University of Augsburg
Prof. Dr. Hans Ulrich Buhl
Research Center
Finance & Information Management
Department of Information Systems
Engineering & Financial Management

Universität
Augsburg
University

Discussion Paper WI-41

Innovation and Taxes: A Financial Analysis of Fiscal Impacts on Investments in Electronic Markets and New Products

by

Hans Ulrich Buhl, Stefan Volkert

September 1997

in: Bons, R., Klein, S., Lee, R. M., Williams, H.,
ed., Proceedings of the Fourth Research Symposium on Electronic Markets:
Negotiation and Settlement in Electronic Markets, Maastricht, (Netherlands),
September 1997, EURIDIS, Rotterdam, 1997, p.29-54

in: Lee, J. K., Steven, H. K., Whinston, A. B., Schmid, B., ed., Proceedings

Universität Augsburg, D-86135 Augsburg
Visitors: Universitätsstr. 12, 86159 Augsburg
Phone: +49 821 598-4801 (Fax: -4899)
www.fim-online.eu

INNOVATION AND TAXES:
A FINANCIAL ANALYSIS OF FISCAL IMPACTS ON INVESTMENTS IN ELECTRONIC MARKETS AND NEW PRODUCTS

HANS ULRICH BUHL
STEFAN VOLKERT
Department of Information Systems, Business School
University of Augsburg, Germany
Universitätsstr. 16, D - 86135 Augsburg
Tel.: ++49 821/598-4140, Secretary: - 4141
Fax: ++49 821/598-4225
E-Mail: Hans-Ulrich.Buhl@Wiso.Uni-Augsburg.DE
Stefan.Volkert@Wiso.Uni-Augsburg.DE

INNOVATION AND TAXES: A FINANCIAL ANALYSIS OF FISCAL IMPACTS ON INVESTMENTS IN ELECTRONIC MARKETS AND NEW PRODUCTS

Hans Ulrich Buhl and Stefan Volkert, University of Augsburg

Abstract

Markets are undergoing a fundamental shift towards the end of the second millenium: in many business branches the traditional market forms are supplemented - and in some of them being replaced in the long run - by new information age forms of business. Firms wanting to meet this challenge are forced to make large investments to establish business in these new markets, only to find themselves later in competition stronger than ever seen before. This "hyper"competition may lead to a too fast rate of innovation causing a social welfare loss. Concentrating on two measures, namely the tax rate and terms of depreciation, in this paper we analyze how a government's fiscal policy influences investment decisions in new markets and new products. While in closed economies a government may be able to adjust the rate of innovation to the social welfare optimum, doing the same for industries acting on global markets will make domestic companies being losers in global competition. The financial analysis yields a number of results for the investor and the government, e.g. that for accelerating innovation cutting down taxes is strictly dominated by improved terms of depreciation. A low-tax-rate-policy instead of good terms of depreciation may well have - on the contrary - a devastating effect on innovation and investments in new markets and new products.

1. Introduction

Markets are undergoing a fundamental shift towards the end of the second millenium: in many business branches the traditional market forms are supplemented - and in some of them being replaced in the long run - by new information age forms of business, where information and communication technologies enable the participants to perform their transactions electronically. Customers - after some reluctance at the beginning differing both locally and by branch - start to accept these new ways of doing business in cyberspace. In the same way these new electronic markets are evolving they are threatening profits earned by established firms doing traditional business in the old markets. This is particularly threatening in markets with low (or even negative) growth rates, where competition between old and new markets may constitute a zero-sum game (or worse). Examples of these kinds of change range from insurance and banking - where the traditional branch banking business model is threatened by direct banking firms communicating with their customers by telephone, fax, internet and proprietary networks - to the printing industry. While in the former the immaterial character of most of their (information) products remains unchanged, in the latter also the character of their products change: printing firms had etablished comparative advantages in dealing with material products such as books, journals, newspapers etc. and are now facing various legal, economic and technological challenges in dealing with immaterial information products. Thus, for a traditional firm entering these new markets is not only difficult for reasons of jeopardizing or even cannibalizing their old markets, but for a variety of other reasons, too.

Suppliers wanting to start business via electronic markets may, on the one hand, look forward to a promising rate of growth of these new markets, but on the other hand are confronted with the need of large investments, e.g. for a sophisticated technological infrastructure, for recruiting skilled personnel and for marketing efforts to establish the new distribution channel. However, electronic markets constitute a step towards the ideal of a perfect market with strong competition among suppliers and better transparency for customers[1]. This - compared to traditional markets - implies decreasing margins[2]; often, this is true both for the traditional and the new markets. These low margins on the market once competitors have entered may lead to the situation that only for the first mover investments pay off. Once the second and following firms have entered, due to marginal costs being close to zero firms will find themselves in strong or even cut-throat competition being forced to accept zero-margins for current products and cannibalize their traditional business only to be first on the new market with the next generation. In the past, such implications could be observed on very competive (often termed hypercompetitive) markets with material products as well, e.g. on the chip market: what is new, however, is that marginal production and distribution costs of the immaterial products are much closer to zero as can be imagined for material ones, and that distribution time (and generally time to global market) is much shorter. In the future this may imply even faster and stronger competition than could be observed so far.

This may well leed to a situation, where competition forces the innovation rate up to a level, which is neither optimal for the firms competing on the market nor for the society as a whole, as Nault and Vandenbosch (1996) have pointed out. When this is true, government might

---

[1] While this statement may not hold for all kinds of electronic markets at any time, particularly in early stages if the market is established by some dominant firm on a proprietary network, we still believe that for most relevant markets there is a long-run tendency to become less imperfect than today. For a discussion of such questions, see e.g. Einsfeld/Schneider (1997).

[2] See, e.g., Buhl/Will (1997b) and Buhl/Will (1998b)

want to intervene and avoid the negative implications outlined above. For influencing private investments - and thus innovation - a government's predestinated means is its fiscal policy to be analyzed here.

Thus, in this paper we want to address the question of how investment decisions in this scenario are made and how these decisions are affected by the government's tax system. Our analysis is split into two parts: first we analyze investment decisions in the closed economy and second we consider decisions in an open economy acting in a global market. Within each of the two parts we discuss two types of investor problems: firstly, how is the decision whether to invest in old vs. new markets affected by government's fiscal policy and, secondly, how is the optimal launch time for a company wanting to enter the new market affected by the tax system. In our analysis, we consider two ways a government may vary its tax policy: On the one hand by a variation of the terms of depreciation and on the other hand via changing the tax rate on company profits. In the third part we conclude from our results how a tax system should be designed for influencing investment decisions in a way to avoid some of the drawbacks discussed before.

2. Investment decisions and the impacts of the tax regime in closed economies

Although it is obvious, that most economies are becoming more and more open ones, we start the analysis by assuming a closed economy. The reason for doing so is not only the fact that much of research and teaching and thus knowledge in economics and business sciences is considering this special case, but that thinking of many leading politicians - particularly with respect to fiscal policy - until today is strongly influenced by this body of knowledge. When comparing the results of this chapter with the ones for open economies in the next one, we can clearly identify the differences, understand reasons for current wrong fiscal policy and draw conclusions on the (in the long run inevitable) needs for change.

As outlined before we start by analyzing how firms considering investments in old versus new markets are affected by fiscal policy and then turn to the question of how the tax policy exerts influence on the innovation rate.

2.1 Investment decisions between old and new markets

The analysis of how the decision of investing in old versus new markets is affected by government's tax regime is conducted by considering the net present values. For the firm this decision criterion is rational if, as is done for reasons of simplicity of illustration, we assume deterministic future payments. The net present value model calculates the value of an investment today by discounting future payments (cash inflows and outflows) up to the end of the planning horizon. Thus, by considering the respective net present values of the payment streams of different investment projects, projects can be compared today: If the net present value is positive, an investment project is advantageous; if for two competing projects the (positive) net present value of one is larger, it can be considered as more advantageous than the other. Although there is still some controversial discussion in the literature, today it is widely accepted that investment decisions are sensitive to taxes[3] and therefore the net present value has to be calculated after taxes, i.e. considering payment streams including tax payments and credits. The model we use within the closed economy scenario in this chapter in the literature is often referred to as the standard model. Profit taxes have impact on the net present value in two ways: firstly, profits before taxes - and thus payments affecting them - are subject to taxation; thus in the world after taxes, tax payments have to be deducted. And secondly, the discount rate determined by the returns on investment of an alternative investment project is affected by taxes as well. When considering investment decisions in closed economies, the earnings of alternative investments, e.g. of purchasing a straight bond with annual coupon *r*, is in the same way subject to the tax rate *s* and thus implies a coupon payment afte tax of *r(1-s).* Thus in this case the discount rate after tax (representing the returns of a an alternative investment) depends on the tax rate s and - compared to the world before taxes - drops from *r* to $r^* = r(1-s)$.

For the subsequent analysis the following notation is used. For reasons of simplicity of illustration, the parameters *r, s,* and *r** are assumed to be constant in time.

Notation:

$i \in \{new, old\}$	: market to be invested in
$C^i > 0$	: present value of necessary (re-)investments in market i
s	: tax rate levied on profits (0<s<1)
r	: interest rate before tax
$r^* = r(1-s)$	: interest rate after tax
t	: time
T	: planning horizon
e_t^i	: earnings in t
$d_t^i \geq 0 \forall t$	: depreciation allowance for investments in t, it holds: $\sum_{t=0}^{T-1} d_t^i = 1$
D^i	: present value of all depreciation allowances,calculated as[4]: $D^i := \sum_{t=0}^{T-1} d_t^i (1+r^*)^{-t}$

Using this notation, the net present value of an investment project can be calculated and illustrated by the following three components:

(a) Present value of investments

In the simplest case C^i represents the investment payment in *t=0* and book value of one single investment project. In more complex situations C^i may represent the net present value of an arbitrary number of investment projects (discounted to time *t=0* with rate *r**).

[3] for the discussion see e.g. Steiner (1983), Mellwig (1980), Wagner (1981), Schwarz (1962), Stöber (1975), p. 37-49, Buhl (1993a), Buhl (1993b) , Buhl (1989)

[4] Notice that this formulation is quite general: all kinds of depreciation regimes - differing by country and type of investment - can be represented this way (and compared) by considering the present value of depreciation allowances.

(b) Tax shield[5]

Investments represent assets with a long-term value and thus have to show up in the balance sheet. As outlined above, they are depreciated over time and this depreciation reduces the taxable income in the subsequent periods. Tax benefits can be calculated by multiplying the present values of depreciation allowances and investments by the tax rate.

(c) Present value of earnings after tax

Earnings are subject to profit taxes with rate *s*. Thus, as outlined above for the straight bond, only a share *(1-s)* of NPV of earnings is left to the investor.

Summing up, the net present value of investments in *(i=)* old and *(i=)* new markets can be calculated and interpreted as follows:

$$NPV^i = \underbrace{-C^i}_{(a)} + \underbrace{sD^iC^i}_{(b)} + \underbrace{(1-s)\sum_{t=0}^{T} e_t^i (1+r^*)^{-t}}_{(c)} \quad . \qquad (1)$$

The payment streams of investments in old and new markets are assumed to differ in the following ways:

1. **New markets require higher investments than old markets, i.e.** $C^{new} > C^{old}$

When starting business in an electronic market a company has to make high investments in information and telecommunication technologies, recruitment of new skilled staff and marketing etc. These investments need to remain on a high level if a strong market position is to be established and maintained, as discussed in the introduction. On the other hand a company considering shrinking traditional markets will usually do no more than to renew obsolete investment goods. Thus the present value of investment of the former is usually larger than of the latter.

2. **New markets are growing, old markets are declining over time,** for simplicity it is assumed that e_t^{new} increases and e_t^{old} decreases exponentially, i.e.:

$e_t^{new} = e_0^{new}\ (1+ a^{new})^t$ with $a^{new} > 0$;

$e_t^{old} = e_0^{old}\ (1+ a^{old})^t$ with $a^{old} < 0$.

As the new technologies needed for electronic markets become widely available and accepted, a part of the customers will switch from the traditional form of doing business to the new electronic markets. In addition growth is likely to concentrate on the new channel, because of the new ways to reach new customers and lower transaction costs inducing additional demand also from current customers. This can be observed, for instance, in banking, where in most countries the share of traditional branch banking drops whereas the share of the new channels such as telephone banking and online banking increases (see, e.g. Penzel (1995)).

For being able to analyze how investments in old or new markets differently react to changes in the tax system, we employ an indifference assumption: at the beginning of the analysis for some given tax system the investor is indifferent between the two competing investment in the

[5] cf. Brealey/Myers (1991), p. 104

old and the new market; their respective net present values are equal and both positive, i.e. $NPV^{old} = NPV^{new} > 0$. Compared with this indifference situation we check how these net present values react if either (the net present value of) depreciation or the tax rate are changed.

This analysis yields the following results:

Result 1: *Better terms of depreciation, i.e. a larger present value of depreciation allowances, benefit both markets, but make investments in new markets relatively more profitable than those in old markets, i.e.* $0 < \Delta NPV^{old} < \Delta NPV^{new}$ *.*

This result is not very surprising and can be easily shown by observing the following: Better terms of depreciation are represented by a larger value of D (in the best case of immediate depreciation we obtain $D = 1$). This of course implies a larger tax refund sD and thus larger NPVs for both, old and new market investments. NPV^{new} profits from a larger D more than NPV^{old}, because new markets have larger net present values of investments and therefore have larger tax refunds, i.e. sDC is larger for the new market. In the case of immediate depreciation we have $D = 1$, implying a tax refund of sC and thus the after-tax present value of investment payments is given by $(1\text{-}s)C$.

Thus by improving terms of depreciation government can give an incentive for capital-intensive investments in new markets. While this result is straigthforward, the effect of tax rate reductions is not so obvious. With respect to that, we can prove the following:

Result 2: *(a) Smaller tax rates make investments in old markets relatively more profitable than those in new markets, i.e.* $\Delta NPV^{old} > \Delta NPV^{new}$ *. (b) It is even possible that due to a tax rate reduction the profitability of investments in new markets decreases.*

The formal proof of *Result 2* - to be obtained from the authors - is based on the following: The total effect of a reduction of s on NPV depends on the relation between the direct effect of a lower tax burden on earnings and the indirect effect of a larger discount rate $r^*=(1\text{-}s)r$. While the former clearly implies larger NPVs (in the literature also referred to as volume effect), the latter becomes clear from the discussion above: in a closed economy a smaller tax rate implies a larger discount rate after tax because the alternative opportunity investment (in a straight coupon bond explained above) benefits from the tax reduction, too. This may lead to a situation in which a lower tax rate-implies a lower net present value.[6]

Although the total effect is not unique, it can be shown that $\Delta NPV^{old} > \Delta NPV^{new}$ holds for smaller values of s, i.e. that old markets profit more than new markets from tax rate reductions in any case. This implies that lower tax rates are inadaequate, if investments in new markets are to be promoted. At least in the context of the analysis presented here, on the contrary it holds that investments in old markets are more promoted by lower tax rates.

Below we present three examples to illustrate these results. The first example shows how investments in new markets can take advantage from better terms of depreciation:

---

[6] Conditions for the occurrence of this phenomenon are extensively dealt with in the literature, cf. e.g. Schneider (1969) and Steiner (1983)

Example 1: Variation of terms of depreciation on markets within closed economies

Consider a bank facing two investment alternatives: either to do further investments of \$ 40 (millions) in their traditional branch banking business or to establish a new direct banking business requiring investments during a planning horizon of T = 12 years of \$ 100 (millions). The branch banking alternative is forecasted to yield \$ 15 (millions) per year with an estimated yearly rate of decline of 3 %, whereas the initial earnings within the new market are estimated to be \$ 17.38 (millions) with a rate of growth of 3 % p.a. In the base case we assume a 12 year straight-line depreciation (rendering D = 0.7406), a tax rate of s = 40 % and a pre-tax interest rate of 10 % (resulting in r* = 6 %).

In this scenario the investor is indifferent between the two alternatives as both render the same after-tax net present value: $NPV^{old} = \$\ 44.402\ \text{(millions)} = NPV^{new}$.

Now consider the implication of another fiscal policy improving terms of depreciation by allowing for immediate depreciation (implying D = 1): Now the investment in the new market is superior to the old market investment: $NPV^{old}{}' = \$\ 48.55$ *(millions)*, $NPV^{new}{}' = \$\ 54.778$ *(millions).*

As pointed out above the inequality $0 < \Delta NPV^{old} < \Delta NPV^{new}$ holds for all improvements of the terms of depreciation. The following two examples are dealing with tax rate reductions. In *Example 2a* a standard scenario is shown, where both investment projects yield a larger net present value for smaller tax rates. As pointed out before, a smaller tax rate results in an advantage for investments in old-markets compared to new ones.

Example 2a: Variation of s in a closed economy

In the base case let the tax rate $s = 0.4$ and let the other parameters be given by:

3 year straight-line depreciation:	$D = 0.944$	planning horizon $T = 10$	
interest rate	$r = 0.1$ (implying $r^* = 0.06$)		
investments	$C^{old} = 40$	investments	$C^{new} = 100$
earnings	$e_0^{old} = 15$	earnings	$e_0^{new} = 17.533$
rate of decline	$\alpha^{old} = -0.04$	rate of growth	$\alpha^{new} = 0.03$

This implies that the investor is indifferent between investments in new and old markets because of $NPV^{old} = 38.436 = NPV^{new}$.

Let us now consider a variation of the tax rate: $s' = 0.2$ (implying $r^*{}' = 0.08$ *and* $D' = 0.928$). For the lower tax rate the NPVs of the two investment projects differ, with investments in old markets now being superior: $NPV^{old'} = 45.859$, $NPV^{new'} = 41.660$.

Compared to *Example 1*, here a lower tax rate also implies improved NPVs, but old markets benefit more, i.e. $\Delta NPV^{old} > \Delta NPV^{new} > 0$.

In Example 2b the lower tax rate implies - in the case of the investments in new markets - the "paradox" result of a smaller net present value. This is caused by the discount rate effect being stronger than the volume effect. The general *Result 2a*, $\Delta NPV^{old} > \Delta NPV^{new}$ also holds here, but we have $\Delta NPV^{new} < 0$.

Example 2 b: Variation of s in a closed economy with a „paradox" result :

As before let in the base case the tax rate be given by $s = 0.4$ and the other parameters as follows:

three year straight-line depreciation:	$D = 0.944$	planning horizon	$T = 30$
interest rate	$r = 0.1$ (i.e. $r^* = 0.06$)		
investments	$C^{old} = 40$	investments	$C^{new} = 100$
earnings	$e_0^{old} = 15$	earnings	$e_0^{new} = 10.270$
rate of decline	$\alpha^{old} = -0.04$	rate of growth	$\alpha^{new} = 0.03$

Again the investor is indifferent in the base case because of : $NPV^{old} = 66.09 = NPV^{new}$.

But now the same variation of the tax rate: $s' = 0.2$ (i.e. $r^{*\prime} = 0.08, D = 0.928$) implies: The NPV of investment in the old market is better whereas the NPV of the investment in the new market is smaller than before, namely $NPV^{old\prime} = 72.619$ and $NPV^{new\prime} = 55.192$

Of course as in *Example 2a* the investment in the old market profits more from the smaller tax rate than the investment in the new market. Formally here we have: $\Delta NPV^{old} > \Delta NPV^{new}$, $\Delta NPV^{new} < 0$.

Summing up, improvements of terms of depreciation do generally have a unique positive effect on investments in new markets, whereas lower tax rates generally are more advantageous for old than for new markets; in relevant cases for lower tax rates investments in new markets may even be less advantageous than for larger tax rates, as *Example 2b* indicates. In the next section we analyze the same variations of the fiscal policy with respect to the speed of innovation.

2.2 Effects of the tax system on launch time for entry on new markets

In the following the discussion is based on work by Nault and Vandenbosch (1996). In their paper they discuss the key strategy for success of high-technology companies by establishing that "eating your own lunch before someone else does" is rational for the firm. They formulate a model for determining the optimal launch-time for a firm to enter the next-generation market. The main aspects - in so far as they are important for this paper - will subsequently be outlined. Notice that compared to Nault/Vandenbosch (1996) also the notation is simplified for reasons of brevity and simplicity of illustration.

The model describes a game within a hypercompetitive market. It assumes an oligopoly which can be reduced to a duopoly without loss of generality[7]. Two participants - an incumbent and an entrant - are competing to launch the next product generation advantageously. Both are confronted with the same launch costs which fall over time. The incumbent is characterized as the party which has most to lose if it does not preempt current profits by launching the next generation. This scenario could be described as a weak form of Betrand competition where firms within an oligopoly choose their prices such as to maximize their profits, based on the assumption that the rivals' prices are fixed[8]. It is weaker than strict Betrand competition in the sense that earnings higher than marginal costs are feasible after the next-generation launch. The company first to launch the next generation tries to decrease potential profits of any further entrant to the new market and thereby prevents furher entry. Thus the second mover

[7] Our work is based on only one type of a competitive scenario, a comprehensive study of different scenarios and corresponding games can be found e.g. in Reinganum (1989)

[8] cf. Stiglitz (1993), p. 438

will not be able to take advantage from a subsequent launch, because he is unable to establish prices in the market covering more than its marginal cost.

The net present value function for a firm being first or second to launch the next generation can be split up into three time spans, namely:

t = 0, ... ,T^1 representing the time span where no party has launched,
t = T^1, ...,T^2 representing the time span where only one party has launched,
t = T^2, ...,T representing the situation when both competitors have launched

the next product generation. For being able to present the key formula of Nault/Vandenbosch (1996) to be modified in our analysis, we need some more notation.

Notation:	
T^l	launch time, being either T^1 or T^2 depending on which competitor is first or second to enter the market
$K(T^l)$	costs for launching the next generation, assumed to apply for both competitors
π_1	profit flow for i when nobody has launched
π_2	profit flow for i when one party has launched; the value is dependent on whether the firm is first or second to enter the market. Formally for the market entry it holds either *market-entry = first* or *market-entry = second.*
π_3	profit flow for i when both competitors have launched

Based on this notation, the key NPV-formula of Nault/Vandenbosch (1996) can be rewritten as follows:

$$NPV = \underbrace{-K(T^l)}_{\text{launch costs}} + \underbrace{\int_0^{T^1} \pi_1(t)e^{-rt}dt + \int_{T^1}^{T^2} \pi_2(t, market-entry)e^{-rt}dt + \int_{T^2}^{T} \pi_3(t)e^{-rt}dt}_{\text{total profit-flow, depending on launch time}} \;^{9}. \quad (2)$$

The optimal launch time for a firm to start the next generation is determined by using an equilibrium model. For a profit maximizing firm equilibrium is given when it is indifferent between being leader and being follower[10] on the market. Based on the key assumption that the incumbent has more to lose if he is not first on the market, it follows from their model sketched above that in the equilibrium only the incumbent launches the next generation.

The following results, which can be derived from their model, are most relevant in our context:

[9] The net present value function here is formulated continuously. While this is contrary to the discrete formulation in Chapter 2.1, it simplifies the subsequent analysis and presentation in accordance with Nault/Vandenbosch (1996).
[10] Notice that this condition is sufficient only.

- Advantages are not sustainable in highly competitive markets.
- Incumbents must strive to maintain leadership in the next generation. This implies that they will be first in the new market, thereby cannibalizing their old markets by the next-generation products. Launching that way the incumbents may lose money (NPV) on the margin.
- The optimal launch time for a single vendor may even imply a total social welfare loss, i.e. the rate of innovation is not socially optimal. For an analysis of welfare aspects, of course not only the producer side, but also the consumer side has to be considered. Clearly for the producer side, the earlier the launch, the lower are the profits, because firstly, potential profits of the current product are not exhausted and secondly, launch costs fall over time. On the consumer side, customers benefit from an early launch of a next generation product, but probably less than the reduction of profits on the producer side. Thus also society may lose money from a competitve early launch on the margin.

In what follows the model is extended (indicated by a *) by including profit tax payments and depreciation allowances reducing taxes. The net present value after tax contains the same components already explained in Section 2.1.

(a) Here the NPV of investments account for the total launch costs.
(b) The present value of the tax shield accounts for depreciation on launch costs. It is assumed that launch costs *K(T ^{l})* are eligible for depreciation, thus reducing taxable income.
(c) Again, profit flows are subject to taxation, leaving only the fraction (1-s) to the investor.

$$NPV^* = \underbrace{-K(T^l)}_{(a)} + \underbrace{sDK(T^l)}_{(b)} + \underbrace{(1-s)\left[\int_0^{T^1} \pi_1(t)e^{-r^*t}dt + \int_{T^1}^{T^2} \pi_2(t)e^{-r^*t}dt + \int_{T^2}^{T} \pi_3(t)e^{-r^*t}dt\right]}_{(c)} \qquad (3)$$

Result 3: *In a closed economy, by means of its fiscal policy a government is able to adjust the rate of innovation closer to the social optimum. If innovation is too slow, government may improve terms of depreciation to accelerate it; if it is too fast for social optimum, government can slow down innovation by a lower NPV of depreciation. Again, the effect of tax rate variations is not unique.*

These results can be derived by observing the following: Without loss of generality considering smaller values of terms of depreciation (NPV *D*) it can easily be shown, that smaller values of *D* imply a smaller net present value of the tax refund, resulting in higher net investment payments and thus a later equilibrium launch time, i.e. $T^{opt'} > T^{opt}$.

The total effect of a variation of s on the net present value and on the optimal launch time depends - as already described in Chapter 2.1 - on the relation between the direct volume effect causing NPV to increase and the indirect discount rate effect implying a decreasing NPV. It is possible that a lower tax rate may either accelerate or slow down innovation.

Summing up the results of this chapter, improving terms of depreciation seems adequate in the closed economy, if innovation or investments in capital-intensive new markets are to be promoted. Reductions of tax rates do not have a unique positive effect, however. Thus it is surprising, that in many countries - as in Germany - emphasis is put on reduced tax rates and, worse, these are to be financed by decreasing NPVs of depreciation. As has been shown in both models considered, this may imply a double negative effect on innovation and entry of promising new markets. We will come back to this discussion in Chapter 4.

3. Investment decisions and the impacts of the tax regime in open economies

Up to now only investment decisions in closed economies were considered. For most markets and firms in developed countries, this case is rather unrealistic. Particularly electronic markets using information and telecommunication technologies are enabling supply and demand to meet on virtual marketplaces, where the location of business partners by far is less meaningful than before. Suppliers on the one hand enjoy the advantage of a worldwide reach for their customers, but on the other hand, at the same time they face global competition with their competitors worldwide as well. So there is no doubt that the analysis of an open economy in this chapter is for most firms and markets in developed countries the more relevant case.

3.1 Investment decisions in old versus new markets

Compared to Chapter 2.1, what changes in the open economy with respect to our investment analysis, is the following: an international investor to be considered here is no longer confined to investment projects within one domestic economy only, but is free to invest his capital anywhere worldwide. Therefore alternative investment opportunities with yields not subject to the domestic tax-system determine the discount rate r of the international investor. In other words, his discount rate is determined by the after-tax yield of the best opportunity worldwide. Thus in an open economy the discount rate can no longer be considered to depend on the domestic tax-rate, but has to be accepted as exogeneous for a government trying to attract international investors (i.e. $r^*=r$)[11].

The implications of this modified assumption (letting the set of other assumptions formulated in Chapter 2.1 unchanged) are the following:

Result 4: *In open economies Result 1 still applies, i.e. better terms of depreciation benefit new markets more than old markets, i.e.* $0 < \Delta NPV^{old} < \Delta NPV^{new}$*.What is new here, however, is that for the case of immediate depreciation - independent of the tax rate - the tax system is neutral with respect to decisions between investments in traditional or new markets in the economy.*

While reasoning for the first statement follows the argument in Section 2.1, the neutrality result can be derived by observing that only for immediate depreciation there is a symmetric effect of the tax rate on NPVs of net investment payments and on NPVs of net earnings. The exogeneous discount rate of the international investor also simplifies the analysis of a variation of the tax rate s: the indirect discount rate effect vanishes and a smaller tax rate always implies a larger net present values for both, investments in old and in new markets.

Result 5: *Contrary to the results in the closed economy, in the open one a variation of the tax rate has a unique effect on investments in old and new markets. If the NPV of depreciation is*

---

[11] The assumption of a tax-unaffected discount rate was formulated by [Brow48] already.

less than one ($D < 1$, i.e. there is no immediate depreciation $D = 1$) it can be shown that investments with positive NPVs in new markets will profit more from a smaller tax rate than investments in old markets (i.e.$\Delta NPV^{old} < \Delta NPV^{new}$ for smaller values of s). Notice that this result also differs from the findings in Section 2.1 where the opposite is true.

While the first part of *Result 5* directly follows from the exogeneous discount rate, the second part can be derived by noting that a positive NPV of an investment implies that the NPV of earnings [c] is larger than NPV from net investment payments [a] + [b]. A smaller tax rate thus clearly benefits the [c]-part more than the latter [a] + [b]-part of total NPV.

The following example illustrates *Result 5:*

Example 3: Variation of s in an open economy

Again, in the base case let the tax rate $s = 0.4$ and let the other parameters be given by:

5 year straigt-line depreciation	$D = 0.834$	investor's planning horizon	$T = 10$
interest rate	$r = 0.1$		
investment	$C^{old} = 40$	investment	$C^{new} = 100$
earnings	$e_0^{old} = 15$	earnings	$e_0^{new} = 19.992$
rate of decline	$\alpha^{old} = -0.03$	rate of growth	$\alpha^{new} = 0.03$

Because of $NPV^{old} = 30.405 = NPV^{new}$ the investor is indifferent for this parameter combination.

If we now consider a variation of the tax rate by letting $s' = 0.2$ be smaller than before, the investment in the new market is now superior because of $NPV^{old}\,' = 42.75$ and $NPV^{new}\,' = 46.07$.

Contrary to the results in the *Examples 2a)* and *2b)* the net present value of the investment in the new market could profit more from the tax rate reduction, i.e. $\Delta NPV^{old} < \Delta NPV^{new}$.

We see some danger of misunderstanding *Results 4* and *5* in the way that government's fiscal policy job in open economies seems much simpler than in closed ones, because lowering tax burden via NPV of depreciation as well as via a lower tax rate both has a unique positive effect particularly benefitting new markets. This is not true, however: while for immediate depreciation the tax system is neutral with respect to domestic investments in new and old markets and for less than immediate depreciation lowering tax burden implies benefits for new markets, these results only avoid problems for competing investment projects within the economy. Our international investor, however, considers investment opportunities worldwide. When making investment decisions he seeks for the best after-tax-opportunities internationally. The tax burden resulting from both, terms of depreciation and from the tax rate are considered in his calculation; they are probably just as important as the return on investment before taxes.

Thus, if a government wants to attract international investors, it has to take into account the best competing investment opportunities worldwide. While in the closed economy it was possible to influence the investment opportunity of the investor on the capital market via the tax rate, this degree of freedom has vanished in the open economy. Thus we state for the government the following result and return to that discussion later.

Result 6: *For encouraging investments of international investors in new markets, government must take into consideration best international investment opportunities and accordingly must reduce the total tax burden.*

3.2 Effects of national taxes of an open economy on launch time in global markets

As pointed out above, the national policy of a single government is strictly limited when considering domestic firms acting within a global arena. Analysing the extension of the Nault/Vandenbosch-model in the context of an open economy yields the following results: In addition to exogeneous discount rates it turns out that also global launch times of next generation products are independent from a government's tax system as competitors, acting in different economies, are not subject to the national tax system. Therefore the rate of innovation is given by the best international investor operating in the most attractive competing economy providing the best conditions for investors.

From this we can conclude that a government that wants to slow down the rate of innovation via fiscal policy to optimize national social welfare - which was possible in closed economies as shown in Section 2.2 - is giving away incumbent advantages and allows entrants from competing economies to become leaders in the markets. As far as variations of terms of depreciation are concerned, again we find that better terms of depreciation imply smaller net launch costs thereby encouraging firms to enter new markets earlier, i.e. the individual optimal launching time is earlier. With respect to variations of the tax rate we find the following: A variation of s has no effect on the launch time if we have immediate depreciation (i.e. $D = 1$). For $D < 1$ a variation of the tax rate has, contrary to the closed economy model, an unique effect on the net present value. Smaller values of s increase the net profit flow implying earlier optimal launch times. Summing up we may state:

Result 7: *In the open economy both a smaller tax rate and better terms of depreciation yield earlier optimal launch times and thus make companies acting in the economy more competitive in global markets. If incumbent advantages are to be preserved or new entrants are to be attracted fiscal policy must take into consideration the best competing investor acting under best investment conditions worldwide.*

4. Implications for a "good" competitive tax system

In this chapter we conclude from the results in the two previous ones how a tax system should be designed for influencing investment decisions in a way to avoid some of the drawbacks discussed before. Comparing the results of the two previous chapters it becomes obvious that the conclusions for closed economies and for open ones are totally different. Thus in the next section we start wirth a brief discussion for the (less relevant) case of a closed economy and then discuss some alternatives of fiscal policies for an open economy with firms acting on global markets.

4.1 Fiscal policy implications for closed economies

We assume that the objective of fiscal policy is to adjust the rate of innovation to the social optimum. Government may do so by either encouraging or disencouraging investments in new markets (as discussed in Section 2.1) or by exerting influence on optimal launch times of successive product generations (as discussed in Section 2.2). It became clear in Chapter 2 that in the closed economy government is able to make such a socially optimal adjustment.

The need for slowing down the rate of innovation stems from hypercompetitive markets, forcing firms to launch next generation products although they are losing money on the margin by cannibalizing their profits earned with products of the current generation. As has been shown by Nault/Vandenbosch (1996) this loss for producers maybe larger than the gain of consumers implying that the society is losing money on the margin, too.

For this scenario, reducing the net present value of depreciation will shift the individual optimal launch time for the next product generation backwards, thereby slowing down the rate of innovation. With respect to the decision to invest in old or new markets worse terms of depreciation also imply less investments in new markets. If on the other hand, innovation is too slow, improving terms of depreciation turned out to have the desired effect.

A variation of the tax rate, however, turned out to be inadequate in the closed economy as the total effect with respect to investments and launch time and thus innovation is ambiguous. The reasons for this are the two contrary implications of tax rate variations, namely the volume effect and the discount rate effect, the latter resulting from tax influence on investment opportunities e.g. on the domestic capital market. Thus the message in the closed economy is clear: government should make adjustments not via tax rate variations, but via terms of depreciation.

Apart from these two measures and strictly outside our model analysis there are of course other ways to exert influence on innovation: Measures discriminating between investments in old and new markets are also capable of influencing the rate of innovation. One could think e.g. of a differentiated tax system for old and new markets, of direct subsidies for research and development speeding up (if properly applied) introduction of next generation products or subsidies for investment in new promising markets or branches; the opposite effect, i.e. slowing down innovation, may be achieved by a special tax burden levied on new investments. Apart from such static arguments, the dynamic aspects to be considered at the end of this chapter apply for the closed economy, too.

4.2 Fiscal policy implications for open economies

As pointed out at the end of Chapter 3, the global rate of innovation in global markets is not subject to local governmental intervention, but will be determined by the best investor acting in the most competitive economy worldwide. Thus a national economy with a rate of innovation being slower than in competing economies will not be competitive on global markets in the long run[12]. Therefore the tax policy in open economies must have a completely different objective: namely to ensure domestic firms a leading role in worldwide competition to be first on the markets with successive product generations.

This objective must even be pursued if the global rate of innovation is faster than is socially optimal. The question of how to optimally act within the global competitive system must be

[12] see also D'Aveni (1994), p. 3

strictly separated from the question whether the worldwide competitive system itself is optimal. If the global rate of innovation is too fast, it may be adequate to try to reach worldwide consensus e.g. on minimum tax rates or maximum depreciation allowances, maximum subsidies and the like. If such consensus cannot be reached on a global scale - as the discussions on environmental standards suggest - introducing such measures locally is dangerous: probably the only real effect of such national policy slowing down innovation maybe a loss of comparative advantages of the national economy and their firms acting on global markets.

Apart from these difficult questions, the model analysis of the previous chapter suggests that in open economies government may choose among different measures to speed up innovation. Investments in new markets and faster introduction of successor products can be promoted by either of the following measures covered by our static analysis:

- good terms of depreciation, where neutrality can be achieved by immediate depreciation;
- lower tax rates on company profits;
- direct subsidies e.g. for innovative branches.

One could even discuss a tax rate of $s = 0$, leaving company profits completely untaxed and thereby providing good conditions for global competition. Neutrality of the tax system with respect to company investments is then, of course, given by default. The government's tax income could be solely rised by taxing natural persons. This measure could also keep the tax system simple by avoiding double-taxation regulatories and the need for depreciation regulatories.

Moreover, dynamic measures could also be considered. Their formal analysis would require dynamic modelling. Due to the dynamic character of investment decisions, however, these dynamic measures are likely to be superior to the static ones discussed above; they require, however, that investors trust in the long-run reliability of government announcements, which may not be given in any economy and for every government.

The following measures seem appropriate to promote innovation and investments in new promising markets:

- Allowance to deduct initial losses in the following periods; this is especially effective for investments in new markets with high initial investment payments and initially slowly increasing earnings.

- Promotion of investments in new markets by announcing a smaller tax rate levied on their future returns. This is particularly adequate for investments with payment streams as discussed in Section 2.1, because a relatively high tax rate at the beginning provides a high tax refund for depreciation whereas a low tax rate is appreciated later when earnings are high. But, of course, for any kind of investment such a (reliable!) announcement of future tax cuts implies such positive effects. As can easily be shown, innovation resulting from such a dynamic tax regime can be better than innovation resulting from zero-taxes.

Recalling *Result 6*, however, we can conclude that there are different measures to promote innovation, but for countries with a large tax burden there is only one way to attract international investors, namely to reduce the total tax burden down to a level adequate for the international competitive situation.

5. Limitations and summary

The model analysis applied here was designed quite simple to ensure mathematical tractability and easy interpretation. This obviously implies a number of limitations. In the following three of the most obvious limitations will briefly be discussed as well as ways to overcome them.

1. An exponential rate of growth and decline is assumed; this assumption was made to keep the analysis simple. It may be realistic to assume an exponential growth function representing the increasing number of customers in initial stages of a new business in an electronic market. More realistic in the long run, however, are of course S-shaped functions. From such a proper extension of the NPV-model considered we do not expect rather different results.

2. The models assume deterministic future payments; investment projects naturally contain a number of imponderabilities implying that future payment streams are uncertain. Extending the models to incorporate uncertainty and modelling risk-averse investors seems promising although more mathematics and statistics is then required. Assuming a larger standard deviation for investments in newly established markets than in traditional markets and more risk for early launch times should, of course, imply more cautious investor behavior. With respect to fiscal policy, not only questions of taxation and depreciation arise, but also optimal risk sharing between individuals, firms and society.

3. The models consider only quantitative aspects; this may not suffice, e.g., when doing welfare analysis (as briefly discussed in Sections 2.2 and 3.2). For instance the welfare analysis should also consider qualitative aspects implied by a faster or slower rate of innovation. For another example, investments in a high-level education system may not only be more mportant for international investors than good terms of depreciation or a low tax rate, but also for the whole society.

The financial analysis presented here provided answers to the question of how variations of the tax system influence investment decisions in new, e.g.electronic markets versus traditional markets and in launching succesive product generations. We dealt with that question by employing two paths: Firstly, we assumed an investor wanting to either reinvest in an established market or engaging on a new electronic market. Secondly, we analysed how the optimal launch time for a firm cannibalizing its established market by a next-generation product e.g. on an electronic market is affected; we took a look at the implications for competition and social welfare. By separating the analysis for open and closed economies we could derive quite diverse implications of various fiscal policies on investment and innovation. Finally we were able to draw some conclusions from our results on how a government should behave both in the close and in the open economy, if it wants to maximizing social welfare by means of fiscal policy. In the open economy we have concentrated on the question of how it can ensure domestic firms strength in global competition.

Briefly summing up, it turned out that for accelerating innovation cutting down taxes - financed by a lower NPV of depreciation, as can be observed in a number of countries including Germany - is strictly dominated by improved terms of depreciation. Such a low-tax-rate-policy instead of good terms of depreciation may well have - on the contrary - a devastating effect on innovation and investments in new markets and new products.

6. References

D'Aveni R. A. (1994): Hypercompetition, New York: The Free Press

Brealey R.A.; Myers S.C. (1991): Principles of Corporate Finance, 4th ed., New York e.a.: McGraw Hill, Inc.

Brown, E. C. (1948): Business-Income Taxation and Investment Incentives, in *Income, Employment and Public Policy, Essays in Honour of Alvin H. Hansen*, New York, p.300-316.

Buhl, H. U. (1989): Finanzanalyse des Hersteller-Leasings, *Zeitschrift für Betriebswirtschaft* (59) 4, pp. 421-439

Buhl, H. U. (1993a): Outsourcing von Informationsvrarbeitungsleistungen und Steuern, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung* (45) 3, pp. 303 - 318.

Buhl, H. U. (1993b): Finanzanalyse von Entscheidungsalternativen bei der Software-Vertragsgestaltung, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung* (45) 11, pp. 911-932.

Buhl, H. U.; Will, A.(1998a): Efficiency Conditions for Electronic Commerce in Financial Services and Advantageous Steps to Extended Offers in Internet Banking, to be published in Nunamaker, J. F.; Sprague, R.H., (eds.), *Proceedings of the Thirtyfirst Annual Hawaii International Conference on System Sciences (HICSS), Information Systems Track - Internet Banking*, Los Alamitos, Hawaii: IEEE Computer Society Press.

Buhl, H. U.; Will, A. (1998b): Finanzintermediation und technologischer Wandel aus Markt- und Produktionssicht, to be published in: Wäscher, G. e.a. (eds.): *Proceedings of "59. Wissenschaftliche Jahrestagung des Verbandes der Hochschullehrer für Betriebswirtschaft e.V.".*

Einsfeld, U.; Schneider, J.(1997): Der Markt für interaktive elektronische Medien aus ökonomischer Sicht, in Krallmann, H. e.a.(eds.): *Wirtschaftsinformatik '97*, Heidelberg: Physica-Verlag, pp. 471-492.

Mellwig (1980): Sensitivitätsanalyse des Steuereinflusses in der Investitionsplanung - Überlegungen zur praktischen Relevanz einer Berücksichtigung der Steuern bei der Investitionsentscheidung, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung*, (32), 1980, pp. 16-39.

Nault, B.R.; Vandenbosch M.B.(1996): Eating Your Own Lunch: Protection Through Preemption, *Organization Science*, (7) 3, pp. 342 - 358

Penzel, G. (1995): Zurück in die Zukunft - Technik 2000: Revolution in der Bank nur dann, wenn die Führung versagt, in *Geldinstitute*, without volume, 10, pp. 6-14.

Reinganum, J. F.(1989): The Timing of Innovation: Research, Development, and Diffusion, in Schmalensee, R. and Willig, R.D.(eds.) Handbook of Industrial Organization, 1, New York: Elsevier Science Publishers

Schneider, D.(1969): Korrekturen zum Einfluß der Besteuerung auf die Investitionen, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung*, (21), pp. 297-325.

Schwarz, H.(1962): Zur Berücksichtigung erfolgssteuerlicher Gesichtspunkte bei Investitionsentscheidungen, *Betriebswirtschaftliche Forschung und Praxis*, pp. 135-153.

Steiner, J. (1983): Ertragsteuern in der Investitionsplanung: Zur Frage der Entscheidungsstabilität bei der Vorteilhaftigkeitsanalyse von Einzelobjekten, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung*, (35), pp. 280-291.

Stiglitz, J. (1993): Economics, New York e.a.: Norton

Stöber, K. (1975): Optimale Nutzungsdauer und steuerliche Investitionsbegünstigungen, Berlin: Duncker & Humblot,

Wagner, F. W.(1975): Der Steuereinfluß in der Investitionsplanung - Eine Quantité négligeable?, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung*, (33), pp. 47-52