Removal of EU Milk Quotas Using a CGE Model with Imperfect Competition and Heterogeneous Firms[1]

George Philippidis[a] and Robert Waschik[b]

[a] Aragonese Agency for Research and Development (ARAID), Centre for Food Research and Technology (CITA), Zaragoza, Spain and the International Policy Group, Landbouw-Economisch Institut (LEI) Wageningen University, Netherlands and

[b]Centre of Policy Studies (CoPS), Victoria University, Melbourne, 8001, Australia

Abstract

The year 2015 marked the end of one of the longest surviving legacies of the 'old' Common Agricultural Policy (CAP) – the elimination of the milk quota. A review of the modelling literature reveals a number of *ex ante* impact assessments of quota abolition. The general consensus is that quota abolition will benefit aggregate EU milk and dairy output, largely through the mechanism of market price falls as quota rents dissipate. Despite evidence to the contrary in the dairy industry, a further common feature to all these studies is the assumption of perfect competition and constant returns to scale to characterise producer, as well as homogeneous product preferences. This study seeks to fill this gap in the literature by focusing on the export potential of EU dairy producers under conditions of imperfect competition, employing the latest developments in the applied modelling literature.

Consistent with previous studies, the results reveal that milk quota elimination and the associated raw milk price falls, benefit EU dairy exporters in the medium term. In addition, the imperfectly competitive variant offers hitherto unseen empirical insights into the potential changes in the structure of the EU dairy industry. More specifically, the results explicitly quantify the concomitant impact of raw milk quota abolition on firm competitiveness (productivities), the resulting increasing degree of export orientation of EU dairy firms, and show how consolidation of EU dairy industry production into fewer larger operations increases welfare gains to the EU Member States.

J.E.L. Classification Codes: C68, F12, Q18

Keywords: EU dairy quota; export competitiveness; CGE, Melitz model.

[1] The authors would like to thank John Helming and Roel Jongeneel for providing estimates of quota rents. We would also like to thank Zeynep Akgul for kindly providing useful technical material to help represent Melitz imperfect competition.

Removal of EU Milk Quotas Using a CGE Model with Imperfect Competition and Heterogeneous Firms

1. Introduction and Background

On the first of April 2015, over thirty years after its inception, the European Union (EU) dairy quota came to an end. This marked the latest chapter in a series of common agricultural policy (CAP) reforms, initiated more than a decade before, to bring EU dairy policy into line with other common market organisation (CMO) schemes, with the aim of fostering a competitive export oriented sector. The 2003 'Mid-Term Review' mapped out the blueprint for greater market transparency whilst maintaining farmer incomes. More specifically, gradual reductions in price support were sanctioned, accompanied by the removal of 'coupled' Pillar 1 (i.e., market support) dairy payments in favour of a single payment scheme (SPS). Under the auspices of the 'Health Check' in 2008, discrete annual increases in the quota were implemented in preparation for a 'soft landing' when the quota expired in 2015. Additionally, from 2009, the EU has effectively ceased the implementation of export refunds on dairy markets,[2] as internal EU support prices and world prices have converged.

According to official data (Eurostat, 2015), the dairy sector accounts for 14% of EU28 agri-food production (2014 figure). This aggregate statistic, however, conceals considerable heterogeneity across Member States, both in terms of size and industrial structure. On the former, the share of agri-food output committed to dairy is as low as seven per cent in Spain, whilst in the Czech Republic, Estonia, Germany, Ireland, Cyprus, Latvia, Luxembourg, Finland and Sweden, it exceeds 20% (Eurostat, 2015). Furthermore, milk production in many EU countries is largely located in disadvantaged regions (EC, 2014).[3] Consequently, safety nets remain in the form of relatively high import tariffs, public and private storage, the option to voluntarily re-couple Pillar 1 support to dairy farmers (the so-called 'article 68' provision) and the availability of rural development (Pillar 2) funds for farmers in marginal areas.

In terms of industry structure, research by Jongeneel *et al.* (2011) reveals that where data is available, firm concentration ratios in milk processing vary dramatically.[4] Indeed, as part of the 'milk-package' (EU regulation 1308) of 2012, the promotion of stable internal market conditions became a priority. More specifically, a system of farmer-purchaser contracts was enforced in certain Member States to avoid unfair commercial practises and allow farmers to plan production volumes in the wake of the quota abolition. Market stabilisation is also promoted under the auspices of the rural development policy of the CAP, which provides support for the promotion of milk producer organisations (EC, 2014).

---

[2] Notwithstanding, under EU Council (2013) regulation 1370, the EU retains the right to employ export refunds, public intervention measures and/or private storage aids if market conditions dictate.

[3] Disadvantaged regions are typified by mountainous areas, regions in danger of high rural depopulation, less-favoured areas (LFAs). At least 50% of milk production is found in such areas in the following EU regions (in descending order): Latvia (100%), Finland (100%), Malta (100%), Portugal (96%), Austria (88%), Germany (70%), Spain (66%), Czech Republic (64%), Slovenia (61%) and Greece (60%).

[4] Examining firm level data for 2009, in Italy the three-firm concentration ratio (CR3) was calculated at 13.4%, in Latvia the CR4 was 66.6%, whilst in the Netherlands, the CR5 was as high as 80%.

The aim of this paper is to examine the export potential of EU dairy enterprises in the wake of the quota abolition. With detailed global coverage of gross bilateral trade flows, this study favours the use of a multi-region CGE model. Standard modelling representations of agricultural sectors (see section 2) typically assume perfect competition and constant returns to scale to characterise producer behaviour. While this assumption is broadly compatible with agricultural markets characterised by many small producers selling broadly homogeneous commodities with little or no market power, it is clearly less appropriate in food processing sectors due to the existence of retailer market power and product variety. To treat this issue, this research incorporates the latest modelling developments in the imperfect competition literature (Melitz, 2003).

Consistent with previous studies, the results reveal that upon milk quota elimination, the associated raw milk price falls, to the benefit of EU dairy exporters in the medium term. In addition, the imperfectly competitive variant offers hitherto unseen empirical insights into the potential changes in the structure of the EU dairy industry. More specifically, the results explicitly quantify the concomitant impact of raw milk quota abolition on firm competitiveness (productivities) and the resulting increase in the degree of export orientation of EU dairy firms, and show how consolidation of EU dairy industry production into fewer larger operations increases welfare gains to the EU Member States.

The rest of this report is structured as follows. Section 2 presents a literature review of modelling efforts examining EU quota abolition. Section 3 discusses the model data and structure, the Melitz extension and the aggregation and scenario design. Section 4 examines the results, whilst section 5 concludes.

2. Related Literature

Recourse to the modelling literature reveals a number of *ex-ante* assessments of EU quota abolition. A quantitative assessment by Bartova *et al.* (2009) examines the impact of quota abolition in 2015 using the AGMEMOD partial equilibrium model. A parallel study of the dairy sector by Witzke et al., (2009a) and Witzke and Tonini (2009b) uses the CAPSIM partial equilibrium model to assess quota abolition (in 2020). With a comprehensive disaggregation of agricultural and food activities, both models provide sectoral detail of dairy for all EU member states, although in each model, the coverage of non-EU regions; intra- and extra-EU trade flows is highly stylised (i.e. net trade only). Finally, in Witzke et al. (2009c) and Kempen et al. (2011), a quota abolition scenario in 2015 is contemplated using the CAPRI partial equilibrium model. The CAPRI model also caters for a highly disaggregated treatment of EU regions (NUTS 2 regions) and agricultural and food activities, whilst a perceived advantage over other PE model frameworks is the superior treatment of trade. More specifically, in a market module with global coverage (mainly via regional aggregates), gross bilateral trade flows are modelled employing an Armington (1969) specification which exogenously differentiates (otherwise homogeneous product) imports by region of origin using an elasticity of substitution parameter.

In all three studies, the results are consistent. Comparing with a baseline (no-quota abolition), raw milk output is found to rise by between 3% (CAPSIM) and 4% (AGMEMOD and CAPRI), whilst the average EU market price for milk falls by 7% (CAPSIM), 8% (AGMEMOD) and 10% (CAPRI) with the lost capitalisation of rents from quota elimination. Downstream dairy activities are also found to exhibit similar trends. Importantly, the measure of relative competitiveness, dictated by the assumed size of the quota rent, is key to determining the spread of supply responses across the member states under quota abolition.

As an alternative framework for quantitative policy analysis, neoclassical multi-region computable general equilibrium (CGE) models have also been employed to examine EU dairy policy. As economy-wide modelling representations, these models capture the interlinkages between agricultural and non-agricultural product-, input- and factor-markets, with Armington preferences of world-wide gross bilateral trade flows between a highly disaggregated list of single country trading partners. Unfortunately, using input-output national accounts as a key data source for calibrating industry cost structures, multi-region CGE models do not capture the same degree of agri-food sector detail as that typically found in agricultural partial equilibrium models. For example, in the Global Trade Analysis Project (GTAP) database, commonly employed as a basis for conducting multi-region CGE analysis, dairy produce is restricted to a 'raw milk' sector and a single aggregate 'dairy' sector.

Calibrating to version 7 of the GTAP data (benchmarked to 2001), Jensen and Nielsen (2004) use two different sources in the literature to experiment with 'small' and large' quota rent scenarios. They simulate an abolition of the EU's export refunds and the removal of the tariff rate quota regime for dairy products. The authors also concur that calibrated quota rent estimates are crucial for model results. Incorporating a novel treatment of the quota rent as an additional factor of production, Lips and Rieder (2005) also employ a multi-region CGE model (benchmarked to 1997 data) to examine quota and dairy export refund elimination with associated compensatory coupled payments to milk producers. Despite different base years and simulation design, the reported rise in EU milk output (3%) is comparable with PE studies, whilst the magnitude of the market price fall for milk is at the upper end of the spectrum (22%).[5]

More recent modelling of the dairy market can be found within the medium term agricultural market outlooks published by the OECD-FAO (2015) and EC (2015). Both applications use the AGLINK-COSIMO partial equilibrium model.[6] As is typical of this class of models, dairy activity is once again well represented, although unlike the aforementioned PE studies, there is no individual Member State coverage, whilst in a similar fashion to AGMEMOD and CAPSIM, it precludes a detailed treatment of bilateral gross trade flows (i.e., net trade model).

From the perspective of the EU, both publications paint an optimistic picture of world dairy markets, with continued growth fuelled by demand from the growing segment of middle class households, largely located in the dairy deficit regions of Asia (particularly, China).[7] In EC (2015), world dairy demand is forecast to continue growing 1.9% per year over the decade 2015-2025; whilst EU dairy production,

[5] It should be noted that in both CGE studies, older versions of the GTAP data were employed, where tariff protection and export refunds were considerably higher than they are now.

[6] As noted by Adenauer (2008), a perceived advantage of AGLINK-COSIMO for the outlook work is that it is a more adept model for incorporating expert knowledge into the baseline through ad-hoc adjustments, as opposed to the more automated procedures found in other PE and computable general equilibrium model representations.

[7] In fact, India is the world's largest milk producer, although due to its internal consumption, it is not (nor expected to be) a large player on dairy export markets (EC, 2015).

unshackled by quota restrictions, is expected to witness production growth of 0.8% a year, with the result that by 2025, 28% of world dairy exports (particularly in cheese) will be of EU origin (second only to New Zealand).

To summarise, there is a clear consensus within the modelling literature that EU milk and dairy production is expected to expand with the removal of the quota. Both PE and CGE modelling applications offer unique perspectives on this issue, where the former provides far superior sectoral detail, whilst the latter is better attuned to examining global trade-driven impacts. All studies concur that the quota rent estimates, as a proxy for competitiveness, serve as a key determinant of the results. On the other hand, despite evidence to the contrary, there is a dearth of modelling literature which accounts for the role of market power, whilst a homogeneous characterisation of preferences for dairy products does not adequately capture the depth of varietal diversity inherent within the EU dairy sector (i.e., cheese, ice cream, yoghurt etc.).

In seeking to focus on the EU's export potential, the current study favours a multi-region CGE model approach, with global coverage of gross bilateral trade flows. As noted above, the Armington specification exogenously differentiates commodities by region of origin, although trade preferences cannot adapt in response to the emergence of new varieties from different countries. Given the high degree of sectoral aggregation for dairy within the GTAP database, a 'large-group' monopolistically competitive approach with 'love-of-variety' effects is chosen, following the early works of Spence (1976), Dixit and Stiglitz (1977) and Krugman (1979). In focusing on export competitiveness in the EU dairy sector, this research also incorporates recent modelling refinements to this market structure, by drawing on the seminal works of Melitz (2003), Balistreri and Rutherford (2012) and Dixon et al. (2015). A pertinent feature of this extension is the endogenous treatment of firm selection by export route, where the decision to operate in foreign market 's' is based on potential profit, which is a function of the minimum productivity threshold required by firms in export region 'r'. This is discussed further in section 3.2.

3. Methodology

3.1 Multi-region neoclassical CGE

Due to their detailed coverage of global bilateral trade flows, multi-region neoclassical CGE models have become a workhorse in the field of trade policy analysis. Employing a system of 'well-behaved' linearly homogeneous mathematical functional forms, these models enumerate the theoretical tenets of constrained optimisation (i.e., cost minimisation, utility maximisation). Under conditions of consistent aggregation and weak separability, optimisation is compartmentalised into 'nests' to add considerable flexibility to decision-making. These behavioural equations are parameterised to the underlying input-output data to recreate the benchmark year under consideration, known as 'calibration'. Additional market clearing and accounting equations are needed to enforce an equilibrium in all markets. Within a model characterised by 'm' variables and 'n' equations (m > n), 'm-n' variables are chosen to be exogenous ('model closure') to ensure a mathematical solution and also impose economic assumptions regarding the functioning of the economy. For example, labour and capital markets are typically fully flexible and fully employed,[8] savings drives investment and capital and current account adjustments ensure that the balance of payments nets to zero.

Under this class of model, the current study employs the Modular Agricultural GeNeral Equilibrium Tool (MAGNET -- Woltjer and Kuiper, 2014) calibrated to the GTAP database (version 9, 2007 benchmark year, Narayanan et al., 2012), with coverage of 57 sectors, 140 regions and five production factors (land, unskilled-, skilled-labour, capital and natural resources). There are a number of tax and subsidy distortions in the GTAP9 dataset on private and public consumption, usage of intermediate inputs by firms, production of outputs and trade. In addition to factor incomes, all net-tax revenue is assumed to be costlessly collected and redistributed to the representative household. In turn, regional incomes are distributed by constant expenditure shares to private, public and savings demands. In the case of the former, a semi-flexible constant difference of elasticity (CDE) function is employed, which allows the user much greater freedom to target *a priori* expectations or empirical evidence of consumer responsiveness to price and income changes.

With its explicit characterisation of agricultural factor markets (i.e., endogenous land supply, multiple land transformation nests, rents and wage differentials between agricultural and non-agricultural sectors) and product markets (i.e., Common Agricultural Policy mechanisms), MAGNET is well placed for examining the export competitiveness of the EU dairy industry. In addition, given the medium term horizon of this study, considerable resources are employed to provide an accurate baseline of period-by-period market developments (based on available data and reasonable assumptions) against which the policy scenario of quota elimination is compared (see section 3.3). To this end, the study uses MAGNET's recursive dynamic extension to reasonably capture investor expectations in line with projected changes in the capital stock. Moreover, an additional module in MAGNET is incorporated which recalibrates medium-to-long term CDE income elasticities downwards in response to purchasing power parity (PPP) corrected developments in real GDP per capita (ch.9, Woltjer and Kuiper, 2014).[9]

As noted in section 2 above, bilateral trade demands follow the Armington (1969) approach where purchases of intermediate inputs or commodities in private and public consumption are CES aggregates of domestically produced goods and their imported counterparts. Thus, buyers in import region 's' exogenously differentiate domestic and imported varieties of the same good by a CES substitution elasticity σ_{dm}: As $\sigma_{dm} \rightarrow \infty$, goods become homogeneous or perfectly substitutable. So the price of one unit of the Armington aggregate of good *i* (PA_i) will be given by:

$$PA_i = \left[\vartheta_i . PD_i^{1-\sigma_{dm}^i} + \left(1-\vartheta_i\right) . PM_i^{1-\sigma_{dm}^i}\right]^{\frac{1}{1-\sigma_{dm}^i}} \qquad [1]$$

where θ_i is the share of domestically-produced *i* in a country/region's use of *i*, PD_i and PM_i are the unit prices of the domestic good and the import composite good, respectively. Imports are further disaggregated by country/region, so the import price index PM_i is a CES aggregate of imports from different regions. The GTAP database makes the assumption that the substitution elasticity between

[8] In labour markets, the assumption is that unemployment follows a medium-to-long-run natural rate.

[9] This extension prevents unrealistically large increases in consumption of food items in fast growing economies.

imports of good *i* from different regions is $\sigma_{mm} = 2 \cdot \sigma_{dm}$, where σ_{dm} are taken from the GTAP9 dataset (Narayanan et al., 2012). The substitution elasticity between imports from different regions is a key parameter for characterising imperfectly competitive markets.

3.2 Imperfect competition

The representation of Melitz type imperfect competition follows from the treatment in Akgul et al. (2016). The dairy industry, with product heterogeneity and market power, is modelled as imperfectly competitive (whilst the upstream raw milk sector remains as perfectly competitive constant returns to scale, with many milk farms producing a largely homogeneous product).

Thus, following the traditional 'love-of-variety' (see section 2) model, one assumes that consumer utility derived from consuming across a continuum of varieties of *i* in region *s* ($Q_{i,s}$), is a CES aggregate of all available varieties sourced from region *r*. To operationalise the abstract concept of a continuum into discrete units, one draws on Melitz (2003) and Balistreri and Rutherford (2012), who make use of the concept of a representative firm, which charges the average industry price ($\tilde{P}_{i,r,s}$) and produces the average industry output ($\tilde{Q}_{i,r,s}$). In this way, we can define the CES aggregate as:

$$Q_{i,s} = \left[\sum_r N_{i,r,s} \tilde{Q}_{i,r,s}^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i}{\sigma_i - 1}} \qquad [2]$$

where $N_{i,s}$ is the number of varieties of *i* in *s* sourced from *r*. Thus, the standard two–layered Armington structure described in equation [1] is collapsed into a single nest. The price index dual to equation [2] is given as:

$$P_{i,s} = \left[\sum_r N_{i,r,s} \tilde{P}_{i,r,s}^{1-\sigma_i} \right]^{\frac{1}{1-\sigma_i}} \qquad [3]$$

The 'love-of-variety' effect is such that varietal proliferations unambiguously increase CES utility (equation [2]) and decrease the per unit cost of utility (equation [3]). Maximising [2] subject to a budget constraint, the aggregate demand for all varieties of *i* in *s* from all regions *r*, is given as:

$$Q_{i,r,s} = N_{i,r,s} Q_{i,s} \left[\frac{P_{i,s}}{\tilde{P}_{i,r,s}} \right]^{\sigma_i} \qquad [4]$$

Thus, in addition to the standard 'expansion-' and 'price substitution-effects' typically exhibited in Armington demand structures, assuming differentiated commodity demands, aggregate consumer purchases in equation [4] also rise with increases in varietal diversity ('variety effect'), where it is implicitly assumed that there is a one-to-one relationship between the number of 'symmetric' (i.e., equal cost structures) firms and available varieties in the industry.

Furthermore, each firm exercises market power over sales of their variety of the Melitz good in region *s*, and as such will charge an optimal mark-up σ_i / (σ_i -1) over their marginal cost of production $C_{i,r,s}$. The average price charged by the firm with average productivity ($\psi_{i,r,s}$), is given by the mark-up expression:

$$\tilde{P}_{i,r,s} = \frac{C_{i,r,s}}{\tilde{\psi}_{i,r,s}} \frac{\sigma_i}{\sigma_i - 1} \qquad [5]$$

In the imperfectly competitive sectors, costs are divided into variable and fixed costs. The former exhibit a constant returns to scale technology (i.e., marginal cost equals average variable costs), whilst internal scale economies by firms occur as fixed costs are spread over a larger number of units of production. In the Melitz model, fixed costs are also categorised into two concepts. The first, consistent with the 'standard' monopolistic competition model, is that of industry-wide research and development (R&D) and product marketing setup costs which allow firms to operate within the industry in their 'home' region *r*. These costs are equal to the per unit fixed input cost ($W_{i,r,r}$) multiplied by the number of units of fixed setup costs ($H_{i,r}$). Thus, industry profit ($\Pi_{i,r}$) is given as:

$$\Pi_{i,r} = \sum_s N_{i,r,s} \tilde{\Pi}_{i,r,s} - N^p_{i,r} W_{i,r,r} H_{i,r} \qquad [6]$$

which is the sum of the profits of the average firm operating in destination market *s* (r=s; r≠s) multiplied by the number of active firms, less the fixed set up costs associated with the number of potential firms ($N^p_{i,r}$) that operate in industry *i* in region *r*.

The second category of fixed costs are destination-specific fixed trading costs associated with an entry of firms in *r* to any bilateral route *s* (r=s; r≠s). These costs are defined as the per unit fixed input cost ($W_{i,r,s}$) multiplied by the number of units of fixed trading costs ($F_{i,r,s}$). The profit condition for an average firm to operate in a destination market *s* (r=s; r≠s) is therefore given as:

$$\Pi_{i,r,s}\left(\tilde{\psi}_{i,r,s}\right) = \frac{P_{i,r,s}\left(\tilde{\psi}_{i,r,s}\right)}{T_{i,r,s}} Q_{i,r,s}\left(\tilde{\psi}_{i,r,s}\right) - \frac{C_{i,r,s}}{\psi_{i,r,s}} Q_{i,r,s}\left(\tilde{\psi}_{i,r,s}\right) - W_{i,r,s} F_{i,r,s} \qquad [7]$$

Both the fixed trading costs and the profit function (equation 7) determine the firm's productivity $\psi_{r,s}$ in serving any of the *s* markets, drawn from a Pareto distribution whose cumulative distribution is $G(\psi) = 1 - (b/\psi)^{a_i}$, where b_i is the minimum productivity (associated with the least productive dairy producer in each country/region) and a_i is the Pareto shape parameter.[10] There will be a firm with productivity $\psi^*_{i,r,s} > b_i$ for which operating profits are exactly equal to fixed costs. Any firm with productivity below $\psi^*_{i,r,s}$ will not operate in this market. Note also that firm profit is a positive function of market size ($Q_{i,r,s}$)

[10] As noted in Akgul et al., (pp17, 2016), the shape parameter is an assumption regarding the dispersion of productivities across firms within the industry. The higher is the value of the shape parameter, the less dispersed is productivity between firms. As a result, with new firms having more or less the same level of productivity as incumbents, the price charged by new entrants will be very similar to existing firms. Estimating the Pareto distribution parameters *a* and *b* is beyond the scope of this paper - see for example Balistreri *et al*. (2011). Some issues in estimating the Pareto distribution parameter are addressed in Spearot (forthcoming).

and productivity level ($\psi_{i,r,s}$) and an inverse function of average variable costs of production ($C_{i,r,s}$), trade and transportation taxes ($T_{i,r,s}$) and fixed trading costs.

In Akgul et al. (2016), it is shown that average productivity thresholds move in proportion to marginal productivity thresholds:

$$\tilde{\psi}_{i,r,s} = \psi^*_{i,r,s}\left[\frac{a_i}{a_i - \sigma_i + 1}\right]^{\frac{1}{\sigma_i - 1}} \qquad a_i > \sigma_i - 1 \qquad [8]$$

Solving equation [7] to derive the minimum threshold productivity ($\psi^*_{i,r,s}$) and substituting [8], it is possible to define changes in $\psi^*_{i,r,s}$ for the average firm as:

$$\psi^*_{i,r,s} = \frac{\sigma_i^{\frac{\sigma_i}{\sigma_i - 1}}}{\sigma_i - 1}\frac{C_{i,r}}{\tilde{P}_{i,r,s}}\left[\frac{\tilde{P}_{i,r,s}}{T_{i,r,s}W_{i,r,s}}\frac{\tilde{Q}_{i,r,s}}{F_{i,r,s}}\right]^{\frac{1}{1-\sigma_i}} \qquad [9]^{11}$$

Under the conditions of the mark-up, the profit expression [6] and the restriction that industry output be equal to average firm output multiplied by the number of firms in the industry ($N_{i,r}$), it is possible to determine changes in the potential number of firms. Finally, of the number of firms in the industry, only those firms whose productivity threshold satisfies the requirement $\psi_{i,r,s} > \psi^*_{i,r,s}$ may operate in market *s*. More formally, if 1 - $G(\psi^*_{i,r,s})$ is the proportion of firms on the cumulative distribution that are active in market *s*, then it can be shown that:

$$N_{i,r,s} = N_{i,r}\left[\psi^*_{i,r,s}\right]^{-a_i} \qquad [10]$$

In parameterising the Melitz model, the two crucial parameters are the elasticity of substitution between competing varieties sourced from *r* (σ_i) and the shape parameter (a_i). In the absence of any empirically robust estimates, a shape parameter value is chosen such that fixed trading costs ($W_{i,r,s}.F_{i,r,s}$) are assumed to be five percent of total dairy industry fixed costs, whilst also satisfying the restriction that $a_i > \sigma_i - 1$ (see equation [8]).

3.3. Model aggregation and Scenario design

The chosen aggregation (Table 1) explicitly separates both upstream raw milk and downstream dairy sectors. Remaining agricultural activities are aggregated into 'arable' and 'other livestock', whilst a non-dairy composite food sector is also created. Remaining activities are concentrated into four aggregate sectors: Resources, utilities, manufactures and services. For the EU regions, the GTAP data is employed to identify and disaggregate significant net exporters (Belgium, Netherlands, France, Germany) and net

[11] In the model, equation [9] is expressed in log linear terms as:

$$\psi^*_{i,r,s} = c_{i,r} - \tilde{p}_{i,r,s} + \frac{1}{\sigma_i - 1}(f_{i,r,s} - \tilde{q}_{i,r,s}) + \frac{1}{\sigma_i - 1}(w_{i,r,s} - \tilde{p}_{i,r,s} + t_{i,r,s})$$

importers (Italy),[12] with remaining EU producers aggregated into 'rest of the EU28' composite. Similarly, for non-EU regions, key net exporters and importers of dairy products on world markets are selected. All residual production and trade flows, also classified by net-trade type, are captured within two additional composite regions.

Table 1 here

To capture the main global economic developments over the medium term time horizon of our experiment (i.e., 2030), exogenous macroeconomic (i.e., GDP) and population changes are based on the Agricultural Model Intercomparison and Improvement Project (von Lampe *et al.*, 2014), which reflect a *status quo* vision of the world known as shared socioeconomic pathway 2 (SSP2). These shocks are computed for our chosen regional aggregation and implemented over three time periods (2007-2013; 2013-2020; 2020-2030 – see discussion below). Furthermore, it is assumed that capital endowments change at the same rate as real GDP (fixed capital/output ratios); skilled and unskilled labour endowments change in proportion to populations (fixed employment ratios) and natural resources grow at 25% of the rate of capital endowment growth. Additional land augmenting technological change shocks are also adapted from SSP2 of von Lampe *et al.* (2014) and aggregated to our agricultural sector classification.

Based on available data considerations for the baseline shocks, the medium term time frame (to 2030) is split into three discrete time periods (2007-2013; 2013-2020; 2020-2030). To enhance the credibility of the study, a key component of the study is a highly detailed baseline design and implementation employing sector-specific data sources. At the current time, the most comprehensive CAP baseline data on agricultural support payments are taken from Boulanger and Philippidis (2015). Based on auditing data from the European Commission (DG Agri), the CAP baseline provides a detailed breakdown for all EU Member States of changes in pillar 1 payments (i.e., coupled- (including article 68 and 69) and decoupled-payments, market measures, other EAGF payments) and pillar 2 payments (i.e., Axis 1 to 5) between 2007 and 2013. Given the focus of the study, it was decided to employ version 9 2007 GTAP data as a starting point, to which a full representation of pillar 1 and 2 of EU domestic agricultural support is calibrated and baseline shocks between 2007-2013 are implemented (following Boulanger and Philippidis, 2015).

To further complement this 'update' period (2007-2013), additional cost-insurance-freight (c.i.f.) values of trade data from time series database in version 9 release of the GTAP database permit an update of the 2007 global trade flows in dairy trade up to the year 2013 following the procedure in Boulanger et al. (2016).[13] In addition, *all* applied tariffs are shocked to match those within release 9 of the 2011 GTAP database. To capture Russia's 2012 accession to the WTO Russia, WTO MFN tariff rates (WTO, 2016) at

---

[12] According to official sources (Agra Facts, 2016), "some three out of four long-life milk cartons sold in Italy are foreign, while half of the mozzarella cheese produced in Italy is made with milk imported from abroad" (pp.4).

[13] Comparing the time series between 2007 and 2013, dairy trade grew by 41% over the period. Moreover, China's import share grew from 1.4% to 6.4% over the period, whilst Russia (3.6% and 5.1%, respectively) and 'other dairy importers' also witnessed important trade share changes (26.8% and 28.4%, respectively). Also it should be noted that the time period intervals of 2013 and 2020 avoid the need to model the Russian import bans on dairy products in 2014. It is assumed that the ban will be lifted by 2020.

HS4 level are inserted into the tariff aggregator and tariff shock tool TASTE (Horridge and Laborde, 2010) compatible with version 2007 GTAP benchmark , to calculate post WTO accession tariff shocks. Finally, a regional saving shifter variable is swapped with an agro-food trade balance variable for each EU Member, which in turn is targeted to 2013 historical trade balance data (Eurostat, 2016).[14]

In the 2013-2020 period, 'tops-down' CAP payment reductions to pillar 1 and 2 are implemented consistent with the budget agreement 2014-2020 (Boulanger and Philippidis, 2015). Additional tariff rate elimination shocks are included to capture EU enlargement to 28 members and extend the EU-Mexico free trade area (FTA) agreement to Croatia, whilst the TASTE software (Horridge and Laborde, 2010) compatible with 2011 GTAP database is employed to extend the EU-South Africa FTA to Croatia, as well as implement EU28 FTA agreements with Korea, Columbia, Peru and Canada.[15]

As identified from the discussion in section 2, the estimates of EU Member State raw milk quota rents are an influential key driver of model results. In the current study, quota rents are calibrated into the GTAP dataset as output taxes on raw milk production based on estimates for the periods 2007, 2013 and 2020 (no quota elimination), taken from the CAPRI model (Kempen et al., 2011 – see Table 2). [16] In the baseline, quota rent changes between periods are controlled exogenously via changes in the quota rent power, whilst in the period 2020-2030, no further quota rent power changes are assumed. In the period 2007-2013, compounded annual changes in the EU milk quota mimic historical data taken from EC (2016). In the quota elimination scenario, the 'tax' power of the quota rent is completely removed in the 2013-2020 period, whilst milk production is allowed to adjust endogenously.

Table 2 here

4. Results

This section presents results of simulations generated using the baseline assumptions detailed in section 3.3, and contrasts these results against those obtained by running the CGE model after removing EU dairy quotas. We begin with a simple version of the CGE model where all markets (including the dairy sector) are perfectly competitive with symmetric firms producing a homogeneous good. This allows us to generate results which can be compared to those in the literature described in section 2. Then we re-run the simulations with the full model where each dairy sector is modelled as a Melitz sector with differentiated firms producing a heterogeneous product. Results from these simulations can be contrasted to those from the perfectly competitive simulations to highlight the insights gained by modelling the dairy sector as an imperfectly competitive market with heterogeneous firms.

4.1 Prices and Output (perfect competition)

[14] In the first period, we effectively break the Cobb Douglas condition that the expenditure shares across savings, private and public expenditure are fixed. In this way, savings adjusts ensure that macroclosure is enforced. In the absence of this closure swap, it was found in this period that the EU agri-food trade balance deteriorated markedly.

[15] Technically, although the agreement text is finalised, the EU-Canada FTA is not yet legally binding under international law and so is still subject to legal review and ratification.

[16] In an initial run employing complementarities to model the quota, the resulting quota rent increases were deemed far in excess of what was considered reasonable.

Treating dairy production as perfectly competitive, Tables 3 and 4 show changes in milk and dairy output volumes and market prices relative to 2013 (=100) for the period up to 2030. With EU raw milk production under quota, the baseline results reveal that the quota is binding for all the EU Member States across the three periods. As a result, downstream dairy production is also static, where for the EU28, it rises to 100.7. In the non EU regions (results not shown), there is continued steady upward growth compared with 2013 production volumes in 'large' dairy net exporters such as New Zealand (52.0 points), 'other dairy exporters' (ODE – 42.0 points), Australia (40.5 points) and the USA (25.2 points). With the quota rent enforced, over the 17 year time period, the EU28 average raw milk price increases 31.9 index points (Table 4 - approximately 1.64% compound growth per annum), with a concomitant price transmission effect on dairy prices over the same period of 11.5 index points (approximately 0.64% compound growth per annum). In the non-EU regions (results not shown), under conditions of free markets, raw milk and dairy prices are held down by anticipated increases in land productivities, macro growth and endowment rises. This price result is consistent with other prospective studies of agri-food markets (e.g., Baldos and Hertel, 2014; OECD-FAO , 2015).

Tables 3 and 4 here

Under quota abolition, there is a marked impact on EU raw milk and dairy market prices and output volumes over the simulation period. By 2030, EU28 average raw milk and dairy prices fall by 39.1 index points and 10.9 index points, respectively, compared with the baseline (Table 4). On a Member State basis, the largest market price falls in both upstream milk and downstream dairy sectors occur in Belgium, France and the Netherlands (with the largest baseline rent estimates). As a result, by 2030 the largest raw milk output volume increases are witnessed in Belgium (15.6 index points), France (13.7 index points) and the Netherlands (16.4 index points) (Table 3). For the EU28, the rise in milk output volume is 8.1 points over the period (approximately 0.45% annual compound growth). For the EU28 dairy sector, the output volume trends are very similar, resulting in an increase of 7.5 points over the period (approximately 0.43% annual compound growth).

4.2 Trade (perfect competition)

Table 5 shows the volume changes in intra- and extra-EU28 dairy imports and exports.[17] In the baseline, by 2030, extra-EU28 dairy exports rise a moderate 6.1 index points. Examining baseline extra-EU dairy exports by destination region, increases occur only to the 'other dairy importers' region (23.1 index points), due to the FTA shocks between the EU and Korea, Peru, Columbia and Canada.[18] In most other export markets, extra-EU exports fall by 15 to 25 index points in the baseline (except Argentina and the USA where falls are higher). At the same time, there is a strong rise in extra-EU imports (60.7 points – from a smaller base). Intra-EU trade, which constitutes the majority of EU dairy trade, rises by a moderate 1.3 index points by 2030.

Table 5 here

[17] Milk is non-tradable in the GTAP database.

[18] This outcome is probably at the upper end of the scale, since it is perhaps unlikely that Canada would grant significant market access to its sensitive dairy sector.

When eliminating the milk quota, the competitive gain from the drop in milk price has a significant impact on the pattern on EU28 dairy exports. By 2030, extra-EU dairy exports now rise 30.4 index points compared with the baseline, with export increases to all non-EU regions (of between 19.8 index points in Argentina to 44.9 index points in Mexico). With this outcome, the EU28's projected 2030 export share of global exports (by c.i.f. values) rises from 29.7% in the baseline, to 36.8% after quota abolition.[19] As the EU28 becomes more self-sufficient in dairy, by 2030, extra-EU dairy imports fall by 38.1 index points compared with the baseline. As a result, the 2030 EU28 import share of global dairy imports falls from 5.5% in the baseline to 4.0% under milk quota abolition.[20] As different Member States experience different supply response effects from quota abolition, intra-EU trade in 2030 also rises by 6.9 index points compared with the baseline. Notwithstanding, with faster rates of change in extra-EU trade, by 2030, extra-EU dairy trade is predicted to rise from 15.6% of total EU trade in the baseline, to 17.6% of total EU trade (not shown).

Table 6 translates the volume index changes into trade balance impacts (€millions, 2007 prices). In the baseline, between 2013 and 2030 there is an improvement in the EU28 dairy balance of €510 million to €9.111 billion, whilst sustained demand for dairy products in China, Russia and Mexico leads to dairy trade balance deficits in 2030 of €5.597 billion, €3.445 billion and €2.498 billion respectively. On abolition of the quota, with the exception of Germany, EU Member State dairy trade balances improve further compared with the baseline. With its slower projected economic growth, Germany's external trade position (although still positive) is eroded by other, faster growing, EU members. The EU28 trade balance by 2030 rises to a surplus of €12.368 billion, an increase of €3.257 billion compared with the 2030 baseline. This increase in EU trade competitiveness on world markets leads to deteriorating trade balances in the traditionally competitive dairy exporting regions, such as the United States (-€805 million), New Zealand (-€758 million), Australia (-€406 million) and Argentina (-€211 million).

Table 6 here

4.3 GHG Emissions (perfect competition)

Of particular interest to policy makers is the environmental impact of the milk reforms. Indeed, the raw milk sector is an important emitter of non-carbon dioxide (non-CO2) greenhouse gases (GHGs) such as methane (CH4) and nitrous oxide (N2O) from manure management practises as well as enteric fermentation (CH4). With the higher global warming potentials associated with non-CO2 gases, changes in EU milk policy can have important implications for the EU's emissions reductions commitments.[21] In the MAGNET model, the GTAP CO2 and non-CO2 databases satellite data are combined with additional

[19] Calculation excludes intra-EU exports. In EC (2015, pp38), by 2025, the EU is expected have captured 28% of world dairy trade.

[20] Calculation excludes intra-EU imports.

[21] It should be noted that although emissions changes reflect different technical combinations of inputs employing exogenous assumptions of technology (i.e., elasticities of substitution) and 'broad' technological change in output and land, it does not account for the adoption of technological innovations over time which could lower emissions totals (i.e., affordable higher concentrated feeds, improved farm management practises, improved health, fertility and management techniques, or the adoption of lower methane producing breeds). As a result, one should consider the CO2e estimates calculated here as being on the high side.

equations which connect emissions changes between periods with relevant endogenous drivers (input and output changes). Thus, emissions from combustion are driven by input demands for energy types. On the other hand, enteric fermentation and manure management emissions in raw milk are linked to output changes.

Table 7 here

In Table 7, the change in EU28 CO2 equivalent (CO2e) emissions for the milk and dairy sectors are presented. In the raw milk sector, the rise in total emissions in the baseline is, as expected, very limited, (from 69.94 million tonnes (mt) of CO2e in 2013, to 70.87 mt CO2e in 2030). With the restriction on milk output, CH4 and N2O emissions changes are limited, whilst baseline EU28 raw milk CO2e emissions are mainly motivated by changes in the pattern of fuel usage over the period. Under quota abolition, EU28 raw milk sector emissions rise to 74.80 mt of CO2e by 2030 (an increase of 3.93 mt of CO2e compared with the baseline). Interestingly, combustion based CO2 emissions fall slightly (0.3 mt) as the expansion of EU milk production is accompanied by a substitution of capital for energy inputs. In the dairy sector, the vast majority of CO2e emissions are generated from 'conventional' fuel combustion production practises. Compared with the baseline total of 7.68 mt of CO2e by 2030, dairy emissions rise a further 0.52 mt CO2e after quota abolition.

4.4 Economic Welfare (perfect competition)

Table 8 presents the decomposition of EU28 economic welfare, measured by changes in equivalent variation (EV) in millions of euros (2007 prices). In the baseline, under conditions of anticipated economic growth, EV is expected to rise in all EU regions (not shown). For the EU28, the total welfare increase from 2013 to 2030 is measured as €1,392,628 million, or in relative terms, an increase of 10.5 index points in per capita utility (not shown). As expected, the regional welfare impact from quota abolition is insignificant, although to the benefit of all EU28 Member States. For the EU28, there is a welfare improvement of €1.923 billion by 2030 (a rise of 0.1 index points in EU28 per capita real income). Decomposing this EV result (Huff and Hertel, 2001), it is possible to see that most of the EV impacts arise from the terms of trade[22], allocative efficiency effects,[23] endowment effects[24] and technical change (productivity) effects.[25] For the EU28, with removal of the quantitative restriction on milk production, compared with the baseline there are money metric welfare improvements from assumed technical change (€765 million), endowment effects from small factor price rises (€677 million) and allocative efficiency (€627 million), whilst the terms of trade fall (-€193 million) is, in large part, due to the fact that dairy exports are cheaper.

Table 8 here

[22] The marginal impact of changes in the per unit rate of exchange between exports and imports.
[23] The marginal impact of changes in resource allocation relative to pareto optimum efficiency, valued by tax/subsidy distortions.
[24] The impact of changes in the stock of endowments based on marginal changes in factor prices.
[25] The impact of exogenous productivity improvements measured by changes in those values flows (output, input) upon which (exogenous) technical change is present.

4.5 Baseline (imperfect competition)

Tables 9, 10 and 11 present the changes in milk and dairy sector output volumes, market prices and trade, respectively, for the Melitz version of the dairy industry. With the same model drivers, a cursory examination reveals that, qualitatively speaking, the results are very similar to the perfectly competitive (PC) model variant. In the baseline, assumed rates of aggressive economic growth in some non-EU regions (e.g., China, Russia, etc.), lead to greater import demand for (*inter alia*) dairy commodities. With the quantitative constraint on its milk production, the EU cannot respond to these demand signals, with the result that the EU loses market share to other non-EU dairy exporters.

Tables 9, 10 and 11 here

On the other hand, there is a richness of detail on the structure of industry costs, firm output (Table 12), industry entry/exit (Tables 13 and 14), and endogenous productivity changes in response to conditions of competitiveness (Tables 15 and 16), which the PC model does not capture. Indeed, these mechanisms contribute to magnify the 'standard' results in the PC model.

Tables 12, 13, 14, 15 and 16 here

In the baseline, Table 10 shows that the rise in EU raw milk prices is similar to that in the PC model. Under the assumption of a fixed mark-up of price over marginal cost/average variable cost, the increases in market prices for dairy in Table 10 indicate the changes in average variable costs which are key to interpreting results when dairy is modelled as a Melitz sector. As in the PC experiment, Table 11 shows that extra-EU exports rise only slightly in the baseline (3.5 index points), due to the increase in EU exports to the 'other dairy importers' market, whilst this increase is smaller than that in the PC model (6.1 index points – see Table 5). In addition, with the exception of extra-EU exports to 'other dairy importers', the loss of market access (falling $Q_{i,r,s}$ in equation 9) results in rising baseline threshold productivities for the average EU firms operating in foreign markets (Table 16). Under the conditions of equation [10], with rises in foreign market threshold productivities (except in 'other dairy importers'), the number of EU dairy firms operating in non-EU markets will fall (see Table 14).

As internal EU domestic demand conditions (income elasticities) are relatively more stable compared with the more price-sensitive purchasing decisions (trade elasticities) of foreign importers, 'home' sales and minimum 'home' market productivity thresholds (Table 15) hold steadier, such that the number of firms in the EU dairy industry rises by 5.3 index points in the baseline compared with 2013 (Table 13). As a result, baseline intra-EU trade increases slightly more in the imperfectly competitive case compared with the perfect competition case (compare Tables 11 and 5). Translating these baseline trade trends into value terms (Table 17), the 2030 EU28 dairy trade surplus for the EU is €9.290 billion by 2030 in the imperfect competition baseline, compared with €9.111 billion in the perfect competition baseline (Table 6).

Table 17 here

With fewer EU dairy firms operating on extra-EU export routes, fixed trading costs on these export routes will fall. [26] But EU dairy trade is far more concentrated in the EU where there is an increase in the number of dairy firms, so there is a rise in the overall number of dairy firms/varieties in the baseline (Table 13). As a result, the demand for fixed R&D and marketing setup costs rises in the dairy industry. With a 5.3 point rise in dairy firms and only a 0.3 point rise in dairy industry production by 2030 (Table 9), the scale of per firm output falls by five points (Table 12). Firms move back up their average total cost curves with associated rises in average fixed costs per firm, consistent with the observed increases in dairy market prices/average costs presented in Table 10.

Compared with the PC variant, the Melitz model introduces additional sources of welfare, owing to the existence of endogenous changes in minimum productivity thresholds, fixed trading cost effects resulting from endogenous changes in the number of firms by sales route, output per firm scale effects, and variety effects from firm/varietal changes over home and foreign markets (see Table 18). In welfare (money metric) terms, the general rise in the minimum required productivity thresholds generates a competitive gain in the EU28 dairy sector of €255 million over the 2013-2030 baseline (not shown). With only a small 5% share of industry fixed costs, the change in fixed trading costs is negligible; although between 2013-2030 negative scale effects generate a loss of €2.363 million to the EU28 dairy industry. This is weighed against the variety effect gain of €2.964 million as love-of-variety EU consumers have greater choice of dairy products in the 'home' market (i.e., per unit cost of utility falls).

Table 18 here

Finally, from an environmental perspective, the relatively poorer baseline performance of the milk and dairy industry compared with the perfectly competitive model variant, leads to a relative reduction in milk and dairy sector emissions (Tables 7 and 19). Thus, total EU28 CO2e emissions by 2030 in the raw milk sector are down 0.5 mt CO2e compared with the corresponding perfectly competitive total of 70.87 mt CO2e (Table 7). Similarly, imperfectly competitive dairy industry CO2e emissions are 0.05 mt CO2e lower than the perfectly competitive experiment.

Table 19 here

4.6 Quota elimination (imperfect competition)

With the fall in the EU28 average raw milk price by 29.4 points compared with the baseline[27], average variable costs in the dairy industry fall by 10.9 points compared with the baseline (Table 10). The matching fall in industry output prices (due to fixed mark-ups) implies that firms are moving down their average total cost curves (average fixed costs are spread over more units of production). The resulting rise in the scale of EU28 per firm output (Table 12) is an increase of 11.8 points over the baseline by 2030. Comparing with the baseline, EU28 dairy industry output rises by a comparatively slower rate (9.0

[26] In this experiment, the `shape parameter' is calibrated such that fixed trading costs constitute 5% of total dairy industry fixed costs (see section 3.2)

[27] This price reduction is smaller than in the perfectly competitive version, since derived demand from downstream dairy is greater in the imperfectly competitive experiment as the dairy sector expands further (see later).

index points - Table 9) than output per firm, which implies that a 'shakeout' of firms in the dairy sector occurs, (firm numbers fall 2.9 points compared with the baseline - Table 13).

Interestingly, although there are now fewer firms/varieties in the EU28 dairy industry, Table 14 reveals that a proportionally larger share of these remaining incumbents is becoming more export oriented (see also below) along all extra-EU export routes. Under the assumption of love-of-variety by importing regions (see equation [3] and [4]), this generates an additional impulse on demand, with the result that variety loving dairy consumers now purchase more EU products than in the PC model variant. Examining Table 11, by 2030 extra-EU exports increase 43.5 index points compared with the baseline (compared with 30.4 index points in the perfectly competitive experiment – Table 5), whilst intra-EU trade rises by approximately the same magnitude as in the perfectly competitive experiment (see Tables 5 and 11).

Examining the trade balance figures (Table 17), by 2030 the extra-EU dairy trade balance rises to a surplus of €13.328 billion, an improvement of €4.038 billion compared with the baseline. Again, these magnitudes are larger than those recorded in the PC experiment (see Table 6). The EU's export share of global exports (by cif values) rises from 28.1% by 2030 in the baseline (compared to 29.7% in the perfectly competitive experiment), to 35.3% by 2030 with quota abolition (compared to 36.8% in the perfectly competitive experiment). With greater dairy self-sufficiency, extra-EU dairy imports fall by 43.3 index points by 2030 compared with the baseline (Table 11). As a result, the EU import share of global dairy imports falls from 4.8% by 2030 in the baseline (compared to 5.5% in the perfectly competitive experiment) to 3.4% under quota abolition (compared to 4.0% in the perfectly competitive experiment).[28] In addition, by 2030, extra-EU trade rises from 16.1% of total EU trade in the baseline, to 18.5% of total EU trade (compared with 15.6% and 17.6%, respectively, in the perfectly competitive model experiment).

Owing to the increase in extra-EU dairy export sales, the resulting 'market access' effect (see equation 9) implies a reduction in required minimum threshold productivities (Table 16) by export routes (r≠s), which is consistent with the observation of greater extra-EU export orientation by EU28 dairy firms.[29] As all EU regions simultaneously benefit from raw milk price falls, the minimum productivity fall on intra-EU sales (r=s) remains very similar to the baseline (Table 15).

Examining the welfare impacts, the EU28 welfare gain from the quota abolition rises from €1.923 billion in the PC experiment (Table 8), to €5.413 billion in the imperfectly competitive experiment (Table 18).[30] This difference is explained largely by the additional scale and variety effects. In the latter case, the overall reduction in consumer choice for dairy products on domestic markets costs the EU28 economy -€1.825 billion compared with the baseline, whilst the consolidation of the EU28 dairy industry into fewer larger firms generates a significant EU28 scale effect gain of €5.236 billion compared with the baseline. The strong falls in the required minimum productivity thresholds on export routes leads to an efficiency loss in the dairy sector of €91 million compared with the baseline, whilst as in the baseline, the increase

[28] Calculation excludes intra-EU imports.
[29] With the fall in the raw milk price from the loss of the quota rent, this affords downstream dairy producers a competitive edge, which implies a decrease in the required minimum productivity for EU firms to profitable.
[30] In per capita utility terms, this effect is still negligible.

in fixed trading costs compared with the baseline (i.e., more export oriented firms) is negligible (€4 million).

Finally, the increase in dairy activity under quota elimination predictably results in an increase in GHG emissions from both the milk and dairy sectors compared with the perfectly competitive model variant (compare Tables 7 and 19). With quota abolition, milk sector emissions rise to 75.22 mt CO2e by 2030 (4.86 mt CO2e higher than the baseline); a higher figure than the corresponding perfectly competitive total (74.80 mt CO2e). A rise is also observed in the downstream dairy industry, which emits 8.27 million tonnes of CO2e by 2030; a rise of 0.64 million tonnes compared with the imperfectly competitive baseline, and an increase of 0.08 million tonnes compared with the perfectly competitive dairy sector emissions total in 2030 under quota abolition.

5. Conclusions

The removal of EU milk quotas in April 2015 is expected to signal a change in the structure of both the upstream raw milk industry and the downstream dairy sector. In the modelling literature, a number of impact studies (principally partial equilibrium) concur that EU milk (and dairy) supply will rise from quota abolition, although hitherto, each study makes the strong assumption that dairy firms interact within a perfectly competitive constant returns to scale environment. The current study uses the latest developments in the computable general equilibrium (CGE) literature (Balistreri and Rutherford, 2012; Dixon et al., 2015) to apply the Melitz (2003) model to capture the key elements of market power, varietal diversity and the self-selection of firms by sales destinations, to examine how removal of the milk quota impacts on the structure of the dairy industry. The main aim of the current study is to understand empirically the degree to which (i) EU export competitiveness, measured by endogenous changes in firm productivities by sales destination, and (ii) export performance, deviate from traditional 'perfectly competitive' model treatments, whilst also providing realistic estimates of the medium-term outlook for EU dairy producers.

Initially we model the dairy sector like all others in the economy, with homogeneous firms operating in a perfectly competitive (PC) market. We generate baseline results which are consistent with those in the literature: By 2030, EU milk prices are expected to rise by about 32%. Higher milk prices contribute to a stagnating dairy sector which sees output increase by less than 1% by 2030. EU dairy output becomes less competitive on world markets, contributing to deterioration in the EU dairy trade balance. After EU dairy quotas are removed, our modelling suggests a drop in EU milk prices of almost 40% relative to the baseline by 2030. As a result, quota removal leads to an increase in EU milk and dairy output by 2030 of about 8% relative to baseline, and a decrease in EU dairy prices of approximately 11%. Over the period 2013-2030, extra-EU dairy exports rise by 30 index points compared with the baseline, and the EU28's projected 2030 export share of global exports rises from just below 30% in the baseline to almost 37% after quota abolition. A drop in extra-EU dairy imports of 38 index points compared with the baseline makes the EU more self-sufficient in dairy.

Extending the modelling of the dairy sector as an imperfectly competitive (IC) market where heterogeneous firms produce differentiated products with increasing returns to scale makes the representation of the dairy sector more appropriate, since goods produced by this sector are not homogeneous, and since firms likely face significant fixed costs to either enter this industry to begin or continue to serve a particular regional market. Results suggest that the decrease in milk prices which derives from the removal of milk quotas in the EU will lead to a rationalization of the EU dairy sector. Such results cannot be derived from a model where the dairy sector is modelled as being PC. An increase in firm-level output combines with a decrease in the number of dairy firms to lead to a decrease in average dairy prices relative to baseline, and reinforces the welfare gains relative to baseline.

As a general comment, the results in the PC and IC experiments are comparable with other studies in the literature in terms of the expected supply response to the milk and dairy sectors and the export trends. Perhaps surprisingly, the price fall effects for dairy reported here are larger than those reported in (partial equilibrium) studies of quota abolition, despite the fact that the current CGE study is calibrated to CAPRI estimates of quota rents. These price differences could be explained by the supply rigidities on factor transfer modelled in the raw milk sector coupled with the longer time frame of our experiment, which combine to generate larger price rises in the baseline. Moreover, differences in the cost share structure of the dairy sector data in the PE and CGE model representations may produce divergent price transmission effects from upstream raw milk to downstream dairy. What is clear is that, oversupply on the internal EU markets has already reduced milk prices to the extent that the European Commission is considering compensating farmers in return for voluntary cuts in raw milk production, a measure which has received a mixed response amongst Member States (Agra Facts, 2016). A further threat to EU dairy exporters is the environmental implication, where emissions are forecast to rise between 5.5 to 6 million tonnes of CO_2e (perfect competition and imperfect competition, respectively) compared with 2013 levels. Even under a burden sharing scheme, such a rise may be untenable if the EU is to meet its obligations.

Future work could focus on refining the process by which key parameters in the Melitz model are set. It is not clear that the substitution elasticity between imports from different regions in the Armington nest is the best parameter to use in the mark-up formula for dairy firms. This mark-up is properly calculated as a function of the demand elasticity faced by dairy firms, and the Armington substitution elasticity is only one parameter affecting this demand elasticity. Also, the specification of the shape parameter of the Pareto distribution function could have important effects on results. Some issues in estimation of this parameter are addressed in Spearot (forthcoming). Another potential avenue for future research would extend market power in the dairy sector in the opposite direction: As well as having market power in the markets where dairy products are sold, it would be interesting to incorporate the effects of monopsonistic behaviour on the part of dairy producers. There is concern in many countries that large dairy firms are exerting market power on upstream milk suppliers to negotiate reductions in the price of milk used as an input in production of dairy products.

6. References

Agra Facts (2016) No 40-16, 31/05/2016

Adenauer, M. (2008) CAPRI versus AGLINK-COSIMO Two partial equilibrium models – two baseline approaches, Paper presented at the 12th Congress of the EAAE, Ghent, Belgium.

Akgul, Z., Villoria, N. and Hertel, T.W. (2016) GTAP-HET: Introducing Firm Heterogeneity into the GTAP Model, GTAP Technical Paper, forthcoming.

Armington, P. (1969), "A Theory of Demand for Products Distinguished by Place of Production", *IMF Staff Papers* 16(1), 159-77.

Baldos, U.L. and Hertel, T.W. (2014) Bursting the Bubble: A Long Run Perspective on Crop Commodity Prices**,** Working Paper 80, Center for Global Trade Analysis

Balistreri, E. J. and Rutherford, T. F. (2012), "Computing General Equilibrium Theories of Monopolistic Competition and Heterogeneous Firms", in Dixon, P. B. and D. W. Jorgenson (eds), *Handbook of Computable General Equilibrium Modeling*, Elsevier, 1513-70.

Balistreri, E. J., Hillberry, R. H. and Rutherford, T. F. (2011), "Structural Estimation and Solution of International Trade Models with Heterogeneous Firms", *Journal of International Economics* 83, 95-108.

Bartova, L., Fellman, T. and M'barek, R. (eds.) (2009), "Modelling and Analysis of the European Milk and Dairy market", Joint Research Centre Scientific and Technical Report, Institute for Prospective Technological Studies (IPTS), European Commission. http://ftp.jrc.es/EURdoc/JRC50915.pdf (accessed March 10, 2016)

Boulanger, P. and Philippidis, G. (2015) The EU Budget Battle: Assessing the Trade and Welfare Impacts of CAP Budgetary Reform, *Food Policy*, Vol. 51, (2015) pp. 119-130. Available at http://dx.doi.org/10.1016/j.foodpol.2015.01.004

Boulanger, P., Dudu, H., Ferrari, E. and Philippidis, G. (2016) Russian Roulette at the Trade Table: A specific factors CGE analysis of an agri-food import ban, *Journal of Agricultural Economics*, (forthcoming).

Dixit, A.K. and Stiglitz, J.E. (1977) Monopolistic Competition and Optimum Product Diversity, *American Economic Review*, 67, 297-308.

Dixon, P. and Jerie M., and Rimmer M. (2015), "Modern Trade Theory for CGE Modelling: The Armington, Krugman and Melitz Models", GTAP Technical Paper No. 36.

EC (2014) Report from the Commission to the European Parliament and the Council: Development of the dairy market situation and the operation of the Milk package provisions, http://ec.europa.eu/agriculture/milk/milk-package/com-2014-354_en.pdf (accessed March 15, 2016).

EC (2015) EU Agricultural Outlook: Prospects for EU Agricultural markets and Income 2015-2025, December 2015, DG Agri, Brussels http://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook/index_en.htm (accessed March 15, 2016)

EC (2016) European Commission Press Release Database http://europa.eu/rapid/search.htm (accessed March 15, 2016)

EU Council (2013) Council regulation 1370/2013, 'Determining measures on fixing certain aids and refunds related to the common organisation of the markets in agricultural products', 16th December 2013, Official Journal of the European Union.

Eurostat (2015) Economic Accounts for Agriculture, http://ec.europa.eu/eurostat/web/agriculture/data/database (accessed March 16, 2016).

Eurostat (2016) Extra-EU28 trade of food, drinks and tobacco (SITC 0+1), by Member State http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tet00063

Horridge, M. and Laborde, D. (2010) TASTE a program to adapt detailed trade and tariff data to GTAP-related purposes, GTAP technical paper, https://www.gtap.agecon.purdue.edu/resources/download/4938.pdf

Huff, K. and Hertel, T.W. (2001) Decomposing Welfare Changes in GTAP, GTAP Technical Paper 5, Purdue University, USA, https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=308

Jensen, H. and Nielsen, C. (2004) EU dairy policy analysis. Assessing the importance of quota rent estimates, Seventh Annual Conference on Global Economic Analysis, June 17-19, 2004, Washington, D.C.

Jongeneel, R., Burrell, A. and Kavallari, A. (2011) Evaluation of CAP measures applied to the dairy sector, final deliverable, University of Wageningen, Contract No. 30-CE-0382055/00-63

Kempen, M., Witzke, H.P., Pérez Domínguez, I., Jansson, T. and Sckokai, P. (2011) Economic and environmental impacts of milk quota reform in Europe, *Journal of Policy Modeling*, 33(1), 29-52.

Krugman, P. (1979) Increasing Returns, Monopolistic Competition and International Trade, *Journal of International Economics*, 9, 469-479.

Lips, M. and Rieder, P. (2005) Abolition of Raw Milk Quota in the European Union: A CGE Analysis at the Member Country Level, *Journal of Agricultural Economics*, 56(1), 1-17.

Melitz, M. J. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica* 71(6), 1695-1725.

Narayanan, B., Aguiar, A. and McDougall, R. (2012), "Global Trade, Assistance, and Production: The GTAP 8 Data Base", Center for Global Trade Analysis, Purdue University.

OECD-FAO (2015) Agricultural Outlook 2015-2024, OECD Publishing, Paris http://www.fao.org/3/a-i4738e.pdf (accessed March 15, 2016)

Spearot, A. (forthcoming), “Unpacking the Long Run Effects of Tariff Shocks: New Structural Implications from Firm Heterogeneity Models”, *American Economic Journal*.

Spence, A.M. (1976) Product Selection, Fixed Costs and Monopolistic Competition, *Review of Economic Studies*, 43, 217-235

von Lampe, M., Willenbockel, D., Ahammad, H., Blanc, E., Cai, Y., Calvin, K., Fujimori, S., Hasegawa, T., Havlik, P., Heyhoe, E., Kyle, P., Lotze-Campen, H., Mason d'Croz, D., Nelson, G. C., Sands, R. D., Schmitz, C., Tabeau, A., Valin, H., van der Mensbrugghe, D. and van Meijl, H. (2014), Why do global long-term scenarios for agriculture differ? An overview of the AgMIP Global Economic Model Intercomparison. *Agricultural Economics*, 45, 3–20

Witzke, H.P., Zintl, A. and Tonini, A. (2009a) The Common Agricultural Policy SIMulation (CAPSIM) Model: Dairy Reform and Western Balkan Countries Accession Scenarios http://ftp.jrc.es/EURdoc/JRC50411.pdf (accessed March 10, 2016)

Witzke, H. P. and Tonini, A. (2009b). "Milk quota expiry impacts and sensitivity analyses using the CAPSIM model, *German Journal of Agricultural Economics*, 58 (5/6), Humboldt-University, Department for Agricultural Economics.

Witzke, H.P., Kempen, M., Pérez Domínguez, I., Jansson, T., Sckokai, P., Helming, J., Heckelei, T., Moro, D., Tonini, A. and Fellmann, T. (2009c) Regional Economic Analysis of Milk Quota Reform in the EU, Joint Research Centre Scientific and Technical Report, Institute for Prospective Technological Studies (IPTS), European Commission. http://ftp.jrc.es/EURdoc/JRC53116.pdf (accessed March 15, 2016)

Woltjer, G., and Kuiper M. (eds) (2014). The MAGNET model - Module description. LEI Wageningen UR Report 14-057. The Hague

WTO (2016) World Trade Organisation Integrated Database (IDB) Notifications for 2014, Russia, http://tariffdata.wto.org/ (accessed March 24, 2016)

7. Tables

Table 1: Regional and commodity aggregation

<u>17 Regions:</u>
EU regions: (1) Belgium: Belgium (bel); **(2) France:** France (fra); **(3) Germany**: Germany (deu); **(4) Italy**: Italy (ita); **(5) Netherlands:** Netherlands (nld); **(6) Rest of the EU:** Austria (aut), Cyprus (cyp), Czech Republic (cze), Denmark (dnk), Estonia (est), Finland (fin), Greece (grc), Hungary (hun), Ireland (irl), Latvia (lva), Lithuania (ltu), Luxembourg (lux), Malta (mlt), Poland (pol), Portugal (prt), Slovakia (svk), Slovenia (svn), Spain (esp), Sweden (swe), Great Britain (gbr), Bulgaria (bgr), Croatia (hrv), Romania (rou).
'Large'dairy exporters: (7) Argentina: Argentina (Arg); **(8) Australia:** Australia (aus); **(9) New Zealand:** New Zealand (nzl); **(10) Switzerland:** Switzerland (che); **(11) United States:** United States (usa)
'Large'dairy importers: (12) China: china (chn); **(13) Japan:** Japan (jpn); **(14) Mexico:** Mexico (mex); **(15) Russia:** Russia (rus)
(16) Other dairy exporters: India (ind), Bolivia (bol), Brazil (bra), Chile (chl), Colombia (col), Uruguay (ury), Costa Rica (cri), Nicaragua (nic), Rest of EFTA (xef), Belarus (blr), Ukraine (ukr), Kyrgyzstan (kgz), Turkey (tur), Kenya (ken)
(17) Other dairy importers: Remaining GTAP regions

<u>9 Commodities:</u>
(1) Arable: Paddy Rice (pdr), Wheat (wht), Cereal Grains (gro), Vegetables, Fruits and Nuts (v_f), Oil Seed (osd), Sugar cane and Sugar beet (c_b), Plant-based Fibers (pbf), Crops (ocr); **(2) Rawmilk:** Milk (rmk); **(3) Othlive:** Cattle, Sheep, Goats, Horses (ctl), Animal Products (oap), Wool, Silk-worm Cocoons (wol); **(4) Dairy**: dairy (mil); **(5) Othfood:** Cattle, Sheep, Goats, Horse (cmt), Meat Products (omt), Vegetable Oils and Fats (vol), Processed Rice (pcr), Sugar (sgr), Food Products (ofd), Beverages and Tobacco Products (b_t); **(6) Res:** Forestry (frs), Fishing (fsh), Coal (coa), Oil (oil), Gas (gas), Minerals n.e.c. (omn); **(7) Util:** Electricity (ely), Gas manufacture, distribution (gdt), Water (wtr); **(8) Manu:** Textiles (tex), Wearing apparel (wap), Leather products (lea), Wood products (lum), Paper products, Publishing (ppp), Petroleum and Coal Products (p_c), Chemical, rubber, plastic prods (crp), Mineral products n.e.c. (nmm), Ferrous metals (i_s), Metals n.e.c. (nfm), Metal products (fmp), Motor Vehicles and Parts (mvh), Transport equipment n.e.c. (otn), Electronic equipment (ele), Machinery and equipment n.e.c. (ome), Manufactures n.e.c. (omf), Construction (cns); **(9) Svces:** Trade (trd), Transport n.e.c. (otp), Sea Transport (wtp), Air Transport (atp), Communication (cmn), Financial services n.e.c. (ofi), Insurance (isr), Business services n.e.c. (obs), Recreation and other services (ros), PubAdmin/Defence/Health/Educat (osg), Dwellings (dwe)

Table 2: Raw milk shadow price as a proportion of the market price

	Belgium	France	Germany	Italy	Netherlands	Rest
2007	0.720	0.839	0.838	0.808	0.677	0.947
2013	0.722	0.856	0.831	0.833	0.698	0.949
2020	0.726	0.876	0.822	0.862	0.723	0.946

Table 3: Change in milk and dairy output volumes (perfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
Milk	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	100.0	100.0	106.1	115.6	15.6
France	100.0	100.0	108.3	113.7	13.7
Germany	100.0	100.0	105.0	103.0	3.0
Italy	100.0	100.0	103.5	105.5	5.5
Netherlands	100.0	100.0	114.1	116.4	16.4
Rest of EU28	100.0	100.0	100.9	105.9	5.9
EU28	100.0	100.0	104.8	108.1	8.1
Dairy	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	99.2	98.1	105.2	116.1	18.0
France	99.8	99.3	108.8	114.1	14.8
Germany	100.4	100.8	105.7	103.6	2.8
Italy	100.1	100.2	103.5	105.4	5.3
Netherlands	100.2	100.1	115.5	117.8	17.7
Rest of EU28	100.5	101.5	100.3	106.1	4.6
EU28	100.3	100.7	104.2	108.2	7.5

Table 4: Change in milk and dairy market prices (perfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
Milk	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	107.2	155.4	71.8	77.4	-78.0
France	109.1	133.8	87.7	94.4	-39.4
Germany	103.4	118.0	87.2	93.3	-24.6
Italy	107.1	129.4	83.1	85.6	-43.7
Netherlands	103.7	121.0	83.1	89.7	-31.3
Rest of EU28	108.8	139.9	92.6	94.9	-45.1
EU28	107.1	131.9	88.4	92.8	-39.1
Dairy	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	102.8	112.3	96.5	99.0	-13.3
France	103.8	114.2	96.2	100.1	-14.1
Germany	101.8	109.7	95.9	100.5	-9.2
Italy	103.2	111.5	97.8	101.8	-9.8
Netherlands	102.5	111.8	93.5	97.9	-13.8
Rest of EU28	102.3	111.0	98.7	101.1	-9.9
EU28	102.6	111.5	97.2	100.6	-10.9

Table 5: Change in dairy trade (perfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	2030	2020	2030	2030
Intra-EU trade	100.6	101.3	105.4	108.2	6.9
Extra-EU imports	126.8	160.7	104.4	122.7	-38.1
Extra-EU exports	103.0	106.1	120.6	136.5	30.4
Destinations of Extra-EU exports:					
	2020	2030	2020	2030	2030
Switzerland	90.2	79.5	111.7	114.5	35.0
United States	80.4	60.9	100.9	93.4	32.5
Mexico	92.7	83.1	117.4	128.0	44.9
Argentina	72.5	38.2	92.7	58.1	19.8
Russia	91.1	87.0	102.9	112.5	25.6
China	92.1	78.0	112.0	111.3	33.3
Japan	97.2	84.1	115.9	115.2	31.1
Australia	90.3	80.5	111.7	121.2	40.7
New Zealand	91.1	81.5	109.0	114.0	32.5
Other dairy exporters	90.1	75.0	111.6	114.1	39.1
Other dairy importers	114.7	123.1	132.2	159.7	36.5

Table 6: Dairy trade balances (perfect competition) (€ millions, 2007 prices)

		Baseline		Quota abolition		Abolition vs. baseline
	2013	2020	2030	2020	2030	2030
Belgium	62	-9	-140	75	222	362
France	4048	3808	3256	4886	5046	1790
Germany	2885	3542	4474	3908	3812	-662
Italy	-1772	-1617	-1668	-1451	-1469	198
Netherlands	3271	3291	3392	4368	4498	1106
Rest of EU28	106	-110	-203	-1353	259	463
EU28	8601	8904	9111	10434	12368	3257
Switzerland	212	322	524	121	141	-383
United States	-300	289	1289	-112	484	-805
Mexico	-1751	-1990	-2498	-1990	-2498	0
Argentina	679	854	1517	782	1306	-211
Russia	-2925	-2906	-3445	-2905	-3441	4
China	-4707	-5105	-5597	-5104	-5589	8
Japan	-953	-1061	-1152	-1061	-1154	-1
Australia	1160	1321	1681	1126	1275	-406
New Zealand	7172	7758	9088	7388	8330	-758
Other dairy exporters	2231	2478	3427	2141	2681	-746
Other dairy importers	-12393	-14037	-17591	-14032	-17580	10

Table 7: Change in EU28 raw milk and dairy GHG emissions (perfect competition) (million tonnes CO2 equivalent)

Milk sector	2013	Baseline 2020	2030	Quota abolition 2020	2030	Abolition vs. baseline 2030
Carbon dioxide (CO2)	2.19	2.29	2.56	2.22	2.26	-0.30
Nitrous oxide (N2O)	16.01	16.16	16.57	16.56	17.04	0.47
Methane (CH4)	51.74	51.74	51.74	53.83	55.50	3.76
TOTAL	69.94	70.20	70.87	72.61	74.80	3.93
Dairy sector	**2013**	**2020**	**2030**	**2020**	**2030**	**2030**
Carbon dioxide (CO2)	7.49	7.52	7.56	7.78	8.07	0.51
Nitrous oxide (N2O)	0.10	0.10	0.10	0.10	0.10	0.00
Methane (CH4)	0.02	0.02	0.02	0.02	0.02	0.00
TOTAL	7.60	7.63	7.68	7.89	8.19	0.52

Table 8: Decomposition of EU28 Equivalent Variation changes (EV) (perfect competition) (€ millions, 2007 prices)

	2013-2020	Baseline 2020-2030	2013-2030	2013-2020	Quota abolition 2020-2030	2013-2030	Abol. vs. baseline 2013-2030
Allocative	147610	137734	285345	147969	138003	285972	627
Endowment	244701	340336	585037	244926	340788	585715	677
Technical change	3461	1078	4539	3609	1695	5305	765
Terms of trade	144734	-18446	126289	144466	-18370	126096	-193
Population	179171	212248	391418	179202	212262	391464	45
EV total	719677	672951	1392628	720172	674379	1394551	1923

Table 9: Change in milk and dairy output volumes (imperfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
Milk	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	100.0	100.0	110.1	119.2	19.2
France	100.0	100.0	110.9	116.0	16.0
Germany	99.9	99.4	107.0	102.5	3.1
Italy	100.0	100.0	104.5	106.0	6.0
Netherlands	100.0	100.0	121.1	122.7	22.7
Rest of EU28	100.0	100.0	100.8	105.9	5.9
EU28	100.0	99.9	106.1	108.8	8.9
Dairy	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	99.4	97.5	111.4	121.7	24.2
France	99.9	99.2	112.0	116.9	17.7
Germany	100.4	100.2	108.4	103.1	3.0
Italy	100.2	100.2	105.0	106.4	6.2
Netherlands	100.3	100.1	123.6	125.1	25.0
Rest of EU28	100.5	100.9	100.2	106.1	5.3
EU28	100.3	100.3	105.9	109.3	9.0

Table 10: Change in milk and dairy market prices (imperfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
Milk	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	105.7	133.8	73.2	79.6	-54.2
France	107.6	125.6	88.4	94.3	-31.4
Germany	102.5	111.6	88.6	93.1	-18.5
Italy	105.6	120.1	83.4	86.0	-34.1
Netherlands	103.3	115.8	85.9	91.5	-24.3
Rest of EU28	107.0	127.5	92.4	94.7	-32.8
EU28	105.7	122.4	89.2	93.0	-29.4
Dairy	**2020**	**2030**	**2020**	**2030**	**2030**
Belgium	102.1	110.1	93.8	96.4	-13.7
France	103.3	112.0	94.2	97.5	-14.5
Germany	101.4	107.8	94.2	98.7	-9.1
Italy	102.5	109.5	96.1	99.8	-9.8
Netherlands	102.0	109.5	90.5	94.3	-15.2
Rest of EU28	101.9	109.4	97.8	99.7	-9.7
EU28	102.1	109.6	95.7	98.7	-10.9

Table 11: Change in dairy trade (imperfect competition) (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	**2030**	**2020**	**2030**	**2030**
Intra-EU trade	100.9	101.8	110.3	108.6	6.8
Extra-EU imports	125.5	157.6	100.9	114.3	-43.3
Extra-EU exports	101.7	103.5	128.2	147.0	43.5
Destinations of Extra-EU exports:					
	2020	**2030**	**2020**	**2030**	**2030**
Switzerland	86.2	78.9	126.3	136.7	57.8
United States	68.6	48.1	107.0	99.2	51.1
Mexico	93.5	87.8	125.7	139.1	51.3
Argentina	54.9	20.8	93.2	40.7	19.9
Russia	91.0	88.2	107.4	118.3	30.1
China	92.5	81.4	118.8	119.8	38.4
Japan	98.3	88.0	121.8	121.9	33.9
Australia	85.9	81.8	126.0	152.4	70.6
New Zealand	84.9	79.4	120.9	136.5	57.0
Other dairy exporters	84.7	71.8	128.8	143.6	71.8
Other dairy importers	115.3	126.3	139.8	170.0	43.8

Table 12: Change in output per firm in the dairy industry (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	**2030**	**2020**	**2030**	**2030**
Belgium	102.2	92.4	113.0	105.7	13.3
France	98.8	91.2	110.2	107.2	16.0
Germany	101.3	98.8	110.3	108.8	10.0
Italy	102.7	100.3	110.2	111.0	10.7
Netherlands	101.0	95.3	116.7	113.6	18.4
Rest of EU28	99.8	93.9	104.3	104.0	10.1
EU28	100.3	95.0	108.0	106.8	11.8

Table 13: Change in number of firms in the dairy industry (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	2030	2020	2030	2030
Belgium	97.2	105.1	98.4	115.9	10.9
France	101.1	108.0	101.9	109.7	1.7
Germany	99.1	101.3	98.1	94.3	-7.0
Italy	97.6	99.9	94.7	95.4	-4.5
Netherlands	99.3	104.8	106.8	111.4	6.6
Rest of EU28	100.7	107.0	95.9	102.2	-4.8
EU28	100.0	105.3	97.9	102.5	-2.9

Table 14: Number of EU firms operating on non-EU routes (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	2030	2020	2030	2030
Switzerland	92.3	92.1	108.0	114.5	22.4
United States	82.2	71.9	99.1	97.6	25.7
Mexico	96.6	98.9	108.5	117.7	18.8
Argentina	73.3	46.8	92.7	61.9	15.0
Russia	95.3	99.0	99.7	107.7	8.7
China	96.2	95.0	105.3	108.7	13.7
Japan	98.8	97.9	106.3	108.7	10.8
Australia	92.4	94.8	108.0	122.2	27.5
New Zealand	91.7	93.3	105.9	115.7	22.4
Other dairy exporters	91.8	88.8	109.4	118.7	29.9
Other dairy importers	107.5	118.8	114.5	130.4	11.5

Table 15: 'Home' market required minimum productivity thresholds (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	2030	2020	2030	2030
Belgium	100.3	99.7	100.6	99.6	-0.1
France	100.1	99.8	100.6	100.4	0.6
Germany	100.4	100.5	100.6	100.5	0.0
Italy	100.4	100.4	100.5	100.6	0.2
Netherlands	100.1	100.0	100.8	100.7	0.7
Rest of EU28	100.1	100.1	100.1	100.1	0.1
EU28	100.2	100.1	100.4	100.3	0.2

Table 16: EU28 average required minimum productivity thresholds by foreign market (2013=100)

	Baseline		Quota abolition		Abolition vs. baseline
	2020	2030	2020	2030	2030
Switzerland	102.3	103.5	98.0	97.1	-6.4
United States	105.5	110.8	100.0	101.5	-9.4
Mexico	101.1	102.0	98.1	97.1	-4.9
Argentina	108.8	124.2	102.3	114.8	-9.4
Russia	101.5	102.0	99.8	99.0	-3.0
China	101.3	103.0	98.9	99.0	-4.0
Japan	100.4	102.0	98.6	98.8	-3.1
Australia	102.3	103.0	97.8	95.6	-7.4
New Zealand	102.5	103.4	98.5	97.1	-6.3
Other dairy exporters	102.5	104.9	97.4	96.3	-8.6
Other dairy importers	98.2	96.9	96.7	94.5	-2.5

Table 17: Dairy trade balances (imperfect competition) (€ millions, 2007 prices)

		Baseline		Quota abolition		Abolition vs. baseline
	2013	2020	2030	2020	2030	2030
Belgium	68	-33	-209	243	459	668
France	4041	3854	3504	5403	5800	2296
Germany	2889	3471	4106	4192	3191	-915
Italy	-1773	-1742	-1820	-1541	-1644	177
Netherlands	3262	3256	3408	5118	5281	1873
Rest of EU28	120	-80	302	-2398	240	-61
EU28	8607	8726	9290	11018	13328	4038
Switzerland	241	350	472	64	37	-435
United States	-457	522	1673	-379	222	-1451
Mexico	-1455	-1654	-2076	-1653	-2075	1
Argentina	789	974	1679	895	1496	-183
Russia	-3293	-3273	-3877	-3270	-3872	6
China	-4568	-4950	-5423	-4957	-5424	-1
Japan	-979	-1089	-1184	-1089	-1184	0
Australia	1264	1398	1678	1116	1148	-530
New Zealand	7609	8103	9345	7758	8749	-596
Other dairy exporters	2581	2829	3768	2276	2726	-1041
Other dairy importers	-13483	-15267	-19124	-15260	-19114	11

Table 18: Decomposition of EU28 Equivalent Variation (EV) (imperfect competition) (€ millions, 2007 prices)

		Baseline			Quota abolition		Abol. vs. baseline
	2013-2020	2020-2030	2013-2030	2013-2020	2020-2030	2013-2030	2013-2030
Allocative	148064	137917	285981	148888	138426	287314	1333
Endowment	245506	341683	587189	245675	342019	587694	505
Technical change	3698	1409	5107	3732	1652	5384	277
Terms of trade	145365	-17561	127804	145034	-17470	127564	-240
Population	179642	212888	392529	179694	212958	392652	123
Variety	32	2932	2964	-1056	2195	1139	-1825
Scale	149	-2513	-2363	3379	-506	2873	5236
Fixed trading costs	3	-1	1	6	-1	5	4
EV	722459	676753	1399212	725352	679272	1404624	5413

Table 19: Change in EU28 raw milk and dairy GHG emissions (imperfect competition) (million tonnes CO2 equivalent)

		Baseline		Quota abolition		Abolition vs. baseline
Milk sector	**2013**	**2020**	**2030**	**2020**	**2030**	**2030**
Carbon dioxide (CO2)	2.15	2.23	2.40	2.19	2.23	-0.17
Nitrous oxide (N2O)	15.95	16.05	16.27	16.68	17.07	0.81
Methane (CH4)	51.76	51.75	51.70	54.57	55.92	4.22
TOTAL	69.86	70.04	70.37	73.45	75.22	4.86
Dairy sector	**2013**	**2020**	**2030**	**2020**	**2030**	**2030**
Carbon dioxide (CO2)	7.49	7.51	7.52	7.90	8.15	0.63
Nitrous oxide (N2O)	0.10	0.10	0.10	0.10	0.10	0.01
Methane (CH4)	0.02	0.02	0.02	0.02	0.02	0.00
TOTAL	7.61	7.63	7.63	8.01	8.27	0.64