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Optimal timing in the presence of uncertainty and non-instantaneous sectoral adjustment: The case of Norwegian grain policy

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Abstract:
This paper discusses how political uncertainty at the international level affects national policy formation for a sector characterized by non-instantaneous adjustment. Uncertainty about internationally imposed constraints on national policy design may induce national governments to postpone policy reforms due to the existence of an option value. At the same time, lagged sectoral adjustments induced by capital input bear the risk of inefficiencies if government changes policies too abruptly. The case is illustrated empirically by combining a one product, two input commodity market model and a political economy model for Norwegian grain policy. Political uncertainty at the international level is motivated by the current Doha-round negotiations in the World Trade Organization. The results of the model are ambiguous within a reasonable range of parameter values. The discount rate and the implementation period turn out to be crucial for the ranking of government strategies.

Keywords:
Optimal timing, endogenous policy formation, uncertainty, capital adjustment, agriculture

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D78, P16, Q18

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1. Introduction

The internationalization of agricultural policies since the mid-1990ies implies an increasing reduction of a country's freedom to set its national policies. A striking example is the Uruguay round agreement on agriculture (URAA) of 1995 that imposed for the first time constraints in the policy areas of market access, export subsidies and domestic support. Although not binding from the very beginning, the URAA starts to leave its footprints on national agricultural policy design. For example, in recent years, the URAA has caused changes in Norwegian agricultural policies in order to comply with the legal commitments of the agreement. It is expected that the current trade negotiations within the Doha-round of the World Trade Organization (WTO) will further reduce the political room for national manoeuvre.

The overall effects of the internationalization of agricultural policies have received wide attention in the literature (GTAP, CAPRI References of Uruguay-round and Doha-round). This literature, however, is static by nature and does not address the issue of how to adjust to a new WTO-agreement which level of reduction commitments and time of implementation is uncertain. There is a related literature that studies the effects of policy risk in agriculture in general (Gardner 2002) and with respect to farm sector adjustment (Lagerkvist 2005, Heikkinen and Pietola 2009). While this literature assumes the national governments as the source of risk, this paper contributes to the literature by assuming that the national government itself is exposed to uncertainty at the international level. We propose a dynamic model of endogenous policy formation in which a government decides about the timing and the design of policies in response to an uncertain future restriction of the country's set of feasible policies.

Some countries like the EU and Switzerland seem to pursue their domestic agricultural policy reforms despite of the uncertainty arising from the Doha-round. The 2003 reform of the EUs Common Agricultural Policy (CAP) has partly been justified as an attempt to comply with an expected outcome of the DDA (Swinbank and Daugbjerg 2006). Switzerland has also justified changes its agricultural policy in a similar fashion. On the contrary, the Norwegian position is that comprehensive reforms should be halted until the DDA has been concluded, and that farmers will be compensated for income losses accrued by a Doha-deal (Riis Johansen 2006, Norwegian government 2009). Theoretical support for the Norwegian position can be found in option theory: In the presence of uncertainty, irreversible costs (e.g., investments made in the farm sector) and the flexibility of timing, there will be an opportunity cost of giving up the option to wait (Dixit and Pindyck 1994). The value of this option implies that it will be efficient to wait to make a decision as more information is revealed over time. On the other hand, the agricultural sector is quite capital-intensive and sectoral adjustment is tardy. The stock of capital cannot be adjusted instantaneous. Agricultural policy reforms thus require predictability to avoid inefficiencies during the adjustment process.

The model results indicate that the parameterization of the model is sensitive to the evaluation of the Norwegian position. Within a plausible range of parameterization, both inefficient and efficient adjustment may occur, even if the government waits to adjust policies until the DDA is concluded.

The remainder of the paper is as follows. The next section lays out the model, while section 3 contains an overview of the model's parameterization and the simulations. Results are presented in section 4, while the last section draws some conclusions and points towards further research and possible extensions of the model.

2. Model

Consider a one-output two-input market model in the tradition of Floyd (1965) and Gardner (1987) extended to a dynamic version with discrete time. Let c_t and d_t represent two factors of production in period t, respectively. Assume c_t to be capital, which flow is given by:

(1) $c_{t+1} = c_t - \delta c_t + I_t$,

where δ is the depreciation rate and I_t is investment made in t. Assume further d_t to be intermediate input which amount is chosen and consumed in the production process within the same period. Let xs_t denote output produced, and assume Cobb-Douglass production technology at the industry level giving rise to the following production function:

(2) $xs_t = Ac_t^{\,C} d_t^{\,D}$

where C and D are input shares of capital c_t and intermediate input d_t, respectively.

Assume three policy instruments: an import tariff, tr_t, a per-unit deficiency payment (i.e., an output subsidy on xs_t) dp_t, and an interest concession (i.e. a government-financed reduction of the commercial interest rate) is_t. Output demand, denoted by xd_t, as well as supply of c_t and d_t is assumed to be linear in prices:

(3) $xd_t = b_0 + b_1 (PW + tr_t) d_t$

(4) $c_t = g_0 + g_1 r_t$

(5) $d_t = h_0 + h_1 p_t$

where xd_t is output demand, r_t is the price of capital, p_t is the price of the intermediate input. The effective demand price is $PW + tr_t$ where PW is the world market price assumed to be constant over the entire time period.

Since the production function in (2) does not yield the usual convex industry supply function in general, two quadratic cost terms depending on the level of capital and other inputs, respectively, are attached to the profit function for the farm sector:

(6) $\Pi_t = Ac_t^{\,C} d_t^{\,D} ps_t - c_t(\delta + r_t) - d_t p_t - QCC_1 c_t - QCC_2 c_t^{\,2} - QCD_1 d_t - QCD_2 d_t^{\,2}$

where QCC_1, QCC_2, QCD_1, QCD_2 are the coefficients of the quadratic cost terms. Calibrating a model by adding quadratic cost terms in addition to the accounting costs (represented by $c_t(\delta + r_t) + d_t p_t$) follows the seminal work of Howitt (1995). The quadratic cost terms cover the effects of restrictions on capital and variable inputs, aggregation bias, risk perceptions, but also potential data misspecification. Input demand for c_t and d_t is given by requiring the first derivative of (6) with respect to factor input to be zero:

(7) $\partial\Pi_t / \partial c_t \equiv ps_t CAc_t^{\,C-1} d_t^{\,D} - (r + DEP + is_t) - QCC_1 - 2QCC_2 c_t = 0$

(8) $\partial\Pi_t / \partial d_t \equiv ps_t DAc_t^{\,C} d_t^{\,D-1} - s_t - QCD_1 - 2QCD_2 d_t = 0$

Equilibrium in the output market is defined by

(9) $xd_t = xs_t + xi_t$

which states that output consumed (xd_t) must be either domestically produced (xs_t) or imported (xi_t). Allowing xi_t to be negative opens the possibility for exports.

Consider a government that maximises total social welfare by choosing optimal levels for the four policy instruments; a tariff, a deficiency payment, an interest concession and a lump-sum payment. Social welfare in each period t is defined as the unweighted sum of producer surplus (PS_t), the surpluses of capital suppliers (CSS_t) and intermediate input suppliers (DSS_t), consumer surplus (CS_t) and taxpayer surplus (TX_t). In addition, social welfare depends on preferences over policies as will be explained below. Total social welfare hence becomes the discounted sum of social welfare in all periods. Social welfare in t can be written as:

(10) $\omega_t(r_t, p_t, \boldsymbol{x_t}, \boldsymbol{b}) = PS_t(r_t, p_t, \boldsymbol{x_t}, \boldsymbol{b}) + CS_t(\boldsymbol{x_t}, \boldsymbol{b}) + CSS_t(r_t, \boldsymbol{b}) + DSS_t(s_t, \boldsymbol{b}) + TX_t(r_t, \boldsymbol{x_t}, \boldsymbol{b})$

where $\boldsymbol{x_t} = (tr_t, dp_t, is_t) \in X_t$ is a vector of (time-dependent) policy instruments at t in policy set X_t and

$\mathrm{b} = (A, C, D, \delta, b_o, b_1, g_o, g_1, h_o, h_1, QCC_1, QCC_2, QCD_1, QCD_2, PPTR, PPDP, PPIS, \sigma)$ is a vector of time-independent market parameters (some of which are defined below). Total social welfare becomes:

$$(11)\ \Omega(r_t, p_t, \boldsymbol{x_t}, \boldsymbol{b}) = \sum_{1}^{T} \sigma^t \omega_t(r_t, p_t, \boldsymbol{x_t}, \boldsymbol{b})$$

Due to linear functions, the calculation of CS_t, CSS_t and DSS_t are straightforward:

$$(12)\ CS_t(\boldsymbol{x_t}, \boldsymbol{b}) = \frac{1}{2}\left(\frac{b_0}{b_1} - (PW + tr_t)\right)(b_0 - b_1(PW + tr_t))$$

$$(13)\ CSS_t(r_t, \boldsymbol{b}) = \frac{1}{2}\left(r_t + \frac{g_0}{g_1}\right)(g_0 + g_1 r_t)$$

$$(14)\ DSS_t(p_t, \boldsymbol{b}) = \frac{1}{2}\left(p_t + \frac{h_0}{h_1}\right)(h_0 + h_1 p_t)$$

Producer surplus including the quadratic cost term is given by:

$$(15)\ \begin{aligned} PS_t(r_t, p_t, \boldsymbol{x_t}, \boldsymbol{b}) &= (PW + tr_t + dp_t) A c_t^{\ C} d_t^{\ D} - (r_t + \delta - is_t) c_t - p_t d_t^{\ 2} \\ &- QCC_1 c_t - 2\,QCC_2 c_t - QCD_1 d_t - 2\,QCD_2 d_t \end{aligned}$$

while taxpayer surplus (TX_t) includes import tariff revenues, deficiency payments, and interest rate concessions:

$$(16)\ TX_t(r_t, \mathrm{x}_t, \mathrm{b}) = xi_t tr_t - dp_t A c_t^{\ C} d_t^{\ D} - is_t c_t$$

As mentioned before, social welfare depends on the economy's preferences over policies. Let *PPTR*, *PPDP*, and *PPIS* represent preferences over the three policy instruments, respectively, measured in monetary terms. Intuitively, policy preferences measure welfare foregone as the economy moves away from the non-intervention solution by introducing policies. The policy preferences may also cover different types of transaction costs (as defined by Williamson 1985 and Eggertsson 1990).[1] The monetary values of the policy preferences are calibrated to

[1] Note that neither limit of the policy instruments is constrained by WTO regulations. Even the applied tariffs are below bounded levels.

observed base year levels of policies and market parameters by assuming economic-political equilibrium in the base year. Due to the lack of empirical evidence, a linear function is applied. This implies that policy preferences increase (and decrease) linearly with the size of the payments. The rationale behind introducing policy preferences is to introduce a theoretical justification of the observed size of the policy instruments.[2]

Government performs sequential policy decision-making at each period t taking policy decisions in previous periods as given. Government commits policies one period ahead not knowing whether the Doha-round will be completed. This implies that government makes provisional plans for all future periods that can be changed at later stages, apart from next year's policy. A typical decision at period r is:

(17)

$$\max_{(\boldsymbol{x}_{s+1},\ldots,\boldsymbol{x}_T)\in X} \Omega(\boldsymbol{x}_{r+1},\ldots,\boldsymbol{x}_T,\boldsymbol{b}|\boldsymbol{x}_1,\ldots,\boldsymbol{x}_r) = \sum_{1}^{r}\sigma^t\,\omega_t(\boldsymbol{x}_1,\ldots,\boldsymbol{x}_r,\boldsymbol{b}) + \sum_{r+1}^{T}\sigma^t\,\omega_t(\boldsymbol{x}_{r+1},\ldots,\boldsymbol{x}_T,\boldsymbol{b}|\boldsymbol{x}_1,\ldots,\boldsymbol{x}_r)$$

where the first term of the right hand side in (17) is a constant measuring welfare in past periods up to s depending on past policy decisions, and $X = X_1 \times \ldots \times X_T$. Government makes policy decisions for all periods between $r + 1$ and T, but only the decision for $r + 1$ is committed.

Uncertainty enters the model in the following way. Imagine a period S^0, known to the government, at which the Doha-round can be concluded for the first time. Starting from S^0, Nature is assumed to draw S, the conclusion of the Doha-round, with a known probability of one half. Once Nature has drawn S, the (known, but uncertain) Doha-commitments are introduced from the period immediately following S onwards. In each period $r \geq S^0$, Nature moves first and draws. If it picks S in r, uncertainty is revealed, and the reduction

[2] Rausser and Freebairn (1974) propose to estimate political weights for interest groups as a calibration of the model. Their approach requires a strong relationship between the number of policy instruments and the number of interest groups (Bullock 1994), which is avoided in the present approach.

commitments are implemented from $r+1$ onwards. Once Nature draws S reduction commitments are implemented starting in the period immediately following S. Upper limits of the tariff and the deficiency payments are reduced in five equal instalments and stay at their final levels until the end of the optimization horizon T. The five year implementation period corresponds to that of the URAA. Government moves second and commits policy x_{r+1}. Note that government is uncertain whether Nature draws S in r when government, in period $r-1$, has to make its policy choice on r.

Government is assumed to have three different strategies to adjust. Strategy "*Wait*" implies that it waits making any policy reforms until Nature has picked S. This strategy corresponds to the Norwegian approach. Strategy "*Expct*" means that government is allowed to change policies as of S^0. It bases its policy reforms on the expected value of the import tariff and the deficiency payment taking uncertainty over Nature's moves into account. It may freely set the rate for the interest concession with the commercial market rate being the upper limit. The last strategy "*FixR*" implies that government starts policy reforms at S^0 (irrespective of what Nature draws), where R is a label for the period at which the policy reform is anticipated to be finished. For example, "*Fix20*" means that the implementation of the policy reform starts in $t = 11$ and ends in $t = 20$. It reduces the import tariff and the deficiency payment in equal instalments during the strategy specific implementation period, and sets the interest concession freely up to the commercial market rate. If Nature draws S at an early stage, the anticipated policy reform in "*FixR*" may have to be accelerated in order to comply with the reduction commitments.

Sub-optimal adjustment is present if the marginal values of the inputs no longer equal their respective factor prizes net of subsidies. In other words, equations (7) or (8) are no longer satisfied. Regarding intermediate input d_t, this will rarely happen as the level intermediate input is chosen and consumed in the same period. For capital input c_t, however, the previous year's capital stock and the investments made in the previous year determine the amount of capital in the current year, running the risk of a higher than optimal capital stock if the variables in (7) change rapidly in an unfortunate manner.

3. Data

In order to study the isolated effect of uncertainty and non-instantaneous adjustment on optimal timing, it is necessary to assume political-economic equilibrium in the base year. Otherwise farm sector adjustments to reach equilibrium would take place immediately and interfere with adjustments induced by the policy shock.

Besides the discount rate, which was set to $\sigma = .05$, the model's parameters were found by using data from the Norwegian agricultural sector model Jordmod (Brunstad et al. 2005, Gaasland and Mittenzwei 2001). The base year was "2006" defined as the unweighted three-year average 2005-2007. Output is a grain composite product made up of wheat, rye, barley and oats. Intermediate input contains all accountancy costs, while capital input consists of building and machinery capital.

In the base year, production was at xs_1 = 1,227 million tons while demand is at xd_1 = 1,644 millon tons leaving xi_1 = 0,417 million tons for imports. Capital was c_1 = 4,371 million Norwegian *kroner* (nkr) and intermediate input was d_1 = 2,614 million nkr. The world market price was PW = .834 nkr/kg, while the import tariff in the base year was tr_1 = .975 nkr/kg. The domestic market price thus became 1.809 nkr/kg, while producers in addition received a deficiency payment of dp_1 = 1.092 kr/kg. The interest rate concessions compared to is_1 = .002 percent of capital in the base year.

The production function was calibrated by approximating the implicit grain supply function in the sector model. The parameter values became $A = .98$, $C = .135$ and $D = .789$, and revealed an elasticity of scale slightly smaller than unity. The depreciation rate δ was set to .117 based on the sector model. The parameters of the output demand function were also taken from the sector model. Assuming a demand elasticity of -.3, the parameters of the linear demand function became b_0 = 2138.081 and b_1 = 272.678. The lack of sufficient data to estimate the supply functions for capital and intermediate inputs made it necessary to use guesstimates. It was assumed that the lowest interest rate at which capital is supplied, was .5%. This gave g_0 = -960.202 and g_1 = 192,040.482. For intermediate inputs, the lowest price at which intermediate inputs are supplied, was set to one quarter of the base year price leading to h_0 = -637.586 and h_1 = 2,465.207.

The parameters of the quadratic cost term in the profit function were calibrated by requiring base year profits. However, with only one observation (the base year values) an additional assumption was necessary to calibrate the values of the four parameters QCC_1, QCC_2, QCD_1, and QCD_2. It was assumed that the linear part of the function would cover one quarter of the difference between profits and costs, while the quadratic part of the function would cover three quarter of the difference. This procedure yielded values of -0.062 for QCC_1, 0 for QCC_2, -0.046 for QCD_1, and 1.256×10^{-4} for QCD_2.

The assumed conclusion of the international trade negotiations within the WTO Doha-round provoked the policy shock. Two sets of commitment reductions are assumed ("high", "low") as any Doha-deal would only be a framework that would leave space for national priorities.

The appropriate reduction according to the tiered formula approach in the "July 2008 package" (WTO 2008) would be 70%. Because of "water" in the tariffs (as Norwegian tariffs are higher than required to maintain the current national price level), the effective tariff reduction would be much smaller. In the base year, the effective tariff (measured as the difference between the domestic price and the world price) was tr_1 = .975 nkr/kg, while the bounded tariff for the composite product was 1.825 nkr/kg. Reducing the bounded tariff by

70% as required would result in .547 nkr/kg, which compares only to a 43.9% reduction from the effective tariff in the base year. One could also argue to reduce the import tariff by its full amount as this would considerably lower feeding costs in other sectors. Therefore, in the "high" ("low") set of commitments, the import tariff is reduced by 70 % and 43.9 %, respectively.

This issue is somewhat more complex in the case of the deficiency payment which is part of total AMS (Aggregate Measurement of Support or 'amber box'). Total AMS, which consists of domestic support to all major agricultural commodities, would have to be reduced by 52.5% for Norway. The effective reduction, however, depends on the national implementation. Other sectors such as milk and beef are more important to Norwegian agriculture in terms of value added and employment, such that higher reduction strategies for grains are likely. In the "high" ("low") set of commitments, deficiency payments are reduced by 100 % and 52.2 %, respectively.

In order to allow sufficient time to adjust policies, a time horizon of $T = 30$ periods is assumed. The first period at which the Doha-round can possibly be concluded is set at $S^0 = 10$, such that implementation can start at $t = 11$ and end at $t = 15$ at the earliest.

The model is facilitated in GAMS® software[3].

4. Results

Table 1 shows total discounted social welfare for five strategies depending on Nature's draw of S. The five strategies cover "wait", "expct" and three strategies with fixed policy reform and different implementation end dates: $t = 15$, $t = 20$ and $t = 25$ ("Fix15", "Fix20", and "Fix25"). They are calculated for the high reduction set of commitments, and the values

[3] The progamming code can be obtained from the author.

depend on the date of actual implementation. The first implementation date is t = 11, and the last is set at t = 20 in order to allow for full adjustment until T.

Table 1. Total social welfare for five strategies for high reduction commitments depending on implementation periods (S)

S	Wait	Fix15	Fix20	Fix25	Expct
11	108 307	108 329	108 329	108 329	108 307
12	108 625	108 644	108 648	108 648	108 630
13	108 928	108 911	108 944	108 947	108 929
14	109 215	109 104	109 211	109 227	109 213
15	109 466	109 184	109 447	109 483	109 483
16	109 747	109 184	109 650	109 718	109 739
17	109 993	109 184	109 813	109 931	109 983
18	110 227	109 184	109 940	110 117	110 215
19	110 450	109 184	110 019	110 283	110 434
20	110 661	109 184	110 055	110 423	110 643

Source: Own calcuations.

At the earliest possible date of implementation, t = 11, total social welfare is almost identical across strategies as the commitment reductions for the import tariff and the deficiency payments are equal, and the only difference between the scenarios is the size and timing of the policy change for the interest rate concession. As implementation is allowed to start at t = 10 for "*Fix15*", "*Fix20*", and "*Fix25*" strategies, total welfare is slightly higher than for "*Wait*" and "*Expct*" given implementation at t = 11 and t = 12. Among the three "*FixR*" strategies, "*Fix25*" weakly dominates the other ones. Quick implementation is not superior irrespective of the actual implementation date. Comparing "*Fli25*" with "*Expct*" and "*Wait*" it turns out, that early implementation yields higher welfare up to t = 15. When actual implementation starts later, "*Expct*" and "*Wait*" outperform "*Fli25*".

Note that government does not know the actual implementation date. A rational government that puts equal probabilities on each of the possible implementation dates in Table 1 would chose "*Expct*" as the preferred strategy followed by "*Wait*". A similar table could be provided for the low reduction set of commitments. In this case, "*Wait*" outperforms "*Expct*", while "*Flex25*" is ranked third. Taken together, if the actual set of commitment reductions is not known to government, placing equal probabilities to the low reduction set and the high reduction set, ranks "*Expct*" first followed by "*Wait*" and "*Fix25*".

The relative differences in total social welfare between the strategies are rather small, with the exception of "*Fix15*" and "*Fix20*", which are always outperformed by "*Fix25*". The percentage difference between the three strategies "*Wait*", "*Expct*" and "*Fix25*" are smaller than 0.25 percent.

The differences in total social welfare between the strategies are related to the non-instantaneous adjustment of capital.

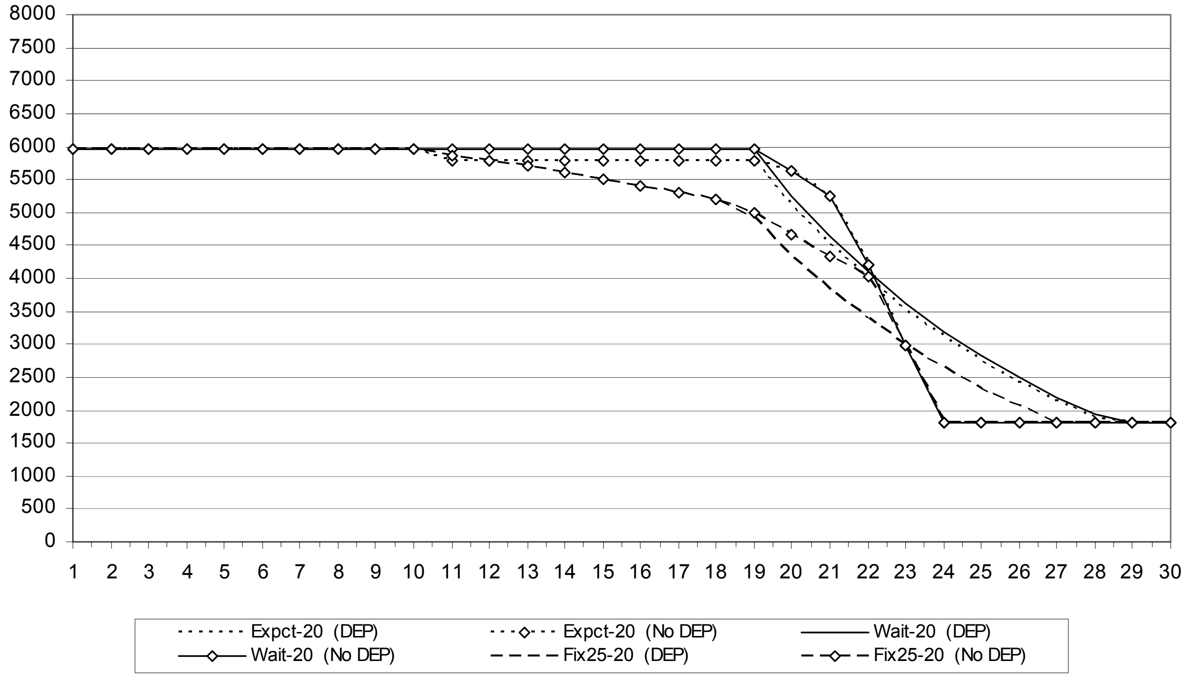

Figure 1. Development of capital for three scenarios with (DEP) and without (No DEP) depreciation (1 000 Nkr)

Figure 1 shows the development of capital for three strategies, "Wait-20", "Expct-20", and "Flex25-20" for the high reduction set of commitments and under the assumption that implementation starts at $t = 20$. For each of the strategies, the optimal adjustment path is shown with depreciation (DEP) and without depreciation (NoDEP). The no depreciation alternative treats capital as an ordinary intermediate input. It can be inferred from figure 1, that capital adjustment that does not depend on past choices (NoDEP) works more quickly (i.e., a steeper slope) compared to the strategies where depreciation is present. Two kinds of inefficiencies can occur that violate the profit maximizing condition according to which optimal use of input is achieved when the marginal product has to equal the factor price (net of subsidies). At the beginning of the implementation period, capital is pulled out more quickly than would be necessary if it could be freely adjusted. At the end of the implementation period, as capital cannot be reduced quickly enough, too much capital remains in the sector. For the strategy "*Fix25-20*", the amount of capital is aligned between the two alternatives with and without depreciation in period $t = 28$, while the same is true for the strategies "*Wait-20*" and "*Expct-20*" in $t = 29$. The absolute sum of differences in capital is 3,08 mill Nkr in the "*Fix25-20*" strategy and 5,33 mill Nkr in the "*Wait-20*" strategy.

This does not mean, however, that total welfare is higher in the "*Fix25-20*" strategy, too. Implementing reduction commitments irrespective of when the actual implementation period starts bears the cost of changing policy too early. Table 1 illustrates that total social welfare is higher for the "*Wait-20*" strategy compared to the "*Fix25-20*" strategy.

Table 2. Total social welfare for Wait-20 and Fix25-20 under high reduction commitments (mill. Nkr)

Periods	Wait-20	Fix25-20	Difference
1-10	57 262	57 262	0
11-19	31 593	31 411	-182
20-24	11 735	11 658	-76
25-30	10 071	10 091	20
Sum	110 661	110 423	-238

Source: Own calculations

In the Pre-implementation period (periods 11-19), changing policy instead of waiting reduces total social welfare with 182 mill. Nkr. During implementation (periods 20-24), additional 76 mill. Nkr are lost. It is only in the Post-implementation period (periods 25-30), that "*Fix25-20*" saves 20 mill. Nkr compared to "*Wait-20*".

Two aspects seem to be of crucial importance for the total social welfare ranking of strategies: The implementation period and the discount rate. In table 3, the implementation period is reduced from five periods to one period. That means, the reduction commitments are implemented in one step only. This increases the losses from not adjusting policies prior to the implementation date. It turns out, however, that even under this assumption "*Wait-20*" still yields higher total social welfare than "*Fix25-20*". The difference is reduced from 238 mill. Nkr to 37 mill. Nkr.

Table 3. Total social welfare for Wait-20 and Fix25-20 under high reduction commitments and instantaneous implementation (mill. Nkr)

Periods	Wait-20	Fix25-20	Difference
1-10	57 262	57 262	0
11-19	31 593	31 274	-319
20-24	10 853	11 104	251
25-30	10 071	10 102	31
Sum	109 779	109 742	-37

Source: Own calculations

The strategy "*Fix25-20*" benefits from the reduction of the implementation period, because policies have been reduced in the Pre-implementation period. Adjustment is smoother, and creates less welfare losses in the sector. On the other hand, the adjustment of policies in the Pre-implementation period (period 11-19), moves the policy mix further away from the (optimal) base year solution creating a lower level of total social welfare compared to the development with a five year implementation period (31 274 mill Nkr in table 3 compared to 31 411 mill Nkr in table 2). Total social welfare is reduced for both strategies, but the reduction is larger for "*Wait-25*" with 882 mill. Nkr compared to 680 mill. Nkr for "*Fix25-20*".

The ranking between the two strategies is changed if, in addition to instantaneous implementation, the discount rate is set to zero (table 4). In this case, "*Fix25-20*" yields 99 mill. Nkr higher total social welfare compared to "*Wait-20*".

Table 4. Total social welfare for Wait-20 and Fix25-20 under high reduction commitments, instantaneous implementation and zero discounting (mill. Nkr)

Periods	Wait-20	Fix25-20	Difference
1-10	79 061	79 061	0
11-19	71 155	70 334	-821
20-24	35 257	36 056	799
25-30	43 291	43 413	122
Sum	228 764	228 863	99

Source: Own calculations

Discounting makes waiting more valuable, because welfare earned in later periods counts less. In other words, the costs of adjusting policies prior to the implementation of the reduction commitments, which arise in early periods, are valued less by society than the benefits of adjusting policies that occur in later periods.

5. Discussion and conclusion

The study presents a political-economy model of dynamic endogenous policy formation for Norwegian grain production. The focus is on the role political uncertainty plays for the timing and design of national policies. The model is set up to investigate the trade-off between the benefits of waiting to adjust policies in order to gain better information and to maintain the political-economical equilibrium in the base year, and inefficiences in the sector due to tardy response of capital adjustment triggered by rapid policy change.

The results indicate the sensitivity of the models' parameters. General conclusions cannot be easily drawn from the model. Instead, the model highlights the relative importance of the different factors that render the ranking of the strategies. Two such factors turn out to be of particular importance: The discount rate and the implementation period.

The discount rate makes waiting more valuable compared to early adjustment. This is because the benefits of waiting accrue in earlier periods, while the costs of not adjusting accrue in later periods. It has been argued that the particular system of policy decision-making in agriculture is consistent with a low discount rate (Mittenzwei and Bullock 2004). In

Norway, annual formal negotiations are held between farm representatives and government representatives on agricultural administrative prices and budget support measures. An important variable in the negotiations is the return to labour and farm-owned capital pr man-year in agriculture. The negotiations are held parallel in time with the wage negotiations in the industry and the public sector, giving the agricultural negotiations a touch of wage negotiations between the farmers and the government. The system of annual occurrence of the negotiations with its focus on farm income, tend to bias the negotiation result in favour of short-term benefits. It can be argued that the system therefore implies a lower discount rate than would be otherwise.

The implementation period plays also an important role as it prevents instantaneous policy adjustment. By delaying the implementation of the reduction commitments, it makes waiting more valuable *ceteris paribus*. The empirical results indicate that different assumptions on the discount rate and the implementation period together can alter the ranking of the strategies with respect to total social welfare.

The above results must be seen, however, in the context of the model's other parameters. It is reasonable that changes in the production function (e.g. a higher share of capital), a higher capital depreciation rate, or a larger policy shock all would act in favour of early adjustment (and is disfavour of waiting). In this respect production lines that are more capital-intensive than grain, such a dairy, may yield different results regarding the ranking of the strategies with respect to total social welfare. Regarding the optimal strategy for the agricultural sector as a whole, a more complex economic model would be needed.

Although there are differences with respect to total social welfare, the relative differences between the strategies appear to be rather small, even with no discounting and a shortest possible implementation period. If these results were to be generalized, they could lead to a hypothesis that potential inefficiences due to delayed sectoral adjustment should play a rather secondary role as an argument to force domestic policy change in the presence of uncertainty regarding the WTO Doha-round. Such a hypothesis would be somewhat in conflict with the arguments put forward by the European Commission in connection with the 2003-reform of the Union's Common Agricultural Policy (CAP) to make the CAP fit for a conclusion of the Doha-round (Swinbank and Daubjerg 2006).

The model makes a contribution to our understanding of the drivers of agricultural policy reform in a dynamic context. In the present paper, the importance of delayed sectoral adjustment due to the capital flow, as an argument to hasten policy reform has been investigated. In a first step, the grain sector in Norway was analysed. Better theoretical and empirical evidence, based on a more comprehensive economic and political model applied to other agricultural sectors and other countries would be valuable in supporting, modifying or rejecting the results of this study.

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