\rho)^t} U_{rt}(Q_{rt}) = \sum_{t=1}^{\infty} \frac{1}{(1+\rho)^t} \log(Q_{rt})$$
$$s.t. \quad W_{rt+1} = (1+r) W_{rt} + E_{rt} - PC_{rt} Q_{rt}$$

With ρ a time preference parameter (households have a preference for immediate utility), Q_{rt} the composite quantity consumed, PC_{rt} the composite consumer price, W_{rt} the wealth of household (due to their ownerships of domestic and foreign capital assets), E_{rt} the sum of labor and land earnings. Periodic household savings are simply given by:

$$S_{rt} = W_{rt+1} - W_{rt} = rW_{rt} + E_{rt} - PC_{rt} Q_{rt}$$

The first order condition of this program determines the level of savings in each region:

$$\begin{aligned} rW_{rt} + E_{rt} - S_{rt} &= PC_{rt} Q_{rt} \\ &= \left(\frac{1+\rho}{1+r}\right)(rW_{rt+1} + E_{rt+1} - S_{rt+1}) \\ &= \left(\frac{1+\rho}{1+r}\right) PC_{rt+1} Q_{rt+1} \end{aligned} \tag{5.2}$$

We again get an implicit equation determining the optimal evolution of consumption expenditure and savings in terms of expected consumer prices and expected incomes. Finally, the periodic income that is not saved is spent by the households to buy consumption goods so as to maximise their (Stone Geary) intra temporal utility.

Equilibrium conditions

Solving an infinite horizon dynamic CGE model with perfect expectations imposes the modeller to define steady state conditions at some future terminal period. The equations determining investment (equation 1) and saving (equation 5.2) relate current decisions to next period decisions in terms of expected prices, incomes and returns. As usual (see for instance, Diao and Somwaru, 2000), we assume that the markets reach a steady state at some period T ;from this period investment equals capital depreciation and the household real wealth does not grow:

$$I_{irT} = \delta_{ir} K_{irT} \tag{5.3}$$

$$W_{rT+1} = W_{rT} \tag{5.4}$$

These two terminal conditions ensure that a country net debt is stable or, equivalently, that the country savings equals its investment at the steady state.

Finally we mention that computing dynamic welfare gains is not straightforward when perfect expectations are assumed. It can not be computed as the discounted sum of yearly welfare effects because there is an optimal transition path that depends on prevailing prices. The consistent decomposition of the total welfare effect between an inter-temporal and an intra-temporal welfare effect is described in appendix 5.A.

5.1.2 The version with adaptive expectations

In the perfect expectation version of the model described above, agents are assumed to know exactly the future market prices and factor returns. This assumption implies that agents have full information and are able to process it so as to perfectly anticipate the evolution of all markets. However, collecting and processing information can be costly, so it may be rational for agents to base their decision on an alternative form of expectations, different from the perfect ones (Just and Rausser, 2002). Furthermore the econometric estimations of farmers' expectations generally conclude they form at best quasi rational expectations, often adaptive expectations (Nerlove and Bessler, 2001). These alternative expectation schemes are taken into account in a second version of our model in which we assume that agents do not know perfectly future prices and factor returns. Instead they form some expectations, based on past observations, about them. We have chosen in that case to adopt an adaptive form of expectations, originally proposed by Nerlove (1958), which are such that:

$$\hat{P}_t = \hat{P}_{t-1} + \alpha \left[P_{t-1} - \hat{P}_{t-1} \right] = \alpha P_{t-1} + (1-\alpha) \hat{P}_{t-1} \tag{5.5}$$

Here $\hat{P}_t$ denotes the price expected for period t, and the α parameter can be seen as a measure of the speed of adjustment of expectations. In fact the lower α is, the slower expectations adjust to market changes. An extreme case of Nerlovian expectations arises when α equals 1: economic agents only consider the previous period to form their expectations. These are called naïve expectations. At the opposite, if this parameter equals zero, then agents have constant expectations: they do not change with previous market conditions. Considering adaptive instead of perfect expectations implies some changes to the model. These changes concern the execution of the model and equilibrium conditions.

Execution of the model

When economic agents have perfect expectations, the prices they expect to prevail for the next period are conform to the economic theory. It implies that at the first period consumers and producers base their decisions on future market prices as determined by the model. All the decisions are thus taken at the first period for all subsequent periods and do not need to be re adjusted in the future: the model is solved once for all period simultaneously. On the contrary, when agents have adaptive expectations, they re-adjust their decisions at each period ; the model is thus solved iteratively, period by period as a temporary general equilibrium (Grandmont, 1977). This does not prevent that at each period agents make plans for several future periods to take their inter-temporal (investment and savings) decisions. More precisely, we assume that at each period, producers define an investment plan for several future periods with some price/return expectations. We furthermore assume that, due to their imperfect information, producers define this investment plan over a finite (rather than infinite) horizon. After some transition period, we assume that producers consider that their investments will be equal to their capital depreciation. Indeed this firm steady state condition may never appear because firms periodically revise their plans, but this formulation defines the current optimal investment plan for firms, including the current investment. Basically we face the same issue for households' dynamic decisions. They save today part of their income for future consumption without accurate knowledge of future prices and returns. We assume that their current saving decision is also determined by a dynamic program with a steady state condition stipulating that wealth no longer accumulates after some period. But the level of this terminal constraint changes every period.

Secondly some particularities of agricultural sectors need to be considered here. Indeed, contrary to some other agents who may observe current market prices at time they take their decisions, agricultural producers have to decide the quantities to produce and inputs to use before knowing the market price of their production ; they thus base their production decisions on expectations. This distinctive feature of agricultural sectors does not have any impact on the execution of the model if farmers have perfect expectations, whereas it needs to be taken into account in the case of adaptive expectations. To do so, the model is solved in two steps at each period. In a first step agricultural production decisions are taken based on farmers' expectations about selling prices and given their capital stocks. In a second step the quantities produced are put on the markets, all decisions by other agents are taken and prices adjust so as to ensure the intra temporal equilibrium for the period.

Equilibrium conditions

Contrary to the perfect expectation case, here investment and savings decisions are taken independently. Accordingly nothing in the model guaranties the equality between global savings and global investments. To overcome this issue, we make endogenous the world interest rate which adjusts to ensure the equality between global world savings and investments at each period.

Furthermore, in a model where future prices are perfectly anticipated, an inter-temporal equilibrium prevails (Pereira and Shoven, 1988). On the other hand, in the case of imperfect expectations, decisions and future plans are readjusted at each period: even if agents expect a future steady state to be realized when they take their inter temporal decisions, this state steady might not effectively be reached. Consequently, we may have a succession of temporary short run equilibriums, instead of an inter-temporal equilibrium, without reaching a steady state (Grandmont, 1977) [2]. It means for instance that at each period the gap between regional savings and investments can be financed by other regions through a foreign debt increase. In that case the steady state where capital stocks and foreign assets/debts are stable may never occur. Despite this issue, we can still compute welfare effects at each period. We follow Ballard (1987) by computing welfare on effective periodic consumptions, thus neglecting periodic savings.

5.2 Empirical framework

We use the GTAP database calibrated on the 2001 economic flows to run our policy simulations. As usual we reduce the dimension of the empirical model. These data are aggregated to 3 regions (the EU, the US and the Rest of the World (Row) and to 10 sectors, among which 7 are agricultural sectors [3].

The calibration of most behavioural parameters is identical to the calibration in the static GTAP-AGR model. The main exception concerns the substitution elasticities used to calibrate the nested CES functions of arable crop production technologies. Indeed, the *ex post* supply price elasticities are rather high in the sta-

2. The other critical issue of existence of this suite of temporary general equilibrium points is discussed below

3. These 10 sectors are: wheat, coarse grains, oilseeds, other crops, cattle, meat production, other food products, manufactured goods, services, trade and transport.

tic GTAP-AGR model because this model aims to simulate the long term effects of policy reforms. On the other hand, our dynamic framework simulates a sequence of short term effects, and agricultural supply adjusts less to price changes in the short term. Moving from the static specification to dynamic specifications already reduces these short run supply responses because the capital stock is fixed in the short run. Nevertheless the resulting supply elasticities remain still too high compared to usual elasticities used in partial equilibrium analyses of agricultural policies (see Table 5.1). In fact fixing the capital stock has a low impact on supply elasticities because the capital returns often represent low shares in total production costs. That's the reason why we reduce all substitution elasticities in arable crop technologies to 0.1. The resulting own price supply elasticities are reported in Table 5.2.

Table 5.1 – Arable crop own price supply elasticities computed with standard substitution elasticities

	Wheat	OtherCereals	Oilseeds
EU	2.868	2.819	2.417
US	0.939	1.259	1.004
RoW	2.330	2.235	1.380

Table 5.2 – Arable crop own price supply elasticities computed with revised substitution elasticities

	Wheat	OtherCereals	Oilseeds
EU	0.677	0.663	0.592
US	0.275	0.340	0.290
RoW	0.664	0.627	0.423

Furthermore additional parameters, compared to the static model, have to be calibrated in our dynamic models (see equations 5.1 and 5.2). For that purpose, we follow Devarajan and Go (1998) and assume that the initial 2001 data correspond to a steady state. We also assume that the initial interest rate, the time preference parameter, and the capital adjustment parameter are all equal to 5%.

Finally, when we adopt imperfect expectations, we also need to assume the horizon of the firms' investment plans as well as the horizon of households' optimal sequence of savings. We tested for different horizons (from 3 years to 8 years) and did not find substantial impacts. So we adopt a 3 year horizon in both cases. We also need to determine the precise way expectations are formed. Here we face some resolution issues already encountered by previous authors with non linear economic models (for instance, Hommes 1994). If expectations are close to be naïve, then the dynamic system quickly diverges as in the standard cobweb model. On the other hand, when these expectations are more stable because all past prices/returns are taken into account, then our dynamic system no longer diverges. We focus our analysis of simulation results on these non divergent cases. We start assuming that the parameter equals 1/5 for all agents and for all decisions (periodic production/ multi period investment). Then a sensitivity analysis of the results on this crucial parameter will be offered.

5.3 Simulation results

We simulate the complete removal of the CAP instruments in the arable crop sectors (wheat, other cereals and oilseeds) in order to maximise the resulting economic impacts on these sectors. On the other hand we maintain CAP instruments in livestock sectors. This illustrative scenario also allows us to circumvent the question of how particular instruments operate at the margin in these arable crop sectors. Practically, we remove export subsidies, import tariffs and direct payments as they are modelled in the static GTAP-AGR framework (a subsidy to land use). As said above, our models are calibrated on 2001 figures using the GTAP database. A real policy analysis must start building a realistic baseline incorporating all policy changes already implemented or projected. Since 2001 the CAP has been reformed twice (in 2003 with the so-called Mid Term Review, in 2008 with the so-called Health Check) but these reforms mainly affect livestock sectors. So we make the simplest assumption to define the baseline: we assume that the year 2001 is a steady state and does replicate in all subsequent years.

We then consider two implementations of our illustrative CAP reform. In the first case, we assume that this reform is abruptly applied in 2013. In the second case, we assume a linear gradual implementation of this reform from 2013 to 2017. In other words, we implement each year a 20% reduction of the pre-reform levels of policy instruments. In both cases, we assume that EU governments agree upon and announce this radical reform in 2011. We thus start simulating our model from 2011 when the policy reform is announced.

5.3.1 Impact on the steady state of a brutal implementation with perfect expectations

Before analysing transition dynamics and the optimal implementation of agricultural policy reforms, it is useful to understand the steady state impacts of this reform on farm markets. Here we focus on the simplest case of a brutal implementation with perfect expectations by all economic agents [4].

Table 5.3 reports the main steady state impacts of our reform. As expected the suppression of tariffs, export subsidies and, above all, direct payments in the EU induces a decrease of production of wheat (by 16.5%) and other cereals (by 12.4%). The production drop is smaller (by 6.3%) in the European oilseeds sector because the share of direct payments in total revenues is initially smaller in this sector and there is no tariffs nor export subsidies.

In these sectors, primary factor uses decrease as expected: land uses decrease more than capital. For instance the capital stock in the wheat sector decreases by 15.9% and the land use by 22.2%. So there is a small change in production technologies toward more input-intensive technologies because the land input subsidy is removed. The returns to land in arable crop sectors dramatically drop (by as much as 83% in the wheat sector). Accordingly we observe a reallocation of land towards the “still protected” livestock sectors (land use for fodder production increases by

4. The perfect expectation version of the model was first solved over 15 years, then over 16 years. Market and welfare results were robust to this choice of the terminal year.

13.6%). This does explain the slight increase in cattle production (by 0.3%).

TABLE 5.3 – Steady state impacts of a brutal CAP reform on agricultural markets when perfect expectations are assumed (percentage changes with respect to the baseline)

		Wheat	Other Cereals	Oilseeds	Cattle
EU	Production	-16.5	-12.4	-6.3	0.3
	Producer price	7.1	8.5	4.5	-0.8
	Exports	33.5	-31.1	13.3	1.6
	Land return	-83.0	-80.3	-70.5	-24.4
	Land use	-22.2	-19.2	-10.6	13.6
	Capitalstock	-15.9	-11.7	-5.9	2.3
US	Production	2.5	0.7	0.4	-0.1
	Producer price	1.3	0.5	0.5	0.2
	Exports	4.4	2.8	0.8	-0.7
	Land return	7.1	3.3	2.6	1.1
	Land use	1.9	0.4	0.2	-0.4
	Capitalstock	2.6	0.8	0.4	-0.5
RoW	Production	1.8	1.0	0.4	-0.1
	Producer price	0.6	0.4	0.3	0.1
	Exports	9.9	8.9	2.5	-0.8
	Land return	4.0	2.4	1.3	0.2
	Land use	1.4	0.8	0.3	0.0
	Capitalstock	1.8	1.1	0.5	-0.2

On the EU agricultural markets, we also obtain a significant reduction of EU exports of arable crops (by as much as 33.5% for wheat). The removal of export subsidies partly explains these results. This reduction is however lower than the production drop, so we end up with higher EU real producer prices of arable crops (for instance by 7.1% for wheat). Without surprise, the impact on US and RoW farm markets are in the opposite directions. For instance, their exports of arable crops increase (by 4.4% for the US wheat, by 9.9% for RoW wheat), their production expands as well. The increases are partly to the detriment of their livestock productions.

At the steady state obtained after 15 years of simulation, the yearly EU welfare increases from the CAP reform because some distorting impacts of this policy are suppressed. The discounted (to 2011) EU economic welfare increases by 580 million US$ in 2025. By contrast, the RoW suffers from welfare losses because this region is a net importer of arable crops and the world prices of these products increase (discounted loss of 255 millions US$ in 2025). Finally the US economy experiences a small welfare gains (by 20 million US dollar in 2025).

5.3.2 The transitory dynamics

Before discussing welfare effects, we first analyse the dynamics of the EU wheat market. The dynamics observed on other markets exhibit the same qualitative patterns. Figure 5.1 (5.2) reports the evolution of the European wheat price (production) for the different simulations. A first thing to note is that the long term effect, a 7.1% increase of wheat price is the same for all the simulations. The transition paths however are different: whereas prices rapidly converge to their steady state value in the perfect foresight setting, they fluctuate much more when expectations are adaptive, especially if the reform is abruptly implemented.

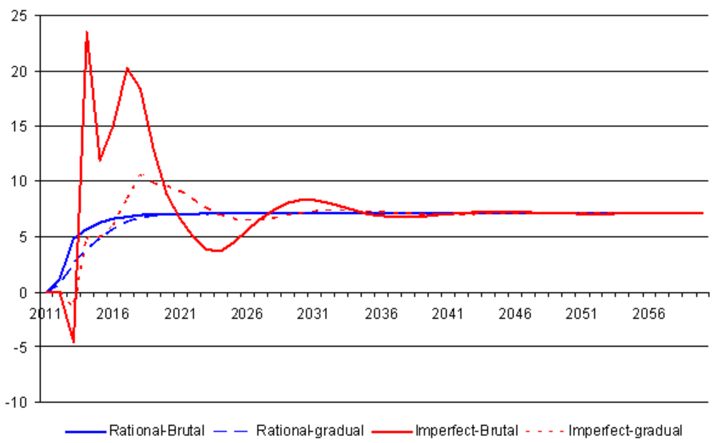

FIGURE 5.1 – Evolution of the European wheat price following the CAP reform (percentage change compared to the baseline)

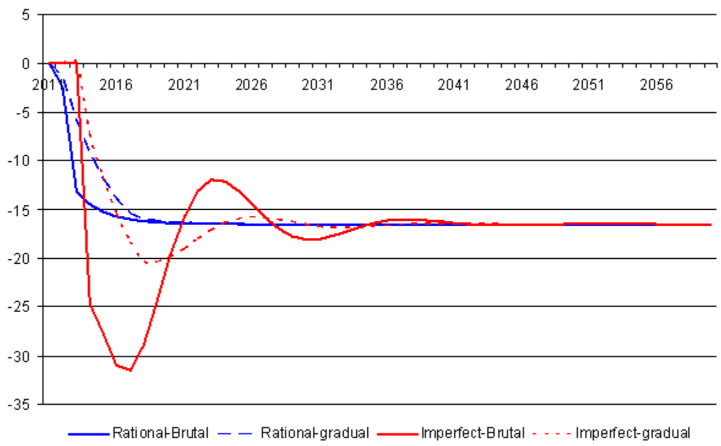

FIGURE 5.2 – Evolution of the European wheat production following the CAP reform (percentage change compared to the baseline)

Let' s start with the perfect expectation results. Producers perfectly anticipate the effects of the reform. Once announced, they immediately adjust downwards their investment levels while other input decisions (land, fertilizer, pesticides, . . .) are already made. This reduction of first year (2011) investment is logically greater in the abrupt implementation than in the gradual implementation. Accordingly the EU wheat production in the second year (2012) already decreases even if the reform is effectively implemented from 2013 onwards. This reduction amounts to 1.4% in the gradual implementation, up to 2.4% in the abrupt implementation with respect to the no-reform benchmark. That's the main reason why we also observe an increase of the EU wheat price in that second year (by 0.7% in the gradual implementation, by 1.2% in the brutal implementation).

The EU wheat producers continue to adjust downwards their investment in the second year (2012). They also modify their other input decisions (intermediate inputs, land and labor) because they perfectly anticipate the price/returns effects of the following years. In particular, they perfectly anticipate the major effects of the (partial/total) removal of direct payments in the third year. The EU wheat production declines by 5.9% in the gradual implementation, up to 13.2% in the brutal implementation. So there is a huge difference in that third year between the two implementations due to the greater modifications in the optimal combination of variable inputs with installed physical capital.

This process of adjustment quickly converges to the steady state with the abrupt implementation. It is more slowly with the gradual implementation because producers still benefit from (declining) CAP price supports and subsidies.

The transition dynamic is completely different with imperfect expectations by economic agents. Even if the reform is announced in 2011, agents do not adjust in the first years because they are backward looking. To justify this assumption, one possible interpretation is that agents believe that the reform is not credible and will not be applied[5]. Another possible interpretation is that agents are not able to figure out their relative competitiveness and the true characteristics of all markets. So they are initially passive and wait to learn from market developments. When the reform is effectively implemented (in 2013), the EU wheat producers significantly loss money (compared to the no reform benchmark) because they produce the same quantity of output but they now no longer benefits from former subsidy and price support levels. The EU wheat price declines by 1% with the gradual implementation, by 4.6% with the brutal implementation.

Because producers are backward looking and just experience negative income effects, they start adjusting their farming system. This adjustment is naturally more important with the abrupt implementation because their income losses (capital returns and land returns) are more significant. So they considerably revise their combination of variable inputs and also their investment. In fact it appears that they sell part of their capital when the reform is abruptly implemented. They only do not invest when the reform is gradually implemented. The main consequence is that the EU wheat production significantly drops in that third year when the reform is abruptly implemented. It decreases by 24.7% leading to a subsequent huge price effect (by 23%). By contrast, this production decreases by 7.2%

5. Agreed reforms often include conditional clauses.

with the gradual implementation, leading to a more moderate price effect (4.7%).

We observe that this process of adjustment converge rather rapidly to the steady state with the gradual implementation. On the other hand, the price and production patterns exhibit more pronounced variations with the abrupt implementation. It is worth mentioning that the production drops by as much as 31% in 2016, three years after the completion of the CAP reform. In other words, we observe on this wheat market that the series do not start converging to the steady state once the reform is completely implemented. The situation is opposite on the EU coarse grain market (not shown). Production and price effects on this market in the first year of reform are even more distant to their steady state levels. In the first year after the completion of the reform, we observe in this market a convergence towards the steady state levels. This initial convergence on the coarse grain market is to the detriment of the initial convergence on the wheat market.

Figure 5.3 represents the evolution of the welfare effects induced by the reform in the different simulation settings. It appears, first, that the long term European welfare gains are higher when expectations are adaptive, whatever the way the reform is implemented: they amount to about US$150 million, compared to US$100 million in the perfect expectations setting. The reason for these differences lies in the macroeconomic closure of the model. Indeed, in the adaptive version of the model the endogenous world interest rate allows European investments to be financed by other regions through an accumulation of the foreign debt. By contrast regional investments have to be entirely financed by regional savings, and foreign debts/assets have to be stable from the steady state period in the perfect foresight version. Long term European investments, capital stocks and capital income are thus higher in the adaptive expectation model, which in turns leads to higher disposable income for consumption and to higher European welfare gains.

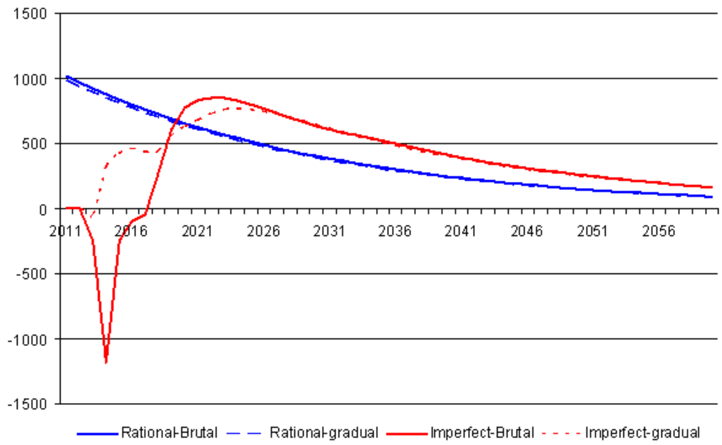

FIGURE 5.3 – Evolution of the Equivalent Variation of income in the EU following the CAP reform (millions US dollars)

If agents have perfect foresight the welfare effects are positive in all cases all along the transition path and slightly higher when the reform is implemented immediately because the gains are reaped earlier. It thus appears that in the case of perfect foresights an immediate reform is preferable to a gradual one. On the other hand, when expectations are adaptive the welfare gains are lower during the 10 first simulation periods, and, above all, the immediate implementation of the reform generates significant welfare losses (among US$1.2 billion) during the 8 first periods. These welfare losses first come from the adjustment costs associated with farmers' disinvestment. As explained above, the EU farmers strongly adjust downwards their capital stocks with the abrupt implementation in the first years following the reform. They thus pay significant des-installation costs. In the first year of the reform, they amount to 203 millions US$ (compared to 20 millions US$ with the gradual implementation) for the three arable crops sectors together. A second source of welfare effects is the foreign investment effect. The EU value of total investment decreases following the reform while the saving is rather stable. This leads to a small decrease of the world interest rate (by 0.06%). This also implies that the EU economy partly finances foreign investments. We thus also observe significant different welfare effects in the other regions. For instance, the US economy in the second year of the reform (2014) experiences a higher welfare gain with the abrupt implementation (663 millions US$) compared to the gradual implementation (174 million US$). As expected the world welfare effects are initially lower with the brutal implementation because other regions also incur adjustment costs.

5.3.3 Sensitivity analysis

In this subsection we test the robustness of the short run welfare losses previously analysed in the case of an abrupt implementation with imperfect expectations.

Our first sensitivity analysis focuses on the imperfect expectations of farmers. So far we assume that agents slowly learn from market developments. This is reflected in the nerlovian parameter equal to one fifth. We now assume that farmers react more strongly to last price/return observations. This parameter is now set to one half. If we impose this parameter to all dynamic decisions, our dynamic system diverges. On the other hand, if we impose this parameter only to the variable input decisions while letting unchanged this parameter for investment decisions, then our dynamic system converges to a steady state. Figure 5.4 reports the effects of the EU welfare. We observe that our main result is quite robust: there are initially welfare losses. We also observe that the results oscillate much more before reaching the steady state. The welfare effects often turn from positive to negative and vice versa before stabilizing in the positive range. The intuition is the following: the more farmers strongly react to last price/return changes, the higher are the endogenous market fluctuations and adjustment costs.

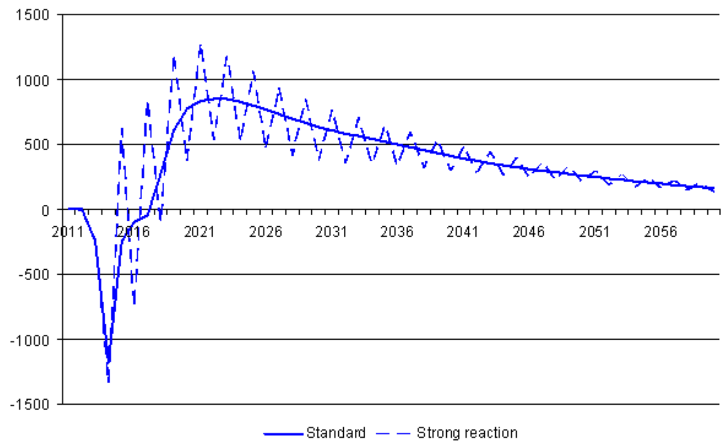

FIGURE 5.4 – Sensitivity of EU welfare effects following a brutal CAP reform to the expectation scheme (million dollars)

Our second sensitivity analyses focuses on the crucial adjustment cost parameter (see equation 5.1). In the standard case, this parameter is such that installation costs represent 5% of investment purchases. We now assume it to represent 2.5% and 7.5% of investment purchases. The impacts on EU welfare are provided in Figure 5.5. It appears that the initial welfare losses are even greater when these adjustment costs are low. This counter intuitive result can be explained as follows. When these adjustment costs are lower, then the farmers adjust their physical capital more strongly. For instance the EU wheat production decreases by as much as 42% following the reform (compared to 31% in the standard case). This also implies stronger adjustment in other sectors (like in the cattle production). In other words, the low adjustment costs favour stronger market fluctuations. Assuming higher adjustment costs have the symmetric effect. Initial welfare losses are more muted but still remain.

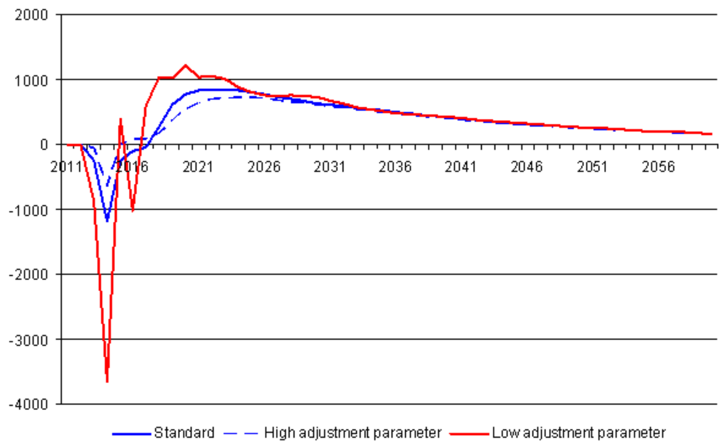

FIGURE 5.5 – Sensitivity of EU welfare effects following a brutal CAP reform to the adjustment cost (million dollars)

Conclusion

What is the best way to implement an agricultural policy reform ? This issue is often overlooked in economic analysis of farm policies where the focus is on the long run, steady state impacts. In this paper we perform a determinist dynamic CGE analysis allowing agents to form imperfect versus perfect expectations. Using an illustrative CAP reform scenario, we simulate an abrupt versus a gradual implementation of this reform.

Our results show that if economic agents are able to perfectly anticipate the impacts of the reform, then delaying its implementation is never optimal. They start adjusting their production patterns once the reform is announced, so that the markets smoothly reach their steady states. On the other hand, if agents gradually learn from market developments, then we find some cases where a gradual implementation of this reform is welfare improving. By contrast an abrupt implementation generates initial losses due to significant adjustment costs. These initial losses are all the more important that agents, in particular farmers, strongly react to last price observations. Accordingly it may be optimal to gradually implement reforms so that agents smoothly learn from market developments.

Even if our modelling framework offers some improvements with respect to traditional models used to assess farm policies, some additional efforts are needed to address the impacts of some modelling assumptions. In particular we neglect in our dynamic framework the various sources of risks present in farm markets as well the risk aversion of farmers. It is however not clear whether this will challenge our main conclusion. Adding risks and/or uncertainty may further raise the economic optimality of gradual policy reforms so that agents are able to discern the effects of reform from the expression of risky events (Calvo Pardo, 2009).

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5.A Computing dynamic welfare effects with perfect expectations

In static CGE models welfare effects of a policy reform are usually measured by the Equivalent Variations (EV). This indicator corresponds to the additional amount of income a household would be willing to pay to reach the post reform level of utility, at pre reform prices. Formally, it is given by:

$$EV = E\left(P^0, U^1\right) - E\left(P^0, U^0\right)$$

with $E(.)$ the household's consumption expenditure function, P^0 the pre reform prices and U^0 and U^1 the respectively pre and post utility levels. In current existing dynamic CGE models, the equivalent variation is often computed globally, as in Diao and Somwaru (2000) for instance, in which the global welfare effect ζ corresponds to the share of additional pre reform consumption necessary to reach the post reform utility level[6]:

$$\sum_t \left(\frac{1}{1+\rho}\right)^t U\left(q^0\left(1+\zeta\right)\right) = \sum_t \left(\frac{1}{1+\rho}\right)^t U\left(q_t^1\right)$$

However this computation does not reveal the transition path in terms of welfare effects. One could be tempted to assume that the overall EV is equal to the discounted sum of the period specific equivalent variations:

$$EV = \sum_t \frac{1}{(1+r)^t} ev_t$$

With $ev_t = \left(e\left(p_t^0, u_t^1\right) - e\left(p_t^0, u_t^0\right)\right)$.

This formulation, for instance used in the Linkage model (van der Mensbrugghe, 2005), gives one path of welfare effects. However the discounted sum of within period equivalent variations does not necessarily equal the overall equivalent variation. Indeed, Keen (1990) demonstrates that:

$$E\left(P^0, U^1\right) = \sum_t e^t\left(p_t^0, H^t\left(p_t^0, E_U\left(P^0, U^1\right)\right)\right)$$

6. Here we assume that the economy to be in steady state before the shock, $q_t^0 = q^0, \forall t$

With $H^t\left(p_t, E_U\left(P, U\right)\right)$ the optimal part of U allocated to period t, when the prices in period t are equal to p_t and the overall price of utility is equal to $E_U\left(P, U\right)$.

Let u_t^{1b} denotes the part of U^1 allocated to period t when prices are equal to their pre-shock levels. It is defined by:

$$u_t^{1b} = H^t\left(p_t^0, E_U\left(P^0, U^1\right)\right) \neq H^t\left(p_t^1, E_U\left(P^1, U^1\right)\right) = u_t^1$$

As a matter of fact:

$$EV = E\left(P^0, U^1\right) - E\left(P^0, U^0\right) = \sum_t \frac{1}{(1+r)^t}\left(e^t\left(p_t^0, u_t^{1b}\right) - e^t\left(p_t^0, u_t^0\right)\right)$$
$$EV = \sum_t \frac{1}{(1+r)^t}\left(e^t\left(p_t^0, u_t^{1b}\right) - e^t\left(p_t^0, u_t^1\right) + e^t\left(p_t^0, u_t^1\right) - e^t\left(p_t^0, u_t^0\right)\right)$$
$$EV = \sum_t \frac{1}{(1+r)^t} ev_t + \sum_t \frac{1}{(1+r)^t}\pi_t \neq \sum_t \frac{1}{(1+r)^t} ev_t$$

Here π_t denotes the inter-temporal equivalent variations and represents the price the household is willing to pay to re allocate their utility across periods. Both inter temporal (π_t) and intra temporal (ev_t) equivalent variations thus have to be taken into account to study the path of welfare gains or losses along with time. So, in order to get the transition path of welfare effects, we rely on Keen's work to find an expression of the ev_t and π_t in our model. More precisely we need to compute $e^t\left(p_{rt}^0, u_{rt}^1\right)$ and $e^t\left(p_{rt}^0, u^1 b_{rt}\right)$ to be able to compute ev_t and π_t. $e^t\left(p_{rt}^0, u_{rt}^1\right)$ represents the minimum amount a household would be willing to pay to reach the utility u_{rt}^1 at price p_{rt}^0 in period t. This expenditure is computed with simulated post reform consumption values and the parameters of the intra temporal Stone Geary utility functions. Regarding $e^t\left(p_{rt}^0, u^1 b_{rt}\right)$, $u^1 b_{rt}$ is the optimal part of U^1 allocated to period t at price p_{rt}^0. This is the solution of the following optimisation program:

$$\min \quad U_r = \sum_{t=1}^{\infty} \frac{1}{(1+r)^t} e_{rt}\left(p_{rt}^0, u_{rt}^{1b}\right)$$
$$s.t. \quad U_r^1 = \sum_{t=1}^{\infty} \frac{1}{(1+\rho)^t} \log\left(u_{rt}^{1b}\right)$$

Because pre reform prices are constant (steady state conditions), we obtain:

$$u_{rt}^{1b} = e^{\frac{U_r^1}{\sum_{s=1}^{\infty} \frac{1}{(1+\rho)^s}}}$$

Chapitre 6 To subsidize or not to subsidize private storage ? Evaluation of the effects of private storage subsidies as an instrument to stabilize agricultural markets after CAP reforms [1]

Résumé

Nous nous intéressons dans cet article aux effets d'une aide publique au stockage sur la volatilité des marchés agricoles suite à une réforme de la PAC. Ce type d'instrument est en effet fréquemment évoqué à l'heure actuelle dans les débats internationaux sur la gestion des fluctuations de prix agricoles. Nous analysons donc, à l'aide d'un modèle d'Equilibre Général Calculable dynamique, les impacts d'une telle subvention en termes de bien être et de stabilisation des marchés agricoles. Le modèle utilisé pose l'hypothèse d'anticipations imparfaites, ce qui nous permet de tenir compte de l'aspect endogène de la volatilité sur les marchés agricoles. Nos résultats confirment le fait, souvent évoqué, que réformer la PAC, en supprimant notamment le soutien des prix européens, tend à augmenter la volatilité des marchés agricoles européens et à limiter celle des marchés extérieurs. Nous montrons également que le stockage compétitif permet de limiter la volatilité des marchés, aussi bien avant qu'après la réforme. En revanche, la mise en place d'une aide publique visant à encourager ce stockage vient brouiller les signaux de marché envoyés aux producteurs agricoles et a, de ce fait, a un effet déstabilisateur.

1. Cet article est accepté pour les journées INRA/SFER/CIRAD de recherche en Sciences Sociales qui se tiendront à Rennes en Décembre 2010

Introduction

The stabilization of European agricultural markets, which was one of the initial objectives of the Common Agricultural Policy (CAP), is today questioned. Indeed, successive reforms have progressively replaced the price support scheme initially set up by the CAP, by a system of payments more and more decoupled from production and prices. While still supporting agricultural incomes, this evolution tends to reconnect European to international agricultural markets, and so to expose European agricultural producers to market fluctuations they did not face in the past. Regarding this increase of European farmers' exposure to market risks, more and more attention is being paid today to private risk managing instruments. Some of these instruments, including storage, already existed in the past but were not extensively used by agricultural producers, notably because of the existence of a public price support. Thought, private storage behaviours, which derive from inter temporal arbitrages, tend to reduce price volatility and can therefore stabilize markets (Makki et al., 1996).

One can presume that, with the removal of the public price support, private storage will be more and more used on European markets and will mitigate the increase of market volatility induced by this removal. There is however some limits to the use of private storage as a risk managing instrument. Anderson (1992) notably shows that the markets' stabilization induced by stockholding behaviours is very sensitive to storage costs: a small decrease of storage costs can generate a huge decrease of price volatility. This raises the question of the opportunity of a public intervention on storage. More and more attention is besides being paid to the opportunity of such an intervention at the world level (see the recent propositions of von Braun and Torero (2009), for instance). One way for governments to intervene on storage is to directly buy or sell stocks, so as to contain market prices, within a band determined by a support price and a release price for instance. This kind of mechanism was besides formerly used by the European Union (EU) to keep agricultural prices above an intervention level and stabilize markets. Nevertheless, public stockholdings have proven to be very costly (Jha and Srinivasan, 1999). Furthermore this mechanism generates a decrease of price volatility, which is a necessary condition for private storage to hold, and thus discourage private stockholdings (Glauber et al., 1989; Zant, 1997). In the United States (US), for instance, the removal, in 1996, of the public storage scheme in agricultural sectors led to an increase of the private storage activity and thus induced almost no changes in the volatility of agricultural prices (Lence and Hayes, 2002). Finally, buffer stock mechanisms can have an impact on production decisions, turn out to be distortive and do not comply with the World Trade Organisation (WTO) rules. Another way for governments to intervene on private storage is to stimulate private storage by providing a financial support to stockholders.

In their study comparing different market stabilization programs, Glauber et al. (1989) conclude that subsidizing private storage is the most cost effective way to stabilize market prices because storage subsidies can easily adjust to stochastic phenomena. Choi and Meyers (1989) however question these results, arguing notably that they do not account for the (positive) impacts of storage subsidies on production decisions in their model. Furthermore, the issue of the impact of such subsidies on speculative behaviours should be considered. Indeed, it has often been mentioned that the behaviours of non rational speculators could destabilized markets (Ravallion, 1987, for instance). Femenia (2010), using a dynamic Computable General Equilibrium (CGE) framework shows that even if they are not fully rational speculative behaviours stabilize agricultural markets, and thus contradicts this assumption. One can however wonder about the new behaviours a storage subsidy could induce. Taking account of all agents' behaviours, as a can CGE model do, to study the effect of storage subsidies thus seem important. Furthermore, as shown by Jha and Srinivasan (1999) greater price stability achieved through a government intervention does not necessarily imply greater welfare for economic agents ; indeed, in that case too much price stability eliminates private storage and generates very high government costs, which decreases social welfare. Here again

CGE models thus seem the most appropriate to simulate global welfare effects. Yet, whereas CGE frameworks are widely used to study the effects of agricultural policies, none of the aforementioned works dealing with private storage subsidies has been conducted using a CGE model. One of the main reasons for that is probably that, as pointed out by Wright and Williams (1988), studying the effects of market stabilization mechanisms requires a dynamic framework and, in the case of storage subsidies, the modelling of stockholding behaviours. However few CGE models display such characteristics. Among them is the inter temporal dynamic CGE model developed by Femenia and Gohin (2009a) and Femenia (2010) which includes stockholding behaviours and can incorporate imperfect expectations.

Our main objective in this paper is to simulate the impacts on markets fluctuations following CAP reforms of a subsidization of storage costs aimed at stimulating private storage at the world level, and to study the welfare effects of this public intervention. To do so, we use the aforementioned dynamic CGE model. We also rely on the work of Femenia and Gohin (2009b) to adequately represent the CAP in the model. We simulate the effects of a radical reform: the complete removal of the CAP in arable crops sectors and study the impacts on the volatility of agricultural markets of a storage cost subsidy set up in the Rest of the World (RoW)
.

We find, as expected, that the CAP removal in arable crop sectors destabilizes European markets and tends to stabilize markets in the United States (US) and in the RoW. Our simulations also confirm the smoothing effect of private storage on market fluctuations. However, the subsidization of private storage, even if it boosts the world stock levels, has a destabilizing effect on agricultural markets. In fact, this subsidy, by lowering the occurrence of stock shortages, and their associated moderated price spikes, deprive economic agents, and farmers in particular, of market information. Once these subsidies are set up, agents are thus less prepared to stock shortages that still (but less frequently) arise, which eventually leads to very large price spikes, and so to larger market volatilities. These subsidies do thus not prove to be efficient in terms of market stabilization. Neither do they prove to have positive effects in terms of welfare. In fact, because the demand for private stocks increase following the subsidies set up, good quantities available for consumption decrease ; this induces welfare losses at the world level.

In the next section we briefly recall the main features the dynamic CGE model. Then, we present the data used with a particular focus on the way the "standard" data have been modified to improve the modelling of the CAP instruments in arable crop sectors, we also present the policy scenarios that are simulated. The last section is devoted to the presentation of our main results. Finally we conclude.

6.1 The model

To be able to study the effects of different storage subsidies on market volatility, while accounting for both the linkages between agents' inter temporal decisions and for the potential role of imperfect expectations, we use a dynamic CGE model developed by Femenia and Gohin (2009a) and Femenia (2010). This model is based on a version of the GTAP framework (Hertel, 1997) adapted to the study of agricultural markets. The main distinctive features of this dynamic model are as folllows .

6.1.1 Dynamics

As usual in dynamic CGE model, the accumulation of capital stocks is used as link between periods: sectoral capital stocks accrue from one period to another in each region: $K_{irt+1} = (1 - \delta_{ir}) K_{irt} + I_{irt}$, with K the capital stock, I the new investment and δ the depreciation rate of capital, the subsets i, r and t denoting respectively the sector, the region and the time period concerned. In addition to this usual linkage between periods, Femenia and Gohin (2009a) give an inter temporal dynamic dimension to their model by introducing the inter temporal dimension of producers' investment and households' savings decisions:

To take his investment decision the producer seeks to maximize the present value of his firm (Devarajan and Go, 1998), which corresponds to the discounted value of all his expected future profits (capital income) minus his expected future investment costs:

$$\max\ \pi_{ir} = \sum_t \frac{1}{(1+r)^t} \left(wk_{irt} K_{irt} - PI_{irt} \left(1 + \frac{\phi}{2} \frac{I_{irt}}{K_{irt}} \right) I_{irt} \right)$$

$$s.t. \quad K_{irt+1} - K_{irt} = -\delta_{ir} K_{irt} + I_{irt}$$

With r the interest rate, wk the capital income, PI the price of investment and ϕ an adjustment parameter: the term $\frac{\phi}{2}\frac{I_{irt}}{K_{irt}}$ represents the adjustment cost of capital (McKibbin and Wilcoxen, 1999). Solving this optimisation problem leads to a condition determining the optimal investment in each sector and each region:

$$\begin{aligned} & wk_{irt+1} + (1-\delta_{ir})\, PI_{irt+1} \left(\phi \tfrac{I_{irt+1}}{K_{irt+1}} + 1 \right) = \\ & (1+r)\, PI_{irt} \left(\phi \tfrac{I_{irt}}{K_{irt}} + 1 \right) - \tfrac{\phi}{2} PI_{rt+1} \left(\tfrac{I_{irt+1}}{K_{irt+1}} \right)^2 \end{aligned} \tag{6.1}$$

Then because, as we will detail later, producers have limited knowledge about output price, capital returns and interest rate in the far future, they are assumed to consider that the economy will reach a steady state at some future period. This "producer steady state" may never arise, because they periodically revise their plans, but this formulation allows to determine the optimal firms' investment plan at each period, and so their current investment.

Households also base their saving decisions on inter temporal arbitrages. Indeed they spend a part of the income they earn at one period to consume goods, which brings them some utility, and save the remaining part. The part of the income saved at one period will be used later to consume and thus represents a future utility. So, the representative household in each region seeks to maximize the value of its inter temporal utility, subject to an inter temporal budget constraint:

$$\max U_r = \sum_t \frac{1}{(1+\rho)^t} U_{rt}(Q_{rt})$$

$$s.t. \quad \sum_t \frac{1}{(1+r)^t} E_{rt} = \sum_t \frac{1}{(1+r)^t} (P_{rt} Q_{rt} + S_{rt})$$

With ρ a time preference parameter (households have a preference for immediate utility), Q the quantity consumed, P the composite consumer price, E the total income (including interest earned from foreign assets, factor returns, distributed profits and tax receipts) and savings. The first order condition of this program allows to determine the evolution of savings:

$$E_{rt} - S_{rt} = \left(\frac{1+\rho}{1+r}\right)(E_{rt+1} - S_{rt+1}) \tag{6.2}$$

As producers, households have limited knowledge about prices and incomes in the far future ; they are thus also assumed to consider that the economy will reach a steady state at some future period. Once again, the steady state expected by households may never be reached but this condition, combined with Equation 6.2 allows to derive savings plan of households and thus current savings at each period.

These different characteristics of agents' inter temporal decisions, combined with a foreign debt accumulation period by period, are the main features of our model allowing the simulation of the dynamic evolution of markets.

6.1.2 Sources of market volatility

Two sources of price volatility on agricultural markets are identified in the economic literature (Butault and Le Mouël, 2004). On the one hand, many economists have argued that fluctuations on agricultural markets were essentially due to demand and supply shocks (Moschini and Hennessy, 2001): the time lag between production decisions of farmers and harvests induces a short-term rigidity of the agricultural supply, which can hardly adjust to market price changes. Furthermore most agricultural products are staples and demand for these goods is quite inelastic. Because of these two characteristics agricultural markets are very sensitive to market shocks: a supply decrease due to a, exogenous shock will result in a large price increase. Yet agricultural production is exposed to several epidemic and climatic risks and these exogenous shocks occur quite frequently, thus generating price fluctuations. On the other hand, the inter temporal dimension of decision processes implies that agents have to form expectations about the future path of economy at the time they take their decisions. Many studies dealing with uncertainty assume rational expectations (Williams and Wright (1991) for instance). However, processing and collecting information can be costly and it can in fact be more rational for economic agents to form imperfect expectations (Just and Rausser, 2002) and thus make expectation errors. As formalized by Ezekiel (1938) in his Cobweb theorem, these expectation errors can spread over time and induce endogenous fluctuations of market prices. Fluctuations on agricultural markets can therefore be first induced by exogenous stochastic shocks and then endogenously amplified and spread over time by the imperfect nature of economic agents' expectations. These two aspects are introduced in the model as follows.

Firstly, the agricultural technology is represented in the model by a nested CES production function. The first nest combines production factors to create value added ; the second one combines the aggregate factors with intermediate consumptions to produce output:

$$\begin{cases} VA_{irt} = \gamma_{ir} \left(a_{ir} K_{irt}^{\rho_{ir}} + b_{ir} L_{irt}^{\rho_{ir}} + c_{ir} T_{irt}^{\rho_{ir}}\right)^{\frac{1}{\rho_{ir}}} \\ Y_{irt} = \Phi_{ir} \left(\beta_{ir} VA_{irt}^{\theta_{ir}} + (1-\beta_{ir}) IC_{irt}^{\theta_{ir}}\right)^{\frac{1}{\theta_{ir}}} \end{cases} \tag{6.3}$$

With VA the value added, L the labour factor, T the land factor, Y the quantity produced and IC the aggregate intermediate consumption. a, b, c and β are share parameters, ρ and θ determine respectively the degree of substitutability between capital, labour and land and between value added and intermediate consumption, finally γ and Φ are productivity parameters. Exogenous supply shocks are introduced through the productivity parameter Φ : Random disturbances ϵ are thus introduced such that $\Phi shock_{ir} = \Phi_{ir}(1+\varepsilon)$, with $\Phi shock_{ir}$ the "shocked" productivity parameter. We assume that $\varepsilon \sim N(0, \sigma_\varepsilon)$ which implies that $\Phi shock_{ir}$ fluctuates around $\Phi_i r$ with a variance equal to $\sigma^2_{\Phi shock_{ir}} = \Phi^2_{ir}\sigma^2_\varepsilon$, that is to say that the $\Phi_i r$ values calibrated from the initial data correspond to average expected values.

Secondly, assuming that farmers have the right information concerning their own productivity (that they know the distribution of the exogenous shocks affecting their production) seems quite obvious. On the other hand, their expectations about market prices are assumed to be imperfect, which introduces an endogenous source of volatility in the model.

For that purpose we follow Femenia and Gohin (2009a) and rely on Nerlove's work (Nerlove, 1958) who proposed a formalisation of adaptive expectations based on past information. These expectations are such that agents take their past expectation errors into account to form their new expectations:

$$\hat{P}_{t+1} = \hat{P}_t + \alpha \left[P_t - \hat{P}_t \right] = \alpha P_t + (1 - \alpha) \hat{P}_t \tag{6.4}$$

$\hat{P}$ denotes expected prices and P observed market prices, α can be seen as a measure of the adjustment speed of expectations.

6.1.3 Modelling of storage

Stockholding behaviours are introduced in the model as in Femenia (2010). Namely, one representative stockholder in each region holds stocks and can sell a part of these stocks or buy other stocks at current market price at each period.

The stockholder seeks to maximize his intertemporal profit which corresponds to the discounted sum of his sales minus his purchases and the storage costs. His program can thus be expressed as:

$$\begin{aligned} &\max \sum_t \tfrac{1}{(1+r)^t} \sum_i \left(-\hat{P}_{irt} \Delta_{irt} - k_{rt} ST_{irt} \right) \\ &s/t \quad ST_{irt} = ST_{irt-1} + \Delta_{irt} \end{aligned}$$

With ST_irt the quantity of good i stored in region r at period t, k_rt the endogenous unitary storage cost in the region, and Δ_{irt} the variation of stock quantities ($\Delta_{irt} > 0$ implies that stocks are bought and $\Delta_{irt} < 0$ implies that stocks are sold during the period). Solving this optimisation program leads to the complementary conditions:

$$P_{irt} + k_{rt} \geq \frac{\hat{P}_{irt+1}}{(1+r)} \quad \perp \quad ST_{irt} \geq 0 \tag{6.5}$$

This equation is the standard relationship explaining stockholding behaviours (Williams and Wright, 1991): if the cost of buying goods at time t and storing them during one period is lower than the (discounted) price at which these goods can be sold at time $t+1$, stockholders buy goods thus increasing the current prices until an equality holds in the first condition of 6.5. On the contrary, if the cost of buying goods at time t and storing them during one period is higher than the price at which these goods can be sold at time t+1, stockholders sell their stocks thus lowering current market prices until the same equality is reached or until their stocks are null (an equality holds in the second condition of 6.5), in which case the market is in equilibrium even if an inequality holds. These considerations explain why stockholding behaviours come to mitigate market price volatility, and also why sudden price peaks can occur in case of null stocks.

Furthermore, storing a commodity generates costs paid by stockholders and made up, for instance, of the rent of grain silos and of the wages of workers who carry out stock handling. In order to determine these factor incomes, a storage service sector is represented in the model. This sector uses labour and capital factors which are combined through a Constant Elasticity of Substitution (CES) function to produce the "storage service good". Then, as for the other goods, the zero profit condition in this sector allows to endogenously determine the price of the storage service which corresponds to the unitary stora,ge cost. Moreover, as capital stocks are subject to adjustment costs, the storage capacity does not adjust instantaneously to stockholders' demand which places an upper limit on this capacity even if no storage bound is explicitly imposed. Finally, the market equilibrium conditions determining market prices includes beginning-of-period stocks on the supply side and end-of-period stocks on the demand side. Stocks buying and sales thus have an impact on equilibrium market prices.

6.1.4 Execution of the model

The model is solved iteratively, period by period, because agents readjust their decisions at each period, and in two steps for each period. This sequencing of the model resolution deserves some explanation.

As we already mentioned, consumers and producers base their decisions on expected future market prices. Furthermore, contrary to other agents, farmers do not observe market prices at time they take their production decisions. To take this specific feature of agricultural sectors into account the model is solved in two steps: in a first step agricultural production decisions are taken, based notably on farmers' expectations about market prices. At this time the prices of factors used for agricultural production adjust to ensure the equilibrium between farmers' demand and factor owners' supply. In a second step, agricultural quantities produced are sold, consumption, savings, investment and stockholdings decisions are taken, and prices of goods and factors allocated to non agricultural activities adjust so as to ensure the market equilibrium. If a productivity shock occurs after agricultural producers have decided how much to produce, then the quantities effectively produced are not equal to what farmers had expect. On the other hand, the other economic agents observe the market conditions and thus know current market prices at time they take their decisions. In the first step, determining agricultural production decisions, the model is thus solved by considering exogenous price expectations of producers, instead of endogenous market prices, and expected productivity values ($E\left[\Phi shock_{ir}\right] = \Phi_{ir}$). The outcome of this first step corresponds to what agricultural producers plan and thus determines the level of production factors they use. The real agricultural supply can then be computed using the production function (Equation 6.3) and the "real" productivity values ($\Phi shock_{irt}$). In the second step, the model is solved by considering the levels of agricultural factors and agricultural supply as exogenous. The outcome of the model corresponds to what effectively happens on markets, and notably determines the market prices, the levels of investment and the stock buying or selling. In the next period, the first step is re-executed by taking into account the new levels of stockholdings and capital stocks, resulting from the previous period decisions, and the new expectations of agricultural producers. The second step is re-executed by taking into account the new producers' plans and the new agricultural supply levels. And so on.

6.2 Data and simulations

As already mentioned, the model we use is based on the GTAP AGR framework. We have already detailed the modifications bring to the GTAP AGR model to introduce dynamic behaviours and to account for private storage. Yet, some other differences with the GTAP AGR framework deserve some explanations. These concern the GTAP database, the calibration of parameters and the modelling of CAP instruments. Before turning to the simulation results, we therefore describe these particular features of our framework. We also devote the last part of this second section to the definition of simulations.

6.2.1 Data

To run our simulations, we use the 6th version of the GTAP database calibrated on 2001 economic flows and including tariffs, export subsidies and direct payments for the different region represented. These data are aggregated to 12 sectors, among which 7 are agricultural sectors, and 3 regions: the European Union (EU), the United States (US) and the Rest of the World (RoW).

As the GTAP database was initially aimed at being used in a static framework to simulate long term effects, we need to make some assumptions to calibrate the data for our dynamic model. Here again we follow Femenia (2010) and assume that the initial interest rate r, the time preference parameter ρ and the unit capital installation cost ϕ are all equal to 5%. This, along with the assumption that the economy is intially in a steady state, allows the calibration of all dynamic parameters. Furthermore, we reduce by half the supply price elasticities in agricultural sectors to account for the fact that agricultural supply adjusts more hardly in the short term than in the long term. Finally, the expectation adjustment parameter α is set to 1/5.

Then, we introduce wheat stockholdings in the three regions. As the economy is assumed to be intially in a steady state, private stockholdings are initially nil. However, the CES form of the production function in the storage service sector does not allow for zero production. To overcome this issue we also assume that some precautionary wheat stocks, representing 10% of wheat production, are held by the public sector in the three regions. These precautionary stocks are constant over time and have thus no effect on price volatility.

6.2.2 Modelling of the CAP instruments

Our main objective is to simulate the effects of a storage subsidy on the market volatility induced by the removal of CAP instruments in arable crops sectors. To do so, we need first to simulate this volatility as accurately as possible. Yet, in the standard GTAP AGR framework the modelling of CAP instruments, notably in the arable crops sectors, suffers from some drawbacks (Femenia and Gohin, 2009b).

Firstly, in the GTAP database the 15 EU members (in 2001) are aggregated to one region but the EU intra-trade flows are maintained. Accordingly, quantities traded between EU members are supposed to be imports (or exports). Yet, a two-stage Armington trade modelling, where goods are differentiated by country of origne, is adopted: The composition of total demand from imports and domestic products is determined in a first stage, and the secind stage determines the import shares from different origins, the subsitution elasticity of the second nest being twice as high as those of the first nest. As goods traded between EU countries are considered as foreign goods, they subsitute with non-EU imports in the second nest. The substitution facilities between non-EU imports and EU domestic products are thus higher than they should be. Now, trade elasticities have very large impacts on the welfare effects of trade liberalisation (Valenzuela et al., 2008). To avoid such misleading results, we therefore follow Femenia and Gohin (2009b) and transfer the EU intra-trade to domestic consumption.

Secondly, in the GTAP framework, arable crop direct payments are modelled as a land subsidy. They thus work as a subsidy to a fixed factor and are implicitly assumed to be capitalised in land values. They consequently have few impacts on inputs allocation and are not very distortive ; the welfare gains induced by their removal are thus usually quite limited. Yet, as pointed out by Gohin (2006), the assumption that direct payments are capitalised in land values is contradicted by observed statistics on land rental rates. To overcome this issue we again follow Femenia and Gohin (2009b) and implement the specifications developed by Gohin (2006) in our framework. Namely, we assume that these arable crop payments are partly land subsidies, partly labour subsidies and partly capital subsidies. The set-aside policy linked to the direct payments is also taken into account in our simulations.

Finally, and most important when dealing with the impacts of the CAP on market fluctuations, is the way variable export subsidies and tariffs are introduced in the standard model. Indeed, these instruments are key elements of the European price support scheme in the wheat and other cereal sectors. Yet, in the GTAP model they are represented as ad valorem instruments, and thus do not adjust to support domestic prices and insulate European from world markets as they do in reality. To account for the effects of these instruments on agricultural market volatility, we therefore change their modelling: we introduce both of them as endogenous variables which adjust so as to keep unchanged imported quantities (for variable tariffs) and domestic prices (for variable export subsidies) in the wheat and other cereal sectors.

6.2.3 Definition of simulations

The simulations are conducted over 30 periods.

We first simulate a benchmark scenario in which there are no political changes. In that case markets volatility results from productivity shocks occurring each year in the wheat, oilseeds and other cereals sectors in all regions (EU, US and RoW). These exogenous shocks can lead agricultural producers to make mistakes when they anticipate forthcoming prices, thus also generating an endogenous volatility of markets. For each region and each sector, the 30 stochastic exogenous shocks affecting agricultural productivity are generated according to normal distributions $N(0, 0.01)$ in the EU and the US, and $N(0, 0.02)$ in the RoW to reflect the highest yield variability, due to climatic hazards for instance, in this large region. 3 regions $x3$ sectors $x30$ periods = 270 shocks are thus generated. Furthermore, to make sure that the results we obtain are not essentially due to some specificity of the generated samples, we run some Monte Carlo experiments and repeat the simulations using 50 different samples.

In a second time, we use the same 50 shock samples and simulate the effects of a removal of the CAP instruments in the wheat, oilseeds and other cereals sectors. Namely, we remove the import tariffs, export subsidies and direct payments, and increase by 5% the land endowment in these sectors to reflect the removal of the set-aside policy linked to the direct payments. This policy reform is implemented gradually from the 3rd to the 6th periods. Indeed, it has been shown by Femenia and Gohin (2010) that, when agents have adaptive expectations, a gradual implementation of a radical reform, such as this one, is preferable to an immediate implementation, in terms of welfare effects. Comparing the results we obtain in this second step with those of the benchmark scenario, we will thus be able to characterize the changes in arable crops markets volatility induced by the CAP reform.

Finally, in a third time, we simulate the effects of the same CAP reform along with a private storage subsidy which is set up at the end of the CA reform (at the 6th period). This subsidy is introduced in the RoW *via* a subsidization of 80%of the production of storage facilities [2], which will lead to a price decrease in the storage service sector, and thus to a decrease of the storage costs.

2. Different rates of subsidy have been tested and the conclusion of the study remain the same

6.3 Results

Before turning to the simulation results, we must make it clear that, for some of the 50 samples, one or more of the simulated scenarios lead to diverging dynamic systems. This is not very surprising. Indeed, even if many feedback effects represented in our CGE model decrease the occurrence of diverging cobwebs (Femenia and Gohin, 2009a), they do not totally eleminate them. We have thus chosen to remove the "diverging" samples, which reduces to 28 the total number of samples used in our analysis.

6.3.1 Benchmark scenario

Table 6.1 below reports the standard deviations of output, price and farm income in the EU, the US and RoW simulated with our model in the benchmark case, that is to say when no changes in agricultural policies are implemented. The figures reported in the table are the mean values of the 28 standard deviations simulated with the different productivity shocks samples. As our main concern will be, in the remaining parts, to study the expediency of subsidizing private storage, we focus yet on the effects of private storage and thus report the results corresponding to a situation without private storage (in the left part of Table 6.1) and those obtained when private storage is introduced in the model (in the right part of Table 6.1.

In this benchmark scenario, the market volatility is only due exogenous shocks arising in all regions and to the expectation errors made by agents when they take their decisions.

It appears that even if the volatility of exogenous disturbance is quite limited, with standard deviations equal to 0.01 in the EU and the US and to 0.02 in the RoW, the volatility of output can be twice higher. This is so because of the endogenous aspect of fluctuations in our model. Indeed, at each period the stochastic disturbances lead agricultural supply and market prices to be different from what agricultural producers had expected, which conduct them to re adjust their price

Table 6.1 – Mean Standard Deviations in the Benchmark

		Without Storage			With Storage		
		EU	RoW	US	EU	RoW	US
Output	Wheat	0.02	0.03	0.02	0.02	0.03	0.02
	Oilseeds	0.02	0.03	0.02	0.02	0.03	0.02
	Other Cereals	0.01	0.03	0.01	0.01	0.03	0.01
Price	Wheat	0.03	0.10	0.10	0.02	0.09	0.09
	Oilseeds	0.13	0.13	0.13	0.13	0.13	0.13
	Other Cereals	0.00	0.09	0.06	0.00	0.09	0.06
Farm Income	Wheat	0.10	0.15	0.07	0.09	0.12	0.06
	Oilseeds	0.27	0.15	0.19	0.27	0.15	0.19
	Other Cereals	0.04	0.12	0.06	0.04	0.12	0.06

expectations and so their production decisions at the next period. This endogenous source of output volatility thus comes in addition to, and is also sustained by, the exogenous shocks.

The standard deviations of prices are even higher in the RoW and the US, between 0.13 and 0.06 without storage depending on the sectors. This is notably due to the inelasticity of the demand for agricultural products and the rigidity of their supply in the short run which makes prices very sensitive to supply changes (as formalised by the King's law). The price volatilities of wheat and other cereals are however much lower in the EU than in the other regions (0.03 instead of 0.10 for wheat and 0.00 instead of 0.09 or 0.06 for other cereals). These figures illustrates the price stabilizing role of the European price support scheme and, in particular, of the variable export subsidies and tariffs. On the contrary, in the oilseeds sector, which is much less protected, the standard deviations of prices are equal to 0.13 for all regions.

Then, in addition to the volatility of output and price, we have chosen to report in Table 6.1 the standard deviations of farm incomes. Indeed, even if most of the studies dealing with agricultural market risks focus on output and price fluctuations, what matters to farmers is the stability of their incomes. Yet, if prices and outputs are negatively correlated, price fluctuations can compensate output fluctuations and thus, in a sense, provide a form of income insurance for agricultural producers. With standard deviations of income ranging from 0.04 to 0.27, this is obviously not the case here.

Finally, when stockholding behaviours are introduced in the model, the price and farm income volatilities in the wheat sector are lower in all regions. This observation comes to confirm the results of Femenia (2010) who shows that, even if economic agents have imperfect expectations, private stockholding behaviours allow to stabilize markets.

6.3.2 CAP removal

Having described the main characteristics of the volatility on agricultural markets in the benchmark case, we now get interested in the effects of a complete CAP removal in the wheat, oilseeds and other cereals sectors on this volatility. However, before turning to this central issue in our paper, we describe the long term effects of this radical policy reform.

The mean effects of the CAP reform observed over the last 5 simulation periods are considered as long term effects. Their mean computed, over the 28 samples, are reported in Table 6.2. Here again, we distinguish the cases with and without storage in the wheat sector.

The effects on output, price and farm income of the removal of CAP instruments in arable crops sectors are in accordance with those commonly found in the economic literature. Indeed, without storage, the suppression of tariffs, export subsidies and, above all, direct payments in the EU induces a decrease of production in the wheat (by 18.7%) and other cereals (by 13.4%) European sectors. The production drop is smaller (-7.6%) in the European oilseeds sector because direct payments are initially smaller in this sector and there is no tariffs nor export subsidies. This production decrease induces a prices increase by 9.9% for wheat, 6.6% for oilseeds and 13.6% for other cereals. Overall, the price increases does not compensate the production decreases and EU farm incomes are negatively impac-

Table 6.2 – Long term effects of the CAP reform (%age changes compared to the benchmark)

		Without Storage			With Storage		
		EU	RoW	US	EU	RoW	US
Output	Wheat	-18.7	2.0	2.4	-16.1	1.4	2.0
	Oilseeds	-7.6	0.6	0.5	-6.4	0.3	0.6
	Other Cereals	-13.4	0.8	0.7	-11.8	0.8	0.5
Price	Wheat	9.9	0.7	1.4	10.1	0.7	1.4
	Oilseeds	6.6	0.3	0.5	6.6	0.3	0.5
	Other Cereals	13.6	0.4	0.5	13.6	0.3	0.5
Farm Income	Wheat	-64.6	3.4	6.9	-64.7	3.2	6.8
	Oilseeds	-36.1	1.0	1.4	-36.1	1.0	1.4
	Other Cereals	-58.3	1.4	2.2	-58.3	1.4	2.2

ted by the reform: they increase by 64.6.5% in the wheat sector, by 36.1% in the oilseeds sector and by 58.3% in the other cereals sector. In the US and the RoW the production increases in the 3 sectors to compensate the decrease of EU exports, due to the removal of export subsidies and the decrease of production, and to satisfy the increase of EU imports due to the tariffs removal. Then, because of the world prices increase induced by the increase of imports and the decrease of exports from the EU, prices slightly rise in these regions (between 0.3% and 1.4%). The production and price increases lead to increase of farm income in the US and the RoW.

Table 6.3 – Welfare effects of the CAP reform (Equivalent variation in income, 2001 US$ million)

Without Storage				With Storage			
EU	RoW	US	Total	EU	RoW	US	Total
25255	-6097	419	19576	25231	-6004	463	19691

Table 6.3 reports the welfare effects of the reform in the three regions. The figures reported in this table correspond to the discounted sum, over the 30 simulation periods, of the mean equivalent variations of household incomes in US$ million. The welfare effect in the EU is highly positive with a total effect over the

30 periods of around 25 US$ billions. This positive effect is essentially due to the additional disposal income induced by the suppression of the removal of the CAP. In the RoW, which is the main trading partner of the EU and thus the main beneficiary of the European export subsidies, the increase of agricultural prices induces a welfare loss which amounts to 6 US$ billions. In the US the additional value added in agricultural sectors comes to mitigate the price increases and allows the welfare effects in the US to be positive, even if rather small (0.4 US$ billion over the 30 periods). Globally, the world welfare impact is positive at the world level.

Table 6.4 – Mean Standard Deviations after the CAP reform

		Without Storage			With Storage		
		EU	RoW	US	EU	RoW	US
Output	Wheat	0.06	0.03	0.02	0.06	0.03	0.02
	Oilseeds	0.04	0.03	0.02	0.04	0.03	0.02
	Other Cereals	0.04	0.03	0.01	0.04	0.03	0.01
Price	Wheat	0.10	0.10	0.10	0.09	0.08	0.08
	Oilseeds	0.14	0.13	0.13	0.14	0.13	0.13
	Other Cereals	0.07	0.09	0.05	0.07	0.09	0.05
Farm Income	Wheat	0.19	0.14	0.07	0.18	0.12	0.07
	Oilseeds	0.19	0.16	0.19	0.19	0.16	0.19
	Other Cereals	0.16	0.11	0.06	0.16	0.11	0.06

As shown in Table 6.4, the effects of the CAP removal on price fluctuations in the EU are unambiguously postive: the mean standard deviation of the EU prices increase from 0.03 to 0.10 for wheat, from 0.13 to 0.14 for oilseeds and from 0.00 to 0.07 for other cereals, in the simulations without stockholdings (the magnitude of the effects beeing almost the same with stockholdings). This is not surprising, since the public instruments protecting European markets from world price fluctuations have been removed. The increase of price volatility is besides much more important in the wheat and other cereals sectors than in the oilseeds sector which was less supported before the reform. Furthermore, output fluctuations also increase in the EU following the reform. This can be explained by the endogenous dimension of the volatility represented in our model: the destabilization of prices induces a destabilization of agricultural producers' price expectation, and so a destabilization of their production. The EU farm incomes are thus also destabilize in the wheat and other cereal sectors, but not in the oilseeds sector where the standard deviation of income decreases from 0.27 to 0.19. In fact, the liberalisation of EU markets tend to "reconnect" the oilseeds sector to the initially highly protected wheat and other cereal ones. The market fluctuations in the three sectors are thus more related after the reform than before which benefits to the oilseeds one. The same kind of mechanism explains why price volatility of wheat and other cereals are reduced in the RoW and the US after the CAP removal. The transfer of risk from protected markets to world markets has besides often been used as an argument in favour of a liberalisation of agricultural markets (see Tyers and Anderson (1992) for instance). However, we must acknowledge that these reductions of price volatility are very limited, and that almost no reduction of output, neither farm income, fluctuations are observed. This is probably, once again, due to the endogenous source of market volatility represented in our model: following the reform expectation errors of European agents spread to foreign markets and come to increase the endogenous fluctuations on these markets. This last phenomenon partly compensates the decrease in volatility induced by the CAP removal.

Focusing now on the effects of private wheat storage on our simulation results, we can first notice that the production effects of the CAP removal are slightly reduced in all sectors. The EU wheat production now decrease by 16.1%, compared to 18.7% when no private stocks are held before and after the reform ; and the RoW and US wheat productions respectively increase by 1.4% and 2.0% compared to 2.0% and 2.4% without storage. This can be explained by considering the price volatilities after the reform, reported in Table 6.4. Indeed, as we have seen, whether private wheat storage is introduced or not, the CAP removal induces an increase of the standard deviations of EU prices in the wheat, oilseeds and other cereals sectors. Yet, the more prices fluctuate the more the private storage activity is stimulated. So, when stockholding behaviours are represented in the model, wheat stockholdings in the EU increase after the reform. In fact, as reported in Table 6.5, wheat stocks are nil before the reform, whereas the mean wheat quantities held by stockholders at each period reach 0.8 millions of tonnes after the reform. This new stockholders' demand for wheat thus comes to mitigate the wheat production decrease induces by the CAP reform. The opposite phenomenon arises in the RoW and in the US: the CAP removal induces a decrease of price fluctuations, which slows down the wheat storage activity in these regions (from 16.2 to 14.4 millions of tonnes of wheat stored at each period in the RoW and from 0.8 to 0.5 millions of tonnes in the US). The decreases of stockholders' demand for wheat have a negative effect on wheat productions which thus increase less when private storage is introduced in the model. The introduction of private wheat storage in the model also reduce, but to a lesser extent, the effects of the reform on the oilseeds and other cereal productions. The three sectors are indeed closely related, as inputs for the animal production for instance.

The differences between the effects of the reform on price and farm income levels, simulated with and without storage, are for their part very small. The only slightly significative effects of storage seem here to be a larger increase in the EU wheat price (10.1% instead of 9.9%) and a lower increase of the RoW farm income (3.2% instead of 3.4%) following the reform. The (relative) decrease of the RoW wheat farm income is easily understandable, since the introduction of storage has a negative effect on the production of wheat and the effect on wheat price is unchanged in this region. The relative wheat price increase in the EU is however more questioning. Indeed, private storage is usually found to have a decreasing effect on prices (see Williams and Wright (1991) or Femenia (2010) for instance). The increasing effect which seems to appear here is in fact due to the nature of the figures reported in Table 6.2: these are percentage changes compared to a benchmark cases. However the price levels simulated in the benchmark (not reported here) are already different with and without storage: they are lower when stockholding behaviours are taken into account. So, what seems to be a price increase due to the introduction of storage in the model is in fact the expression of the same price levels arising in the EU wheat sector after the CAP reform, whether storage is accounted for or not.

TABLE 6.5 – Mean quantities of wheat stocks held by period (in millions of tonnes)

	EU	RoW	US
Benchmark	0.0	16.2	0.8
CAP reform	0.8	14.4	0.5

Finally, stockholding behaviours have a positive impact on world welfare gains, which are 115 US$ million higher with storage than without (see Table 6.3). These positive effects benefit to the RoW (93 US$ million) and the US (44 US$ million). On the contrary the EU welfare gains are reduced when private storage is taken into account (-24 US$ million). An increase of private storage (as in the EU) thus seems to lower welfare gains, whereas a decrease of private storage (as in the RoW and the US) seems to increase them. This can be explained by the reduction of wheat quantities available for consumption and the increase of wheat price caused by an increase of stockholders' demand for wheat ; and the increase of quantities available for consumption caused by a decrease of stockholders' demand. However, as risk neutrality is assumed in our model, these welfare effects do not acknowledge for the positive effect market stabilization could have on welfare if agents were risk averse.

6.3.3 Private storage subsidies

We have seen, in the previous section, that private storage has a positive effect in terms of global welfare and tends to limit the market fluctuations induced by the CAP removal. One can therefore presume that stimulating private stockholdings behaviours at the world level by subsidizing private storage could be beneficial. This is what we evaluate now.

We simulate the impacts of a 80% subsidization of production costs in the RoW storage service sector implemented at the end of the CAP reform. This induces a decrease of wheat storage costs at the world level and stimulates private storage: the mean quantities of wheat stocks held by period are now equal to 0.8 millions of tonnes in the EU, 24.9 millions of tonnes in the RoW, and 1.1 millions of tonnes in the US, that is a 67% mean increase world stocks.

The long term effects of this new reform are reported in Table 6.6 below. We can notice, on the one hand, that the introduction of the storage subsidy has almost no effect on productions. On the other hand, the price increases are now higher than with the CAP removal alone, especially in the wheat sector: the price increases following the reform are now equal to 10.3% in the EU, 1.0% in the RoW and 1.7%, compared to 10.1%, 0.7% and 1.4% without the storage subsidy. Contrary to the previous (seeming) price increase observed in the EU wheat sector after the introduction of storage in the model (see section 6.3.2), these results cannot be explained by a the nature of the figures reported here. Indeed, the benchmark cases compared to which these percentage changes are computed are the same for the CAP reform alone and the CAP reform and the storage subsidy. These results are thus surprising, since one would better expect a negative effect of the increase of stockholdings on wheat price levels.

Table 6.6 – Long term effects of the CAP reform with private storage subsidies in the RoW(%age changes compared to the benchmark)

		EU	RoW	US
Output	Wheat	-16.1	1.5	2.1
	Oilseeds	-6.4	0.3	0.6
	Other Cereals	-11.8	0.8	0.5
Price	Wheat	10.3	1.0	1.7
	Oilseeds	6.7	0.4	0.6
	Other Cereals	13.7	0.4	0.5
Farm Income	Wheat	-64.6	4.0	7.4
	Oilseeds	-36.1	1.1	1.5
	Other Cereals	-58.3	1.5	2.3

Another surprising result lies in the volatilities observed in the wheat sectors.

Indeed, the main argument in favour of a subsidization of private storage is that stockholding behaviours allow to stabilize agricultural markets. This is besides what we observed in the benchmark and the CAP removal scenario. Yet, as reported in Table 6.7, the standard deviations of wheat productions, prices and farm incomes are higher here than before the introduction of the storage subsidy. In the RoW, for instance, the standard deviation of output is now equal to 0.04, compared to 0.03 without the subsidy, the standard deviation of price is equal to 0.09, compared to 0.08, and the standard deviation of farm income is equal to 0.13, compared to 0.12. These differences are certainly small, but are in sharp contrast to what was expected from the subsidy.

Table 6.7 – Mean Standard Deviations after the CAP reform and the set up of private storage subsidies in the RoW

		EU	RoW	US
Output	Wheat	0.06	0.04	0.02
	Oilseeds	0.04	0.03	0.02
	Other Cereals	0.04	0.03	0.01
Price	Wheat	0.09	0.09	0.09
	Oilseeds	0.14	0.13	0.13
	Other Cereals	0.07	0.09	0.05
Farm Income	Wheat	0.19	0.13	0.07
	Oilseeds	0.19	0.16	0.19
	Other Cereals	0.16	0.11	0.06

In fact, a closer look at the results we obtain for a particular representative sample allows to understand the mechanisms at work here, and to explain both why the fluctuations on wheat market increase, and why the wheat prices increase, once the storage subsidy is introduced. We have reported the evolution, for that sample, of wheat prices following the CAP reform without (Figure 6.1) and with (Figure 6.2) the subsidization of private storage in the RoW. Figure 6.3 reports the evolution of wheat stocks in the world with and without storage subsidy.

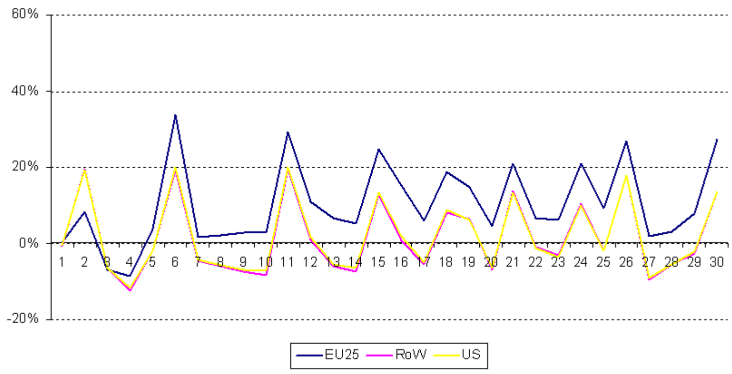

FIGURE 6.1 – Evolution of wheat prices following the CAP reform, without storage subsidization (percentage change compared to the baseline)

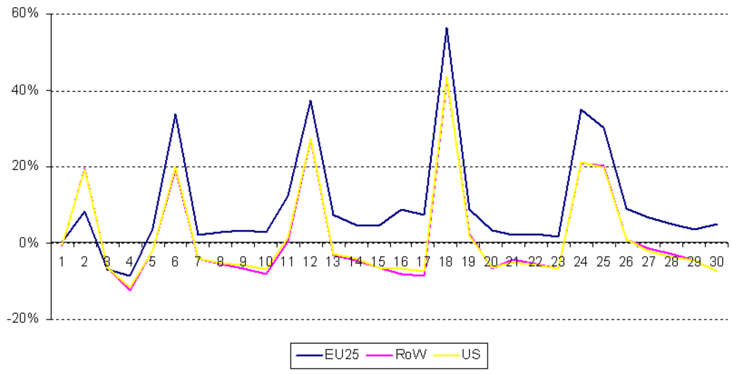

FIGURE 6.2 – Evolution of wheat prices following the CAP reform, with storage subsidization (percentage change compared to the baseline)

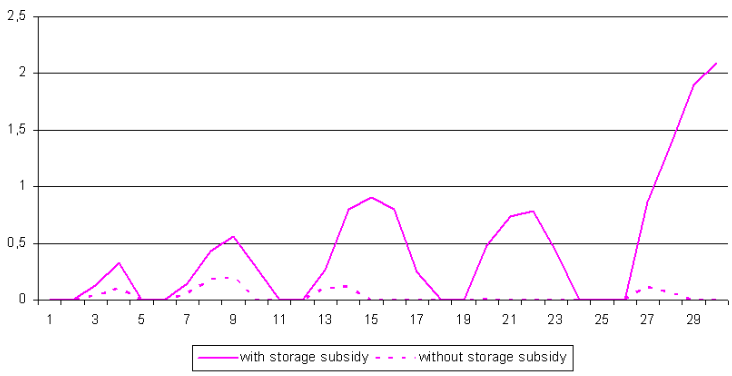

FIGURE 6.3 – Evolution of wheat stocks in the world following the CAP reform, with or without storage subsidization (percentage change compared to the baseline)

What appears first, on Figure 6.1, is that, at the beginning of the simulations prices are identical with and without storage subsidy. However, from period 10, they start evolving differently: sudden price peaks are rarer but higher with the storage subsidy. As illustrated by Figure 6.3, these peaks correspond to stock shortages in both scenarios. These well known effects of stock shortages on prices are, in a sense, responsible for the increase in market volatility following the subsidization of private storage. Indeed, when storage is subsidized quantities of wheat stored by private stockholders are higher (see Figure 6.3), which can prevent some price increases, as in period 10 for instance: with the subsidy, world wheat stocks are sufficiently high to prevent the price increase due to a stock shortage that arises without the subsidy. However, the stock shortage effectively arises in the next period and its consequences on wheat prices are more important. The difference is that, with the subsidy, wheat producers, who have not observed the sudden price increase in period 10, expect a relatively low price for period 11, they thus plan to produce a relatively low quantity of wheat ; as a negative productivity shock arise the quantities effectively produced are even lower, and since quantities of wheat stored are not, this time, high enough to satisfy the demand, stocks are completely cleared and wheat prices highly increase. On the other hand, without the subsidy, wheat producers who observed a price increase in period 10, plan a higher price for period 11 and thus produce more wheat which prevents wheat market prices to reach too high values. To sum up, when the storage subsidy is in place, wheat stocks, by preventing frequent price rises, eliminate these market signals and thus decrease the amount of information used by producers to take their decisions, which eventually gives rise to higher price increases. As a matter of fact, since, even if rarer, sudden price increases are higher with the storage subsidy, the standard deviation of prices are also are higher, and so are mean wheat price levels.

Finally, Table 6.8 reports the welfare effects of the CAP reform with private storage subsidies. The welfare gains in the EU and the US are lower, and the

Table 6.8 – Welfare effects of the CAP reform with private storage subsidies in the RoW (Equivalent variation in income, 2001 US$ million)

EU	RoW	US	Total
24959	-6708	455	18707

welfare loss in the RoW is higher than when the CAP reform was implemented alone. As a consequence, the overall welfare gains decrease from 19691 US$ millions to 18707 US$ millions, which represents almost a 1 billion US$ loss. This is in fact not very surprising regarding first the huge increase in world wheat stocks which tends to decrease the quantities of goods available for consumption, and second the increase of mean prices of wheat following this reform.

The effects of the storage subsidy simulated here are thus globally negative, in terms of welfare first, but also in terms of market stabilization. As this subsidy tends to destabilize markets. The only (slightly) positive effect of the subsidization of private storage we find here is a relative increase of farm incomes in the wheat sector.

Conclusion

Our main objective in this article was to study the effects of a subsidization of private storage on the volatility of agricultural markets following the removal of CAP instruments in arable crop sectors. Indeed, in the current context of agricultural market liberalisation, more and more attention is being paid to the need for a public intervention to stablize these markets. Such an intervention could take the form of storage cost subsidies aimed at stimulating private storage at the world level. We have thus used a dynamic CGE model, taking into account the inter temporal dimension of economic agents' decisions, to study the impacts of a subsidy of wheat storage costs implemented in the RoW, both in terms of market stabilization and welfare effects. This model assumes that agents have imperfect expectations, which allows a representation of the endogenous source of market volatility. The exogenous source of volatility is also represented through the introduction of productivity shocks.

Our first results, concerning the effect of the removal of CAP instruments in the wheat, oilseeds and other cereals sectors, illustrate the effects of this reform on agricultural market fluctuations. Indeed, following the reform, the output, price and farm income volatilities increase in the EU, especially in the wheat and other cereals sectors where prices were highly supported (by variable tariffs and export subsidies) before the reform. On the contrary, the fluctuations on arable crop markets tend to decrease in the other regions (the US and the RoW). This comes from the suppression of the transfer of risk from EU to world markets initially induced by the EU price support mechanism. However this decrease of volatility observed on foreign markets is rather limited compared to the increase observed in the EU. As these simulations have been conducted with and without introducing wheat storage in the model, our results also reveal the stabilizing effect of stockholding behaviours on agricultural markets. We also show that an increase of the storage activity (as induced by the higher price volatility in the EU after the CAP reform) tends to have negative effects on welfare. This can be explained by the negative effect of stockholders' demand on quantities of goods available for consumption. Turning then to the effects of the storage cost subsidy, we find that, whereas this subsidy effectively increase the quantities of stocks held at the world level, they do not have the anticipated effects on market fluctuations. Indeed, this subsidy, by increasing stocks, lowers the occurrence of stock shortages, and their associated price spikes. But this deprive economic agents, and farmers in particular, of the market information provided by these (moderated) spikes. Once these subsidies are set up, agents are thus less prepared to stock shortages that still (even if less frequently) arise. This eventually leads to very large price spikes, and so to larger market volatilities than without the subsidy. These subsidies do thus not prove to be efficient in terms of market stabilization. Furthermore, as they increase storage, they also generate welfare losses at the world level.

From the results of this study, it thus appears that, whereas private storage allows to stabilize agricultural markets, stimulating private stockholders' activity by subsidizing storage costs can in fact destabilize markets. According to these results, private storage subsidies should therefore not be considered as an instrument to stabilize agricultural markets after CAP reforms. We are however quite reluctant to draw too general policy conclusions from this study. Indeed, the potential risk aversions of economic agents have not been introduced in the model, yet this could change the outcomes of the model. Furthermore, the subsidy we have chosen to represent here is rather basic: it simply consists in a fix subsidy to production costs in the storage service sector. More elaborated ways to stimulate private storage at the world level, like subsidies adjusting market conditions, should certainly be considered before concluding that there are no incentives to publicly intervene in storage at the world level.

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Conclusion Générale

La stabilisation des revenus et des marchés agricoles est, avec le soutien des revenus des agriculteurs, l'un des objectifs initiaux de la PAC. Les mécanismes de l'intervention et des prix garantis ont longtemps permis de viser ces deux objectifs simultanément. Toutefois, les réformes successives de la PAC ont progressivement réduit les niveaux de ces instruments de gestion de marché au bénéfice de l'instauration d'aides de plus en plus découplées de la production et des prix. Cette évolution des instruments de la PAC interroge donc sur son aspect stabilisation des marchés et revenus agricoles. Face à cette éventuelle variabilité accrue des prix agricoles, et en anticipation d'une possible évolution à la baisse du niveau des aides directes, de nombreux acteurs agricoles européens soutiennent aujourd'hui publiquement le maintien d'un volet gestion des risques dans la PAC. Se pose alors la question des effets de nouveaux instruments de gestion des risques sur les productions et les marchés. Cette question est peu analysée par les modèles économiques de marchés qui sont pour la plupart déterministes. L'enjeu principal de cette thèse était donc de développer un cadre d'analyse dynamique, adapté à la prise en compte de l'incertitude, pour pouvoir évaluer ces nouveaux instruments.

La modélisation macro-économique avec prise en compte de l'incertain est confrontée à de nombreux défis méthodologiques. En effet, l'activité agricole est confrontée à de multiples sources de risques qu'il faut être en mesure d'évaluer avant même de s'intéresser aux effets des instruments de gestion des risques. Or, le fait que, d'une part la volatilité des marchés agricoles observée sur les séries passées varie dans le temps, et que d'autre part les politiques passées ait eues un impact sur ces séries, rendent difficile une approche économétrique. D'autre part, les impacts des instruments publics de gestion des risques dépendent du comportement des acteurs vis-à-vis des risques. Or, en économie de la production agricole, il est difficile d'identifier simultanément les degrés d'aversion au risque, les technologies de production et les anticipations des producteurs. Enfin, si, dans les modèles de producteur, il est possible d'introduire des instruments spécifiques de gestion des risques, il est en revanche nettement plus difficile d'étudier les interactions entre les différents types d'instruments mis en oeuvre ainsi que leurs impacts sur l'ensemble des marchés avec ce type de modèle. Pour pallier à ces difficultés nous avons adopté dans cette thèse une modélisation en Equilibre Général Calculable (EGC) dynamique. Ce cadre de modélisation nous a ainsi permis de simuler la volatilité qui pourrait survenir sur les marchés dans l'avenir sous différents scénarios d'évolution des politiques agricoles, ainsi que la volatilité des revenus agricoles dans différents secteurs. Nous avons également pu tester, par simulations, différentes structures pour les anticipations des agents économiques afin d'évaluer l'effet de cette composante du comportement des agents vis à vis du risque sur la dynamique des marchés agricoles. En intégrant le stockage dans les modèles d'EGC dynamiques développés, nous avons enfin pu simuler l'impact sur l'ensemble des marchés de cet instrument privé de gestion des risques et d'une éventuelle intervention publique à son niveau.

Dans la première partie de cette thèse, nous avons présenté les enjeux liés à l'évaluation des politiques publiques de gestion des risques sur les marchés agricoles. Une revue des arguments sur la nécessité d'une telle intervention (Chapitre 1) a tout d'abord permis de souligner les controverses existant sur la quantification des risques agricoles et sur l'efficacité des instruments privés de gestion des risques, ainsi que la nécessité de développer des cadres d'analyse plus sophistiqués que ceux actuellement disponibles intégrant de la dynamique, et traitant du problème des anticipations. Il ressort de cette revue de littérature que la question de la définition d'une éventuelle intervention publique pour stabiliser les marchés et revenus agricoles en Europe est loin d'être tranchée et que des travaux de modélisation intégrant notamment des caractéristiques spécifiques aux risques agricoles, tels que ceux développés dans cette thèse, sont utiles pour éclairer la décision publique et nourrir les futurs débats sur l'évolution de la PAC. Nous nous sommes également attachés, dans cette première partie, à présenter les limites du modèle d'EGC statique, très utilisé pour l'évaluation des politiques agricoles, sur lequel nous nous sommes basés pour développer les modèles dynamiques présentés dans la thèse (Chapitre 2). Les limites mises en évidence concernent la représentation des instruments de la PAC, et notamment des droits de douane et subventions à l'exportation variables qui sont des éléments clés du soutien des prix agricoles européens. Nous avons ainsi montré qu'une calibration et une modélisation plus justes de ces instruments peuvent conduire à des résultats très différents en termes d'implication politique que ceux simuler avec la version "standard" du modèle. Ces améliorations ont par la suite été prises en compte lorsque nous avons simulé les effets d'une suppression PAC sur la volatilité des marchés agricoles et l'impact d'une subvention au stockage sur cette volatilité.

La deuxième partie de la thèse était consacrée à la présentation du modèle que nous avons développé pour évaluer l'impact des politiques publiques sur la stabilité des marchés agricoles. Nous avons tout d'abord expliqué comment, à partir du modèle d'EGC statique GTAP AGR, nous avons développé un modèle d'EGC dynamique. Ce modèle se différencie de la plupart des modèles d'EGC dynamiques existants par la prise en compte des décisions inter temporelles (épargne, investissement) des agents économiques. Il permet également de prendre en compte différents types d'anticipations (rationnelles ou imparfaites) et ainsi de représenter la dimension endogène du risque de marché qui est un argument souvent avancé en faveur d'une intervention publique pour stabiliser les marchés. Les premières simulations de réforme politique conduites à l'aide de ce modèle ont révélé que, sous l'hypothèse d'anticipations rationnelles, les marchés évoluent de façon linéaire vers un état stationnaire correspondant aux résultats simulés à l'aide du modèle statique. Par contre, sous l'hypothèse d'anticipations imparfaites, la réforme engendre des fluctuations de marché endogènes liées aux erreurs d'anticipation des agents. Notre approche en EGC révèle toutefois que les conséquences de ces erreurs d'anticipation sont atténuées par plusieurs ajustements sur les marchés, que notre modélisation en EGC permet de représenter. Dans un second temps, nous avons introduit un instrument privé de gestion des risques, le stockage, dans ce modèle

(Chapitre 4). Cet instrument présente un intérêt en raison du rôle potentiel qu'il pourrait jouer pour limiter la volatilité des marchés suite aux réformes de la PAC. Ici encore, quelques éléments intéressants sont ressortis des premières simulations conduites à l'aide de notre modèle. En effet, notre cadre de modélisation nous a permis de simuler l'impact des comportements de stockage, non pas uniquement sur la volatilité des marchés agricoles de source exogène comme de nombreuses études passées, mais également sur la volatilité de source endogène. Nous avons ainsi pu montrer que, contrairement à ce qui a parfois été avancé dans la littérature économique, même s'ils ne sont pas rationnels, les comportements des stockeurs privés permettent de stabiliser les anticipations des autres agents, notamment des agriculteurs lorsqu'ils prennent leurs décisions de production, et, de ce fait, de limiter la dimension endogène de la volatilité et donc de stabiliser les marchés. Ceci souligne l'importance d'une prise en compte du lien entre les décisions inter temporelles des différents agents économiques pour analyser les effets des instruments de gestion du risque sur la stabilité des marchés.

Enfin, des simulations permettant d'analyser l'impact de politiques publiques sur la stabilité des marchés agricoles ont été conduites dans la troisième partie de la thèse. Nous nous sommes tout d'abord intéressés à l'impact de la façon même de réformer les politiques agricoles (Chapitre 5). Nous avons donc utilisé notre modèle pour simuler une réforme de la PAC mise en place de deux façons différentes : en une seule fois ou de façon progressive. Nos résultats ont montré que si les agents ont des anticipations parfaites, il n'est jamais optimal de réformer progressivement car ils commencent à ajuster leurs décisions dès que la réforme est annoncée et les marchés évoluent régulièrement vers un nouvel état stationnaire. Par contre, si les agents ont des anticipations imparfaites qu'ils ajustent progressivement en fonction des nouvelles informations révélées sur les marchés, une réforme progressive peut parfois améliorer le bien être global. Une réforme trop brutale génère en fait des pertes de bien être initiales dues à des coûts d'ajustement importants. Ces coûts sont d'autant plus importants que les agents, et en particulier les agriculteurs, réagissent fortement aux derniers prix observés. Il peut donc dans ce cas être optimal de réformer de façon progressive pour permettre aux agents d'intégrer progressivement l'information disponible sur les marchés. Enfin, nous avons simulé les effets d'une suppression de la PAC sur la volatilité des marchés agricoles et nous nous sommes intéressés aux impacts que pourrait avoir une subvention au stockage privé sur cette volatilité(Chapitre 6). Les résultats de ces simulations ont permis de mettre en évidence la déstabilisation des marchés agricoles européens et la stabilisation des marchés étrangers qu'engendrerait une suppression de la PAC dans les secteurs des grandes cultures. Il est également ressorti de ces simulations que l'action des stockeurs privés sur les marchés tendait à les stabiliser. En revanche, nous avons trouvé qu'une aide publique visant à accroitre cette activité de stockage n'avait pas l'effet stabilisateur escompté. En effet, sous l'hypothèse d'anticipations imparfaites formulées ici, l'accroissement des stocks mondiaux faisant suite à la mise en place de la subvention vient en fait brouiller les signaux de marché envoyés aux agents par le biais de hausses, modérées, de prix dues à des ruptures de stocks. Ils bénéficient donc de moins d'information pour former leurs anticipations et prendre leur décisions ce qui *in fine* amplifie les conséquences de certains chocs de productivité et vient accroitre la volatilité sur les marchés agricoles. En termes politiques, ces résultats suggèrent donc que, contrairement à ce qui est aujourd'hui fréquemment évoqué dans les débats internationaux sur la gestion des fluctuations de marchés agricoles, il n'est pas souhaitable d'encourager le stockage au niveau mondial. Nous devons toutefois souligner que l'aide au stockage privé, que nous avons représentée ici, de façon assez rudimentaire, sous la forme d'une subvention fixe des coûts de stockage, pourrait être envisagée de façon plus élaborée et avoir, de ce fait, d'autres impacts sur les marchés.

Les travaux menés dans le cadre de cette thèse apportent des éléments de réponses aux problèmes qui se posent pour l'évaluation de l'impact des réformes de la PAC sur la stabilité des revenus et marchés agricoles européens. Ils présentent toutefois certaines limites.

Nous devons, en premier lieu, reconnaitre que certaines hypothèses de nos modèles pourraient être améliorées. En effet, nous avons, certes, amélioré la façon dont la PAC est habituellement représentée dans les modèles d'Equilibre Général, mais nous avons conservé certaines hypothèses "standards" du modèle d'EGC statique qui a servi de base à nos développements méthodologiques. Ainsi, même si les élasticités prix de l'offre agricole ont été réduites pour tenir compte du faible degré d'ajustement de l'offre à court terme, nous n'avons pas modifié les élasticités d'Armington. Ces élasticités représentent le degré de substituabilité entre biens domestiques et biens importés. Valenzuela et al. (2008) ont montré qu'elles pouvaient avoir un impact important sur les gains de bien être simulés à l'aide du modèle GTAP. Qui plus est, ces élasticités peuvent jouer un rôle dans la façon dont les marchés s'ajustent suite à une réforme politique, une plus grande substituabilité entre biens domestiques et importés facilitant ces ajustments. Or, comme nous l'avons montré dans le Chapitre 3, l'ajustment des marchés contribue à limiter l'amplitude des fluctuations endogènes générées par ces réformes, lorsque les anticipations des agents sont imparfaites. Les résultats des simulations conduites dans cette thèse, et les conclusions qui en découlent, sont donc vraisemblablement liés à la valeur des élasticités d'Armington. Pourtant, certaines hypothèses, notamment celle d'élasticité de substitution constante (CES), sur lesquelles repose l'estimation de ces élasticités sont très discutables. Elles ne tiennent en effet pas compte du fait que les élasticités de substitution puissent évoluer avec le temps et ne permettent pas d'avoir des échanges nuls entre deux régions, ce qui est pourtant fréquemment le cas. L'utilisation de systèmes de demande plus flexibles tels que le système AIDS (Almost Ideal Demand System) semble être une première étape intéressante pour remédier à ce problème (Gohin et Féménia, 2009).

D'autre part, dans une vision progressive de notre travail et afin de mieux identifier les effets simulés à l'aide de nos modèles, nous nous sommes focalisés sur certains secteurs agricoles, à savoir les secteurs du blé, des autres céréales et des oléagineux. Les décalages entre décisions de production et récoltes, les chocs exogènes et le stockage n'ont donc été introduits que dans ces secteurs. Or, les réformes de la PAC ne concernent pas que ces secteurs. Il serait donc intéressant d'intégrer les mêmes caractéristiques de modélisation pour d'autres secteurs, tels que le lait ou le sucre par exemple. Cela nécessiterait toutefois de prendre en compte certains instruments politiques spécifiques à ces secteurs (les quotas de production, par exemple). Nous n'avons pas non plus introduits de chocs au niveau de la demande de biens agricoles, mais seulement au niveau de l'offre au travers de chocs de productivité. L'introduction de chocs de demande dans le modèle mériterait donc d'être étudiée, même si, comme le souligne Glauber et al. (1989), les effets de chocs exogènes à la demande sont négligeables en comparaison des effets de la variabilité des rendements. Ces chocs d'offre exogènes n'ont, enfin, été introduits que dans la version à anticipations imparfaites du modèle (dans les Chapitre 4 et 6). La prise en compte de chocs exogènes en anticipations rationnelles est en fait très délicate car considérer que les agents sont rationnels ne signifie pas dans ce cas que leurs anticipations sont parfaites. Il faudrait donc, à chaque période, tenir compte de l'évolution de l'économie qu'ils anticipent conditionnellement, d'une part à leur observation du présent, et d'autre part à leurs anticipations des valeurs futures des paramètres stochastiques (la productivité agricole dans notre cas).

Nous avons aussi exclu l'aversion au risque de nos modèles. Pourtant, outre la question des anticipations sur laquelle nous nous sommes focalisés, se pose la question de la représentation des préférences des différents agents potentiellement averses au risque. Femenia et al. (2010) ont d'ailleurs montré empiriquement, comme le supposait Roberts et Gunning-Trant (2007), que les aides directes, supposées n'avoir que peu ou pas d'impacts sur les marchés, peuvent en fait en avoir via leur effet richesse sur l'aversion au risque des agriculteurs. Or, le paradigme dominant de la maximisation de l'utilité espérée se prête difficilement à l'introduction de l'aversion au risque dans les modèles de marché, qui plus est dynamiques comme les notres car il n'offre pas de solutions analytiques. Les solutions adoptées jusqu'à présent dans les travaux essentiellement conduits par Boussard et al. (2004) consistent à se rabattre sur l'approche moyenne-variance. Certes, sous les deux hypothèses de normalité des variables aléatoires et d'aversion absolue au risque constante, cette approche est équivalente à l'approche de l'utilité espérée. Cependant son principal défaut est un traitement symétrique des situations favorables et défavorables. Or les agents économiques averses au risque sont plus préoccupés par l'occurrence d'une situation défavorable que l'inverse. Par ailleurs, les instruments de gestion des risques ne sont généralement actifs que pour ces situations défavorables. Il serait préférable de pouvoir en tenir compte dans la modélisation. C'est pour cette raison que des développements méthodologiques pour intégrer les moments d'ordre supérieur aux deux premiers moments mériteraient d'être considérés (Chavas, 2004). L'approche moyenne variance découle en effet d'un développement de Taylor au second ordre des fonctions d'utilité et il est possible d'étendre ce développement plus en avant. Vont alors apparaître les comportements de prudence des agents dont les évaluations empiriques directes sont certes peu nombreuses mais qui peuvent être calibrés pour reproduire des aversions absolues au risque décroissantes avec les niveaux de richesse et donc tenir compte de l'effet richesse de certaines composantes de la PAC.

Enfin, nous n'avons étudié qu'un instrument de gestion des risques, le stockage, et montré qu'une intervention publique au niveau de celui ne semblait, tout au moins sous la forme rudimentaire d'une subvention des coûts de stockage privés, pas opportune. Il serait nécessaire d'étudier l'impact d'autres instruments, d'analyser leurs effets ainsi que ceux d'une éventuelle intervention publique à leur niveau. Nous pensons en premier lieu aux développements de systèmes d'assurance (récolte et chiffres d'affaires). De tels systèmes existent aux Etats-Unis et ne sont aujourd'hui opérationnels que grâce à des soutiens budgétaires. En effet, le développement de ces mécanismes est, pour partie, contraint par les problèmes simultanés de sélection adverse, d'aléa moral et par la nature systémique des risques de production et de prix. Ces assurances sont certes représentées dans les modèles agrégés qui évaluent la politique agricole américaine, mais de manière très imparfaite. En effet, soit les dépenses publiques qui leur sont associées sont considérées comme de simples subventions à la production dans les modèles d'équilibre partiel du département américain à l'agriculture (Young et al., 2001), soit elles sont considérées comme de simples subventions à l'utilisation de terre dans la modélisation GTAP. Il s'agit évidemment de modélisations nécessairement frustes car ces modèles n'intègrent pas les dimensions de la dynamique et de l'incertitude. Pourtant les modèles de producteur montrent en général qu'à dépenses budgétaires données, ces systèmes d'assurance ont nettement plus d'effet sur la production que les traditionnelles subventions à la production (Anton et Giner, 2005). Il n'est donc pas possible de se contenter durablement des modélisations agrégées adoptées jusqu'à présent. Il serait également intéressant s'interroger sur le rôle jouer par les marchés financiers. En effet, en théorie, ces marchés ne portent pas spécifiquement sur des produits agricoles et ont donc une capacité financière suffisante pour dépasser le problème de la non assurabilité évoquée ci-dessus. En théorie donc, ils devraient permettre de "régler" les risques prix. Toutefois, cette théorie repose sur l'hypothèse d'un faible risque de base. Par ailleurs ces marchés n'existent pas pour tous les produits agricoles, vraisemblablement encore une fois à cause de problèmes d'information.

Tous ces éléments constituent un agenda de recherche prometteur.

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Résumé

Nous nous intéressons dans cette thèse aux conséquences des réformes de la PAC visant à remplacer les mécanismes de soutien des prix agricoles européens par des aides de plus en plus découplées de la production et des prix, ainsi qu'à la nécessité d'une nouvelle forme d'intervention publique pour stabiliser les marchés et revenus agricoles. Il apparait, aux vues des arguments présents dans la littérature, que des cadres d'analyse plus sophistiqués que ceux actuellement disponibles sont nécessaires pour étudier cette question. Il s'agit notamment de prendre en compte la dynamique d'évolution des marchés et la façon dont les acteurs forment leurs anticipations. Pour ce faire, nous développons un modèle d'Equilibre Général Calculable dynamique intégrant les décisions inter temporelles des agents économiques et permettant de considérer différents types d'anticipations. Les résultats de nos simulations montrent que des fluctuations de marchés endogènes, liées aux erreurs d'anticipation des agents, peuvent exister mais sont limitées par plusieurs ajustements des marchés. Ils révèlent également qu'en cas d'anticipations imparfaites, il est préférable d'appliquer progressivement les réformes politiques de façon à laisser le temps aux agents d'ajuster leur décision en fonction de l'information qu'ils reçoivent sur les marchés. Enfin, nous montrons que même s'ils ont des anticipations imparfaites, le comportement des stockeurs privés permet de stabiliser les marchés agricoles. En revanche, une intervention publique visant à encourager le stockage n'est pas souhaitable car elle vient en fait perturber les signaux envoyés aux différents acteurs et, de ce fait, accroitre la volatilité des marchés.

Abstract

We focus here on the consequences of the CAP reforms which have progressively replaced the european price support scheme by a system of payments more and more decoupled from production and prices, and on the opportunity for a new form of public intervention to stabilize agricultural markets. From the different points of view expressed in the economic literature, it appears that some frameworks, more sophisticated than those currently available, are needed to study this question. Those frameworks should notably account for dynamics and the form of agents' expectations. We thus develop a dynamic Computable General Equilibrium model including the inter temporal decisions of economic agents and allowing the representation of different expectation schemes. Our simulation results show that endogenous market flucutuations, due to expectation errors from economic agents, can arise but are limited by many feedback effects. These results also reveal that, if expectations are imperfect, a gradual implementation of policy reforms is preferable to an immediate one because, in that case, agents have time to adjust their decisions according to market news. Finally, we show that even if stockholders are not fully rational, their behaviours tend to stabilize agricultural markets. However, a public intervention aimed at increasing stockholdings is not suitable because it can, in a sense, scramble market signals given to agents, and thus increases markets volatility.