From World Market to Trade Flow Modelling
– The Re-Designed WATSIM Model –

Final Report on the Project:

WATSIM AMPS

- Applying and Maintaining the Policy Simulation Version
of the World Agricultural Trade Simulation Model -

by

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Introduction

The version of WATSIM which has been in use until 2001 has covered all countries of the world, aggregated to 10 stylised regions, and 29 raw and processed agricultural products.[1] To make WATSIM a suitable tool to analyse international agricultural trade, a substantial effort to redesign the model has taken place during the duration of the WATSIM AMPS research project. The changes to be implemented to the model comprise a new regional composition of the model which will be described in the next section. But even more important, WATSIM had to be transformed: from a gross trade model clearing through a "world market" to a trade flow model in order to reflect the impact of bilateral trade policies. For instance, the impact of the EBA ("everything-but-arms") agreement on both the EU and the beneficiary countries can hardly be analysed when trade flows between individual regions in the model are not taken into consideration.

This progress report consists of three parts. First, the methodological issues connected with the redesign of the model are discussed, followed by a detailed description of the model functions. The second part describes the model database with a special emphasis on the new regional structure and the incorporation of interregional trade. The third part describes the model parameters and the two resulting alternative reference runs. The fourth part of the report is devoted to sensitivity analyses and a policy application. A critical assessment of the achievements and limitations of the current model design concludes this report.

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1 This version will be referred to as WATSIM99, since it has been developed in the year 1999.

1 Methodological Issues

In this section the redesigned WATSIM shall be described. To explain the necessity of changes, a short overview on the previous WATSIM99 version (HENRICHSMEYER et al. 2001, VON LAMPE 1999) of the modelling system is given in the following.

1.1 Basic Modelling Features of WATSIM99

Simulation year concept:

The WATSIM99 database consisted of time series dating from 1961 to 1997. On the basis of these time series, projections on basic trends in consumption levels and patterns, feed use, yield levels and crop acreage for future years (e.g. 2005 and 2010) were calculated. These trends were complemented by assumptions on inflation of commodity prices. The trends were then used to calculate projected regional area use, livestock inventories, yields, production levels, and at the same time consumption elements like human consumption, feed use, processing and others for the years 2005 and 2010. The emerging gaps between regional supply and demand were finally closed by varying the net trade component in the commodity balance. WATSIM99 was thus both a tool for commodity outlook, but also for *comparative-static analysis* of external shocks and policies.

Gross trade model concept:

WATSIM99 was a model which considered both imports and exports of the same commodity. As usually, this was done by using a concept called the Armington approach (ARMINGTON 1969). It has emerged because classical trade theory has not been able to explain the existence of both exports and imports even in small countries. The Armington approach has several problems, one of these is that if there has been no trade in the reference situation, no trade flows can emerge when for instance price relations change.

World market concept vs trade flow model:

WATSIM99 was based on the assumption that all countries import from and export to a fictitious "world market". This means that there were no bilateral trade flows: the countries/regions exported to and imported from some kind of a commodity pool. This concept can deal with national trends and global trade policy changes like multilateral liberalisation, but it is limited when dealing with bilateral or preferential trade relations.

1.2 Model Features of the New WATSIM

A number of methodological changes were needed to improve the analytical power of the former WATSIM99. These comprise the representation of trade flows, tariff quotas and other non-smooth policy measures, and the static nature of the model.

Representation of trade flows

As already mentioned, WATSIM99 was a numerical trade model which had an Armington-style gross trade formulation (i.e. imports and exports of the same commodity at the same time in the same country). However, all trade has been channelled through a stylised world market, and all trade prices were linked through a uniform world market price. This is basically contradicting the *Armington assumption* of commodities differentiated by their geographical origin. In this trade model, ACP sugar, for instance, is not the same as EU sugar, but a more or less close substitute with a different price. In that way the Armington assumption allows to model commodity flows in a fairly realistic manner by facilitating the modelling of both imports and export in the same period.

On the way to the new truly spatial WATSIM, the model has been transformed into a real trade flow model in order to fully exploit the opportunities of the Armington approach. This has an important consequence: there is no uniform world market price any more. The imports of a country are now the sum of bilateral commodity inflows from several regions. However, the special formulation of the trade model does not allow for trade flows to emerge which have not existed before. Nevertheless, countries can change their net trade position, but not so easy as in a common net trade model, depending on trade elasticities in the Armington-style trade equations.

Representation of trade policies

Even though the multilateral trade agreements under the auspices of the WTO are intended to rule out discriminatory trade policies, “positive” discrimination is still increasing world-wide. The major reason for this is the fact that market access concessions have to be granted by industrialised member states, and the most common instrument in that area are tariff rate quotas (TRQs). WATSIM99 was able to represent only global TRQs through a non-linear approximation function. To analyse problems of bilateral trade concessions, the handling of region-specific TRQs is now standard in WATSIM. However, a complete coverage of all existing TRQs world-wide is an enormous effort, taking into consideration that TRQs are increasingly used to meet the market access requirements of the WTO obligations.

Other trade policies comprise intervention prices, which are modelled as minimum prices in WATSIM. Intervention price regimes are characterised by flexible levies which emulate safeguard measures, and, more importantly, by export refunds. If a TRQ is present in the bilateral trade relationship, the flexible levy is ruled out, and instead a TRQ tariff regime is applied. The floor price is then guaranteed by the export subsidy alone, as it is the case for large parts of the EU sugar market. When a country pays export refunds in the presence of bound exports, stocks are built up to prevent exports increase beyond the bound. These stocks represent the structural surplus which emerges due to the minimum price policy, and are not carried over to the next simulation period.

Developing a model with dynamic features

The reference run of WATSIM99 is built upon trend estimations for the years 2005 and 2010. This procedure has been inevitable since a dynamic formulation of the model (i.e. certain model variables are dependent on results from previous periods) has not been feasible in the past due to lacking computational power. The disadvantage of trend estimations independent from each other for different variables and regions was an unbalanced database for the reference run. A change in the model formulation towards MCP will allow to save two thirds of CPU time required for the iterative solution process, so that there is no argument any more against a dynamic model formulation.

It is now possible to use WATSIM like a quasi-dynamic model which solves on the basis of the trend-corrected results of the previous period *t*-1. The merit of such an approach is that the development of important variables can be presented over the whole simulation period. This is particularly interesting when is comes to tariff reduction and other liberalisation schedules. However, it is important to note that the endogenous price paths which WATSIM produces are heavily dependent on the trend shifters for land availability, yields, per-capita consumption, and income. These *trends*, as will be explained later, have been derived more of less by extending past trends up until now. But there is an important drawback to this approach, which is the equating of an ex-post *trend* with the *shifter* in a supply or demand function. These *shifters* are rather an exogenous input into a market model, while the *trends* represent the total market result of equating supply and demand through equilibrium prices. The true but non-observed *shifter* for, e.g., beef demand in China may be much higher than the observed *trend* in per-capita consumption, but could perhaps not materialise due to shortfalls in supply. The consequence of this pitfall in WATSIM at the moment would be to estimate these shifters together with the supply and demand elasticities in a consistent framework by using econometric techniques of system estimations. Unfortunately, such an approach would go far beyond the resource endowment of WATSIM AMPS, and it is questionable as to whether international commodity statistics deliver enough data at all to arrive at robust estimations.

In view of the fact that the resources of the WATSIM staff to carry out outlook activities is limited, the shifters currently used in WATSIM are past trends which have been modified in order to roughly meet price projections delivered by the outlook publications of the DG Agriculture (2002), OECD (2002) and FAPRI (2002, 2003). This approach still allows for sensitivity analyses regarding alternative productivity or consumption developments, particularly for regions where the future trends are somewhat uncertain, such as the CIS or China. Sensitivity analyses will then result in different price trends compared to the central reference run oriented at OECD/FAPRI. The consequences that a less positive price trend for grain would have for the CAP of the European Union is clear: it would be more difficult to defend the domestic price levels without returning to export subsidies in a larger scale. The latter might be further restrained in the coming WTO negotiations, and the EU should be aware of the fact that too optimistic assumptions on the price developments in the next decade could lead to concessions in the area of maximum subsidised exports which might be difficult to comply with in the end.

1.3 Detailed Model Description

The new model version of WATSIM is a trade flow model which is formulated as an MCP problem. This variety of models, which is a generalisation of the more common NLPs (nonlinear programmes), allows the direct simulation of non-smooth inequalities which are not feasible in an NLP. Particularly TRQs, domestic quotas, flexible levies or safeguards, and export refunds can be modelled in this way.

The following chapters introduce the reader into the individual equations of the model. Variables and parameters are explained as appropriate.

1.3.1 Production

As long as activity levels refer to cropping areas, it is obvious that the total available cropping area world-wide as well as in the WATSIM regions can not increase without limits. Therefore the total cropping area has an upper limit for each region and simulation year, and a ratio is calculated to reflect whether the total cropping area in a WATSIM region is under- or overused.

Eq. 1: Ratio between available and used cropland

$$landratio_r^t = \sum_i Z_{i,r}^t \Big/ \sum_i Z_{i,r}^{trend^t}$$

The level of production activities for commodities with a yield parameter (crops, livestock) is determined by a double-log function. An increase beyond the limit is constrained the *landratio* variable:

Eq. 2: Level of production activities

$$Z_{i,r}^{(t)} = \frac{Z_{i,r}^{(t-1)} \cdot \prod_{j} \left(\frac{p_{j,r}^{P(t)} + prem_{j,r}^{t}}{p_{j,r}^{P(t-1)} + prem_{j,r}^{(t-1)}} \right)^{\varepsilon_{i,j,r}^{P}}}{landratio_{r}^{t}}$$

with

Z = activity level (cropping area, livestock number)

t = number of the simulation year

p^P = producer price

$prem^t$ = price equivalent of area payments and other premiums

ε^P = constant supply elasticity

i = WATSIM products

r, s = WATSIM regions

When using the above formulation, the model reflects a sequence of comparative-static experiments. Even though the assumption may not be realistic for any commodity that producers react on the producer price of the harvest year regarding their activity level (crop area or livestock inventory), it is necessary as long as the model does not contain a price expectation function which does not allow for cyclic supply behaviour.

If a quota is in force, the activity level is fixed to the quota:

Eq. 3: Level of production activities under quotas

$$Z_{i,r}^{(t)} = Q_{i,r}^{(t)}$$

with

Q = production quota (activity level or production amount)

Agricultural producers tend to react on price changes primarily by increasing or decreasing activity levels. But to a smaller extent they also change the yield levels of crops. A uniform yield elasticity of 0.1 for crops has been assumed for the current WATSIM version.

Eq. 4: Level of yields

$$Y_{i,r}^{(t)} = Y_{i,r}^{(t-1)} \cdot \prod_j \left(\frac{p_{j,r}^{P(t)}}{p_{j,r}^{P(t-1)}} \right)^{\xi_{i,j,r}^{P}}$$

with

Y = yield variable

ξ = yield elasticity

The production quantity of activity-based commodities is determined by the yields which are multiplied with the activity level:

Eq. 5: Production quantities

$X_{i,r}^{P(t)} = y_{i,r}^{(trend)} \cdot Z_{i,r}^{(t)}$; with $y = 1$ for processed commodities

with

X^P = Production quantity

The supply of processed products such as oils or milk products is also price-responsive. However, it is assumed that producers anticipate the increase in demand for the processed product between *t*-1 and *t* by multiplying the population increase times the trend in per-capita consumption (the last term in the equation below) and add this to the constant in the supply equation. In the absence of better estimates of the processing capacity in the food industry, this approach prevents an excessive price increase over the simulation periods due to underestimated supply response by processors.

Eq. 6: Supply of processed products

$$X_{i,r}^{(t)} = X_{i,r}^{(t-1)*} \cdot \prod_j \left(\frac{p_{j,r}^{P(t)}}{p_{j,r}^{P(t-1)}} \right)^{\varepsilon_{i,j,r}^{P}}$$

with

$X^{(t-1)*} = X^{(t-1)} + (POP^t - POP^{t-1}) \bullet CONTRD_{i,r}$

POP = regional population in the simulation year

Eq. 7: Production quantities under quotas

$$X_{i,r}^{P(t)} = Q_{i,r}^{(t)}$$

1.3.2 Demand

Domestic demand (X^C) consists of human consumption, feed, processing, seed, waste and other uses:

Eq. 8: Regional demand

$$X_{i,r}^{C} = X_{i,r}^{H(cons)} + X_{i,r}^{F(feed)} + X_{i,r}^{I(proc)} + X_{i,r}^{S(seed)} + X_{i,r}^{W(waste)} + X_{i,r}^{O(other)}$$

with

X^C = regional demand

Individual demand components

Human consumption is determined by multiplying the consumption amount of the previous year with the price reaction (second term on the right hand side) and the demand trend *CONTRD*.

Eq. 9: Human consumption per capita

$$X_{i,r}^{Hpc(t)} = X_{i,r}^{Hpc(t-1)} \cdot \prod_j \left(\frac{p_{j,r}^{C(t)}}{p_{j,r}^{C(t-1)}} \right)^{\varepsilon_{ij,r}^{C}} + CONTRD_{i,r}$$

with

X^{Hpc} = human consumption per capita

P^C = consumer price

CONTRD = human consumption trend parameter (linear)

Total human consumption is per-capita consumption multiplied by the population in the simulation year.

Eq. 10: Total human consumption

$$X_{i,r}^{H} = X_{i,r}^{Hpc(t)} \cdot POP_r^t$$

with

X^H = total human consumption

POP = regional population in the simulation year

Feed demand and demand for raw products to be processed is similarly determined as human food demand, thus using a price elasticity applied to the price change, and a trend factor:

Eq. 11: Feed demand

$$X_{f,r}^{F(t)} = X_{f,r}^{F(t-1)} \cdot \prod_j \left(\frac{p_{j,r}^{P(t)}}{p_{j,r}^{P(t-1)}} \right)^{\varepsilon_{ij,r}^F} \cdot FEEDBAL_r$$

with X^F = feed demand

FEEDBAL = feed demand balance

The feed demand balance reflects the feed energy balance between energy need of animal production and energy content of feed used:

Eq. 12: Feed energy balance

$$FEEDBAL_r = \frac{X_{l,r}^L \cdot ENEED_{l,r}}{X_{f,r}^F \cdot ENER_f}$$

with X^L = animal product (meat and milk)

ENEED = energy need of one unit of animal production

ENER = energy content of feed commodity

Eq. 13: Demand of products for processing activities

$$X_{i,r}^{I(t)} = X_{i,r}^{I(t-1)} \cdot \prod_j \left(\frac{p_{j,r}^{D(t)}}{p_{j,r}^{D(t-1)}} \right)^{\varepsilon_{ij,r}^I}$$

with

X^I = industrial demand

P^D = domestic price

Other uses and waste enter the model as fixed shares of consumption demand:

Eq. 14: Other uses

$$X_{i,r}^{O(t)} = \left(X_{i,r}^{H(t)} + X_{i,r}^{F(t)} + X_{i,r}^{I(t)}\right) \cdot \frac{X_{i,r}^{O(bas)}}{\left(X_{i,r}^{H(bas)} + X_{i,r}^{F(bas)} + X_{i,r}^{I(bas)}\right)}$$

with

bas = base year

Eq. 15: Waste

$$X_{i,r}^{W(t)} = X_{i,r}^{C(t)} \cdot \left(\frac{X_{i,r}^{W(bas)}}{X_{i,r}^{C(bas)}}\right)$$

Also the input-output relations between raw and processed products as well as seeds to harvest amount are fixed, based on the base year relation.

Eq. 16: Input-output relation between raw and processed products

$$X_{i,r}^{I(t)} = X_{j,r}^{P(t)} \cdot \left(\frac{X_{i,r}^{I(bas)}}{X_{j,r}^{P(bas)}}\right)$$ for i = milk, oilseeds ; j = milk products, oilseed products

Eq. 17: Input-output relation for seed demand

$$X_{i,r}^{S(t)} = X_{i,r}^{P(t)} \cdot \left(\frac{X_{i,r}^{S(bas)}}{X_{i,r}^{P(bas)}}\right)$$

The following equation describes the substitution of domestic for imported commodities according to the Armington assumption. It is basically a cost minimisation exercise (first order condition) based on a CES utility function. The elasticity of substitution between domestic and foreign goods is ρ, while δ is a share parameter reflecting the expenditure ratio of the imported commodity in the total expenditures of the representative consumer.

Eq. 18: Determination of import demand

$$X_{i,r,s}^{M} = X_{i,r}^{D} \cdot \left(\frac{p_{i,r}^{D}}{p_{i,r,s}^{M}} \cdot \left(\frac{\delta_{i,r,s}}{1 - \sum_{s} \delta_{i,r,s}}\right)\right)^{\left(\frac{1}{1+\rho_{i,r}}\right)}, \quad r \neq s$$

with

X^M = imports

X^D = consumption of domestic origin (domestic sales)

p^M = import price

ρ = CES substitution parameter

δ = CES share parameter

1.3.3 Commodity balances

Production must be equal to domestic sales plus exports to other regions (= imports of other regions from r, as expressed in the equation below) plus the build-up of stocks in case of limited subsidised exports.

Eq. 19: Regional supply balance

$$X_{i,r}^{P} = X_{i,r}^{D} + \sum_{s \neq r} X_{i,s,r}^{M} + X_{i,r}^{STOCKS}$$

with

X^{STOCKS} = "GATT-stocks"

Demand must be equal to domestic sales plus imports from other regions:

Eq. 20: Regional demand balance

$$X_{i,r}^{C} = X_{i,r}^{D} + \sum_{s \neq r} X_{i,r,s}^{M}$$

The two balance equations ensure that regional and thus also world markets are cleared.

1.3.4 Prices

The producer price is equal to the price for domestic sales p^D plus direct support measures (direct and indirect PSE transfers and area payments).

Eq. 21: Producer price

$$p_{i,r}^{P} = p_{i,r}^{D} + pse_{i,r}^{d} + pse_{i,r}^{i} + \frac{arep_{i,r}}{y_{i,r}^{trend}}$$

with

$pse^{d,\,i}$ = direct and indirect producer subsidy equivalents per tonne of production

arep = area payments

The effect de-coupling area payments from production can be simulated by adding a de-coupling factor.

Eq. 22: Aggregated consumer price

$$p_{i,r}^{C} = \frac{p_{i,r}^{D} \cdot X_{i,r}^{D} + \left(\sum_{r} p_{i,r,s}^{M} \cdot X_{i,r,s}^{M} \right)}{X_{i,r}^{C}} - cse_{i,r}$$

with

cse = consumer subsidy equivalent

The consumer price is a weighted average of domestic and import prices minus indirect consumer subsidies (*cse*).

Eq. 23: Export price

$$p_{i,s,r}^{E} = p_{i,r}^{D} - refund_{i,s,r}^{E} \cdot \left(\frac{X_{i,r}^{Esubs}}{\sum_{s} X_{i,s,r}^{M}} \right)$$

with

$refund^{E}$ = export refund per ton

The export price is the world market price from the viewpoint of the importer. It is equal to the domestic price for domestic sales minus export refunds in the case of administrative minimum prices. The export refunds are then reduced by the ratio of subsidised exports to total exports.

Import prices

Eq. 24: Import price without price floors or TRQs

$$p_{i,r,s}^{M} = p_{i,r,s}^{E} \cdot \left(1 + tc_{i,r,s}^{Mav}\right) + tc_{i,r,s}^{Msp} + freight_{i}$$

with

p^{E} = export price

$tc^{Mav, Msp}$ = ad-valorem and specific import tariffs

$freight_{i}$ = transport costs

In the presence of safeguard regulations, a flexible levy covers the difference between p^{m} and p^{e}.

Eq. 25: Import price with price floors and no TRQs

$$p_{i,r,s}^{M} = p_{i,r,s}^{E} + flev_{i,r}^{MPF}$$

with

flev = flexible levy

Eq. 26: Import price with a TRQ

$$p_{i,r,s}^{M} = p_{i,r,s}^{E} + tc_{i,r,s}^{IQT} + qr_{i,r,s}^{TRQ}$$

with

tc^{IQT} =in-quota tariff

qr^{TRQ} = TRQ quota rent

In the case of TRQs, the import price is formed by adding ad-valorem (tc^{Mav}) and specific tariffs (tc^{Msp}) to the export price of the delivering region. In the case of domestic price floors (MPF) and the absence of a TRQ in the bilateral trade relation, a flexible levy ($flev^{MPF}$) is charged instead. In the case of TRQs, the in-quota tariff (tc^{IQT}) is charged plus the "quota rent equivalent" (qr^{TRQ}). In the latter case, a possible price floor is both guaranteed by applying flexible levies in other trade relations without TRQs, and by export subsidies which clear domestic markets from excess supply.

1.3.5 MCP equations

The use of flexible levies, export refunds, TRQs and the build-up of GATT stocks requires the modelling of non-smooth functions. For that purpose, the model has been redesigned into the MCP mode, which allows the modelling of non-smooth inequality conditions. The design of this system of MCP equations to model agricultural trade policies is a major achievement which has been made in the course of the research project. Principally, an MCP equation is a conditioned inequality depending on "flag variable". An illustrative example is the MCP condition for flexible levies.

Eq. 27: MCP condition for flexible levies

$$p_{i,r}^{imp} + flev_{i,r} \geq MPF_{i,r} \cdot pthres_{i,r} \quad \perp \quad flev_{i,r} \geq 0$$

MPF = intervention or minimum price

pthres = threshold factor in EU grain markets (1.55)

The import price index is higher than the floor price MPF times the threshold as long as the flexible levy is zero. If the import price is about to fall below MPF, *flev* becomes positive and ensures that the import price will be the same as MPF. The lower bound of the flexible levy is thus zero.

In the case of the EU sugar common market organisation, the safeguard regulation is somewhat more complicated and has thus been reflected using a non-linear approximation function:

Eq. 28: Approximation function

$flev^{Sugar,\ EU15} = (-180) * \log(p^{world}) + (1450)$

with p^{World} = Average world export price

The MCP formulation of export subsidies is somewhat more complicated. Export subsidies are assumed to be differentiated across target regions. There are two MCP equations governing this mechanism, while the amount of subsidised exports is determined by a logistic function. The logistic function makes sure that subsidised exports do not occur when domestic market price increases beyond the minimum price plus roughly 15%.

Subsidised exports are determined by logistic approximation functions in two different ways. In the normal case, where the WTO-limit refers to exactly one WATSIM commodity, the subsidised exports of the commodity converge to the WTO-limit, which makes a separate condition to observe this limit unnecessary.

Eq. 29: Quantity of subsidised exports – one WTO-limit per one WATSIM commodity

$$X_{i,r}^{Esubs} = X_{i,r}^{E\max} \cdot \left(1 + \exp\left(\frac{lpar_{i,r}}{\left(MPF_{i,r} \cdot dist_{i,r}\right) \cdot \left(p_{i,r}^{D} - MPF_{i,r} \cdot dist_{i,r}\right)}\right)\right)^{-1}$$

with

X^{Esubs} = total amount of subsidised exports

X^{Emax} = maximum of subsidised exports (WTO-limit)

lpar = parameter which determines the slope of the approximation function

dist = parameter defining the level of domestic prices at which the function reaches its maximum. At a value of 1, half of the maximum level of the function is the result.

Calibrated values for *dist* can be found at around 1.1, with values for *lpar* of about 40.

In the case of coarse grains in the EU, where the WTO-limit applies to three WATSIM commodities (barley, maize, other grains), the subsidised exports of the commodity converge to the total exports of the single commodities, because it would not be useful to let them converge jointly to the WTO-limit. This design implies that the WTO-limit to subsidised exports is not automatically observed by the logistic function for coarse grains as compared to the case of ordinary commodities.

Eq. 30: Quantity of subsidised exports – collective WTO-limit for several WATSIM commodities

$$X_{i,r}^{Esubs} = \sum_{s \neq r} X_{i,s,r}^{M} \cdot \left(1 + \exp\left(\frac{lpar_{i,r}}{\left(MPF_{i,r} \cdot dist_{i,r}\right) \cdot \left(p_{i,r}^{D} - MPF_{i,r} \cdot dist_{i,r}\right)}\right)\right)^{-1}$$

The next two equations calculate the level of the spatially different export subsidies.

The spatially differentiated export subsidy is calculated according to the following equation:

Eq. 31: MCP condition for export refunds – basic spatial subsidy rate

$$p_{i,s}^{D} - \left(tariffs_{i,s,r} + freight_{i}\right) \geq \left(p_{i,r}^{D} - red_{i,r}\right) - subs_{i,s,r}^{spat} \quad \perp \quad 0 \leq subs_{i,s,r}^{spat}$$

$subs^{spat}$ = regionally differentiated export subsidy

If the specific subsidy component is positive, the above equation becomes an equality, determining the level of the subsidy to the price difference between the domestic price of the exporter and the import price of the trade partner.

There is also an additional rate which is paid as soon as the domestic market price falls below the floor price:

Eq. 32: MCP condition for export refunds – additional subsidy rate

$$p_{i,r}^{D} \geq \left(MPF_{i,r} - red_{i,r}\right) \quad \perp \quad 0 \leq subs_{i,r}^{add}$$

with

$subs^{add}$ = additional export subsidy

The total export subsidy is then calculated as follows:

Eq. 33: Export refunds – total subsidy rate

$$refund_{i,r,s} = subs_{i,r}^{add} + subs_{i,r,s}^{spat}$$

If the additional export subsidy and the total refund are positive, the domestic price has to be equal to the floor price until the total refund is about to go beyond its upper bound. This upper bound is a maximum which the CAP regulations determine for export subsidies paid per tonne. Once the upper limit of the refunds is reached, the domestic price would fall below the intervention price. This is the moment when “GATT-stocks” are built up, which constitute the structural surplus of the commodity which the EU cannot get rid of with the CAP instruments under WTO restrictions.

When consequently exploiting the logic of the MCP framework, a formulation for the problem of bound subsidised exports looks like this:

Eq. 34: Determination of the build-up of "GATT-stocks" – MCP solution

$p_{i,r}^{D} \geq MPF_{i,r} \cdot 0.99 \quad \perp \quad 0 \leq X_{i,r}^{STOCKS}$ for ordinary commodities, and

$X_{i,r}^{E\max} \geq \sum_{s \neq r} X_{i,s,r}^{M} \quad \perp \quad 0 \leq X_{i,r}^{STOCKS}$ in the case of coarse grains.

One can see that the trigger for ordinary commodities is that the domestic price falls below MPF because the export subsidies cannot increase any more, while the trigger for coarse grains is given when the export subsidy goes beyond the WTO-limit. The coarse grains solution has been chosen because the logistic function governing the quantity of subsidised exports of coarse grain does not converge to the WTO limit of coarse grains.

The variable X^{STOCKS} is then the amount of stocks which enters the commodity supply balance (equation 19 above).

The quantitative MCP equations for TRQs are:

Eq. 35: MCP condition for TRQs

$$TRQ_{i,r,s} \geq X_{i,r,s}^{M} \quad \perp \quad \left(tc_{i,r,s}^{OQT} - tc_{i,r,s}^{IQT}\right) \geq qr_{i,s,r}^{TRQ} \geq 0$$

with

tc^{OQT} = over-quota tariff

As long as imports are below the quota, the quota rent qr^{TRQ} as a supplement to the in-quota tariff will be zero. As soon as imports are equal to the quota, the quota rent can increase from zero to the difference between the over-quota and the in-quota tariff. If the quota rent is at its upper limit, imports can further increase beyond the import quota.

This expression of quotas implies that global (non-bilateral) tariff rate quotas will be evenly distributed among the exporting countries according to their historical trade shares in the corresponding commodity.

2 The WATSIM Database

The update and extension of the comprehensive WATSIM data base is one of the crucial points in this project, since it provides the basis not only to work with most recent data available, but represents the necessary precondition for the change from a world market to a trade flow model. Principally, the raw data contain information on hundreds of products from almost all countries in the world. The objective of the WATSIM database system is to aggregate this information to the WATSIM region and commodity scheme, and to ensure consistency of the commodity and trade accounts. The database consists of two fundamental components.

Non-Spatial Database (NSDB)

On the one hand, the Non-Spatial Data Base (NSDB) for the WATSIM modelling system contains data given by FAOSTAT, USDA, the World Bank and OECD. Time series comprise the years 1961 to 2000, which allows to determine 2000 as the model's base year. The most important part of the non-spatial database contains FAO data regarding regional land use and production, SUAs (supply and utilisation balances), import prices and trade. Also the population growth trends are taken from the FAO. FAO data are complemented by USDA data where appropriate. Data on regional per capita income from the World Bank and policy data delivered by the OECD complete the WATSIM-NSDB.

Data are read in raw form and aggregated to the WATSIM regions and commodities after having been processed in a routine called CONSIS which ensures the SUAs' consistency for every single country in the database. Also the information on trade policies from the OECD is re-calculated in a FORTRAN routine into specific tariffs and direct PSEs and CSEs.

To better cover trade policies in non-OECD countries (mostly developing and transition economies), the TRAINS database by UNCTAD and the AMAD database have been used to get information on applied ad-valorem tariffs and TRQs. These data are not read in by a FORTRAN routine, but directly inserted into the GAMS code. TRQ information from AMAD is mostly not specific to particular countries of origin of the preferential imports. Some regionally specific import quotas, such as the ACP sugar import quota in the EU, have been obtained from other sources (e.g. NEI 2000).

Spatial Database (SDB)

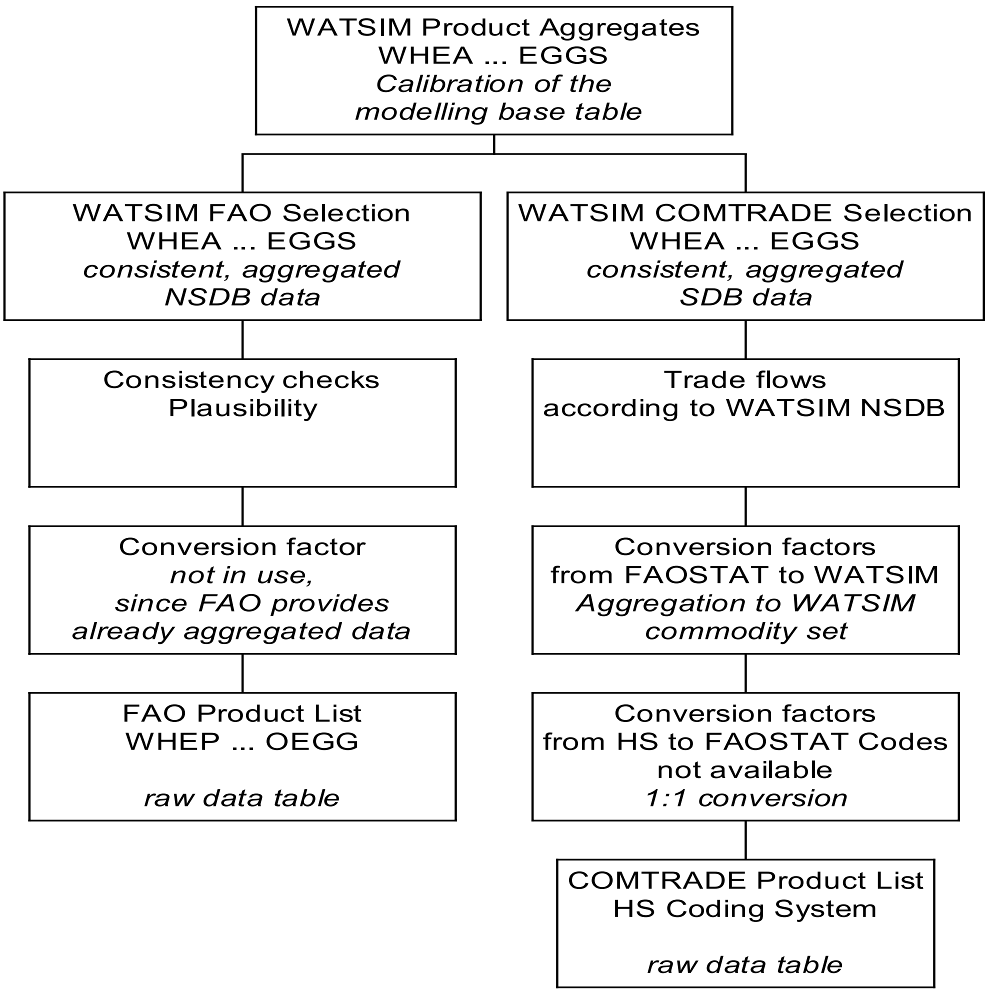
The Spatial Data Base (SDB) contains bilateral trade flows across all WATSIM regions. The COMTRADE database published by the United Nations Statistic Division represents the source of necessary data on trade flows for the WATSIM-SDB. To process the raw data from COMTRADE, a consistency check was employed to ensure that

a) the trade flow data are consistent with each other (i.e., import and export quotations must match), and

b) the resulting trade data are consistent to the NSDB data.

In previous versions of WATSIM a cross-entropy (CE) calibration approach had been used for this purpose, but only for trade flows separately. The new version of WATSIM uses a balancing method which minimises least squares of deviations of all quantitative variables compared to the data input. The main problem of merging different data sources is that product definitions differ across data sources. For the modelling system, however, the data had to be aggregated to a specific level and checked for consistency in order to create a sound reference run.

Figure 1: Data processing in the WATSIM modelling system



Source: Own representation

As an example, Figure 1 shows the aggregation process for the two main production, demand and trade data sources FAOSTAT and COMTRADE. The final merged database is shown at the top of the diagram. For the COMTRADE data string, the determination of the right conversion factor between the codes of the Harmonised System (HS) and FAOSTAT, which are similar to the SITC 2 coding system, is unsolved. Therefore, a 1:1 conversion is used, i.e. values and quantities of these HS products are added together to SITC 2 product aggregates, knowing that processing steps may already have changed the composition of single raw products. Since at this step the aggregation level is quite low (HS 6 digit), the resulting error is expected to be relatively small.

For further aggregation of COMTRADE data to levels used by WATSIM, detailed conversion factors are available and have been used. Due to the co-operation with colleagues from DG-Agri, the WATSIM-SDB now includes properly aggregated data for all WATSIM model commodities.

2.1 Regional Composition of WATSIM

To meet the requirements of the new trade policy agenda of the EU Commission, the regional composition of WATSIM has been modified in order to include particular groups of developing countries. In particular, new groups of developing countries are contained in the updated WATSIM version: ACP countries, the Mediterranean countries and the Middle East, India, those members of the "Cairns Group" which are developing countries, and a group of highly protectionist OECD countries (Japan, Switzerland, Norway, and Iceland). The groups of EU 15 countries and the EU candidate countries are not be changed. The following table gives an overview on the groups present in WATSIM:

Table 1: Regional composition of WATSIM

E15	**EU 15**
CEE	**EU Applicant Countries** (countries applying for accession to the EU)
ANZ	**A**ustralia and **N**ew **Z**ealand
ACP	**ACP** countries
CAD	**Ca**irns **D**eveloping
MED	**Med**iterranean and Middle East
HIT	Japan, Switzerland, Norway, Iceland
Other countries	Canada, USA, India, China (each individual)
ROW	**R**est **o**f **W**orld (all other countries not explicitly mentioned)

WATSIM is foremost a policy analysis tool tailored for the needs of EU decision makers. The individual countries USA, Canada, India and China have been introduced because they are important players on the world agricultural markets as either producers or consumers. The composition of some of the groups is oriented at the similarity of the members regarding agricultural trade policy, which is the case with "Cairns developing" (CAD), ANZ and "High tariff countries" (HIT). Other groups are chosen because they correspond to country groups which have special trade relations with the European Union, such as CEE, ACP and MED. The criteria which determine the group composition do not necessarily lead to geographically homogenous groups, which is particularly the case with CAD, HIT, and ACP. Therefore the presented version of WATSIM is not a true spatial equilibrium model which could take transport costs into account in a reasonable way.

2.2 Commodity Breakdown

The commodity composition of the 29 WATSIM commodities has not been changed from previous versions and is as follows:

- Sugar: processed commodity in refined (white sugar) equivalents.
- Cereals: wheat, barley, maize, other cereals, rice
- Starch crops (containing potatoes, yams, etc.)
- Oilseeds: soybeans, rape, sunflower, other oilseeds
- Oils and cakes of the above mentioned oilseeds

- Pulses
- Meat products: beef, pig meat, poultry, meat of other origin
- Eggs
- Milk products: milk, butter/cream, cheese, skimmed milk powder

Since the world markets for oilseeds are fairly liberalised, it would be possible to aggregate the individual oilseeds, oils and cakes into one commodity respectively. This would make the model easier to solve. Problems exist in particular with the market for skimmed milk powder (MILS), because the commodity statistics of the FAO are not complete for this product. This refers to the fact that MILS (in liquid form) is both a processed product and an input to cheese and other milk products like calf feed.

3 Two Alternative WATSIM Reference Runs

3.1 General Features

The fact that WATSIM is not a comparative-static model, but a model which solves for consecutive years, means that two different runs of the model over the simulation period have to be compared in any impact analysis: a *reference run* on the one hand, and a *scenario run* including the intended external shock on the other hand. This chapter intends to give a short overview on the assumptions underlying the current WATSIM reference run. Two "frame scenarios" about the development of world agricultural markets have been designed. The main difference between the two scenarios are the assumptions on the productivity trend in the former Soviet countries. These are dominating the Rest-of-World (ROW) aggregate region in WATSIM. One scenario assumes that the crop yields and livestock productivity in ROW will only slightly improve during the first decade of the 21st century. This scenario will come more close to the current outlook assumptions of FAPRI and the OECD which involve a relatively steep increase in world prices for wheat and other grains. The second scenario, however, is more optimistic regarding the yield trends in the CIS (and thus ROW) and would lead to only slightly improving nominal grain prices.

3.1.1 Exogenous Assumptions for the Reference Run

The reference run of a model like WATSIM is predominantly driven by exogenous trend and shift parameters, as inflation, land availability, productivity, incomes and consumer preferences. These parameters are called non-policy parameters, while tariffs, intervention prices, subsidies, and quantitative restrictions are policy parameters. Most non-policy parameters have to be estimated in some or the other way for the regional aggregates and the specific commodities. This estimation is currently not mainly an extrapolation of past trends, with some important exceptions.

In order to be able to predict prices and quantities for the future, the numerical simulation model has to contain trend shifters for yields, land availability and human consumption (taste shifts, income and population growth) which are to a certain extent independent from market developments. While population and income trends are borrowed from external sources (UN, World Bank), agricultural trend shifters are calculated on the basis of the WATSIM database which contains time series dating back to 1961. However, this does not mean that all trend parameters can simply be calculated by extrapolating linear time series trends. In many cases time series reveal the effects of structural changes which cause a kink in the trend. The most prominent example for such a structural change is the end of central planning in the countries of Eastern Europe and the former Soviet Union. The transition period after the end of communism was accompanied by a pronounced production and demand slump, particularly for the production of grains, oilseeds and livestock products, while demand decreased mainly for high-valued products like meat and milk products. In the most recent years it appears that this transition crisis in post-communist countries like Russia and Ukraine is coming to an end, and that agricultural production is recovering. Simply extrapolating trends from the nineties for transition countries would mean that world market prices for many agricultural commodities would be grossly overestimated, taking the immense production potential of these regions into account.

The change of the regional composition of WATSIM means that many of these trends had to be re-calculated for the new WATSIM regions. This meant detailed estimation work,[2] comparisons with estimations from other institutions, and finally a lot of model runs to ensure that the interplay of these trends produce reasonable results. A recursive dynamic model like the new WATSIM version is more prone to instability due to weird trends than a comparative-static version which calculates future prices only against a base year price and does not produce a price path. Therefore trend parameters have to be carefully estimated, compared, discussed, and tested.

Non-policy parameters: using past trends as shifters

Macroeconomic trends: WATSIM internally calculates with real prices. Nevertheless, inflation can be observed in the real world, even though to a lesser extent than in the seventies and eighties. For the simulation period of the model, the inflation is expected to amount to an average annual rate of 1.8% for the whole world, a figure which is in line with inflation expectations by OECD and FAPRI. If real prices in the model are to be kept constant, nominal monetary parameters like specific tariffs, fixed payments, intervention prices etc. have to be deflated by this inflation rate in the course of the solution run of the model. After the solution of the model, real prices p_{real} are inflated to nominal prices p_{nom} using the formula $p_{nom}^{t} = p_{real}^{t} \cdot (1+ifl)^{t-1}$ with *ifl* as inflation rate and *t* as the number of simulation periods.

But why not simply calculate in nominal prices? The reason for this is that the demand and supply elasticities in the model are calibrated according to some basic microeconomic assumptions about the behaviour of the agents. One of these is the assumption that producers

2 The number of commodities (29) times the number of regions (12) is 348. Commodity-specific trends are needed for yields and human consumption, which means 696 trends to be estimated.

and consumers do not succumb to money illusion. This means that economic agents are aware of inflation and will not produce more or consume less because nominal prices increase. To reflect this properly in the model, real prices have to be used, because the model formulation of any demand function implies a decreasing demand when prices increase. But since price increases driven by inflation do not reflect increased scarcity of the commodity under consideration, this would lead to severe biases in the course of the solution process, and even more so in a dynamic model. Regarding *exchange rates*, prices and values in WATSIM are expressed in constant 2000 US$. The long-term exchange rate between the Euro and the Dollar is assumed to be 1:1.

Moreover, WATSIM contains trends on assumed regional economic growth. Economic growth has two countervailing effects: on the one hand, it enables consumers to buy more goods and hence consume more. In the case of basic food stuffs, on the other hand, increasing incomes lead to a decreasing marginal willingness to pay for basic demands (food), while demand for "luxury goods" (e.g. motorcars) is increasing much faster. While the demand increasing income effect is mainly incorporated in the per-capita demand shifters, the decreasing marginal willingness to pay is reflected by an increasing processing margin (driven by an income increase of the national economy) in the demand functions of the model. Trends of per-capita income are shown in the following table.

Table 2: Assumed regional growth trends in real income per-capita

	Annual growth of per-capita income
EU 15	2.25%
CEECs	4.15%
India	2.50%
China	5.74%
Austr./NZ	1.82%
Cairns developing	2.82%
USA	1.54%
ACP countries	0.50%
Medit. & Middle East	1.50%
High tariff traders	1.89%
Canada	1.88%
Rest-of-World	1.20%

Source: World Bank, World Development Indicators database

Major uncertainties exist for several country groups. Especially, it may be questionable as to whether the growth rates of groups containing transition countries are not underrated, as for instance "Rest-of-World" containing Russia and many other countries of the former Soviet

Union. However, a much more important parameter influencing commodity demand is the per-capita demand shifter described in the following.

Demand trends: The demand trends are extrapolated from per-capita food demand data from the FAO database. As already discussed in the general description of the model, some uncertainties exist also within this group of exogenous shifters, again mainly in country groups which contain transition countries.

The most prominent figures are shortly mentioned in the following. For wheat, there is still a quickly increasing demand world-wide with slightly more than 0.5 kg per capita and year. The two most important regional figures for wheat demand can be found for China and India. Both countries have a population of more than one billion, and will become net importers of wheat when current trends continue and trade liberalisation will be accelerated. In the case of China, the figures also suggest that a substitution of other cereals and starch crops for wheat. In India, both demand for rice and wheat will continue to increase over the next decade at the cost of “other cereals”, the latter probably traditional local varieties.

Table 3: Assumed regional growth trends in per-capita demand (kg/per capita/year)

	EU 15	CEECs	India	China	Aus./NZ	Cairns dev.ping	USA	ACP	Mediterr.	High Tariff	Canada	ROW
Wheat	-0.009	0.055	0.607	1.013	-0.435	0.124	0.720	0.046	0.896	0.205	0.662	0.238
Barley		-0.007	-0.016		0.010	0.004	-0.007	-0.022	-0.027		-0.005	-0.005
Maize		-0.135	0.010		0.046	0.294	0.278	0.263	0.441		0.001	0.129
Other cereals	-0.088	-0.482	-0.395	-0.151	-0.080	0.021		0.069	-0.184	0.007	0.092	-0.077
Rice	-0.147	-0.160	0.654	0.149	0.098	0.306	-0.024	-0.059	0.139	-1.022	0.033	-0.152
Starch	-0.495	-0.085	0.549	-0.997	0.782	-0.553	0.860	0.230	0.627	-0.205	0.409	-0.707
Sugar	-0.099	0.127	0.345	0.145	-0.135	0.422	0.075	-0.005	0.075	-0.143	-0.076	0.106
Pulses		-0.004	-0.137	-0.065	0.134	0.058	0.054	-0.057	-0.018	-0.023	0.119	-0.020
Soybeans	-0.016	0.002		0.031	0.005	0.057				0.022		-0.009
Sunflower					0.002	0.001			0.000			-0.041
Rapeseed			0.012		0.002							0.002
Other oilseeds		0.039	0.104	0.064				-0.032	0.129	0.018		0.018
Soy oil	0.028	0.013	0.038	0.038	-0.011	0.050	0.187	0.016	0.033	0.041	-0.107	0.036
Sunflower oil	0.018	0.008	0.020	0.002	-0.002	0.011	-0.002	0.003	0.071	0.003	-0.002	0.005
Rape oil	0.102	0.092	0.044	0.080	0.010	-0.001	0.008	-0.003	0.003	0.048	0.383	0.003
Other oils	0.005	0.004	0.017	0.060	0.182	0.031	-0.053	0.047	0.030	0.022	-0.001	0.086
Beef	-0.117	-0.090	0.016	0.342	-0.752	0.027	-0.225	-0.067	0.043	0.261	-0.809	-0.087
Pork	0.405	-0.331	0.010	1.110	0.215	0.164	-0.031	0.030	0.008	0.385	-0.189	-0.208
Other meat	0.006	-0.059	0.001	0.082	-0.666	-0.002	-0.028	-0.002	0.000	-0.031	-0.019	-0.011
Poultry	0.258	0.183	0.020	0.443	0.426	0.302	0.625	0.021	0.183	0.207	0.506	0.143
Eggs	-0.040	-0.106	0.042	0.919	-0.212	0.106	-0.090	0.008	0.153	0.186	-0.129	-0.083
Milk	-0.951	-1.247	0.281	0.250		0.969		0.007	0.148	0.174	-1.891	0.352
Cheese	0.077	0.019		0.001	0.041	0.004	0.076	0.000	0.004	0.023	0.029	0.001
Butter	0.006	0.019	0.010	0.000	-0.120	0.000	-0.012	-0.002	-0.026	-0.005	-0.054	0.007
Skim milk				0.000	-0.002	0.001	0.006		0.000	0.003	-0.001	0.002

Source: FAO database, own calculations

While Chinese and Indian consumers show similar patterns regarding crop demand, their demand growth for livestock commodities will be completely different. While Indian consumers only expand the demand for milk products, Chinese consumers increase mainly the demand for meat. Particularly pork, followed by poultry and beef, will become a part of the daily diet for more and more people. This of course will require increased feed use, and thus increased imports of feed commodities. World-wide demand for cheese will also increase, but mainly in the industrialised countries.

Yield trends (mainly derived from FAO data) constitute the most important supply shift parameter. Major uncertainties exist for the developments in transition countries. The grain yield trends according to the FAPRI projections assume that the transition economies will only slowly recover from the transition recession. This means that in the reference run nominal world market prices will increase by about 20 US$/t for wheat. This scenario may look somewhat optimistic, but one has to bear in mind that already in the beginning of the nineties a production boost for the CIS countries following the introduction of free market economies had been expected, which has not yet materialised.

The world-wide yield trends indicate that the largest progress can be expected for maize, sugar, oilseeds, and rice. All of these crops will increase their area productivity by more than 1.5 % per year. Traditional cereals, starch crops and pulses are lagging somewhat behind, which has clearly to do with stagnating long-term demand for these crops. In the area of livestock production, eggs, poultry and milk productivity will increase by around two percent per year. When looking at individual WATSIM regions, it is striking that the EU 15 is the world leader in raising the productivity of wheat, maize, starch crops, and soybeans production. Another distinctive country is China which is leading in raising the productivity of the rice, pork, poultry, and eggs production. The “Cairns Developing” group is on top with sugar and “other oilseeds”, most of the latter palm oil. On the other hand, productivity growth of almost all commodities is far below the world average in the ACP countries, most of them sub-Saharan African countries.

Table 4: Assumed regional growth trends in yields (in kg per ha or animal unit)

	EU 15	CEECs	India	China	Aus./NZ	Cairns dev.ping	USA	ACP	Mediterr.	High Tariff	Canada	ROW
Wheat	88.85	32.08	55.88	50.61	21.23	28.23	5.77	25.21	23.00	45.08	18.97	23.23
Barley	24.00	64.54	29.92	25.71	28.64	30.54	22.84	4.92	20.08	36.31	41.08	26.46
Maize	150.71	35.30	27.17	136.58	159.60	50.24	105.90	16.67	81.58	144.09	93.73	32.71
Other cereals	43.61	44.18	13.43	56.78	18.58	19.95	41.35	2.10	23.50	30.82	33.60	14.88
Rice	31.02	25.31	32.25	63.43	36.10	34.56	44.45	5.61	67.45	35.11	0.00	27.26
Starch	602.28	63.54	278.86	232.35	530.54	80.86	541.75	58.79	365.42	224.29	322.28	36.80
Sugar	81.31	91.80	94.45	30.35	84.85	148.54	37.23	43.46	21.38	50.11	88.67	47.38
Pulses	45.59	51.28	3.98	20.29	0.02	7.45	14.44	-2.40	3.80	14.54	19.47	7.38
Soybeans	64.68	27.78	17.43	39.17	19.00	35.00	33.36	17.78	13.80	25.35	27.39	-1.56
Sunflower	24.02	28.69	2.63	14.73	11.07	41.33	12.85	10.09	16.23	0.00	15.25	20.77
Rapeseed	34.90	33.85	24.22	28.54	22.65	0.67	24.34	5.76	99.10	26.35	8.51	-0.73
Other oilseeds	23.36	16.29	22.60	40.20	12.99	135.85	6.09	2.69	18.77	97.85	16.92	17.62
Beef	3.49	5.42	0.88	2.97	3.50	0.23	3.83	-0.25	3.66	2.20	4.77	1.83
Pork	0.34	0.53	0.00	1.40	1.05	0.50	0.66	0.05	0.28	-0.04	0.64	0.43
Other meat	0.01	0.02	0.00	0.12	0.10	0.06	0.30	0.01	0.13	0.11	0.11	0.07
Poultry	0.03	0.03	0.02	0.05	0.02	0.02	0.05	0.00	0.01	0.05	0.01	0.01
Eggs	0.19	0.18	0.32	0.55	0.19	0.01	0.07	0.00	0.10	0.10	0.17	0.10
Milk	99.02	67.60	25.61	26.90	61.00	12.26	167.49	0.50	20.68	109.15	169.60	42.30

Source: FAO database, FAPRI (2002), own calculations

Trends in land availability: This last trend shifter refers to the increase or decrease of arable land which is available for cropping activities and hence belongs to the supply shifters. Generally the trends which have been observed in the nineties have been used. But the same problem as for yields and demand applies here regarding transition economies. However, it can be assumed that declining land use in these regions will continue for some additional years. Successful producers will rather increase their yields than increase sown areas. The land availability trends are displayed in the following table.

Table: Assumed regional growth trends in available crop land

	Annual growth of crop land use in 1000 ha
EU 15	-28.8
CEECs	-87.0
India	-140.0
China	-224.5
Austr./NZ	400.0
Cairns developing	656.0
USA	-109.4
ACP countries	1335.0
Medit. & Middle East	541.0
High tariff traders	-14.8
Canada	0.0
Rest-of-World	-51.9

Source: FAO database

The area trend of all WATSIM regions together result in a total decrease of world crop land of only 0.013 % over the simulation period until 2011. Some regions will continue to increase their cropping area, as for instance the ACP countries, Cairns developing, Australia and the Middle East, partly by introducing more double-cropping through irrigation. On the other hand, set-aside regulations in the EU and the US are not likely to persist in an environment of increasing nominal world crop price levels, which could mean that the trends assumed for EU 15 are still somewhat pessimistic.

Another new feature in WATSIM is the consideration of transport costs. This area of parameters is still in its infancy, and thus only very stylised transport costs have been applied. In particular, they are not dependent on the distance between the two regions.[3] The freight rates assumed are 15 US$/ton for crops, 100 US$/ton for livestock products, and 20 US$/ton for all other commodities (oils and cakes).

3.1.2 Coverage of Agricultural Trade Policies

Policy parameters do not represent trends, and their estimation requires less data. Nevertheless, the aggregation of single country policies, like tariffs on certain commodities, is not always easy. To aggregate a tariff for a WATSIM region, an average across countries weighted by import quantities is calculated. Moreover, some countries within a certain regional group may apply specific tariffs, while other use ad-valorem tariffs. The aggregation of these two different in instruments may be difficult and requires the calculation of tariff equivalents. However, the policy database of WATSIM could be enlarged to a considerable extent, and thus make the results of WATSIM more reliable.

So far agricultural policy indicators have solely been borrowed from the OECD's subsidy equivalent concept for the industrialised regions contained in WATSIM. The advantage of this methodology is that it offers a consistent policy database for the OECD countries, many of which are included in WATSIM as single countries or groups (E15, USA, Canada, Austr./NZ, Japan/Switzerland/Norway/Iceland, some CEECs). However, the remaining part of regions in WATSIM99 was lacking an appropriate reflection of trade policy. In this respect considerable progress has been made during the WATSIM AMPS research project. For all country groups, applied ad-valorem tariffs from the TRAINS database[4] have been aggregated. Moreover, tariff rate quotas (TRQs) have been constructed for the WATSIM regions on the basis of data from the AMAD database.[5]

Even though the expansion of the policy coverage of WATSIM is remarkable, only border measures are explicitly taken into account for developing countries and the ROW aggregate, while domestic policies influencing world trade outcomes have been considered only in the case of OECD countries in the form of general PSE and CSE (producer and consumer subsidy equivalent) estimates. The model particularly focuses on the Common Agricultural Policy

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3 Some of the WATSIM regions are aggregates of countries which are dispersed of over the globe. Nevertheless transport costs (and other trade costs as well) constitute a wedge between domestic and foreign prices which will not disappear even in the case of total liberalisation of trade, and represents a kind of natural trade protection.

4 The TRade Analysis and INformation System (TRAINS) is a comprehensive computerised information system covering trade control measures (tariff, para-tariff and non-tariff measures) maintained by UNCTAD (United Nations Conference on Trade and Development).

5 The Agricultural Market Access Database (AMAD) is a joint project of various national and international organisations involved in agricultural trade monitoring (www.amad.org).

(CAP) of the European Union, and is therefore most detailed for this region. The following policies relevant to the CAP have been considered:

- Intervention price systems for grains, sugar, beef, butter, and skim milk powder including safeguards (grains, sugar) and export subsidies,
- WTO-limits on export subsidies, leading to surpluses when intervention purchases cannot be sold any longer,
- Quotas on sugar and milk production, modelled in a simplified manner as fixed production,
- Area payments for the *grand cultures* which are assumed to be fully effective as production incentives,
- A rotating set-aside of 10 %, modelled by a 10% depression of yields ,
- Tariff rate quotas for imports, some of them bilaterally, other as global (non-specific) quotas.

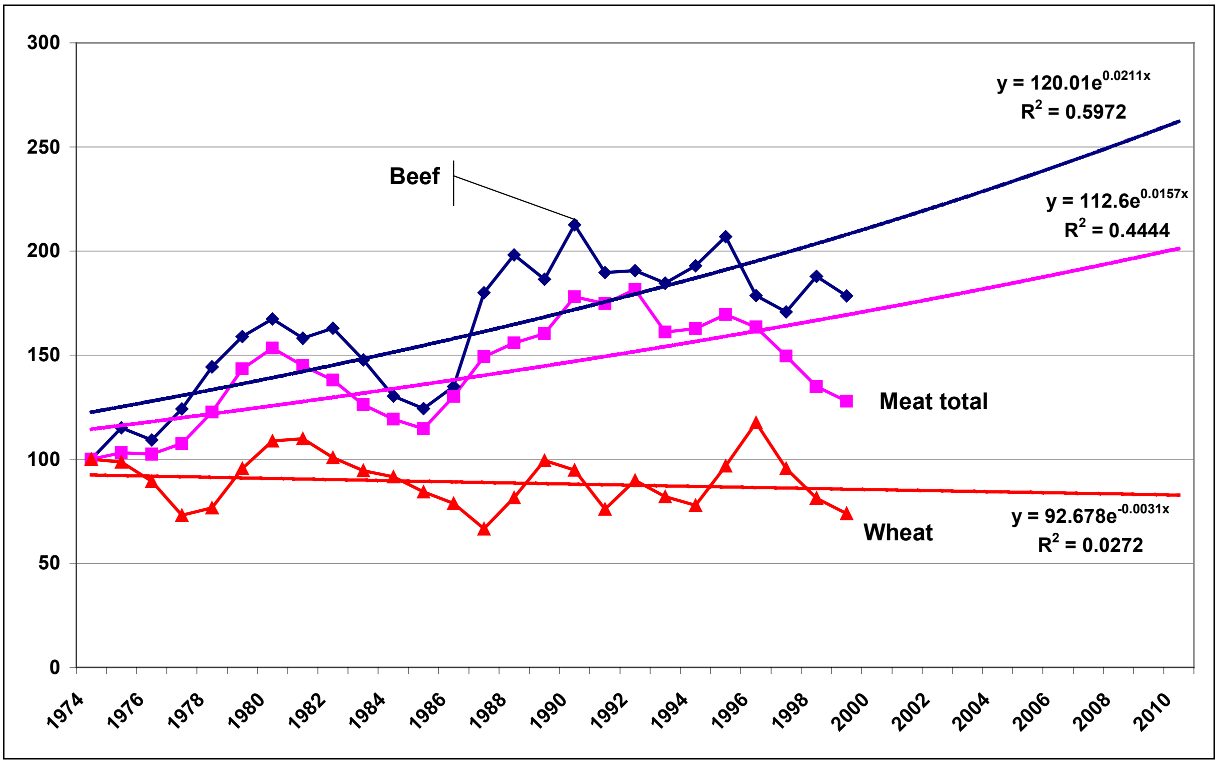
3.2 Comparison of the two Reference Runs

It has already been mentioned above that the WATSIM AMPS project was not endowed to estimate a truly independent commodity outlook for 29 commodities in 12 world regions. Only organisations of a size like FAO, FAPRI, the OECD or IFPRI (International Food Policy Research Institute, Washington) command over resources sufficient to (more or less) closely monitor developments for so many products in all world regions. Therefore the WATSIM shift parameters for demand and supply have been trimmed to a certain extent in order to loosely match the price and quantity predictions made by FAPRI.[6] However, particularly the FAPRI price projections regarding grain prices seem to be overly optimistic. FAPRI assumes that world wheat prices (FOB gulf) will increase to around 154 US$/ton in nominal terms in 2011. On the other hand, prices for livestock products are assumed to increase at a much slower rate. This seems to be counter-intuitive when taking into account past trends. When looking at Figure 2, one can see that, historically, meat prices have been increasing since 1974, while wheat prices remained grossly stable in nominal terms. One important explanation for this might be that the price ratio between labour and capital has increased, particularly in industrialised countries which account for most of the world trade. Therefore, the produc-

[6] A table comparing the results of the WATSIM reference run 1 and FAPRI projections for quantitative results and underlying trends can be found in the annex (chapter 7).

tion costs of capital-intensive commodities like grain increase less (if at all) than those of more labour-intensive activity like the raising of cattle.

Figure 2: Price trends for Beef, Meat and Wheat, 1974 - 2000



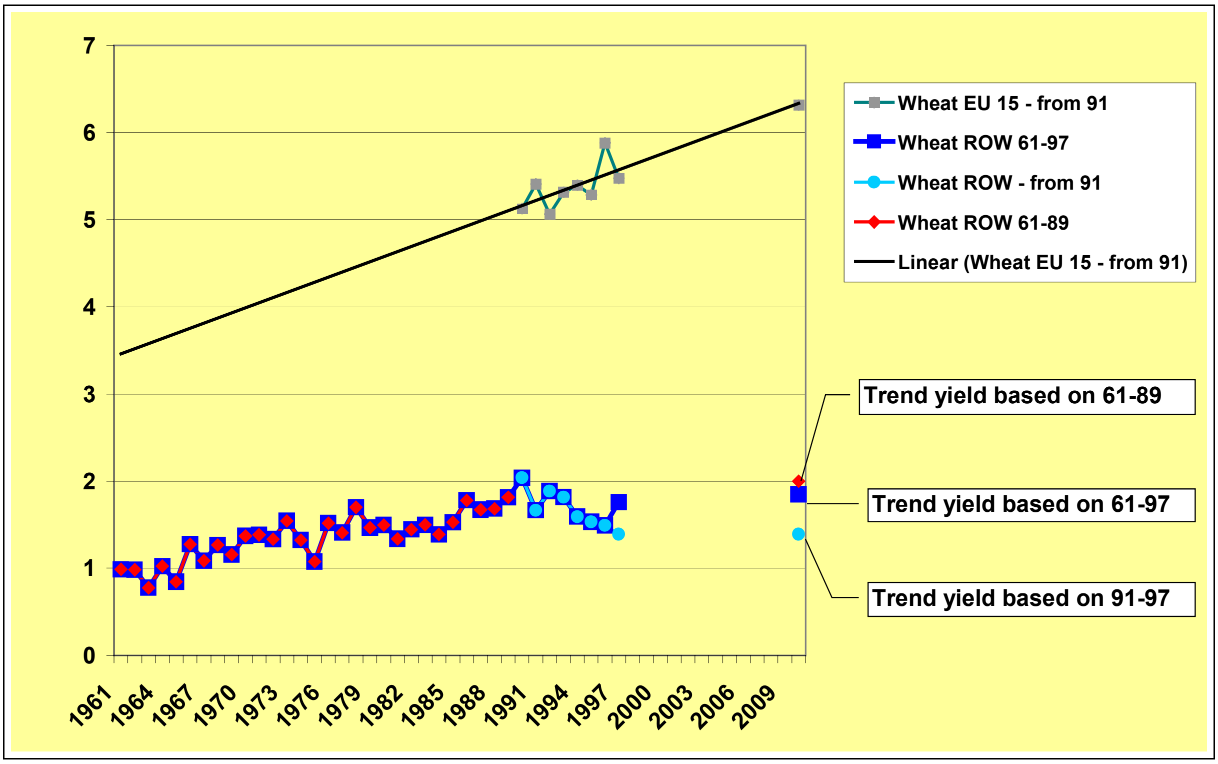
Source: FAO

The exponential trend function attached to the price indices suggests that beef prices increased by 2 % on average per year, while wheat price remained where they were in 1974. It may still be true that meat prices in the nineties have decreased, but in the long run it is hard to imagine that an important input to meat production (grain) will become more expensive, while meat itself becomes cheaper.

To offer a more cautious alternative to the optimistic price scenario in the first reference run (further called REF 1), the second reference run (REF 2) is based on the assumption that crop yields in the Rest-of-World aggregate in WATSIM, consisting mainly of CIS countries, will catch up more quickly and will be set equal to the world average crop yield growth. The following graph explains the underlying problem and shows that the modified assumptions for ROW yields in REF 2 are not exaggerated. Figure 3 shows the derivation of wheat yields for the EU 15 using a short time series from 1991 to 1997. Since there has not been a major structural change in the incentive system of EU farmers which would influence the yield levels of wheat, one can simply extrapolate the yield shifter for WATSIM by a linear extension of the time series. With ROW, matters are more complicated. Yields have steadily increased from 1961 to 1991, even though the yield levels were lower than in the EU. But after the beginning of the transition crisis in the countries of the former Soviet Union, yields have decreased during most of the nineties. The derivation of a yield shifter is not as straightforward. If we would base it on the period from 1991 onwards (91-97), we would get a negative yield trend. We might also forget about the nineties as some kind of a "lost decade" and continue the trend which ended in 1991. Finally, we could calculate the shifter on the basis of the whole period (61-97). Whether these different approaches are realistic remains difficult to decide. Continuing the trends before the transition break, annual wheat yields would increase by 23 kg/ha and end up at around 2.1 t/ha in 2010, which is the assumption made in REF 1. But we could also imagine that the CIS (=> ROW) will catch up and increase their productivity at the same pace as the world as a whole. This would lead to yield increases of 34.36 kg/ha and a wheat yield of around 2.4 t/ha in 2010.

Most recent developments suggest that this scenario is not unrealistic at all. In 2002, both Ukraine and Russia have already produced a large surplus, a major part of which has been imported to the EU. Only bad weather conditions as in 2003 may from time to time slow down the speed with which the CIS become major players as exporters on the world wheat markets. Thus, REF 2 operates with the assumption of a catch-up of the CIS to world productivity growth levels.

Figure 3: Derivation of yield trends for wheat and alternative assumptions regarding the productivity development in ROW



The following table shows the difference between REF 1 and REF 2, which only contains different yield growth assumptions for the Rest-of-World region. The most pronounced deviation from the more pessimistic outlook for ROW yields may exist for maize, because ROW has a high market share for this crop. But also other grains, starch crops, and sugar reveal a major potential for a productivity catch-up.

Table 5: Yield trends in kg/ha/year for ROW in the two reference runs

	REF 1	*REF 2*
Wheat	23.23	34.36
Barley	26.46	28.12
Maize	32.71	65.16
Other cereals	14.88	14.03
Rice	27.26	38.98
Starch crops	36.80	121.21
Sugar	47.38	86.95
Pulses	7.38	5.54
Soybeans	-1.56	32.78
Sunflower	20.77	23.31
Rapeseed	-0.73	23.38
Other oilcrops	17.62	46.03

The results of the two reference runs will be presented in a way that REF 1 is the "basic" reference run, against which the results of REF 2 will be considered as the outcome of alternative scenario assumptions. We will start with a comparison of world market prices, and continue with a closer look the results for the ROW aggregate. Finally, the differences in subsidised exports from the EU will be examined.

Even though the new spatial version of WATSIM does not contain a unified world market price which clears all regional markets, it is possible to calculate a trade-weighted average of all regional f.o.b. export prices during the model run. This export price does still play a minor role in the new WATSIM by serving as a benchmark to calculate flexible import tariffs in the framework of the safeguard regulations of the CAP. Moreover, the average export price is assumed to be the best approximation of the "world market price" of which the public is used to talk about. Table 6 presents the differences in world market prices between the two reference runs. Grain prices in particular would be affected by the catch-up, followed by starch crops and sugar. Another interesting result is that pork, which heavily relies on feed grain, would become 3 % cheaper. Pulses and oilseeds would be less affected.

Table 6: Differences in world market prices between the two reference runs in 2010 (in US$/ton)

	REF 1	REF 2	Difference in %
Wheat	142	133	-6.3
Barley	112	103	-8.3
Maize	116	109	-5.8
Other cereals	126	118	-6.6
Rice	288	281	-2.6
Starch crops	166	157	-5.5
Sugar	260	245	-5.9
Pulses	392	386	-1.5
Soya seed	234	230	-1.7
Sunflower	302	294	-2.6
Rapeseed	296	289	-2.5
Beef	1966	1934	-1.6
Pigmeat	1287	1248	-3.1
Other meat	1683	1671	-0.7
Poultry	1238	1229	-0.7
Eggs	1163	1153	-0.9

The results for the ROW aggregate on maize (Table 7) show the regional effect of the increased productivity growth. Production increases by five million tons lead to a drastic import reduction, which in turn increases supplies on world markets. Despite decreased imports, this artificial region does not turn into a net exporter, but the effect on world markets remains the same. The import price decreases by -5.1 %, the domestic market price even by -11.5 %. The price reductions do not, however, lead to significant increases of consumption due to inelastic demand.

Table 7: Differences between REF 1 and REF 2 for the ROW region for maize (in 1000 t, if not mentioned otherwise)

	REF 1	REF 2	Difference in %
Area harvested	17707	17645	-0.3
Yield (in t/ha)	2.78	3.08	10.9
Production	49188	54427	10.6
Imports	17344	12995	-25.0
Exports	1186	1604	35.1
Net trade	-16157	-11391	-29.5
Human demand	21918	22004	0.3
Processing demand	3422	3527	3.0
Feed demand	33829	34076	0.7
Import price ($/t)	119	113	-5.1
Domestic price ($/t)	110	97	-11.5

The last table compares the results of the reference runs with regard to the subsidised exports of the EU 15. It is striking to see that export subsidies for grains increase considerably in REF 2 compared to REF 1 where the world market price level is much lower.

Table 8: The difference in subsidised exports of the EU 15 between the two reference runs in 2010 (in 1000 t)

	REF 1	REF 2	Difference in %
Wheat	97	820	746.1
Barley	1364	2991	119.3
Maize	7	35	373.5
Other cereals	1043	2021	93.8
Rice	106	117	10.2
Sugar [7]	4109	4201	2.3
Beef	552	584	5.8
Butter/cream	14	17	21.0
Skim milk powder	99	103	4.5

This result should serve as a warning sign for policy makers in the EU. The current agricultural policy of the EU 15 is built on the assumption that future world market prices for the grand cultures will remain far above the EU intervention price levels. However, a catch-up of the CIS with a depressing effect (*ceteris paribus*) on world prices is very likely, and it may not come alone. Other risks originate from the Euro – US$ exchange rate. The Euro has sub-

7 For sugar in the EU, it is assumed all sugar exports are more or less implicitly subsidised, because WATSIM does not distinguish between quota and C-sugar.

stantially appreciated against the dollar during the recent months, and the high deficit in the United States' balance of payments does not suggest a quick return to the low Euro rates like at the beginning of the decade. The appreciation of the Euro has already put the intervention price on par with the world market price for barley, and only tight supply saves the EU from the need to start subsidised exports on a large scale. The following chapter will deal with such uncertainties using sensitivity analyses.

4 Sensitivity Analyses and Policy Simulations

4.1 Impacts of Alternative Exogenous Parameters and Policies

Appreciation of the EURO

One attractive feature within the new WATSIM version is its ability to produce time series of all the model results. It has already been said that the calculated ultimate price level is dependent on various exogenous parameters. One central parameter is the assumed exchange rate between the Euro and the US dollar. The standard exchange rate in WATSIM is set to 1, which is in line with the assumptions made by OECD or FAPRI. However, when looking at the most recent developments, an increase of the exchange rate to 1.15$/€ cannot be considered as impossible.

The sensitivity analysis assumes that the Euro will be worth 1.07 US dollars in 2001 and 1.15 US$ from 2003 onwards. The results on the world market prices in 2010 are shown in Table 9 for those commodities which are subject to subsidised exports in the EU. The results show that the price decreases are most pronounced for those commodities where the EU does not fully exploit the WTO limits in the reference run (grains, milk products). It can be fairly assumed that increased subsidised exports by the EU would be responsible for the fall in the average world price level.

Table 9: International price response to an appreciation of the Euro

	REF1	*with Euro appreciation*	*Change to REF1 in %*
Wheat	142	138	-2.8
Barley	112	104	-7.4
Maize	116	115	-0.8
Other cereals	126	117	-7.5
Rice	288	288	0.1
Sugar	260	266	2.3
Beef	1966	1950	-0.8
Butter/cream	1561	1337	-14.4
Skim milk powder	1796	1256	-30.1

This assumption is confirmed when looking at the EU results in detail in Table 10. Both the quantities and value of subsidised exports would increase significantly. For wheat and coarse grains, the refunds per ton have reached the new admissible limits set by the EU, and the quantities for coarse grains, rice, skim milk powder and beef are coming close to the quantitative WTO limits. The most interesting result is how differently commodities react dependant on the level of the intervention price in comparison to the average world market price. While commodities with a minimum price far above the world market level react less to exchange rate appreciation, those commodities like grains for which the intervention price has been purposefully reduced below the world market price react very sensitive. It would probably be better to determine the intervention price in UD dollars, or at least to let intervention prices fluctuate in Euro to a certain extent when the Euro/Dollar exchange rate changes.

Table 10: Export subsidies under an appreciation of the Euro

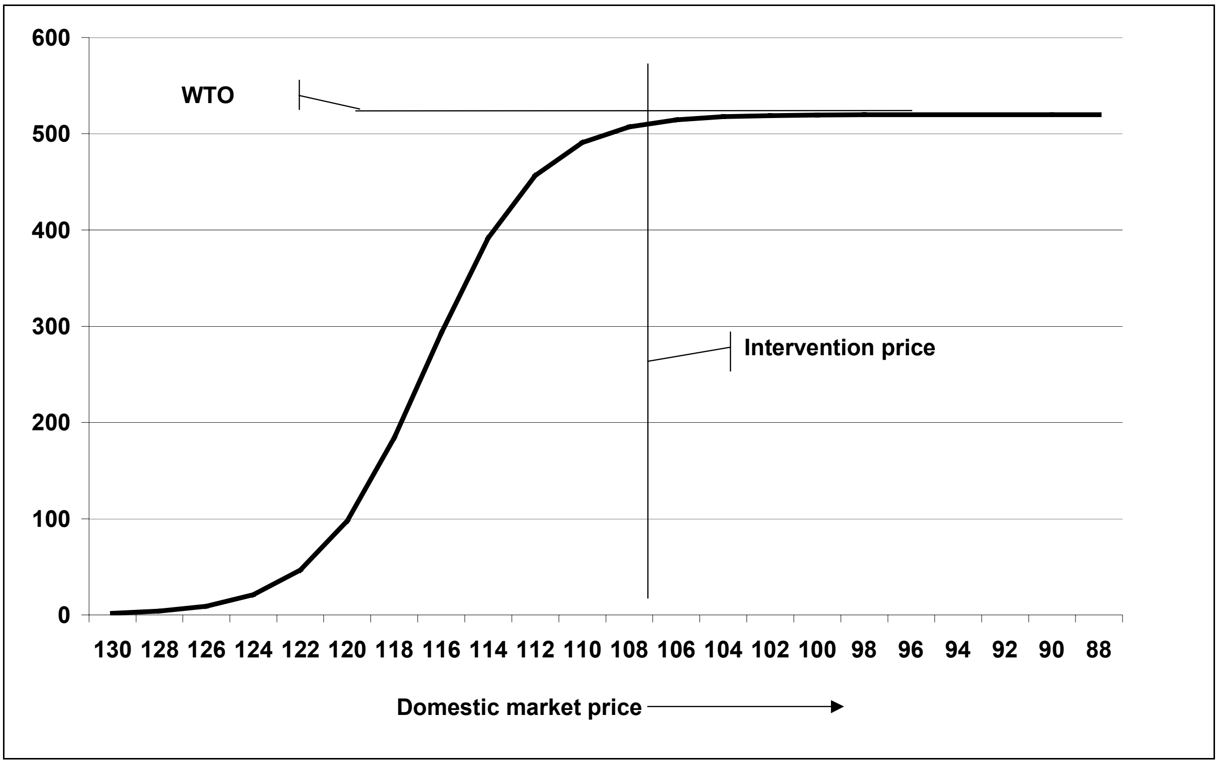
	REF1	*with Euro appreciation*
Export subsidies in $/ton		
Wheat	23	39
Barley	20	39
Maize	21	38
Other cereals	6	39
Rice	52	139
Sugar	402	464
Beef	735	1158
Butter/cream	1448	1564
Skim milk powder	532	1259
Subsidised exports in 1000t		
Wheat	97	7268
Barley	1364	6750
Maize	7	549
Other cereals	1043	3543
Rice	106	131
Sugar	4109	4483
Beef	552	769
Butter/cream	14	117
Skim milk powder	99	275

Alternative approaches to model export subsidies

The modelling of export subsidies in connection with WTO-limits on the quantity of subsidised exports was the most challenging part of the modelling work. Export subsidies are usually paid for such commodities which are subject to a minimum price above the average world price in connection with import protection. As long as there is no surplus production, as for instance in the case of EU maize, no export subsidies are required. In the EU, export subsidies are granted to traders who win with their bid in a tender. Traders offer to export a certain quantity of the commodity in question to a certain destination when they get paid a certain refund (subsidy) per ton. The product can either originate from the free market (mostly the case with EU sugar), or from intervention stocks which have been built up when the domestic market price was about to undercut the minimum price (intervention price) for a certain period of time. In the case of subsidised exports out of the free market, the trigger is also the domestic price falling below the intervention price.

The basic idea behind modelling export subsidies in WATSIM is that a certain percentage of the exports of a region has to be made artificially cheaper in order to export them to markets where they could not be sold otherwise, thereby keeping the market prices above the minimum prices. To simplify the modelling exercise a bit, it is assumed that no intervention stocks are accumulated, so that in WATSIM only the free-market procedure is modelled at the current stage of model development. Moreover, WATSIM has to make certain assumptions about the mechanism which triggers export subsidies. The model has to determine on two variables, i.e. the quantity of subsidised exports, and the export subsidy per ton of subsidised exports. Regarding the determination of the export quantity, it has been decided to use a logistic function which converges to the WTO limit for subsidised exports (or the total export amount), the closer the domestic price comes to the minimum price (see equations 29 and 30 above).

Figure 4: Subsidised exports as a function of the domestic price, observing the intervention price and the WTO limit



In the case of most commodities the average domestic prices in a certain year are above the intervention price, despite the fact that subsidised exports have been observed. There must be a kind of pre-emptive action by the EU Commission, which is particularly evident in the case of sugar, where only once in almost 40 years the intervention mechanism lead to the build-up of stocks. This is the reason why the approximation of this "political demand function for subsidised exports" starts already to export with refunds when the domestic price is still more than 15% above the intervention price. There are two parameters of the function determining the slope and the start of action (*lpar* and *dist*, see equations 29 and 30), which are calibrated according to the observed quantities and prices in the base year.

The second task is to determine the per-unit export subsidy. To put it simple, an export subsidy is supposed to bridge the gap between the domestic and world market price level. To calculate the export subsidy would simply mean to subtract the world market price from the domestic price. However, EU regulations mention that export subsidy payments are supposed to be adjusted to the price level of the country of destination. This is in line with the general concept of WATSIM as a spatial model, where a unified world market price does not really exist. Consequently, in the standard version of the model the basic amount of export subsidies is calculated as the difference between the domestic price of the exporter and the domestic price of the importer minus tariffs and transport costs. If the subsidised export quantity is at the WTO limit, and the domestic price nevertheless is about to fall below the minimum price, an additional export subsidy is added to the basic export subsidy. This additional export subsidy is not spatially differentiated because it is connected with a non-spatial equation. Both subsidy elements are then added to the total subsidy, which has an upper bound below the intervention price. Subsidies can only be paid as long as the domestic price is above the domestic price of the trade partner net of tariffs.

To test the standard version of WATSIM against an alternative approach towards export subsidies, a scenario run has been carried out using a model formulation with a unified basic export subsidy, calculated as the domestic price minus the world market price.

Table 11: Export subsidies and subsidised exports with spatially differentiated vs non-differentiated subsidy payments

	Spatially differentiated subsidies			Spatially not differentiated subsidies			Difference in %		
	2000	2006	2010	2000	2006	2010	2000	2006	2010
Export subsidies in $/ton									
Wheat	41	29	23	0	0	0	-100	-100	-100
Barley	28	24	20	7	0	0	-75	-100	-100
Maize	64	40	21	15	4	0	-77	-91	-100
Other cereals	51	24	6	2	7	0	-95	-71	-100
Rice	84	65	52	50	25	8	-41	-61	-84
Sugar	500	439	402	412	357	322	-18	-19	-20
Beef	1269	938	735	562	403	295	-56	-57	-60
Butter/cream	1575	1548	1448	1431	1121	978	-9	-28	-32
Skim milk powder	969	594	532	656	223	0	-32	-62	-100
Subsidised exports in 1000 t									
Wheat	373	451	97	0	0	0	-100	-100	-100
Barley	3280	2784	1364	4877	0	0	49	-100	-100
Maize	0	2	7	0	5	0	80	105	-100
Other cereals	791	1324	1043	1197	1788	0	51	35	-100
Rice	117	120	106	124	127	119	6	6	12
Sugar	4167	4138	4109	4483	4483	4483	8	8	9
Beef	425	554	552	614	717	699	44	29	27
Butter/cream	152	88	14	124	85	20	-19	-3	42
Skim milk powder	199	155	99	261	229	0	31	48	-100

The allocation of subsidised exports is not so much different, but the export subsidy payments which certain target regions will face are quite different from the spatially differentiated approach. Table 11 shows the results for the export subsidies of the EU .

The results show that the non-differentiated approach to export subsidies generally leads to smaller average subsidy payments per ton. On the other hand, the amount of subsidised exports has to be higher in most cases to offset the reduced ability of the EU to influence the willingness of certain import countries to import EU commodities by paying a subsidy which is the higher, the lower the domestic price of the target region is. The results regarding both, the subsidy per unit as well as the quantity of exports seem to be closer to reality under the spatially differentiated regime. To compare WATSIM results with historic data, Table 12 shows some quantities and subsidy payments for the year 2000 according to FEOGA data. The results for cereals in the WATSIM reference run are much lower than they have actually been in 2000, because in 1999/2000 the intervention prices for cereals were still higher than after the price cuts of the Agenda 2000. Nevertheless, the export subsidies paid in 2000 give an idea about the amount needed to sell a ton of the protected EU commodity. Some subsidies are outrageously high, as for instance in the case of coarse grains or rice. Under neither approach towards export subsidies, WATSIM comes close to these very high payments. This shows that the modelling of export subsidies is still in its infancy.

Table 12: Historic subsidised exports and subsidy payments for the EU in 2000

	Export subsidy in US$/t	*Subsidised exports in 1000 t*
Wheat	40	10204
Coarse grains	96	7080
Rice	277	132
Sugar	392	882
Beef	1526	475
Butter	1248	197
Skim milk	1004	128

Source: FEOGA data

4.2 A Policy Application: The HARBINSON-Proposal for the Doha Round of WTO-Negotiations

The new WTO trade talks are under way since November 2001 under the label of the "Doha round". The negotiations include those on agriculture and services, which began in early 2000. In the course of the negotiations, the WTO Agricultural Committee Chairman STUART HARBINSON has made a comprising proposal to reduce the world-wide level of barriers to trade of agricultural commodities. To demonstrate the potential of WATSIM to quantify the impact of such reform proposals, a scenario containing the most important elements of the proposal has been run for both versions of the reference run.

The Harbinson proposal suggests reforms in the areas of market access, domestic support and export competition. Some suggestions could not be properly analysed within the WATSIM framework. Those suggestions which fit into the WATSIM model are shortly sketched in the following. In the are of a market access, a reduction of tariffs is proposed, whereby the highest tariffs are reduced most[8]:

Tariffs > 90 % => reduction by 60 %

Tariffs 15-90 % => reduction by 50 %

Tariffs < 15 % => reduction by 40 %

[8] The ad-valorem equivalent of specific tariffs is supposed to be calculated on the basis of the prices in 2000.

Moreover, all TRQs are expanded to 10% of domestic reduction. Finally, the special safeguard provisions are to be abolished. In the area of domestic support, the premium payments (amber box) will be reduced by 50 %. In the area of export competition, export subsidies are phased out until 2010.

Table 13 contains the average world market prices for 2010 which result from the WATSIM calculations. Almost all prices tend to increase, and it seems that particularly those commodity prices have been driven up where the EU has a high export market share by means of subsidised exports: sugar, barley, other cereals, butter.

Table 13: Selected average world market prices under the Harbinson scenario for 2010

	REF1	*Harbinson*	*Change to REF1*	*REF2*	*Harbinson*	*Change to REF2*
Wheat	142	151	6.4	133	144	8.4
Barley	112	125	11.4	103	121	17.5
Maize	116	120	3.6	109	114	4.5
Other cereals	126	134	6.4	118	129	10.0
Rice	288	289	0.5	281	283	0.9
Starch crops	166	171	2.6	157	162	2.8
Sugar	260	353	35.8	245	335	37.0
Pulses	392	409	4.5	386	405	5.0
Beef	1966	2099	6.8	1934	2077	7.4
Other meat	1683	1794	6.6	1671	1784	6.8
Milk	346	342	-1.3	346	342	-1.1
Cheese	2628	2780	5.8	2631	2784	5.8
Butter/cream	1561	1772	13.5	1576	1784	13.2
Skim milk powder	1796	1833	2.1	1804	1839	2.0

The impact on regional production is shown in Table 14. Only changes to the reference run 2 (higher yields in ROW) are displayed, and only those exceeding 10 %. It is not surprising that the commodities with the greatest price changes also reveal the largest production changes. In the case of barley, for instance, production will decrease most in the high tariff regions (Japan, Switzerland, Norway, Iceland). In the case of sugar, the main exporters (Cairns) will be able to extend their production considerably, while ACP countries will not be deprived of their preferential imports into the EU.

Table 14: Production impact of the Harbinson proposal (selected REF2 results only)

		REF2	*Harbinson*	*Change to REF2*
Barley	India	1644	1447	-12.0
Barley	Cairns dev.ping	1468	1616	10.0
Barley	High tariff traders	768	388	-49.5
Maize	High tariff traders	12	14	16.4
Other cereals	High tariff traders	443	512	15.6
Sugar	Austr./NZ	6164	7059	14.5
Sugar	Cairns dev.ping	42680	49369	15.7
Sugar	ACP countries	9661	11748	21.6
Sugar	High tariff traders	965	1079	11.9
Sugar	Rest of World	27964	31256	11.8
Pulses	High tariff traders	21	25	18.5
Sunflower seed	India	1863	1607	-13.7
Sunflower oil	India	473	408	-13.7

The next Table 15 lists the structural surpluses (virtual "WTO-stocks") in the EU which would result from the phasing-out of export subsidies. The surpluses can be found for coarse grains,[9] rice, sugar, and skim milk powder. Other commodities do not need subsidised exports any more, partly due to rising world market prices and also reduced EU production due to reductions of direct payments. The result is most pronounced for sugar, which is probably the most heavily protected commodity in the CAP. As long as the political pressure to ban export subsidies remains high, the results confirm that the EU urgently needs to reform those sectors which are listed in Table 15.

Table 15: "WTO-stocks" in the EU as a result from the abolition of export subsidies

	Harbinson (REF1)	*Harbinson (REF2)*
Barley	2827	4335
Maize	2827	4335
Other cereals	2827	4335
Rice	453	527
Sugar	15707	16140
Skim milk powder	53	46

9 The value for WTO-stocks is unitary for all coarse grains, because the WTO-limit applies for the commodity group of barley, maize, and "other grains". The build-up of stocks for the three commodity groups is triggered by the same one MCP equation. This calculates stocks as soon as the sum of subsidised exports for coarse grains is above the WTO-limit. Because all coarse grains use this one equation, there are no differentiated results for stocks across the commodities in the bundle. This solution is still not satisfying, because, for example, maize is definitely not a commodity which would cause such surpluses in the case of an abolition of export subsidies until 2010. The model needs improvement at this particular point.

In the case of coarse grains, the EU has already made a start by eliminating the intervention system for rye. The intervention price for rice will be cut from around 300 to 150 €/ton; the losses for the farmers are intended to be compensated by direct payments. In the area of milk products, intervention prices will be lowered by 20 % and replaced by direct payments per cow. Only the common sugar market organisation has so far resisted more profound reform steps. But these reforms will become inevitable, 2009 at latest when least developed countries (LDCs) will be granted practically unlimited duty-free access to the EU domestic market for sugar in the framework of the Everything-but-Arms initiative (EBA).

5 Achievements and Limitations

5.1 Summary of Major Achievements of the WATSIM AMPS Research Project

5.1.1 List of Achievements Made

The design of the model itself, i.e. the system of equations which are supposed to approximate the reality of international agricultural trade, makes WATSIM as one of the most sophisticated trade models in the world. There is no other partial equilibrium model which covers so many commodities, regions and trade-relevant policies at the same time.

1. WATSIM has been turned into a **trade flow model**. Together with the fact that WATSIM is calculating in physical quantities and in nominal prices instead of quantity and price indices such as CGE models (e.g. GTAP), this facilitates the realistic implementation of minimum prices, TRQs, export subsidies and other quantitative restrictions into the model.
2. WATSIM has been changed into a model **formulated as an MCP problem**. This facilitates a very efficient inclusion of restrictions and non-smooth policies into the model.
3. WATSIM is now equipped with a highly differentiated mechanism to calculate the necessary level of **export subsidies**. This feature enables the model to estimate structural surpluses or, alternatively, necessary price or quota reductions to maintain certain levels of intervention prices in the framework of the CAP.
4. WATSIM has been formulated as a **quasi-dynamic model**. This allows to distribute the impact of shocks (e.g. through policy reforms) over several periods, thereby avoiding a possible overshooting reaction in a purely comparative-static model. On the other hand, the dynamic formulation needs further improvement by including demand for storage and price expectations into the model.
5. The database of WATSIM has been enlarged and updated to a considerable extent. The **base year has been shifted from 1997 to 2000**. Beyond more up-to-dateness, this has the particular advantage that the year 1997 was very odd with respect to grain prices.[10]

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[10] In that year the world markets experienced a steep price increase for grains and their substitutes.

6. The **regional composition** of WATSIM has been changed after prior consultation of the DG Agri in order to arrive at a regional partition which can meet the requirements of the WTO-negotiations. The new regional composition puts greater emphasis on developing countries (ACP countries) and on groups with similar bargaining stances in the WTO talks (e.g. "Cairns developing").
7. With the help of the AMAD database, a comprising **inclusion of world-wide TRQs** and the related preferential tariffs could be realised.
8. For most of the non-members of the OECD, a **database of average applied tariffs** was assembled, facilitating the simulation of world-wide liberalisation efforts in WATSIM for the first time.
9. For some regions like China or India, **domestic price levels** could not be reasonably derived from the FAO trade database. Domestic prices for these countries have been established on the basis of USDA attaché reports for the countries and commodities in question.

The re-designed WATSIM has been applied for the following **analytical tasks**:

1. The new WATSIM – in a version modified with respect to the regional composition – has been intensively used for a study on reform options of the EU sugar market organisation on behalf of the EU Commission ("Study to assess the impact of future options for the future reform of the sugar common market organisation", together with the CAPSIM and CAPRI modelling systems at the Institute of Agricultural Policy in Bonn, Feb. 2003). As soon as the confidentiality clause of the contract will allow it, the major results of the study will be published as a working paper. It has been the first time that WATSIM has been officially used for policy consulting.
2. The consequences of the Eastern enlargement of the EU have been analysed in a conference paper presented in September 2002 (A. Kuhn and P. Wehrheim, "Agricultural Trade Diversion due to EU Eastern Enlargement: A Quantitative Analysis Based on a Partial Equilibrium World Trade Model (WATSIM)", GeWiSoLa, Halle/Germany). The research was based on a preliminary version of the re-designed WATSIM.

5.1.2 Assessment of the Achievement of Objectives

The WATSIM AMPS research project was supposed to deliver the following achievements:

(1) "Support for the refinement of the CAP and for strategic positioning in the ongoing WTO negotiations"

This goal was intended to be achieved through an update and improvement of the database, particularly with respect to trade policies and developments in non-OECD member countries. The actual achievements during the project with respect to the database amelioration have without doubt contributed to this task. The suitability of WATSIM as a powerful tool for CAP- and WTO-relevant policy analysis has been demonstrated during the involvement of the new WATSIM in the sugar policy study for the EU commission mentioned above.

(2) "Objective oriented methodological improvements of WATSIM"

This second area of activity required improvements with respect to the following items:

- *Export subsidies and their limitations*: This has been one focus of the research project, and has been successfully achieved.
- *Tariff rate quotas and MFN tariff structures:* The TRQ representation in the model has been changed to an MCP formulation. The aggregation of regional tariff quotas on the basis of the AMAD database has also been achieved, together with preferential and MFN tariffs.
- *Domestic policies (of non-EU countries):* This area, as outlined in the research proposal, has not been further worked on beyond the PSE/CSE parameters which are extracted from the OECD database, because model re-design, database updates and the inclusion of new trade policies have been regarded as more urgent. Nevertheless the inclusion of domestic policies of important players like the EU, USA, Canada, China or India cannot be totally disregarded, particularly when explicit trade policy is step by step replaced by indirect domestic support in the course of multilateral liberalisation.
- *Market and policy structures in CEEC countries:* This area has been covered by the conference paper on Eastern enlargement mentioned above.

Summing up, it can fairly be said that the WATSIM AMPS project has reached a high degree of achievement of the stated objectives.

Nevertheless, the modelling system has still various limitations, especially with respect to the labour input required by the complexity of the model, and the representation of dynamic features. The most important limitations will be critically discussed in the following section.

5.2 Limitations of the WATSIM Modelling System

Even though a lot of effort has been spent in order to make WATSIM a functional policy analysis tool for agricultural trade, the model still has a number limitations which have to be taken into account. These limitations are rooted in certain methodological shortcomings, sometimes in connection with data problems. To reduce these limitations, it is strongly recommended to strengthen the co-operation of WATSIM with other research partners in Europe.

5.2.1 Needs for further Methodological Improvements

Dynamic formulation

The new WATSIM has been labelled "quasi-dynamic" throughout the report so far, because the dynamic features which are employed by the model algorithm are relatively simple. The decisive element of a dynamic model is the representation of price expectations. In the current WATSIM version the price expectations are "naive" in a sense that the economic agents in the model assume that the prices of the current period will also be the prices of the next period, and plan their behaviour accordingly. There is no anticipation of foreseeable shocks in the model, which can be observed in reality. Another critical matter is that the price volatility in most markets increases with a decrease in the volumes of carry-over stocks, which can be observed in the markets for grain and sugar. The issue of dynamic formulation for the model systems WATSIM, CAPSIM and CAPRI will be a focus of the future research agenda at the Institute of Agricultural Policy (IAP) in Bonn.

Derivation of shift factors

The problem that past trends or anticipated future trends in yields of per-capita consumption can not be simply equated with shift factors for supply and demand functions in a market model has been extensively discussed in chapter 3. The only theoretically sound solution to this problem would be a systems estimation of supply and demand for all WATSIM commodities and regions.

Synthetic elasticities

"Synthetic elasticities" are such elasticities which are not estimated by using econometric techniques, but rather guessed by the researcher. WATSIM uses elasticities deriving from the SWOPSIM database as starting values for a calibration procedure. During this procedure, the magnitude of the individual elasticities is determined by varying the initial elasticities under restrictions reflecting microeconomic behaviour. As with the derivation of supply and demand shifters, econometric systems estimation would be theoretically the best solution to arrive at reliable parameters for the model. However, such an estimation approach would require series of domestic prices for all countries of the world for at least three decades. In contrast to quantitative data (areas, production, consumption etc.), such price series do not exist within a consistent database at the moment, and would thus have to be assembled first. This would indeed be a Hercules task, which cannot be expected to be carried out by a University Institute.

Representation of certain domestic policies

"Blue box measures", de-coupling, multi-functionality, and other keywords in the current debate of the WTO Doha round represent measures which impact on trade is difficult to analyse even theoretically, and all the more in the framework of a market model. To some extent it seems that the replacement of direct barriers to trade by more or less production-neutral support pushes traditional market models to the limit of their analytical potential. One solution to this problem might be the linking of WATSIM to models which explicitly deal with decisions on the farm level, as for instance the CAPRI model at the IAP Bonn.

Fodder and feed modelling

The feed sector in WATSIM has several shortcomings which could be sorted out with some effort. The feed demand is calculated only on the basis of feed energy, while feed protein is no argument in the equation. The introduction of energy and protein prices would be highly desirable to allow for a more subtle representation of feed demand. Moreover, only feed and no fodder crops are contained in the commodity list. On the other hand, fodder crops constitute a major input to ruminants' diet, and partly compete with food and feed crops for arable land.

5.2.2 Data Challenges

Monitoring of agricultural trade policy measures

Parallel to the multilateral trade agreements in WTO, various bilateral or regional trade agreements have emerged during the last two decades. Particularly country-specific TRQs have come into fashion, very often as a compromise between trade partners' demands and the producer lobbies at home. These bilateral agreements may be substantial and have a tremendous impact on world markets, as for instance in the case of the EU-ACP sugar protocol. But there is no publicly available database where the key figures of all these bilateral agreements are stored. For the time being, WATSIM is working with the most important EU TRQs, both bilateral and global ones, and, on the other hand, with global TRQs from the AMAD database.

Another important area of trade policy is the increasing emergence of bi-lateral free-trade agreements. The implementation and analysis of these bilateral liberalisation efforts represents another huge challenge to the further development of WATSIM. A start has been made with the analysis of the Eastern enlargement of the EU, but the issue remains a promising field of activity in both methodological and empirical research.

Monitoring of domestic policy measures

As already discussed in chapter 5.1.2, domestic policies which influence the international competitiveness of a country are contained in the WATSIM database only in a rudimentary fashion. A careful and systematic examination of the respective WTO notifications would improve at least the data situation, but not solve the methodological problem involved with more or less indirect domestic subsidies to agriculture and the food sector.

5.3 The Need for Extended Research Cooperation

WATSIM in its current shape can fairly be considered a large-scale model. A model run generates roughly 14600 equations with the same number of non-fixed variables. The model consists of roughly 340 regional markets and more almost 4000 bilateral trade relations. Particularly this huge number of regional markets for the various products with their supply and demand variables, prices and development trends calls for a group of researchers to maintain and further develop the modelling system.[11] This group should consist of researchers form other European partner institutions. On the basis of the previous experience, the following division of research tasks is suggested:

1. Algebraic model design and maintenance of the central model database

2. Determination of shift factors and elasticities

3. Monitoring and processing of domestic and trade policies world-wide

It would be most efficient to continue activity 1.) at Bonn University, while research partners would be responsible for the other two activities in the framework of an FP6 research project. Another important element of this strategy of model development is to partially integrate

[11] All other outlook and policy analysis tools like AGLINK, FAPRI, or the IMPACT model of IFPRI (ROSEGRANT et al. 2002) are taken care of by medium-sized groups of researchers which facilitates a more efficient allocation of time resources through specialising on certain tasks within the modelling system.

WATSIM with the modelling systems concentrating on Europe (CAPRI, CAPSIM at the Institute for Agricultural Policy and EuroCARE GmbH in Bonn) in order to achieve a most detailed reflection of EU agricultural policies.

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7 Annex

Comparison of the WATSIM reference run REF 1 with the results of the FAPRI outlook 2003

		2003		2010		Change in %		
		WATSIM	FAPRI	WATSIM	FAPRI	WATSIM	FAPRI	Difference in % points
Barley	Feed use	96525	91454	106000	95581	10%	5%	5%
Barley	Area	56636	54599	56918	53959	1%	-1%	2%
Barley	Yields	2.43	2.51	2.61	2.65	7%	6%	1%
Barley	Cons. p.c.	0.77	7.16	0.73	7.26	-4%	1%	6%
Beef	Production	137898	136856	148277	142999	8%	4%	3%
Beef	Production	61095460	48524	66035340	53891	8%	11%	3%
Maize	Production	626669	635153	704278	693432	12%	9%	3%
Maize	Feed use	423437	439433	478879	486271	13%	11%	2%
Maize	Area	140374	139393	143848	138977	2%	0%	3%
Maize	Yields	4.46	4.56	4.90	4.99	10%	9%	0%
Maize	Cons. p.c.	15.27	31.56	16.52	31.99	8%	1%	7%
Pig meat	Production	95336010	92043	108509000	103785	14%	13%	1%
Poultry	Production	72402120	47201	85455420	54705	18%	16%	2%
Rapeseed	Production	38637	38354	45747	41356	18%	8%	11%
Rapeseed	Processing	31943	35443	37806	38513	18%	9%	10%
Rapeseed	Area	26169	24304	27670	24235	6%	0%	6%
Rapeseed	Yields	1.48	1.58	1.65	1.71	12%	8%	4%
Rapeseed	Cons. p.c.	0.31	0.46	0.33	0.43	5%	-5%	11%
Rapeseed meal	Production	21454	21328	22361	23147	4%	9%	4%
Rapeseed oil	Production	14264	13154	16915	14290	19%	9%	10%
Rapeseed oil	Cons. p.c.	1.51	2.17	1.67	2.18	10%	1%	10%
Rice	Production	404794	392611	445950	431739	10%	10%	0%
Rice	Area	149853	149193	152052	152524	1%	2%	1%
Rice	Yields	2.70	2.63	2.93	2.83	9%	8%	1%
Rice	Cons. p.c.	59.62	67.82	60.46	66.32	1%	-2%	4%
Soya meal	Production	102584	134135	109727	156806	7%	17%	10%
Soya oil	Production	23492	30971	27110	36185	15%	17%	1%
Soya oil	Cons. p.c.	3.04	5.12	3.26	5.52	7%	8%	0%
Soybeans	Production	161692	199349	184700	229298	14%	15%	1%
Soybeans	Processing	125338	169682	144471	198308	15%	17%	2%
Soybeans	Area	57001	82774	60635	88750	6%	7%	1%
Soybeans	Yields	2.84	2.41	3.05	2.58	7%	7%	0%
Soybeans	Cons. p.c.	3.61	4.48	3.61	4.71	0%	5%	5%
Sugar	Production	135685	141242	153013	164362	13%	16%	4%
Sugar	Area	26424	26279	26777	27690	1%	5%	4%
Sugar	Yields	5.13	5.37	5.71	5.94	11%	11%	1%
Sugar	Cons. p.c.	21.45	23.63	22.40	25.31	4%	7%	3%
Sunflower	Production	27541	25390	30200	27416	10%	8%	2%
Sunflower	Processing	23326	22482	25917	24555	11%	9%	2%
Sunflower	Area	20782	21569	20361	21361	-2%	-1%	1%
Sunflower	Yields	1.33	1.18	1.48	1.28	12%	8%	3%
Sunflower	Cons. p.c.	0.22	0.46	0.17	0.43	-21%	-5%	16%
Sunflower meal	Production	11414	10052	11626	10979	2%	9%	7%
Sunflower oil	Production	9943	8993	11036	9841	11%	9%	2%
Sunflower oil	Cons. p.c.	1.48	1.48	1.52	1.50	3%	1%	2%
Wheat	Production	602716	604565	665105	653694	10%	8%	2%
Wheat	Feed use	104078	118694	110039	125218	6%	5%	0%
Wheat	Area	221469	220925	226402	218693	2%	-1%	3%
Wheat	Yields	2.72	2.74	2.94	2.99	8%	9%	1%
Wheat	Cons. p.c.	71.56	80.62	74.11	81.09	4%	1%	3%