Reaping What Others Have Sown:

Measuring the Impact of the Global Financial Crisis on Spanish Agriculture

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Abstract

Employing a dynamic computable general equilibrium (CGE) model of the Spanish economy, this study explicitly aims to characterise in detail the impact of the crisis on Spanish agrofood activities. In particular, we focus on the extent to which primary agricultural sectors are insulated from the broader macroeconomic effects of the crisis and consequently the limit of the agrofood sectors' stabilising role within the wider economy. The results have broad implications for neighbouring Mediterranean EU economies given similarities in the relative size and structure of primary agriculture, and in the macroeconomic difficulties they face.

Comparing with a status quo (i.e., no crisis) baseline, we estimate that the conditions of the crisis lead to a cumulative contraction of 10 per cent in Spanish agricultural activity by 2015, with concomitant reductions in real farming incomes of 17%. Notwithstanding, in accordance with previous studies and *a priori* expectations, this contraction is notably smaller than in non-food sectors. Comparing between agricultural activities, those with smaller land cost shares exhibit greater supply responsiveness, particularly rice, raw sugar and intensive livestock sectors. Finally, the crisis induces greater income inequality across Spanish households, with utility from food consumption falling 11% in the poorest segment, compared with only 1% in the wealthiest.

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1. Introduction

Since 2007, the global economy has been battling with the financial and economic consequences of the global depression precipitated by the US sub prime mortgage crisis in August of that year. Widely considered as the worst crisis since the 1930s, the ensuing downturn in consumer and investor confidence has catalysed a series of business closures, bank insolvencies, and stock market falls, whilst many western economies have been saddled with heavy national debts, unemployment and sluggish growth. This is particularly true in the European Union where the downturn in Euro zone economic activity in 2009 exceeded that of the United States, and recent macro projections have forecast a period of stagnant growth of just 1-2% over the 2010-2015 period (IMF, 2010).

In Spain, the fallout from the financial crisis has been particularly severe. A decade ago, Spain's entry into the single currency led to a period of historically low interest rates. Consequent increases in real estate demand (some speculative), met by an elastic supply response owing to large influxes of cheap immigrant labour, bestowed an unhealthy degree of protagonism upon the Spanish construction industry which played a key role in leading the economy wide growth on an uninterrupted upward path for 15 years (Eurostat, 2010). However, by 2007 the rapid real growth rises had already begun to lose pace and the ensuing credit run over the following 12 month period meant that Spain suffered the sharpest construction industry decline in Europe (Eurostat, 2008). Despite labour market reforms to reduce hiring and firing costs and the slackening of locked-in union-industry pay deals (The Economist, 2010), low skilled labourers (many of whom are migrants) remain jobless, with unemployment currently over 20%; the highest in the euro zone. Given these structural weaknesses, it is expected that the recovery in Spain will be particularly sluggish in comparison with its European counterparts.[1]

Turning to agriculture, expectation is that it will be relatively more resilient as a sector to the process of macro adjustment which is currently underway: a sentiment echoed in a report by OECD (2009). As an initial observation, lower income elasticities lead to greater demand stability for many agro-food purchases (vis-à-vis non food purchases) in times of hardship. This balancing mechanism ensures that the agrofood sector has a (albeit limited) stabilising influence over the broader economy, and is one aspect of the crisis this study sets out to quantify. Furthermore, this research examines the distribution impacts of the crisis across Spanish households, by estimating the impacts on food (and non-food) budget shares, and on real incomes.

Another key observation is that the credit crisis hit investor expectations hard with the result that capital flows in Spain contracted heavily from the middle of 2007 to 2009, significantly impacting on financial markets and construction in particular. Agricultural sectors are 'relatively' less exposed to volatility on capital markets given the more stable nature of food demands alluded to above. Notwithstanding, it still remains the case that for food industries (as in other sectors), trade credit availability remains "a significant problem for manufacturers, processors and producer cooperatives" (OECD, 2009, pp47). Thus, a third aim of the paper is to estimate the impact of lowered investor 'expectations' on food and non food activity. Finally, by including biofuels sectors into our analysis, we ascertain the relationship between fossil fuel prices, first generation biofuel demand and consequently, the potential impact (if any) on cereals (ethanol) and oilseeds (biodiesel) sectors.

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[1] Indeed, recent fears relating to Spain's perceived inability to adjust to the current macro climate have fuelled speculation led rises in interest yields on Spanish bonds.

As a theoretically consistent empirical framework for modelling the economy-wide impacts resulting from macro or commodity specific shocks, a number of authors have turned to the computable general equilibrium (CGE) tool to examine the crisis. In each case, the authors do not attempt to model the causes of the crisis, but rather play to the strength of the CGE modelling approach, by capturing the symptoms of the crisis as a vehicle for assessing its impact on commodity markets, trade and real incomes. With some exceptions (e.g., Raihan 2010; Ahmed *et al*, 2010) a common theme is the inclusion of investor expectations in successive time periods, which in turn lends itself to a dynamic CGE model treatment.

A number of CGE dynamic studies examine the crisis from a global perspective. Employing a six sector 15 region dynamic CGE model, McKibbin and Stoeckel (2009) examine the importance of risk perception amongst businesses and households as a precursor for rapid recovery from the global recession. Strutt and Walmsley (2010) also use a dynamic variant of the well known GTAP model to compare three policy scenarios with a status quo baseline: a moderate crisis; a severe crisis; and a protectionist response to a moderate crisis. In the context of our paper, they find agriculture, particularly crops, is one of the least affected sectors. Moreover, unlike primary agriculture and food activities, the construction and manufacturing industries in the European Union (EU), as well as in the US and Japan, witness the largest falls in output due to falling investment.

To allow for a more detailed examination of the crisis for a particular case study, other dynamic CGE studies employ in-house single country models. Focusing on South-Africa, Chitiga (2010) examines three different aspects of the crisis: reductions in export demand; world price falls; and a collapse in foreign direct investment. Classifying their 37 sectors into those which are ‘unaffected’, ‘weakly affected’, ‘mildly affected' and 'strongly affected', 'agriculture and forestry' and 'food' are typically located in the first two groups.

In this paper we construct a single country dynamic CGE model of Spain to assess the medium term impacts of the crisis on a detailed breakdown of agricultural sectors. In the context of its structural rigidities alluded to above, the focus on Spain is justified by weaker expectations of its ability to recover quickly in comparison with other EU partners.[2] Taking 2008 as our point of departure, we take an anachronistic approach by comparing a 'crisis-free' baseline based on pre-crisis macro projections and modelling assumptions, with a crisis scenario. An important feature of this study is that it follows a recent paper by Dixon and Rimmer (2010)[3], which captures the observed tendency for industries to hold excess capital capacity in times of recession. The typical (and simplistic) 'full-capacity' utilisation assumption of CGE models (i.e., no idling of capital) implies an unrealistically high reduction in rental rates when demand falls and a new market clearing equilibrium is found. By modelling excess capacity, there is sticky adjustment downwards in rental rates as capital stocks are left unemployed.[4]

The rest of this paper is organised as follows. Section 2 describes the methodology deployed, the model framework and the scenario design. Section 3 presents the results of our study and in section 4 we offer some concluding comments.

2. Methodology

2.1 Model Database

This study employs a heavily modified version of the 'standard' single country ORANI computable general equilibrium (CGE) model template, developed by the Centre of Policy Studies (CoPS) at Monash University in Australia (Horridge, 2003).

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[2] Spain has been grouped into the collective of 'problem' EU economies designated by the acronym "PIGS" (Portugal, Italy, Greece, Spain).

[3] Dixon and Rimmer employ a single country dynamic CGE model (USAGE) to examine the impacts of the stimulus package on the US economy.

[4] A further perceived advantage of this approach is that the price level does not fall quite as dramatically resulting in unrealistic surges in exports.

To support our construction of the Spanish database, the 2005 Input-Output (IO) tables published by the Instituto Nacional de Estadística (INE) are a principle source of secondary data. The IO data provide tables at basic prices (prior to indirect taxes and transport/retail margins) and purchaser's prices (inclusive of taxes and margins) for 118 commodities and 75 industries as well as final demands. Moreover, IO tables are subdivided between domestic and imported activities in Spain across all intermediate and final demand accounts. Importantly, the conditions imposed by the IO table (demands equal supplies; output equals expenditure equals income) underlie the fundamental accounting conventions of the CGE model framework.

To construct a consistent CGE model database, the IO data in concert with additional secondary data sources are required to perform the necessary series of arduous steps.[5] For the purposes of this study, a 41 commodity by 38 industry aggregation is employed with a focus on primary agriculture and food processing activities. Given the linkage between first generation biofuels and crop production, fossil fuel and biofuel ('bioethanol' and 'biodiesel') sectors are also disaggregated.[6] The remaining sectors consist of construction activities, manufacturing and services. The model has three broad factors (capital, labour and agricultural land), whilst labour is split into "highly skilled", "skilled", "unskilled", and armed forces, while household purchases are disaggregated into eight income groups based on monthly disposable income.

2.2 Model framework

The standard CGE framework is a 'demand' led model, based on a system of neoclassical final, intermediate and primary demand functions. With the assumption of weak homothetic separability, a multi-stage optimisation procedure allows demand

[5] For the interested reader, full details of the database construction can be provided on request.
[6] First generation bioethanol is based on cereals feed, whilst biodiesel principally employs oilseeds (rapeseed). To the best of our knowledge, sugar beet ethanol is not currently produced in Spain.

decisions to be broken into ‘nests’ to provide greater flexibility through the incorporation of differing elasticities of substitution. Moreover, accounting identities and market clearing equations ensure a general equilibrium solution for each year that the model is run. After appropriate elasticity values are chosen to permit model calibration to the database, and an appropriate split of endogenous-exogenous variables is selected (closure), specific exogenous macroeconomic or trade policy ‘shocks’ can be imposed to key variables (e.g., tax/subsidy rates, primary factor supplies, technical change variables, or real growth in GDP and/or its components). The model responds with the interaction of economic agents within each market, where an outcome is characterised by a ‘counterfactual’ set of equilibrium conditions.

Given the importance of investor expectations, we attempt to capture the main symptoms of the crisis on the Spanish economy.[7] To incorporate excess capacity in the capital market, we follow Dixon and Rimmer (2010):

$$\left[\frac{R_t^P}{R_t^B}-1\right]=\left[\frac{R_{t-1}^P}{R_{t-1}^B}-1\right]+\alpha.\left[U-1\right] \qquad (1)$$

Thus, the capital rental rate in the policy (crisis) scenario in period t, (R_t^P), relative to the rental rate in the base (no crisis) scenario in period t, (R_t^B), is a positive function of the corresponding ratio in period t-1 and a negative function of excess capital capacity (U), measured by the ratio of capital in use to capital in existence (i.e., U ≤1). In the crisis years, the excess capacity term on the right hand side of (1) is activated by a closure swap.

The ratio of investment to capital (i.e., capital accumulation) is characterised by the following logistic function (Dixon and Rimmer, 2007):

[7] Given the lack of any detailed financial sector (in common with other CGE studies), we do not set out to model in detail the drivers of the crisis, but rather capture the symptoms of the crisis for the purposes of fulfilling our principle research objective (i.e., measure the concomitant impacts on Spanish agrofood sectors).

$$G = Q.G_{trend} M^{\alpha} U / (Q - 1 + M^{\alpha}) \quad (2)$$

Capital stock accumulation by industry (G)[8] is a positive function of the ratio of 'expected' to 'normal' rates of return (M). Thus, if the expected rate of return exceeds (falls below) the economy-wide 'normal' rate of return then the investment/capital ratio will exceed (fall below) its trend (G_{trend}). Other things equal, the change in G with respect to changes in the ratio M is governed by the investment elasticity α. Following Dixon and Rimmer (2010), the impacts of new investment on capital growth rates are moderated when there is excess capital stock in the crisis years (i.e., $U < 1$). The parameter Q captures the ceiling on the investment/capital ratio as a multiple of the trend ratio.

In our model closure, changes in investor expectations are calibrated to exogenous (historical and projected) shocks on macro investment changes (see later). Expected rates of return in period *t* (E_t) are a weighted average of expected rates of return in period *t-1* (E_{t-1}) and actual rates of return in period *t* (R_t).[9]

$$E_t = U.\left[(1-x)E_{t-1} + xR_t\right] - (1-U).D \quad (3)$$

Furthermore, following Dixon and Rimmer (2010), in the crisis years, the expected rates of return are lowered by the emergence of excess capacity. Thus, in the crisis years, the rate of return on idle capital is also a negative function of the depreciation rate (i.e., that proportion of capital not in use accrues no return and deteriorates at the rate of depreciation).

A further defining characteristic of the Spanish economy has been the severity of its unemployment. In this study, we implicitly capture unemployment via exogenous shocks on aggregate employment and population according to historical data (Eurostat, 2010) and projections (European Commission, 2009). As a corollary of the investment

[8] Also known as the change in the investment/capital ratio in the model.
[9] The larger is the parameter 'x' in equation (3), the faster is the convergence of expected rates to actual rates of return.

module, actual employment rates (L) are compared with trend employment rates (T) in order to determine changes in the real wage rate (W):

$$\Delta W / W_0 = \gamma[(L_0 / T_0) - 1] + \gamma\Delta(L / T) \qquad (4)$$

Equation (4) states that the change in the real wage ($\Delta W / W_0$) is the total derivative of changes in the ratio of employment to an exogenous trend rate (or natural long run rate) (L_0 / T_0) and the wage elasticity (γ). In our model, to capture the sticky nature of real wages to employment levels (particularly given the strong presence of trade unions in Spain) we carefully examine the impacts of exogenous employment rate (L) shocks on real wages and compare with historical data on ('sticky') real wage changes for the Spanish economy (INE, 2010). This technique was employed to calibrate the wage elasticity parameter.

In addition, Labour Force Survey data (INE, 2010) allow for a disaggregation of labour by occupation. In Spain, there is a heavy degree of regulation and barriers to entry in the labour market (particularly amongst higher skilled occupations) which implies supply rigidity. Consequently, labour supply functions are introduced, where owing to the dearth of relevant estimates, it is assumed that high skilled occupations have a labour supply elasticity which is one-tenth of the central estimates employed in this study (see below).

The representation of energy demands follows the nesting structure of the GTAP-E model (Burniaux and Troung, 2002), where separate energy nests allow for a more flexible representation of substitution possibilities between differing energy types (e.g., electricity, coal, petroleum, biofuels), particularly the blending possibilities between biofuels and petroleum products in transport. In the standard Spanish IO database there is no explicit recognition of biofuel activity, whilst recent experience suggests that these sectors will continue to have added significance to agricultural activity in the medium run. Employing the SPLITCOM facility in GEMPACK (Horridge, 2005), first-generation biofuels sectors are disaggregated from existing industries. Cost share data[10] for bioethanol and biodiesel are taken from Bamiere et al (2007) and the Ministerio de Industria, Comercio y Turismo, (2005), whilst Spanish data from APPA (2009) are employed to estimate biofuel domestic household demands, exports and imports.

In the context of our study aims, additional code is implemented to support the representation of the CAP. In the model data, coupled support payments by agricultural sector are characterised as subsidies on land (e.g., set-aside and area payments) capital (e.g., headage premia on livestock, investment aids), production (e.g., production aids, stock purchases) and intermediate input subsidies (seed payments, irrigation aids, distribution and marketing payments, etc.). Given the policy evolution of the CAP, sector specific payments are gradually decoupled year on year (see section 2.3) and reconstituted as a Single Farm Payment (SFP), which is introduced as a uniform subsidy rate on the land factor (Frandsen *et al.,* 2003). Intervention prices are modelled as changes to trade protection whilst pillar II modulation payments are implemented year on year as a direct payment to the 'agricultural farm household', which collects all agricultural policy payments and returns on agricultural value added. Employing complementarity step functions (Elbehri and Pearson, 2005), production quotas are modelled for raw sugar and milk (Lips and Rieder, 2005), as well as Uruguay Round constraints on export quantities and subsidy expenditure. Set aside is characterised employing a technical change variable on the land factor (Frandsen and Jensen, 2000).

In agricultural factor markets, capital and labour move sluggishly between agricultural and non-agricultural sectors to capture rental and wage differentials between sub-sectors (Keeney and Hertel, 2005). The movement of heterogeneous land types between agricultural sectors is governed by a three nested elasticity of

[10] Characterised as 'capital', 'labour', 'feedstocks', 'chemicals', 'energy', 'other inputs'.

transformation function (OECD, 2003). Finally, to explore the distributive effects of policy changes, Household Survey Data (INE, 2009) permit a disaggregation of private household purchases for up to eight distinct disposable income groupings

Given the lack of relevant Spanish data sources, calibration is facilitated through usage of substitution and expenditure elasticities from the standard GTAP version 7.1 database (Narayanan and Walmsley, 2008). In the energy module, substitution elasticities from GTAP-E econometric estimates for developed countries are employed. Export demand elasticities are borrowed from the Australian ORANI database, whilst the transformation elasticities for land (between uses); and capital and labour (between agricultural/non-agricultural uses) are taken from Keeney and Hertel (2005). Central tendency estimates of labour supply elasticities for Spain are taken from Fernándes-Val (2003) whilst for agro-food products, private household expenditure elasticities are taken from a study by Moro and Sckokai (2000) on Italian households stratified by wealth.

2.3 Scenario Design

A key determinant of the results is the choice of macro closure and background shocks employed. The study implements year on year shocks for two alternate realities over a ten year period (2005-2015). The baseline contemplates a 'non-crisis' time frame, which is subsequently compared with a policy scenario which captures the crisis. It is assumed that the point of departure for the two scenarios is 2008. From a cursory review of older economic projections, it becomes apparent that the crisis was largely unforeseen. Consequently, to characterise the baseline scenario we employ, where possible, Spanish macro estimates from reports prior to the crisis (circa 2008) coupled with our own calculations. In the case of the policy (crisis) scenario, there is a greater dependence on secondary data projections. Details of the magnitudes and data sources for all years relating to each exogenous macro variable are presented in Table 1. With shocks to public expenditure we capture the fiscal stimulus that took place in the crisis years as well as the 'austerity measures' that followed, whilst exogenous shocks on aggregate investment are designed to capture the downturn in investor expectations, which had such a detrimental impact on the (*inter alia*) construction industry.

In addition to the annual macro changes, further exogenous shocks (Table 2) are imposed on world prices[11] and trade for fossil fuels; agrofood exports in 2006-7; biofuel consumption, trade and production trends; consumer taste changes toward red meats; and total factor productivity for all sectors. Finally, exogenous changes in CAP policy are detailed in Table 3. Second pillar support (Axis 1, 2 and 3) is not modelled because its allocation is largely based on political considerations which are beyond the scope of the model. Notwithstanding, modulation of funds from Pillar I to Pillar II are implemented into the farm household income function as a direct payment. Since these are merely reported as summary statistics, this category of Pillar II payments does not impact on market activity and consequently, factor returns in agriculture.

3. Results: Crisis Scenario vs. Baseline Scenario.

In the following sections results are grouped into macro effects; sectoral impacts; trade; and household utility and farm incomes. Unless otherwise stated, estimates are presented as cumulative differences to 2015 with respect to the no crisis baseline.[12]

3.1. Macro Impacts

Examining Figure 1, an initial observation is that by 2015 the Spanish economy remains below its no crisis baseline path for all macro variables (except net trade – see section 3.3). The implication from our exogenous macro estimates (Table 1) is that the

[11] It is assumed that the slump in fossil fuel prices which occurred in 2009 following the peaks of 2008, does not occur in the baseline. There we follow an OECD assumption of 2% growth a year. In subsequent years, there is a degree of price convergence in fossil fuel prices between the baseline and the crisis scenarios.

[12] Consequently, reported "falls" may sometimes be interpreted as relatively smaller increases in the policy scenario (relative to the baseline) of the economic variable being discussed.

crisis is expected to have a long term effect on macro readjustment as Spain implements its fiscal retrenchment programs under conditions of sluggish economic growth. As expected, the largest decline occurs in the period 2009-2011.

The initial impact of the crisis was witnessed in the investment markets, where concomitant downturns in investor confidence are estimated to reduce investment by 29% by 2011 and 35% by 2015 (Figure 1). In Spain, this initial impact manifested itself most prominently in the housing market, which hitherto constituted an important driver of economic growth. In Table 4, real net investment in construction and real estate is estimated to fall 32% by 2009 (compared with 18% for the economy), and is approximately half its baseline level by 2015. As a result, there are concomitant reductions in construction and real estate output of 14% in 2009, rising to 30% by 2015.[13] With contractions in construction activity, the rate of return on capital[14] also falls more noticeably in construction compared with the rest of the economy (Table 4).

Returning to Figure 1, aggregate government spending exceeds the baseline by 8% in 2009 owing to the fiscal stimulus package, which by 2015 falls back to 20% below the baseline as austerity measures are phased in. Interestingly, the cumulative improvement in the trade balance by 36% (€34bn – Table 7) reflects the sharper reduction in Spanish imports as Spain's economy readjusts. Relative to the baseline, private consumption and employment have also fallen by 13% and 15% respectively by 2010,. By 2015, the rate of decline has slowed, although employment, a key economic and political gauge in Spain at the current time, is estimated to have fallen by 23% compared with the baseline. Retail prices and real growth fall by 10% and 27%

[13] This statistic is estimated under our assumption of 'excess capacity'. That is, additional purchases of capital do not reduce as dramatically (since some is assumed to be left idle), with the result that capital rental rates are sticky downward compared with a standard CGE model treatment.
[14] The rate of return is calculated as the per unit ratio of capital rents to capital good construction costs (price of net investment).

respectively, compared with 2015. Expressed another way, we estimate that the value of Spanish GDP is €565 billion lower in 2015 compared with the baseline scenario.

3.2. Sectoral impacts in Spain.

3.2.1 Agrofood vs. non food sectors

Examining our estimates in Table 5, falls in output are more moderate in the agrofood sector compared with the rest of the economy. For example, relative to the baseline, primary agricultural and food processing outputs fall 10% and 15%, respectively. These statistics compare with the Spanish average statistic of -23%, suggesting that the agrofood sector is fulfilling (to an extent) the stabilising role referred to in the introduction. Indeed, by 2015, the share of agrofood activity in overall GDP is greater in the crisis scenario (6.4%) than in the baseline (5.7%). There are various factors that help explain this observation.

Firstly, agrofood commodities have lower income elasticities of demand than non-agrofood commodities, particularly 'staple' primary agricultural commodities. Consequently, with falling real incomes in Spain, the impact of leftward shifts in the demand curve are moderated considerably. Secondly, as land is modelled as a relatively sluggish factor (compared with labour and capital), agricultural supply responsiveness (and to a lesser extent, food) is greatly reduced. Accordingly, the effect of the crisis in these sectors is manifested relatively more through price reductions than declines in output (this issue will be explored in greater detail in section 3.2.2 below).

Thirdly, the importance of investment markets to construction and real estate is also of significance to the Spanish economy as a whole. Column 1 of Table 5 shows that 39% of construction and real estate sales are in the form of investment demand. In contrast, relatively little agricultural and food produce is investment dependent.[15] In the

[15] These statistics are based on the underlying data from the input-output table for Spain in 2005.

context of the discussion above relating to the collapse in investment, it follows that agro-food sectors are relatively insulated from the downturn in expectations.

A secondary impact of the crisis is that relatively larger cumulative contractions in manufacturing (-29%) and construction (-30%) release larger quantities of labour and capital (Table 5). Real wages and capital rents and employment fall across all sectors in the economy (Table 5), but the falls are generally smaller in the agrofood sector as these industries take advantage of the resources released by the larger, but shrinking, industries in the non-agrofood sector. That said, employing input-output data on full time equivalent jobs in agriculture, in the year 2015, primary agriculture is still operating with 120,000 fewer workers.

3.2.2 Individual primary agricultural and food sectors

As a 'sluggish' factor of production,[16] it is expected (*ceteris paribus*) that those agricultural sectors which have relatively larger (smaller) land cost shares are less (more) supply responsive. With some notable exceptions (e.g., fruit and vegetables[17]) primary agricultural demands are derived from (income inelastic) downstream food demands. For example, raw milk and sugar consumption is a function of dairy and sugar processing industry demand. A final consideration is the relationship between real investment falls and capital availability. The strength of this relationship is a function of the capital intensivity of each agricultural industry.[18]

In the cereals and oilseeds sectors, price falls are more exaggerated whilst output falls are small. This is partly because of the low demand elasticity with respect to expenditure for staples, whilst the supply curve is also inelastic due to the large land

[16] The elasticity of transformation on land between similar activities (e.g. wheat and barley) is greater than that between more 'varied' activities (e.g. wheat and raw milk) (see section 2.2).

[17] Vegetables and fruit constitute approximately 20% and 15%, respectively, of primary agricultural output in Spain.

[18] Note that land, capital and labour cost shares for Spanish agricultural sectors are based on both cost estimates in RECAN (2008) and the anuario de estadisticas (MARM, 2006) which give land prices and hectare usage by crops types.

cost shares in these sectors. The market for wheat is particularly inelastic with output falls of only 7% compared with the baseline (see Table 6).

With its larger land cost share, fruit faces a steeper supply curve than vegetables, which is reflected in the results when comparing the relative magnitudes of price and output changes for these two large sectors (Table 6). Interestingly, both sectors are export orientated, with overseas markets accounting for approximately half of all Spanish vegetable sales, and more than half of all Spanish fruit sales. With its relatively smaller output decline and larger sectoral terms of trade fall, fruit exports do not suffer quite as much as vegetable exports (for further discussion see section 3.3).

Raw sugar quotas remain non-binding throughout both baseline and crisis scenarios, whilst with its relatively small land cost share, the crisis induced impact on output is notable (-18%),[19] with accompanying moderate price falls (5%). In the relatively capital intensive livestock sectors (pigs, poultry, raw milk) crisis induced output falls are also elastic (smaller land cost shares) and poor investor expectations impact more on capital uptake in these sectors. Moreover, with greater dependence on high concentrate feed inputs whose price falls only 4% compared with the baseline (not shown), poultry and pig price falls are moderated. With gradual exogenous increases in the milk quota, rents disappear in the crisis scenario as the quota becomes non-binding prior to its elimination in 2015. In extensive livestock sectors (cattle, sheep and goats), with greater usage of pasture, supply elasticities are (*a priori*) moderated. With reductions in tastes and preferences for red meats coupled with falling disposable incomes, price falls for sheep and goats are estimated at 16% compared with the baseline, with a cumulative output fall of 10% by 2015. In the cattle sector, the value added share of production is smaller, where animal feed (intermediate input) shares play

[19] The sugar beet sector in Spain is small. Thus, our output statistic is taken from a small base.

a larger role. Thus, despite taste changes in favour of white meats, relatively stable feed prices mitigate the price falls that would otherwise occur in this sector.

In our crisis scenario, world prices of fossil fuels (particularly oil and natural gas) fall from their peaks in 2008, while in the baseline, it is assumed that these prices are more or less sustained over the simulation period. This assumption has implications across the economy, but the effects are particularly marked in the nascent biofuels industries. By 2011, biodiesel output has contracted 52% compared with the baseline (although still an increase of 84% on 2005) while the corresponding statistic for bioethanol is a reduction of 21%. By 2015, biodiesel and bioethanol production recovers to 31% and 15% lower, respectively (Table 6), as the projected oil price begins to converge with the baseline. As an important feed input into the biodiesel industry, the biodiesel share of Spanish oilseed (rapeseed) sales is approximately 13% in 2005, compared with approximately 20% by 2015 in the crisis scenario. By 2011, Spanish oilseed production is 6% lower, of which it is estimated that one-third is due to the relative contraction in the biodiesel industry. That the effect is not more noticeable is because much of the demand reduction for biodiesel is soaked up by falls in extra-EU biodiesel imports (principally from the USA). Although Spanish bioethanol employs cereals as key feedstocks, the usage of these inputs as a proportion of total cereal sales is moderate, such that Spanish bioethanol market trends are not found to impact on Spanish cereals prices and outputs.

3.3. Trade Balances

According to our estimates, Spain's trade balance witnesses a relative cumulative improvement of €34billion by 2015 compared with the baseline (Table 7), reflecting the large drop in imports in response to falling national incomes. Notwithstanding, as the crisis reduces the size of Spain's economy by around half a trillion euros over the simulation period, the trade deficit as a proportion of GDP actually worsens relative to the baseline. More specifically, Spain's trade deficit is 9.1% of GDP in 2005, compared with 13.4% in 2015 in the baseline and 17.0% in 2015 in the crisis scenario.

In the agro-food sectors, in comparison with the baseline, cumulative trade balances generally improve, most notably for wheat (€211 million), maize (€215 million), oilseeds (€229 million), red meat (€249 million), dairy (€483 million) and sugar (€641 million) (Table 7). However, the cumulative trade balance statistic for the *aggregate* primary agricultural and processed food sectors shows a deterioration of -€758million and -€1,090 million, respectively. In primary agriculture, the result is dominated by deteriorations in vegetables (-€1,377 million) and fruit (-€797 million). In Spain, both sectors are heavily export orientated, where the export share of total sales is considerable (40% and 60% for vegetables and fruit, respectively). Consequently, output reductions in these sectors impact heavily on exports. In the food processing sectors, large trade balance deteriorations occur for alcoholic beverages (-€875 million), white meat (mainly pork) (-€513 million) and oils and fats (-€831 million). As with fruit and vegetables, the trade balance deteriorations are due to the export orientated nature of these sectors.

3.4. Utility and Farm Household Incomes

Overall, cumulative utility (real income) per household from the crisis falls by 19.2% (an economy wide fall of €103,820 million) in 2015 compared with the baseline. Further examination of the table shows that income inequality widens as per household utility falls are more severe in the poorer household groupings.[20] Since poorer households have a higher elasticity of marginal utility with respect to changes in

[20] The discrete income groupings are defined by the National Statistics Institute of Spain (INE, 2010).

expenditure, their utility is hit harder in the crisis scenario.[21] Thus, in Table 8 the poorest households witness real income reductions of 28% (€2,366 million) compared with only 12% (€4,266 million) for the wealthiest. Consistent with Engel's Law,[22] falling average real incomes result in a change in the composition of food/non-food purchases. Thus, from a food budget share base of 21% in 2005, by 2015 'poor' household food budget shares rise to 23% in the crisis scenario, compared with a fall to 20% in the baseline (not shown). In contrast, food budget shares in the wealthiest group stay more or less fixed at 2005 levels (10%) in the crisis scenario, compared with a slight fall in the baseline (to 9%). With a larger food budget share, food utility losses are larger in the poorer households. A cursory view of Table 8 shows that the decline in food utility in the poorest households is 11%, compared with only 1% for the richest households. Finally, comparing food and non food utility reductions, Table 8 reveals that the latter is larger; in part because the non food budget share (weighting) is greater; but also owing to the larger fall in nominal food prices, resulting in a smaller negative real income effect on food purchases.

In Figure 2 we estimate the impact of the crisis on farm incomes relative to the baseline. Overall, the crisis causes real farm incomes to fall by 17% by 2015, principally owing to a decline in real factor returns of 22%, whilst net off-farm receipts rise owing to the contraction in tax payments paid by farmers on their reduced output.[23] The point of inflection in 2011 is due to the large build up of capital accumulation which occurs in the baseline (not present in the crisis scenario), resulting in capital

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[21] In the linear expenditure system (LES) function, this elasticity is calibrated to the Frisch (1959) parameter, which can also be interpreted as the ratio of total income to luxury goods expenditure. The higher is the absolute value of the parameter, the poorer is the household.

[22] In dynamic CGE models, the marginal budget shares in the LES private household function are updated at the end of each year. Thus, over time, Engel curves are not restricted to be straight lines from the origin.

[23] It is assumed that agricultural support payments are more or less stable in both scenarios since the allocations are pre-agreed as part of the EU's budgetary framework agreement.

rental falls which dents (agricultural) factor incomes from capital. After 2011, this effect reverts to its long term trend as the capital market corrects itself.

4. Conclusions

From its origins in late 2007, many countries in the West are still recovering from the legacy of the financial crisis, regarded as the largest global downturn since the 1930s, and the European Union has suffered more than most other regions. Of the larger EU economies, Spain was the last to emerge with positive growth figures. In common with its euro zone neighbours, Greece and Portugal, it has a relatively high national debt as a proportion of GDP and rigid labour markets, whilst its unemployment rate is approximately double the EU average. In addition, like Ireland (and to a lesser extent, the UK), falling property prices have weakened domestic demand considerably.

In cumulative terms compared with the *status quo* (i.e. no crisis) baseline, by 2015 primary agricultural output falls by 10%, employs 120,000 fewer workers and faces real farm income reductions of 17%. Behind these headline figures, the contraction in Spanish agriculture and food industries is relatively less than the non food sectors, resulting in a larger agrofood proportion of Spanish GDP in the crisis scenario (6.4%) compared with the baseline (5.7%); a result which supports *a priori* expectations (OECD, 2009) and previous literature (e.g., McKibbin and Stoeckel, 2009; Chitiga, 2010). This finding is attributed to more inelastic supply in agriculture, lower income elasticities of demand for food products, and the reduced relative importance of investor expectations compared with manufacturing and construction. Further examination reveals that with greater supply inelasticity in primary agriculture (owing to the presence of agricultural land), crisis induced agricultural market price falls exceed those of the non food sectors.

Comparing between agricultural sectors, supply responsiveness depends broadly on the cost share of the land factor, the size of the derived demand shift from real income falls and the relative loss in capital availability from poorer investor expectations. Consequently, intensive livestock sectors (poultry, raw milk, pigs), sugar and rice exhibit greater supply responsiveness (reductions) than, for example, cereals, oilseeds and extensive livestock activities. On the relation between first generation biofuels and feed crops, with its relatively small cereals sales share, there is little evidence to suggest that bioethanol contractions have much impact on cereals demand. On the other hand, crisis induced output contractions in first generation biodiesel production are estimated to account for one-third of the reduction in oilseeds production. Turning to Spain's trade, the deterioration in the agricultural trade balance (-€758 million) is driven by worsening conditions in the two large export orientated sectors of fruit (-€797 million) and vegetables (-€1,377 million), but mitigated by modest improvements elsewhere (see Table 7).

Finally, an examination of household expenditures suggests that there is a worrying increase in income inequality in Spain resulting from the crisis. In terms of food demands, budget shares for poorer households rise in accordance with Engel's Law, whilst cumulative reductions in 'food utility' are 11% in the poorest households, compared with 1% in the wealthiest.

As a caveat to the analysis, the credibility of the results can principally be judged on the quality of the underlying CGE data flows, elasticities and macro shocks. With some unknowns regarding projections shocks, particularly in the baseline, plausible 'trend' assumptions have been applied employing time series data. Against this background, an underlying hypothesis of our macro projections is that the Spanish economy under the crisis remains some way below its baseline trajectory in 2015. Implicitly we postulate, based on official forecasts supported by current structural (e.g., unemployment, competitiveness) and financial indicators (e.g., national debt, house prices), that recovery for the Spanish economy is going to be slow, although not unprecedented (e.g., Japan's 'lost decade'). In this context, our model results should be considered as lower bound estimates.

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Baseline Annual Projections Shocks (%)										
	Historical Data Shocks		Projections Shocks							
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Real GDP	4.75	4.11	1.07	1.55	3.29	3.29	3.29	3.29	3.29	3.29
Real Consumption	3.98	4.10	0.99	1.43	3.02	3.02	3.02	3.02	3.02	3.02
Real Investment	10.27	4.26	2.54	3.68	7.78	7.78	7.78	7.78	7.78	7.78
Real Public Expenditure	4.87	6.14	1.25	1.81	3.83	3.83	3.83	3.83	3.83	3.83
Real Exports	4.89	4.66	1.58	1.96	3.93	3.93	3.93	3.93	3.93	3.93
Employment	4.08	3.08	1.19	1.72	3.65	3.65	3.65	3.65	3.65	3.65

Sources:
Historical data: GDP, consumption, investment, exports & employment from Eurostat (2010); Public expenditure from INE (2010)
Projections data: GDP from IMF (2008); consumption, investment, exports & employment from own calculations[24]

Crisis Annual Projections Shocks (%)										
	Historical Data Shocks			Projections Shocks						
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Real GDP	4.75	4.11	-0.73	-3.17	-1.19	0.60	0.75	1.73	1.94	2.35
Real Consumption	3.98	4.10	-5.38	-1.28	1.51	2.20	1.97	2.00	2.00	2.00
Real Investment	10.27	4.26	-17.60	-10.50	-1.97	3.10	4.57	5.20	5.58	6.60
Real Public Expenditure	4.87	6.14	5.58	0.02	-1.39	-2.20	-2.73	-0.50	1.50	2.50
Real Exports	4.89	4.66	-14.20	1.62	4.21	5.80	6.07	5.84	5.62	5.30
Employment	4.08	3.08	-6.76	-1.90	0.70	1.90	2.30	2.30	2.70	3.00

Sources:
Historical data: As baseline, but applied up to 2008.
Projections data: GDP from IMF (2010); investment from Eurostat (2010) and European Commission (2010); consumption, exports, employment and public expenditure from European Commission (2010)

Table 1: Year on Year Macro Assumptions for Spain (baseline and crisis scenarios)

[24] Time series data from 1995-2007 was used to estimate an elasticity for the relevant variable with respect to real GDP. This was then used in conjunction with real GDP projections, to calculate projections for that variable.

Shocked Variables	Baseline Scenario	Crisis Scenario
World prices of fossil Fuels (oil. coal. crude gas)	IMF (2010) for 2006-2008. 2009 onwards assumed 2% annual increases (as OECD 2009 projections).	IMF (2010)
World prices of biofuels (bioethanol & biodiesel)	OECD (2010)	OECD (2010) slow recovery estimates
Imports (Fossil Fuels) & Exports (Fossil Fuels and Agrofood)	Datacomex (2010)	
Biofuels (domestic sales, production & trade)	2006-8. APPA Biocarburantes (2009) 2009 onwards. Endogenous	
Total factor productivity shocks	Taken from Ludena et al. (2006) and Jensen & Frandsen (2003)	
Red/white meat taste changes	OECD (2008)	

Table 2: Additional Shocks and Sources Summary

Common Agricultural Policy (CAP) Shocks
• Introduction of the Single Farm Payment – year on year shocks (2006-2015) taken from historical data (FEGA, 2010). Complete decoupling of agricultural payments by 2015.
• Modulation implemented based on historical data (FEGA, 2010). Modulation projections assumed to rise to 3% by 2015. Given the structure of the agricultural industry in Spain and the small farms exemption, historical data reveals that Spain's modulation rate is below the EU policy prescribed rate (1% a year from 4% in 2006 to 10% in 2012) (FEGA, 2010). Consequently, we assume that the modulation rate rises to 3% by 2015. Pillar II Modulation payments transferred to farm household income function.
• One-off sugar quota reduction (2006). No further cuts are necessary due to the sizeable 'voluntary' cuts in production resulting from intervention price reductions.
• Dairy (2006-2008) and sugar (2006-2010) intervention price reductions.
• Export subsidy changes based on historical data (2006-2009) (FEGA, 2010)
• 6.5% tariff on biodiesel implemented from 2005/6 onwards (APPA, 2009). 33% weighted tariff on Bioethanol implemented from 2005/6 onwards (APPA, 2009).
• 2% increase in EU wide milk quota sanctioned by the EU (April 2008). Year on year 1% increases (2009-2014). Abolition 2015.
• Abolition of set-aside (2009)

Table 3: CAP Policy Shocks

	2008	2009	2010	2011	2015
Capital Rental Rate:					
Construction and real estate	-4	-20	-24	-25	-22
Economy	-2	-10	-15	-18	-24
Per Unit Cost of Net Investment:					
Construction and real estate	0	-5	-6	-7	-6
Economy	0	-4	-5	-6	-7
Capital Employed:					
Construction and real estate	0	-1	-3	-6	-21
Economy	0	-1	-2	-3	-12
Real Net Investment:					
Construction and real estate	-8	-32	-50	-54	-47
Economy	-6	-18	-24	-29	-35
Output:					
Construction and real estate	-4	-14	-19	-23	-30
Economy	-2	-10	-16	-20	-24

Table 4: Investment and Capital Effects (cumulative % change relative to baseline)

	Investment Sales Share	Market Price	Output	Real Wages	Employ.	Capital Rents	Capital
All Sectors	11	-8	-23	-8	-23	-22	-12
Agriculture	1	-11	-10	-6	-12	-19	-9
Food	0	-8	-15	-8	-15	-21	-8
Non Agrofood	12	-8	-24	-8	-23	-21	-12
Specific Non-Agrofood Sectors:							
Services	8	-11	-18	-8	-19	-22	-7
Manufacturing	6	-8	-29	-8	-31	-25	-17
Constr. & real estate	39	-13	-30	-8	-29	-17	-22

Table 5: Cumulative Outcomes by 2015 for Some Selected Industries (% change relative to baseline)

	Effect of Crisis on Price by 2015 (%)	Effect of Crisis on Output by 2015 (%)
Wheat	-12	-7
Barley	-10	-9
Maize	-10	-9
Rice	-8	-11
Other Cereals	-12	-9
Oilseeds	-18	-6
Vegetables	-11	-16
Fruit	-13	-12
Sugar	-5	-18
Other Crops	-9	-10
Cattle	-9	-9
Pigs	-9	-12
Sheep and Goats	-16	-10
Poultry and Eggs	-10	-13
Raw Milk	-9	-11
Biodiesel	-10	-31
Bioethanol	-13	-15

Table 6: Effect of the Crisis on Prices and Output

(€ millions)	Trade Balance	Cumulative Impact on Trade Balance vs. Baseline				
	2007	2008	2009	2010	2011	2015
Wheat	-445	-2	51	75	103	211
Maize	-716	5	57	88	119	215
Other Cereals	-144	0	10	15	22	48
Oilseeds	-2,086	13	102	136	168	229
Fruit	3,139	-31	-366	-478	-601	-797
Vegetables	3,198	-49	-616	-881	-1,103	-1,377
Livestock	-335	0	44	61	44	103
Red Meat	-36	-30	-37	-38	-45	249
White Meat	1,715	-83	-370	-401	-838	-513
Dairy	-1,532	-40	-15	34	90	483
Oils & Fats	1,126	-67	-549	-689	-796	-831
Sugar	-1,613	-10	126	208	290	641
Alcohol	361	-40	-457	-561	-651	-875
Agriculture	**800**	**-50**	**-664**	**-868**	**-1,041**	**-758**
Food	**-1,108**	**-280**	**-1,442**	**-1,622**	**-2,242**	**-1,090**
Macro total	**-94,610**	**1,111**	**947**	**43**	**4,156**	**34,179**

Table 7: Trade Balance Impacts in Agrofood Commodities.

Income (2005 prices)	Utility	Food utility	Non-food utility
1. €499 a month or less	-28	-11	-31
2. €500 to €999 a month	-24	-8	-27
3. €1.000 to €1.499 a month	-21	-7	-24
4. €1.500 to €1.999 a month	-20	-6	-22
5. €2.000 to €2.499 a month	-18	-5	-20
6. €2.500 to €2.999 a month	-17	-4	-19
7. €3.000 to €4.999 a month	-15	-3	-16
8. €5.000 a month or more	-12	-1	-13
Aggregate household	-19	-5	-22

Table 8: Cumulative Impact on Poor/Rich Households by 2015.
(% change relative to baseline)

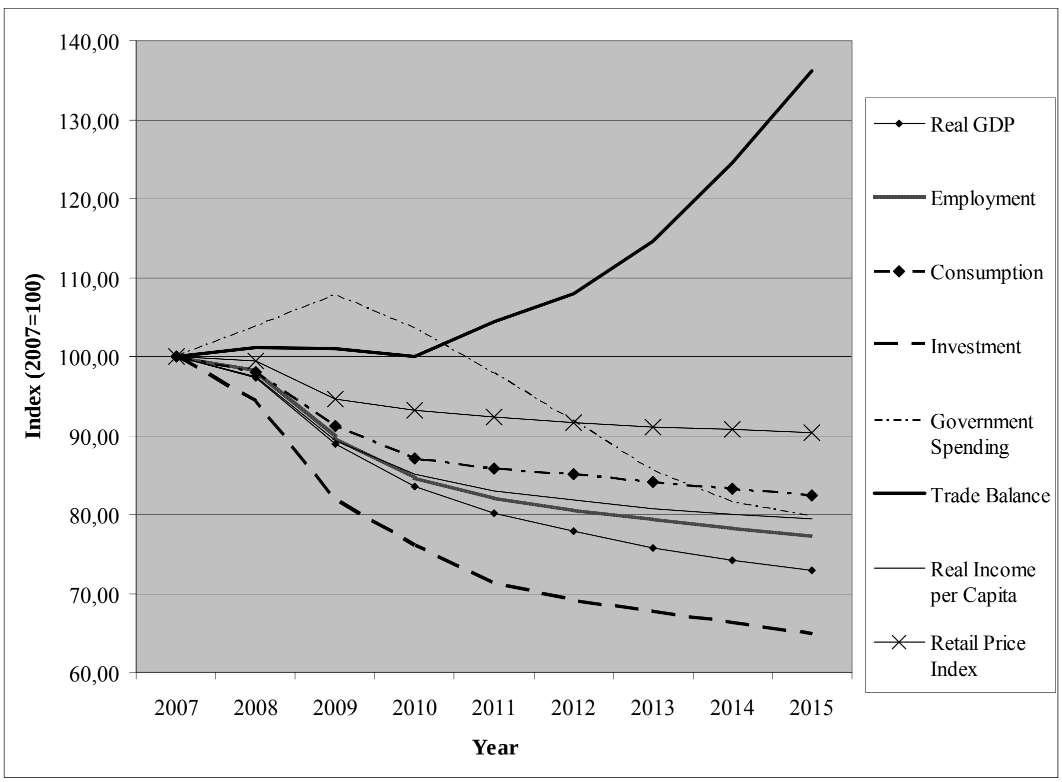

Figure 1: Impacts of the Crisis on Spanish Macro Indicators

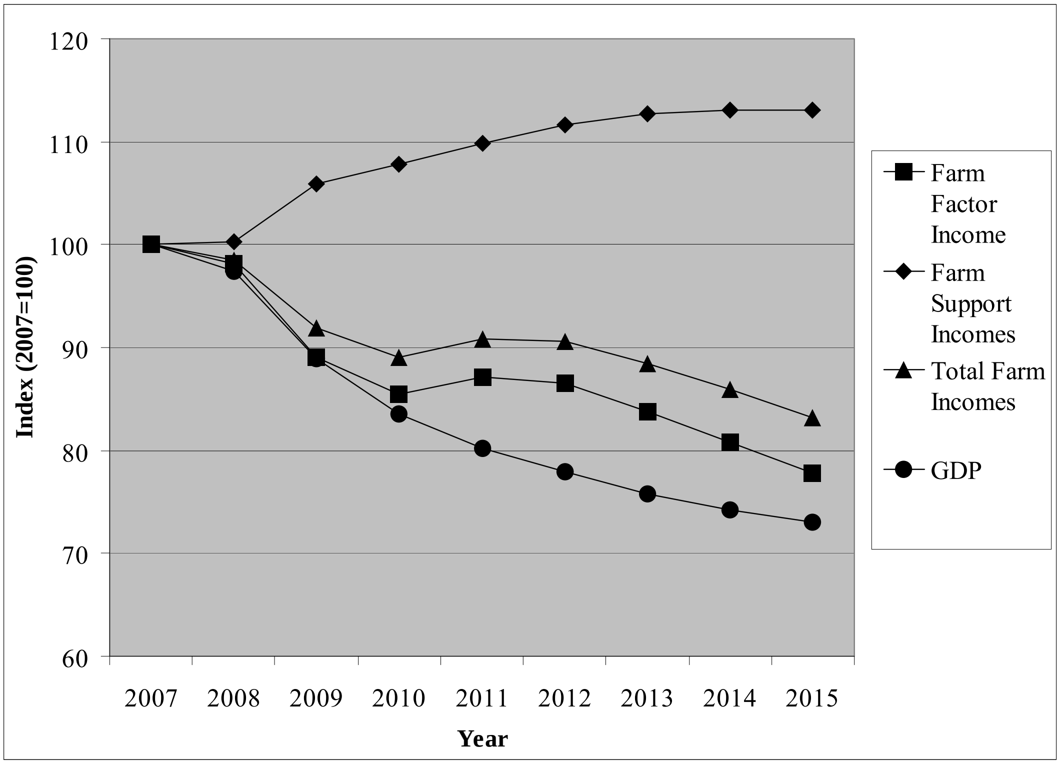

Figure 2: Effect of the Crisis on Real Farm Income