Strategic Decisions in the Transition to Deregulated Markets

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Abstract

Liberalisation of markets is supposed to be an adequate procedure to satisfy the worldwide demand for innovations. However, the transition from regulated markets to competition is a disequilibrium phenomenon and requires specific consideration of the appearing dynamics. We present in this paper a simple, yet general, model which is instrumental in understanding the likely market evolution during a liberalisation process. Furthermore, the developed System Dynamics-based model provides the possibility to simulate strategic decision-making in out-of-equilibrium markets caused by deregulation. The impacts on firm and market performance of a price-maker strategy, enabled through process innovation, on the one hand and a differentiation strategy on the other hand are discussed in details. The model is adapted to a goods market, albeit the presented implications have much wider use.

Keywords: Liberalisation; Deregulation; Innovation; Strategy decision-making; Simulation; System Dynamics

1 Introduction

Accordant to economical as well as political statements, product and labour market regulations are jointly responsible for the poor European performance of the last decades [1]. Deregulation of markets is supposed to increase firm performance for potential gains from increased market competition are amongst others:

- Improvements in technology – with positive effects on production methods
- A faster pace of invention and innovation

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The overall impact of increased market competition is aimed to be an improvement in economic welfare. Industries like electricity, natural gas, telecommunications, airlines, water utilities and cable television are just some examples which are currently in the transition into competition or got already liberalised [2].

Deregulation is fundamental about reducing and redistributing rents, leading economic players to adjust in turn to a new market situation [3]. According to Gary and Larsen [2], the transition to competition for firms is inherently a disequilibrium phenomenon for which traditional equilibrium approaches are not well suited and are likely to mislead managers. To support strategic decisions in such an environment, specific models to understand the out-of-equilibrium transition to competitive markets are required. These models are essential to help managers evaluate the performance impact of various strategic policies.

A general overview about liberalisation and the use of economic models can be found in Hunt and Shuttleworth [4]. More recently, efforts have been undertaken to describe the dynamic effects of regulation and deregulation [3, 5]. A. Graham and D. Mayo [6] investigated investment responses under different regulatory regimes and moreover specific System Dynamics models have been used to improve the understanding of deregulation in the utility sector [2, 7, 8] and in goods markets [9].

Our ambition is to gain awareness of the market evolution and the implications of strategic decisions on firm and market performance. We present in this paper a simulation model (System Dynamic Model build with Vensim® software), that allows to try out different policies. The Model is adapted to the situation of a goods market, however, the basic ideas and implications have much wider use.

The applied systemic approach is generally known as System Dynamics or Business Dynamics. This method is a discipline for the modelling, simulation and control of complex dynamic systems, developed at the Massachusetts Institute of Technology (MIT) by Jay W. Forrester (1961, 1968). The art of System Dynamics modelling is basically about discovering and representing the feedback processes, which, along with stock and flow structures, time delays and nonlinearities, determine the dynamics of a system. A main feature of this modelling method is that the issue modelled is represented by closed feedback loops made up of essentially two kinds of variables – stocks and flows – supplemented by parameters and auxiliary variables [10]. For a detailed description and explanation we refer to the work of John D. Sterman [11].

The paper is organized as follows: Section 2 presents the core structure of the model including the fundamental feedback loops. Section 3 introduces the relations between the cause variables and shows the complete System Dynamics model. Section 4 reviews simulation experiments carried out with the model. Especially the implications of a price-maker strategy and a differentiation strategy are discussed in details. Section 5 completes the paper with a conclusion and future prospects.

2 The underlying structure of the model

Because our aim is to understand the behaviour of the complex system of a market just after the lift of regulations, we need to understand the dynamics of the interactions (feedbacks) among the components of the system. According to Sterman [11], all dynamics arise from the interaction of two types of feedback loops, positive (or self-reinforcing) and negative (or self-correcting) loops. Positive loops tend to reinforce or amplify whatever is happening in the system, while negative loops counteract and oppose change.

To visualize the feedback structure of our system, we used causal loop diagrams as can be seen in Fig. 1. Such diagrams consists of variables linked through arrows denoting the causal influence. Each arrow has a defined polarity either positive (+) or negative (-) which implicates the following nature of relationship:

$$x \overset{+}{\rightarrow} y \;\Rightarrow\; \frac{\partial y}{\partial x} > 0 \quad \text{and} \quad x \overset{-}{\rightarrow} y \;\Rightarrow\; \frac{\partial y}{\partial x} < 0 \quad .$$

The complete loops are indicated with a small loop-sign and the corresponding (+) or (-) sign according to its self-reinforcing or self-correcting character. Causal loop diagrams provide a language for articulating our understanding of the dynamic feedback structure of the system, however, they do not provide a quantitative description of the interactions.

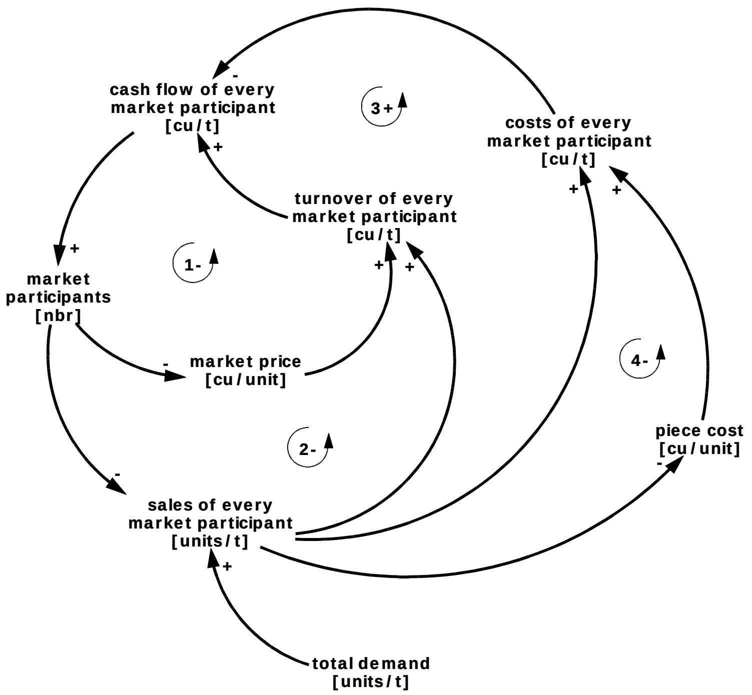

Figure 1: Causal loop diagram of the market

The core structure of our market model illustrating the main feedback loops is shown in Fig. 1. We assume that the evolution of a deregulated market starts with one single firm generating initially a big cash flow which attracts new market participants leading in the long run through price decline to a small cash flow and thereby to a new equilibrium state with a certain number of market participants.

Starting point for our consideration of the liberalisation process is an existing market initially dominated by one company possessing the monopoly and determining the price. An attractive cash flow gained by this firm combined with the cumulative lift of regulations leads to an entry of new market participants. The increasing number of market participants yields a toughened competition resulting in a price decline. This reduces the individual turnover leading to a smaller cash flow of the existent market participants and thus reduces the attractiveness to enter the market for new players. The part of the total demand which is equally distributed among the new market participants increases with the lift of regulations and according to this with the time. The costs per piece (piece costs / unit costs) are linked with the number of sold units per time (sales) for a decrease of the sales leads to higher piece costs. It is of particular importance that the sales denotes the sold units per time whereas the turnover stands for the net sales measured in currency units per time. The remaining arrows just illustrate the trivial relations between sales, turnover, costs and cash flow. In total four fundamental feedback loops can be observed.

The aim of our model primary is to simulate the market evolution but moreover it should demonstrate the impact of different strategies embarked by the company holding the initial monopoly position. Therefore the previously mentioned relations have to be quantified and translated into a simulation compatible language. Such undertaking is described in the next section.

3 The System Dynamics Model

We performed a System Dynamics approach for modelling the market structure based on the causal loop diagram described in the previous section. In doing so we created a mathematically formalized, quantitative model providing the possibility of numerical simulations. Following the argumentation of Schwaninger [10], there are several reasons for modelling quantitatively: First, it conduces to higher precision of the theory by specifying the relations between the variables as algebraic functions. Secondly, hypotheses can be derived mathematically from formalized theories by which new and surprising insights are often gained. Thirdly, a model allows testing the theoretical assumptions for inconsistencies in a more stringent fashion and facilitates checking the deduction of errors. The motivation for using System Dynamics in particular is based upon the fact, that investigation elements like feedbacks, nonlinearities and delays have always been an explicit strength of the System Dynamics methodology. As a consequence of this methodology all variables are considered to be continuos including the number of competing companies.

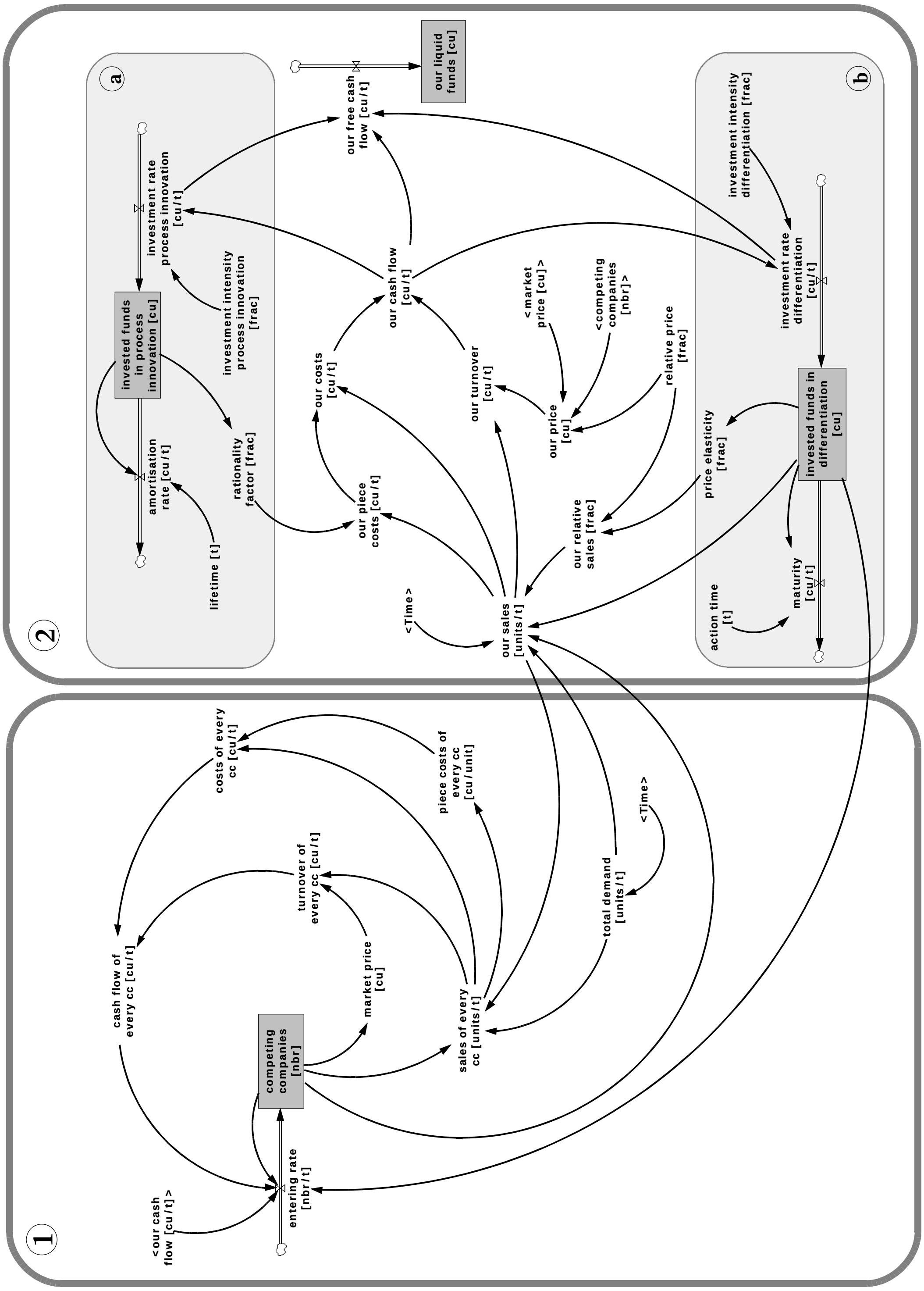

Figure 2: System Dynamics model of the market including the competing companies (1) and the company possessing the initially monopoly position labelled as “our company” (2).

Fig. 2 shows the complete model[1] wherefore the corresponding narrative model that forms the basis of the System Dynamics model is elucidated in the text below. The underlying set of mathematical equations is provided in appendix A. The model structure consists of two conceptional elements: (1) the competing companies and (2) the company holding the initial monopoly, hereinafter called “our company”. The two substructures (a) and (b) within “our company” represent two investment policies allowing to influence both, the firm performance and the total market evolution.

(1) competing companies (cc)

- The continuous number of competing companies is defined by the integration over the entering rate. This entering rate is proportional to the average cash flow of our company and the one generated by the existing competing companies. Furthermore, the rate is reduced whenever the invested funds in differentiation of “our company” rises above a certain limit.
- The total demand per time consists of an initial value and increases linearly with time.
- The part of the total demand which is equally distributed among the competing companies defining their sales (units sold per time) is a function of their number and the sales of “our company”.
- The initial value of the market price declines with the increasing number of competing companies due to the toughened competition.
- The piece costs (unit costs) of every competing company consists of two shares: the variable costs and the fixed costs. The later share is reduced with an increasing sale of the company.

(2) “our company”

- The sales of “our company” are affected by means of three influences: First by the competing companies claiming a certain share of the total demand. This share increases with time for the transition to competition requires awhile. Secondly by the relative price in combination with the price elasticity. Thirdly by investment efforts corresponding to the invested funds in differentiation.
- The price is defined in relation to the market price via the relative price which can be determined as an exogenous variable. The opportunity to vary our price compared to the market price is one procedure leading to a possible market differentiation.
- The piece costs are a function of the sales in analogy to the piece costs of every competing company. Additionally our piece costs can be reduced by a rationality factor. This factor which is smaller or equal than one results from investments in process innovations.

1 The model is written using the Vensim® software produced by Ventana Systems Inc.

- The free cash flow is equivalent to the cash flow reduced by the two investment contributions (a) and (b). The accumulated rate generates the liquid funds.
- Compared to the competing companies, “our company” has two investment possibilities. They both provide a procedure leading to a market differentiation:

  (a) An amount, determined by the investment intensity in process innovation, can be diverged from the cash flow building the investment rate in process innovation. The accumulation of this rate defines the invested funds which value determines a rationality factor. This factor reduces our piece costs. The invested funds in process innovation get decomposed by an amortisation rate according to the lifetime belonging to it.

  (b) A second amount, determined by the investment intensity in differentiation, can also be diverged from the cash flow building the investment rate in differentiation. The accumulation of this rate defines the invested funds which value directly affects the price elasticity and the sales. The invested funds in differentiation decline according the maturity determined by the action time.

All dependences in our model not mentioned in details are trivial. In consideration of the relations described above, the main dynamics of the market evolution and the performance of “our company” can be simulated. The outcomes including the impact of different strategies achieved by our company are discussed in the following section.

4 Simulation experiments

We performed simulation experiments to check the plausibility of the model and to understand the general behaviour of the market evolution during a liberalisation process. Compared to the base case scenario where no investment strategies are achieved, the impact of several different policies have been tested. The underlying comparison simulations are discussed in this section. As a matter of course, the model was primarily subjected to sensitivity analysis for numerous model parameters to ensure the results of the model were robust. The used simulation settings and the chosen values of the model parameters are displayed in Appendix B.

4.1 Base case scenario

The base case scenario represents the market evolution likely to happen when no investment efforts are undertaken by “our company” and the price of “our company” is always equal to the market price. In this scenario the only difference between “our company” and the competing companies is the fact that the liberalisation process takes some time and therefore the total demand is not equally distributed among all market participants until a certain time delay. This point is motivated for also after deregulation, barriers to entry may persist hindering successful market entry even by more efficient operators (e.g. incumbent's control over legacy infrastructure, economies of scale and scope) [12]. The base case refers to a scenario where after the mentioned time delay the market will change to perfect competition. Such an economic model describes a hypothetical market form in which no producer or consumer has the market power to influence prices. Moreover, perfect competition requires amongst others that there is no product differentiation and that any firm may enter the market as it wishes.

For the numerical simulation it is mandatory to determine exact values for the model parameters like the initial market price, the pice costs, the total demand, etc. (see Appendix B). Although these values are indeed logically determined, they are freely chosen for we are not interested in the magnitude of the simulation outcome but in the dynamic of the individual variables. In the same manner the mathematical equations have been determined. We believe the relations are plausible. Thus the System Dynamics model is supposed to be adjustable to a real case and may be used to simulate an ongoing liberalisation process.

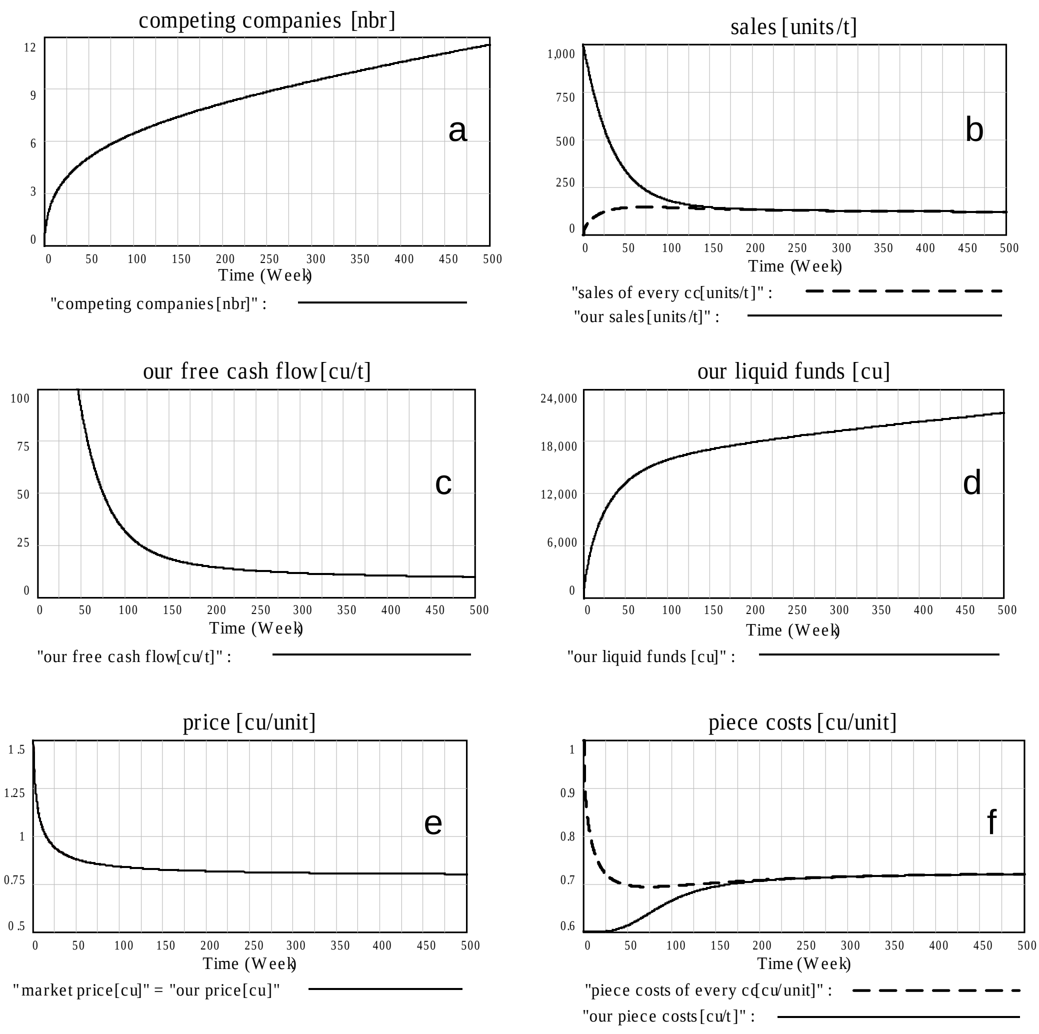

Figure 3: Simulation output for the base case scenario

The numerical output of the base case scenario is illustrated in Fig. 3. The simulation is performed over 500 time units (weeks). In Fig. 3(a) it can be seen that the number of competing companies increases strongly at first and level off later on. The reason lies in Fig. 3(b) which implicates that the total demand is distributed among more and more participants leading to smaller sales and respectively to a smaller cash flow of "our company" according to Fig. 3(c). For reasons of scale, the cash flow is only plotted for values below 100 currency units per time. The described evolution reduces the entering rate exponentially which results in a kind of level off in the number of market participants. Furthermore, Fig. 3(b) shows the assumed smoothly transition to deregulation giving rise to a new competition equilibrium after about 150 weeks. In this equilibrium the total demand is equally distributed among all participants so that the sales of "our company" are equivalent to the sales of every competing company. The liquid funds of "our company" shown in Fig. 3(d) is just the integration of the free cash flow. Fig. 3(e) illustrates that the market price decreases with time due to the toughened competition caused by the increasing number of market participants. In the last Fig. 3(f) the piece costs of "our company" and the one of every competing company is plotted over the simulation time. The curves are approximately reciprocally proportional to the curves in Fig. 3(b) corresponding to the idea, that a smaller sale leads to higher piece costs.

At this point, it is essential that the presented market evolution for the base case scenario comes up with the estimated behaviour according to the narrative model elucidated in Section 2. Consequently the obtained results justify the System Dynamics model and build a veritable basis of comparison for the following strategic decision scenarios.

4.2 Strategic decision analysis

As the base case points out, in the beginning of the transition to deregulation entry barriers are responsible that the main part of the total demand is covered by the company holding the initially monopoly ("our company"). But within the simulation the last continual regulations vanish and the total demand gets distributed among several market participants. As a consequence the sales as well as the cash flow decrease dramatically. To avoid such an undesirable scenario "our company" is forced to implement an expedient investment strategy. The two possibilities whichour model takes into account are introduced in Section 3(2). As a main achievement of the System Dynamic model, different strategic policies can now be simulated and compared with the base case. Two selected policies are introduced in this section and discussed in details.

4.2.1 Price-maker strategy

A possible strategy to achieve a larger free cash flow in the long term run, is to gain advantage of competition by economies of scale. A certain amount of the cash flow gets invested into process innovations causing smaller piece costs via the rationality factor. The low piece costs allow consequently to reduce the price compared to the particular market price. Assuming a relative high price elasticity of demand, the price reduction leads to a larger market share and thus to larger sales.

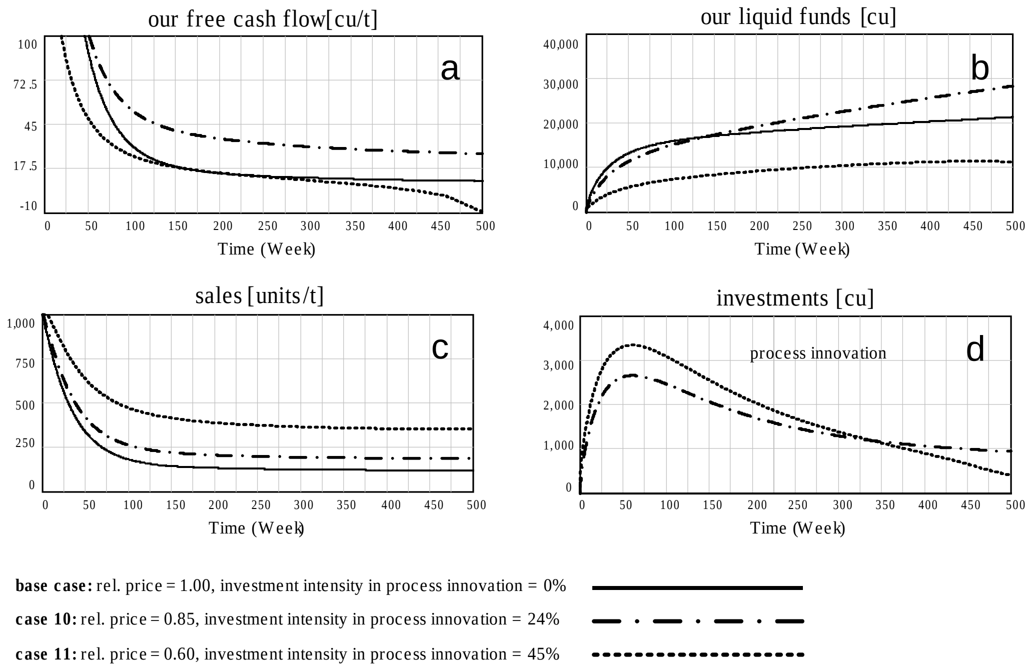

Figure 4: Simulation output for a price-maker strategy

Fig. 4 shows the simulation results of the described strategy. For our fictitious case a relative price of 0.85 and an investment intensity in process innovations of about 24 % of our cash flow appears optimal in the long term run as can be seen in Fig. 4(a) and 4(b) (case 10). It is important to observe the evolution of the specific variables over time. Fig. 4(b) makes clear that this strategy has only a positive effect on the liquid funds after about 150 weeks although the free cash flow (Fig. 4(a)) is larger compared to the base case for a long time before. A second more aggressive price maker strategy is also performed (case 11). With a price reduction of 40 % and an investment intensity of 45 % the sales are much larger compared to the base case (Fig. 4(c)). But this dimension is clearly suboptimal for despite the large sales, the liquid funds never reach the magnitude of the base case (Fig. 4(b)). As Fig. 4(a) illustrates, the price drops even below the piece costs resulting in a deficit. According to Kim Warren [13] strategic managers face the challenge and responsibility to understand and direct the time-path of performance for their enterprise. It is vital to understand that time-path, not just qualitatively but including the specifics of scale and timing as well. In this point we see the great benefit provided by our model. Additionally it is not only possible to check the general implications of a strategy. Moreover the model allows to find the optimal parameters within the strategy.

4.2.2 Differentiation strategy

The second policy aiming for a larger free cash flow in the long run follows the idea of a differentiation strategy. Besides the rationality action described in the previous case, an additional amount of the cash flow gets invested into a differentiation. Possible forms of differentiation include marketing, image, product quality, services, speed or flexibility. The goal of the associated efforts is to rise the costumer loyalty and thus reducing the price elasticity of demand. Consequently an autonomy in price fixing gets generated meaning that “our company” is able to rise the price above the market price without a serious loss of customers. An additive effect arises directly from the assumed implications on the sales.

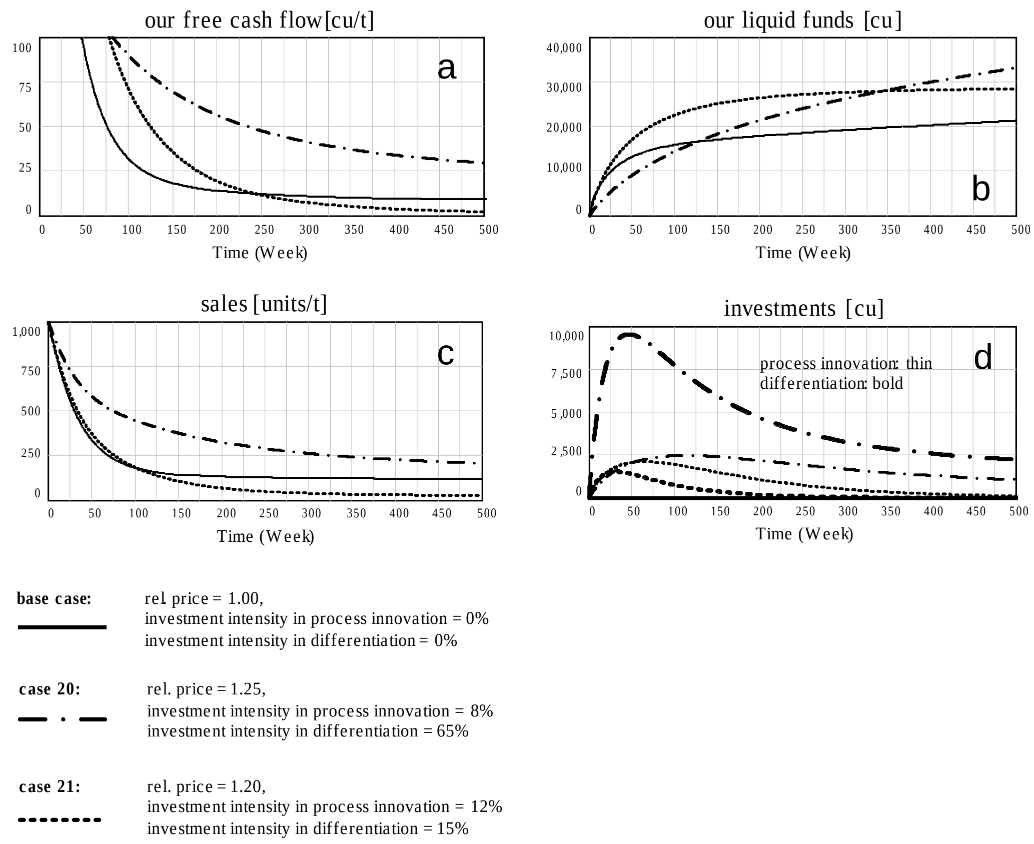

Figure 5: Simulation output for a differentiation strategy

The simulation outputs of a differentiation strategy are shown in Fig. 5. In a first attempt (case 20) the relative price is set to 1.25, the investment intensity in process innovation constitutes 8 % of the generated cash flow whereas 65 % of the cash flow are invested in a differentiation. Fig. 5(a,b&c) impressively show the advantage in the firm performance of this policy. Furthermore a second case (case 21) is illustrated where the relative price amounts 1.20 and 12 % are invested in process innovations but only 15 % are invested in a differentiation. In the beginning "our company" profits from the monopoly position generating a large cash flow caused by the high price and only small investments. But in the course of the simulation more and more market participants canvass for costumers. Because of minimum efforts in differentiation undertaken by "our company" the customers switch to the competitors leading to a slump in the sales. Although there is a respectful amount of cash in the hand of "our company" it collapses for lack of costumers. This case clarifies the fact that many variables have to be considered in order to choose the right policy.

5 Conclusion and future prospects

Being aware of the complex dynamics of any market deregulation the purpose of this paper was to identify the main influencing variables and to construct a System Dynamics model out of it. Economics tend to focus on the long-term equilibrium, which in most of the markets will never be reached [7]. Furthermore there exists a very real danger that strategic decisions made based on equilibrium analyses neglecting dynamic aspects could result in extremely costly mistakes in out-of-equilibrium markets [2]. Our model, however, enables insights in the transition process and gains an understanding of the fundamental dynamics and evolution of the key variables. In addition the simulation of different policies allows to optimise any strategic decision-making achieved by the company holding the initial monopoly. Two examples, a price-maker strategy and a differentiation strategy have been discussed in greater details. The specific result that both strategies improve the firm performance in the long run is related to our fictitious case and has no general meaning. The presented cases just exemplify the possibilities provided by our model.

For simplicity reasons the model has been adjusted to a fictitious product market basically to be instrumental in explaining students and managers the liberalisation process as well as in understanding the importance of considering the time-path of performance for their enterprise. In principle just as the famous beer game has been helpful probably for millions to understand basic industrial dynamics [14] our model provides theoretical knowledge about the dynamics of a liberalisation process. Nonetheless, it would be very interesting to adopt the model to a real case in order to check the actual validity of the implications.

Further development stages of the model are likely to provide more possibilities for strategic policies including a gaming aspect, where decisions can be varied during the simulation in consideration to the behaviour of the competing companies.

6 References

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Appendix A

This Appendix provides a more detailed description of the model's structures and defines the nontrivial relations between the variables. The model is formulated in continuos time indexed by *t* where the simulations run over a period of *T* time units in length. Other units used in the model are:

- currency units (cu)
- fraction (frac)
- numbers (nbr)

The most relevant functions of the two substructures are alphabetically listed below. The greek symbols stand for parameters whose chosen values are defined in Appendix B. To keep the equations short, the following abbreviations are used:

- ar = amortisation rate
- cc = competing companies
- cfcc = cash flow of every competing company
- e = entering rate
- ifd = invested funds in differentiation
- ifpi = invested funds in process innovation
- iid = investment intensity differentiation
- iipi = investment intensity in process innovation
- ird = investment rate differentiation
- irpi = investment rate process innovation
- m = maturity
- mp = market price
- ocf = our cash flow
- ofcf = our free cash flow
- op = our price
- opc = our piece costs
- ors = our relative sales
- os = our sales
- pcecc = piece costs of every competing company
- pe = price elasticity

- rf = rationality factor
- rp = relative price
- secc = sales of every competing company
- td = total demand

(1) Competing companies

- $$cc(t)=\int_0^t e(t)\,dt \qquad (1.1)$$

- $$e(t)=\frac{(ocf(t)+cc(t)\cdot cfcc(t))}{\alpha\cdot(1+cc(t))}\,e^{\frac{-ifd(t)}{\beta}} \qquad (1.2)$$

- $$mp(t)=\gamma+e^{\frac{-cc(t)}{\delta}} \qquad (1.3)$$

- $$pcecc(t)=\eta+\theta\cdot e^{\frac{-secc(t)}{\kappa}} \qquad (1.4)$$

- $$secc(t)=\frac{(td(t)-os(t))}{cc(t)} \quad \text{if} \quad cc(t)\geq 1 \quad \text{and} \quad 0 \quad \text{else} \qquad (1.5)$$

- $$td(t)=\epsilon+\zeta\cdot t \qquad (1.6)$$

(2) "our company"

- $$ar(t)=\frac{ifpi(t)}{lifetime} \qquad (2.1)$$

- $$ifd(t)=\int_0^t (ird(t)-m(t))\,dt \qquad (2.2)$$

- $$ifpi(t)=\int_0^t (irpi(t)-ar(t))\,dt \qquad (2.3)$$

- $$ird(t) = iid \cdot ocf(t) \tag{2.4}$$

- $$irpi(t) = iipi \cdot ocf(t) \tag{2.5}$$

- $$m(t) = \frac{ifd(t)}{action\,time} \tag{2.6}$$

- $$ofcf(t) = ocf(t) - (irpi(t) + ird(t)) \tag{2.7}$$

- $$olf(t) = \int_0^t ofcf(t)\,dt \tag{2.8}$$

- $$op(t) = mp(t) \cdot rp \quad \text{if} \quad cc(t) \geq 1 \quad \text{and} \quad mp(t) \quad \text{else} \tag{2.9}$$

- $$opc(t) = (\eta + \theta \cdot e^{\frac{-secc(t)}{\kappa}}) \cdot rf(t) \tag{2.10}$$

- $$ors = MAX(0, -pe \cdot (rp - 1) + 1) \quad \text{if} \quad rp < \omega \quad \text{and} \quad 0 \quad \text{else} \tag{2.11}$$

- $$os(t) = Max(0, Min(td(t), x(t) + (td(t) - x(t)) \cdot e^{\frac{-t}{\xi}})) \tag{2.12}$$

  with $$x(t) = \frac{td(t)}{cc(t)+1} \cdot (ors(t) \cdot (2 - e^{\frac{-ifd(t)}{\lambda}})) \tag{2.13}$$

- $$pe(t) = \tau \cdot e^{\frac{-ifd(t)}{\phi}} \tag{2.14}$$

- $$rf(t) = \rho + (1 - \rho) \cdot e^{\frac{-ifpi(t)}{\sigma}} \tag{2.15}$$

Appendix B

The System Dynamics Model is simulated using the Euler integration method and runs in weeks with a time step of 0.125. In each case, it is run for 500 weeks. The applied parameters, fixed for all runs, are listed in the table below.

Parameter	Meaning	Value
α	An average gain of α currency units per time leads to a new market participant	1000 cu
β	Influence of invested funds in differentiation on the entering rate	4000 cu
γ	Constant part of the market price	0.8 cu
δ	Influence of competition on the variable part of the market price	2
ϵ	Initial value of the total demand	1000
ζ	Proportionality factor for the increase of the total demand in time	1
η	Variable piece costs	0.6 cu
θ	Fixed piece costs	0.4 cu
κ	Influence of the sales on the fixed piece costs	100
λ	Direct influence of the invested funds in differentiation on our sales	3000 cu
ξ	Time delay for the transition to competition	30 weeks
ρ	Lower boundary of the rationality factor	0.7
σ	Influence of invested funds in process innovation on the rationality factor	500 cu
τ	Initial value of price elasticity of demand	4
ϕ	Influence of invested funds in differentiation on price elasticity	400 cu
ω	Upper boundary of the relative price	1.3
lifetime	Lifetime of process innovations	100 weeks
action time	Action time of differentiation efforts	30 weeks