The research proposal addresses the intriguing relationship between competition and innovation for the Netherlands. Recent findings for the UK suggest that the relationship is shaped like an inverted U. As empirics for the Netherlands are missing, the research fills in this gap by using Dutch firm-level data. Applying econometric techniques, it controls for the endogeneity problem between innovation and competition. Moreover, the research explicitly focuses on what is meant by ‘competition’ and how policy can affect productivity (growth) through competition policy and/or innovation policy. Finally, the importance of market structures and size of firms are also taken into account.

COMPETITION AND INNOVATION

It seems rather obvious that competition and innovation are important phenomena both in economic theory and in our day-to-day lives. People who 15 years ago did not know how to switch on a DOS computer, now surf over the World Wide Web and send emails to distant relatives and friends. This is both because of improvements in hardware but also because of innovations that make working with computers easier. People also experience more competition: electricity markets become liberalized and consumers can choose their energy provider. When buying a house (which one of us recently did) you can phone around for the cheapest notary (as indeed not all notaries have yet a webpage).

Both competition and innovation are important economic concepts and there is a vast literature trying to unravel the relation between the two. If by affecting the competitiveness of certain industries we can stimulate innovation and growth, this has important implications for both economic and competition policy. The endogenous growth literature stresses the link between innovation and growth and over a long enough time horizon changes in growth dwarf level differences between countries. In the Netherlands, this relation is especially interesting since for many years the Netherlands’ performance on productivity growth is low in an international perspective, pushing the Netherlands back in their top-ranking based on the level of productivity (see, for instance, van der Wiel (2001)). Some people claim this is due to a lack of competition in many Dutch industries. The problem, however, is that with our current knowledge of the relation between competition and innovation we cannot meaningfully inform Dutch policy on what to do. This is due to a number of reasons. First, state of the art research on the empirical relation between competition and innovation as Aghion et al. (2002) did for the UK has not been done for Dutch industries. This research can identify in which industries in the UK an increase in competition would increase in innovation efforts. We do not know whether there exists an inverted U curve for the Netherlands, and which industries are beyond the optimal innovation/competition level. Second, it is not always clear what

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different studies mean by ‘competition’ and how policy can affect competition in these cases. Third, most studies use rather incomplete measures of innovation. These three problems are the ones we want to address in the research we propose here.

We illustrate our approach using Figure 1, which pictures the ambiguous relationships between competition and innovation. When we talk about competition, we mean product market competition. Hence, we do not focus on the patent race literature which asks questions like: what is the effect of more firms in the R&D market on the number or speed of innovations and what are the differences between an auction style R&D contest and a race where firms can affect their probability of winning by investing in R&D but where the highest spender is not necessarily the winner. The reason why we do not focus on this is that the implications for economic and competition policy from this literature are not clear.

We ask the question what is the relation between product market competition and innovation. Product market competition can be increased through an increase in the number of firms on the market but also through more aggressive interaction between the existing players. Both these channels are relevant for policy. Regarding the first channel, the main focus of current Dutch competition policy is on: reducing the administrative burden on firms, making it easier for people to start a new firm (through less regulation or by providing more and cheaper licences) and making it less costly for firms to go bankrupt. The efforts by the Nma to break cartels and punish collusion are ways in which policy can make the interaction between firms more aggressive. Other examples include abolishing minimum prices, extending shop opening hours and forbidding industry associations to make price recommendations. Such policy initiatives often try to increase competition and hence reduce prices, but we do not know whether, eventually, they also foster innovation and raise productivity.

**Figure 1 Competition, innovation and productivity**

There is also a link from innovation back to competition. It may happen that an innovating firm becomes so successful that it becomes dominant in its industry. A clear example is Microsoft. Such a dominant firm affects the competition in its sector (stifles competition claim some commentators) and often calls for scrutiny by competition authorities. This effect has two implications.
First, we need to worry about how we identify the effect of competition on innovation when there is also a reversed causality from innovation on competition. We propose two ways to do this. First, we follow Aghion et al. (2002) in using instruments for competition. We are thinking here about the MDW operations and interventions by Nma in certain industries. Hence, over time we can see whether industries that had such a competition enhancing intervention experienced a change in innovation effort and innovation output. Second, we will estimate a simultaneous equation model to unravel the causality structure between innovation and competition.

The second implication of the causal effect of innovation on competition is the following. Below we discuss the literature analysing the identity of the innovator. Do big incumbent firms innovate or small existing firms or entrants? We will argue that the more competitive the product market becomes, the more likely it is that the incumbent will innovate thereby increasing its dominance. Hence, increasing product market competition in an innovative sector may actually create a dominant firm. We will try to establish this effect of product market competition on the identity of the innovator empirically. This relation has clear policy implications. If, for instance, the Nma finds it hard to win cases of abuse of dominance against big incumbent firms, it may be better to soften product market competition in an innovative sector to avoid the creation of a dominant firm.

Finally, throughout our research, we will also consider the effects of both competition and innovation on productivity (growth) because of the productivity problem in the Netherlands mentioned above. Will a more aggressive competition policy or direct stimulation of R&D (e.g. through WBSO) raise the productivity performance in the Netherlands? Moreover, both policies can be at odds with each other. This research will try to put forward more insight into the drivers of economic growth, and hence, which policy is more appropriate to stimulate growth.

The structure of the research proposal in this section is as follows. Section 3.2 briefly reviews the theoretical and empirical economic literature on the interaction between competition and innovation. Section 3.3 presents the empirical analyses of this research proposal. It discusses the data and model that is going to be used.

**REVIEW OF LITERATURE**

**An inverse U relation?**

For ease of presentation, we take Aghion et al. (2002) as the steppingstone of our discussion of the theoretical literature. The reason is that it gives an overall structure with which we can capture earlier results. We will discuss three questions here:

- What is the effect of product market competition on firms’ innovation effort?
- What is the effect of product market competition on the identity of the innovator and thereby on the competitive environment in the industry?
- What is the effect of product market competition on the type of innovation (drastic vs. incremental)? For these last two points, we will refer to Baumol’s (2002) recent work.

The literature on the relation between product market competition and innovation started off with Schumpeter’s (1942) observation that monopoly power gives existing firms the rents which motivates them to undertake R&D. This result is often misunderstood and— in fact— not
directly related to our question. The point is here that an innovation should be protected, for instance through a patent giving monopoly profits for some time. Our question is: given that patent protection exists, how are incentives for firms to win a patent affected by the intensity of competition in the product market. To see the opposite of the Schumpeter effect: if competition is soft (say because you are protected by government regulations or there is a minimum price in your market), you do not worry about other firms innovating and hence your incentive to innovate is small.

The competition concept that we use captures two ways through which a sector can become more competitive. First, for given conduct, the number of firms in the sector can increase (say, because entry costs fall). Second, for given number of firms, competition intensifies if firms’ conduct becomes more aggressive (say, firms switch from collusion to more aggressive price competition). As discussed below, one of the measures that we use to capture competition in empirical terms is the Relative Profits (RP) measure (in Dutch policy circles sometimes known as the ‘Boone indicator’). Theoretically, Boone (2000a) shows that this measure is indeed consistent with both ways in which competition can be intensified.

In the economic literature, both positive effects and negative effects from competition on innovation have been found (see, for instance, Kamien and Schwartz (1982), Martin and Theeuwes (2001), and Cohen and Levin (1989)). The Aghion et al. (2002) paper tries to capture the main effects from this literature and comes up with an inverse U relation between competition and innovation: both a positive and negative effect of competition on innovation exist depending on the initial level of competition. There are two main effects driving this result. First, in a very competitive market the profits of a laggard do not depend much on how far he is behind the leaders: his profits are almost zero anyway. While in a market with soft competition, your efficiency does affect your profit level. This is illustrated in figure 2 which considers a duopoly and where firms can be either level (both same efficiency level) or unlevel (the leader one (n=+1) step ahead of the follower (n=-1)). Intensifying competition reduces the incentive for laggards (n=-1) to catch up with the leaders (assuming that innovation is of the ‘step by step’ variety and not of the ‘leapfrogging’ sort).
This can be seen in figure 2 as the profit gain from moving from $n=-1$ to $n=0$ is smaller in the more competitive industry. Hence, we have the effect here that an increase in competition reduces R&D effort. Second, in a very competitive market it pays off handsomely if you can outperform your opponents. As competition intensifies in figure 2 the difference between being ahead ($n=+1$) and being level ($n=0$) increases. Thus, making the market more competitive increases the incentive of the leaders to innovate and move ahead of their opponents. This is the effect where more intense competition leads to more innovation. By introducing a composition effect and controlling for endogeneity, Aghion et al. (2002) find that the latter effect dominates for low levels of (initial) competition while the former effect dominates for high levels of competition.

This brings us to the second question: what is the identity of the innovator. This is a question where Schumpeter changed his mind over time. According to Schumpeter Mark I (1934), innovating firms are new small firms and they challenge the incumbent firms (by so-called 'creative destruction') Those firms can more easily introduce fundamental breakthroughs as they are better equipped to step into new technological trajectories and have the flexibility of overcoming organisational inertia. According to Schumpeter Mark II, the large established firms are responsible for technological progress. Those incumbents will defend their leading market position against potential entrants by investing in R&D. As incumbents have more to lose, their incentive to raise R&D investments is stronger than that of potential entrants. The incumbent firm avoids substituting high monopoly profits by lower oligopoly profits, while the potential entrant realises the oligopoly profits at best.

Here the main intuition can be summarized using two effects. On the one hand, there is the Arrow replacement effect: when an incumbent innovates, he replaces (cannibalises) his old product with a new one. Hence, the incentive to innovate is a profit difference, while for the
entrant (or a small existing firm with little current profits) the incentive to innovate is the profit level earned after innovating. This effect makes it more likely that small or entering firms innovate instead of big incumbents. On the other hand, there is the efficiency effect (see, for instance, Gilbert and Newbery (1984)): when an entrant innovates he will still be faced with an important competitor (unless the innovation is so drastic that the incumbent disappears, which does not happen often). Hence, the entrant will earn ‘only’ duopoly profits, whereas the incumbent when innovating earns monopoly profits. Also, when the monopolist does not innovate, he loses his current monopoly profits. This also gives an incentive for the monopolist to innovate. The efficiency effect works in the direction of the big incumbent firms innovating instead of small or entering firms.

Boone (2001) links these effects to the ones above on the relation between competition and innovation. He argues that in very competitive industries the efficiency effect tends to dominate the Arrow replacement effect. Hence, in a very competitive industry we should expect a leader to increase his dominance. In weakly competitive industries, the Arrow replacement effect dominates and we should expect small and entering firms to innovate. Here we have the reversed causality effect from innovation on industry structure. One part of the empirical research will focus on whether we can identify this effect in the data. If we can, it will have a clear policy implication: if one wants to avoid dominant firms in innovative industries (as Microsoft) one should not make these industries too competitive to start with.

In this respect, it is also interesting to take account of recent notions of Baumol (2002) on the contribution of small and large (probably dominant) firms to innovation and growth. According to Baumol, the main driver of innovation is oligopolistic competition between large firms. Driven by ‘free’ competition, the innovation process may be characterised by efficiency properties such as routinization, voluntary knowledge sharing and beneficial spillovers. Innovation is the main competitive battle weapon among these oligopolistic firms. Although the contribution of small firms should not be neglected in terms of revolutionary breakthroughs, added together the incremental innovations of large firms can become substantial.

**Testing four hypotheses**

From our review of the literature we would like to test the following predictions:

- The relation between competition and innovation is an inverse U.
- In very competitive industries innovations are mainly undertaken by the current leaders in the industry (leading to increasing dominance) while in less competitive industries small and entering firms tend to innovate.
- Competition as well as innovation are the main determinants of productivity growth making both important to solve the Dutch productivity problem.
- Large firms tend to produce incremental innovations, whereas small and new firms generate drastic innovations.
EMPIRICAL FRAMEWORK

Introduction

In this section we describe the data we are going to use and outline our empirical strategy to test the predictions above.

Using Dutch firm-level data and industry data, we intend to start with a replication of the Aghion et al. (2002) analysis of the inverse U relation for Dutch industries. The reason is that for the Netherlands, no studies are available that include the complex interactive relationship between competition and innovation including policy options illustrated in Figure 1. To capture changes in competition, the Aghion et al. paper uses as instruments the privatisations during the Thatcher years in the UK. We intend to use as instruments the MDW and NMa interventions in the Netherlands. This exercise will already be informative for policy makers, as it will identify the industries where an increase in competition can raise innovation. Then we will extend this analysis along three dimensions, which capture our three ‘comparative advantages’.

First, the Aghion et al. (2002) paper uses the price cost margin as a measure of competition. As argued by Boone (2000a) this is not a robust measure from a theoretical point of view. The Relative Profits (RP) measure seems to perform better. Together with Jürgen Weigand, Jan has already done some preliminary research while working for the CPB. Currently he works with Rachel Griffith and Rupert Harisson (IFS and UCL) on comparing competition measures in UK data (actually, the same data that was used for the Aghion et al. study). In the research proposed here we will examine whether the RP measure gives a better fit in the innovation regressions than the price cost margin.

Second, building on Erik Brouwer’s experience (see, e.g., Poot et al. (2003), Ophem et al. (2002), Kleinknecht et al. (2002), Brouwer et al. (1995, 1997, 1999 and 2003)) with the variables in the Innovation Survey data and other innovation indicators (like R&D-intensity and expenditures on innovation), we will be able to come up with a better innovation measure than used by Aghion et al. (2002). They use patent data (weighted by citations), however, it is well known that patents cover only a small part of all innovations (Griliches (1990) and Kleinknecht et al. (2002)). Many innovations are not patented by firms but simply kept secret (Brouwer & Kleinknecht (1999)). Our data allows us to identify such innovations as well, giving a better picture on actual innovation activity. This data also allows us to identify which firms innovate (leaders or followers) shedding light on the relation between intensity of competition and the emergence of dominant firms. Further, we can identify the ‘size’ of innovations (incremental versus drastic) and see what the relation is with intensity of competition in the industry. If more competition leads to both more innovations and to more drastic innovations, increasing competition in a sector becomes even more attractive.

Finally, when addressing the specific Dutch problem of lagging productivity growth which is potentially caused by a lack of competition in certain industries, we will draw on Henry van der Wiel’s experience with earlier productivity analyses. He found that in some parts of the services sector, particularly the business services, labour productivity growth was meagre in an international perspective (see e.g., Van der Wiel (1999) and (2003)). We will try to see whether lack of competition in these sectors can explain this.
Data
We developed a unique firm level dataset during several assignments for the Dutch Ministry of Economic Affairs. We merged Community Innovation Surveys (CIS) of the Dutch statistical Office (CBS) for the years 1996, 1998 and 2000. In addition, we merged the Productivity Surveys (PS) for the years 1995-2000, and we merged subsidies data (SENTER) for the years 1994-2002. All this makes the database unique. We have data about different innovation-, productivity- and market-indicators and background characteristics as well. We have data about innovative and non-innovative companies and we have these for all type of firms (manufacturing, services and public utilities) with at least 10 employees.2 This database makes it also possible to lag variables in the model to make the interaction more realistic. After all, it takes some time before R&D-expenditures lead to productivity effects3. We will use all the mentioned alternative indicators one by one in the model. An issue in this type of research is how to define the relevant market. Which firms belong to one market? Firms often produce several products and serve differentiated markets. We will have to make choices during the project. The simplest way is to define markets at the three or two digits NACE level, but we will check the robustness of such definitions as we go along.

Modelspecification: some preliminary ideas
As mentioned earlier we intend to start with a replication of the Aghion et al. (2002) analysis. Then we will also try another way (than using instruments) to solve the endogeneity problem. In particular, we will estimate a simultaneous equation model of the relation between market structure, innovation and productivity. To give an idea, consider the following equations numbered below from one to three. The variables can vary in time (subscript t). The equations will be estimated on the firm level and the sector level. In case of the sector level we will also include other countries.

1) \[ R & D_{int} = f_1(\text{Marketstructure}_t,GV_t,X_{1,t}) + \varepsilon_{1,t} \]
2) \[ \text{Marketstructure}_t = f_2(R & D_{int,t-1},GV_{t-1},X_{2,t}) + \varepsilon_{2,t} \]
3) \[ GV_t = f_3(R & D_{int,t-1},\text{Marketstructure}_t,X_{3,t}) + \varepsilon_{3,t} \]

where:
R&D_{int} = R&D-intensity in period ‘t’
Marketstructure_t = Market structure variable in period ‘t’
GV_t = Productivity variable in period ‘t’
X_{j,t} = Exogenous variables j=1 influence innovation, j=2 influence Market structure and j=3 influence productivity in period ‘t’
\varepsilon_{j,t} = error term in period ‘t’, for equation j=1..3

The type of model is dependent on the level and characteristics of the data. At the sector level we can use simultaneous continuous models (e.g. GLS, 3SLS). But if we estimate the model at the firm level we have to use truncated models (i.e. Tobit, Heckman, Threshold models),

2 Due time the research period, we will decide whether more recent data should be included in the analysis.
3 Estimates of R&D-expenditures leading to productivity effects vary in most cases between one and four years (See, Pakes & Schankerman (1984), Acs & Audretsch (1988)).
because most firms are not innovative. The estimation of different type of indicators results in using full maximum likelihood models (FML) or two stage approaches (see Maddala (1983)). An alternative model is the non-linear General Method of Moments (SYS-GMM model). This is a simultaneous estimation of level and growth equations\(^4\). Analysis at the firm level is also more time consuming because the work has to be done onsite the Statistical Office in Netherlands (CEREM).

*Can the empirical findings help policy makers?*

Figure 1 also points at the challenge for policy makers aiming at boosting productivity growth and finding the right balance between competition and innovation policy. Competition policy tries to limit the abuse of market power and assesses market concentrations that could decrease competition and welfare. Additionally, competition policy induces competitive pressure on firms which may lead them to innovate. The main emphasis of our research will be on economic policy affecting competition in industries. However, we also consider innovation policy which aims directly at dynamic efficiency. Sometimes competition policy is seen to be mainly focused on static efficiency. As a trade-off may exist, the aims of innovation policy and competition policy can be at odds with each other. Canton (2002) shows that the effectiveness of either policy to raise welfare depends on the particular market situation. Aghion and Howitt (1998) actually argue that one should either use competition policy or innovation policy but never both instruments at the same time in a sector. We will address this in our research. As discussed, we explicitly consider the effects of the MDW operations and we will estimate the effect of several R&D-subsidies on cooperation, innovation, performance and market structure (Brouwer et al. (2003)).

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Much effort has been put into research to understand the so-called Solow Paradox concerning the limited evidence of the positive productivity impact of ICT (Jorgenson and Stiroh 1999). Significant changes within the company structure, such as a shift in the employment structure from low to high skills, the diffusion of ICT and the redesign of a company workplace organisation, can be observed over recent years and present new challenges for companies. They contribute to productivity both directly and indirectly through the innovation equation. Dáz-Chao Spain (Catalonia) 2009 Wage is the main determinant of et al. The term innovation means the introduction of something new, a new idea, method or device. Innovation characteristically involves creativity, but the terms are not synonymous. Innovation is distinct from invention and involves the actual implementation of a new idea or process in society. Innovation is an important topic in the study of economics, history, business, technology, sociology, policy making and engineering. Historians, sociologists and anthropologists study the events and... The concept of market structure is central to both economics and marketing. Both disciplines are concerned with strategic decision making. In decision-making analysis, market structure has an important role through its impact on the decision-making environment. The extent and characteristics of competition in the market affect choice behavior among the actors [Baumol, 1961; Yadav, 1995]. The problem for economists and marketers is that a meaningful operational definition of market structure is elusive [See Horowitz, 1981; Belk, 1975]. Each discipline takes a different methodological approach toward solving this problem, and each has its own strengths and limitations.