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SUMMARY
IMPACT OF GOVERNMENT SUPPORT TO AUTOMOTIVE RESEARCH

Implications of research and renewal for the competitiveness of the Swedish automotive industry

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SUMMARY
Impact of Government Support to Automotive Research

– Implications of research and renewal for the competitiveness of the Swedish automotive industry

SVEN FAUGERT, ERIK ARNOLD, MARIE-LOUISE ERIKSSON, TOMMY JANSSON, PAULINE MATTSSON, LARS NIKLASSON, PETRA SALINO, HENRIK SEGERPALM & TOMAS ÅSTRÖM

Foreword

At the start of the 1990s the government, in close collaboration with the automotive industry, invested in a vehicle research programme called ffp. Both sides invested SEK 30 million per year in the initial years. Its most important impact was helping strengthen the research expertise of the automotive industry and its interest in and capacity to absorb research results into its own development activity. Amongst other things, this was because the industry could employ research-trained people. It also helped strengthen the collaboration with universities and research institutes and bolstered the internal competitiveness of passenger car manufacturers within foreign-owned groups. Aided by ffp, both Volvo PV and Saab were able to establish-internal Excellence Centers within important technological fields.

Accordingly, the Vehicle Research Programme has made a significant contribution to maintaining the Swedish automotive industry's competitiveness through strengthened research expertise and absorption capacity, strengthened collaborative relationships with universities, strengthened internal competitiveness for passenger car manufacturers within foreign-owned groups and vital research results applicable in product development.

The applied academic vehicle research has been extended into a number of areas of importance to society such as quality, safety and environment and has been adapted according to the needs of the industry. The relationships between the automotive industry and the authorities have gradually changed from negotiating opponents to that of partners. This has built up a platform for ongoing joint ventures of interest to both sides and of benefit to the international competitiveness of the Swedish automotive industry. An important policy issue is whether and how this collaboration or consultation model can be utilised in the current crisis to maintain the Swedish automotive industry's future in ever-toughening international competition.

The Vehicle Research Programme was new in a number of respects, both in regard to its elements and as an example of a new form of collaboration between the state, industry and the research community. Analysis of these impacts has been conducted by a team within the Technopolis Group under the leadership of its Swedish company, Faugert & Co Utvärdering AB. The report is based on a number of subsidiary studies, including studies of statistics, questionnaires, in-depth interviews and case studies. Peter Stern was the administrator in charge at VINNOVA.

The impact analyses which VINNOVA carries out on the instructions of the Swedish

government are particularly valuable because they provide a description and an understanding of the more long-term effects of investment in research, innovation and sustainable growth. We would like to thank everyone who contributed directly or who in any other way shared their experiences and made it possible to carry out this study.

VINNOVA, April 2009

Lena Gustafsson
Acting Director General

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Acting Head of Division
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Introduction

At the time of writing (December 2008), the front pages of the daily papers, Internet discussion sites, news reports and trade supplements are filled with news of the crisis in the Swedish automotive industry. The headlines deal in warnings, rumours of closures or sell-offs, speculation as to corporate survival chances and what the US and German governments may or may not have agreed – plus what the Swedish government is doing now, should do and should have done sooner. This report deals with what the government ***has done***, going as far back as ***15 years ago***, and what we can say about the impact of this now.

What the government did back then was to invest in a research programme in close collaboration with the automotive industry. This went by the name of the Vehicle Research Programme (*fordonsforskningsprogrammet* in Swedish, or ffp). In the initial years, both parties invested SEK 30 million per year each. In part because the industry was able to employ research-trained people, the most important impact of the programme was to help strengthen the automotive industry's research expertise as well as its interest in and ability to take on board research results in its own development operations. It also contributed to strengthening the collaboration with universities and research institutes and to bolstering the internal competitiveness of passenger car manufacturers within the foreign-owned groups. With the aid of ffp, both Volvo PV and Saab were able to maintain Centres of Excellence within important fields of technology.

Overall conclusions

The Vehicle Research Programme (*ffp*) 1 and 2[1] can be said to have acted as an intervention at an innovation system level. This effort has made a significant contribution to maintaining the competitiveness of the Swedish automotive industry by strengthening research expertise and absorption capacity, strengthening partnerships with universities and institutes, and strengthening internal competitiveness for the passenger car manufacturers within the foreign-owned groups. It has also provided important research results applicable to product development.

The applied academic automotive research has been expanded into fields of public

1 It should be pointed out that ffp 1 and 2 were not the only government efforts in automotive-related research and development during the period in question. Efforts are still being made, as far as possible, to identify and single out exactly what ffp 1 and 2 meant, given these premises. By the same token, this does not imply an attempt to assess or evaluate the other programmes; this has been done elsewhere.

importance such as quality, environment and safety and has been adapted according to the needs of the industry. Relationships between the automotive industry and the agencies have gradually changed from those of negotiating opponents into partnerships that have built a platform for ongoing mutual efforts of interest to both sides and beneficial to the Swedish automotive industry's international competitiveness. An important policy issue is whether and how this collaboration or consultation model can be utilised in the current crisis to promote the future of the Swedish automotive industry in the face of ever-toughening international competition.

If we are to try and draw any general policy conclusions from the study, we would have to begin by noting that the incentives, the control and stimulus measures and the organisation which was launched in order to realise the intentions of *ffp*, came into existence and operated in the context that prevailed in the early and mid-1990s. It is not possible to simply copy what worked then and has worked well for a long time. However, it is possible to conclude that a number of factors all played an important role during the period studied:

1. the injection of funds from the government,
2. the focus of *ffp* on certain technological fields,
3. the rules of project support, stating that it was not universities or institutes but rather companies which were the applicants for research support (and thus had the power to set the agenda) and that projects should be implemented in collaboration between companies and universities/institutes (which in practice were receiving the majority of the state funds),
4. requirements for corporate co-financing,
5. the design of the agreement between the state (the government) and companies, and
6. the composition of the Program Board for Automotive Research (*PFF*) with its independent chairman and role as an ongoing trust-building forum for discussions on the future and technology, as they developed.

In the light of this, it is possible to draw the following conclusions of general relevance to *policy* regarding government support for this kind of research.

1. The entire *ffp* setup (and the simultaneous National Aviation Engineering Research Programme, *NFFP*) was an early success as well as a trendsetting example of the form of a Triple helix with broad official involvement, which:
   a) made it possible to factor in a number of public interests,
   b) involved genuine user-controlled research and *offered* companies as well as research institutes something they needed (a win-win solution),

c) followed rules that compelled a collaboration with universities and research institutes at project level and thereby achieved a genuine behavioural additionality. In other words, *ffp* has helped the industry continue to run its development work differently than it would have done otherwise, and

d) served as an effective focusing device (positive feedback loop) at programme level.

However, the model also had certain limitations. For example, it did not do particularly much about the fact that the knowledge infrastructure continued to be quite fragmented; probably not the best use of research resources, at least not from the automotive industry's perspective. This raises the question of whether sectorially-targeted efforts of this kind are the best means of achieving adequate structural changes, whether in terms of research implementers or those who commission research or define research problems. A deeper analysis of the long-term, structuring impacts of *ffp* and similar efforts on universities would probably help answer that question.

2. The arrangement made it possible (for example in the National Aviation Engineering Research Programme) to maintain and further build up some *long-term research within companies* of a certain scale. It also made it possible to increase the expertise of both companies and universities/institutes as well as contributing agencies. Amongst other things, this led to an increased capability to participate in the EU framework programmes and to generally better conditions and readiness for innovation within the automotive industry.[2] Further analyses of the importance of the fairly large number of research-trained people added to the industry through various forms of sectorially-targeted research and development (R&D) support – and of various obstacles and opportunities in terms of their potential to play the role of "border commuters" between academia and industry – would lead to important conclusions on how government R&D support can be used.

3. The fact that companies were compelled by the rules to collaborate in projects with external R&D suppliers was vital to the behavioural additionality on the part of companies that *ffp* brought about. Naturally, the fact they also had the power to set the agenda and were compelled to co-finance projects (in practice often by participating actively in them) facilitated their direct or indirect use of the results.

2 This, in turn, presupposes that the relevant industry has a clear wish to, and capability for, development and growth through innovation. Also, it is known from other studies that external research funding can have major significance in maintaining individual competent researchers and research groups with so-called critical mass within a company. In this case, it is particularly important, considering that both passenger car manufacturers were entirely foreign-owned during the period in question. Had it not been for government funding through such programmes as ffp, it could easily have led to their having even less influence over the priorities of their own R&D efforts.

4. Of major significance for these results was the success over the years of the Program Board for Automotive Research *(PFF)* and its working group in building up trust between the parties to the agreement and creating a flexible working organisational platform for new initiatives. An important key to this success was the fact that it involved a voluntary collaboration on an overall programme level plus a form of consultation which respected the needs and situation of all parties, rather than a forced coordination. This also created a forum for some informal mutual programme design through the information exchange between various actors that took place under *PFF*. Thanks to the long overall programme period, it was also possible to create continuity in the work. *PFF* proved to be an organisation that learned from experience and was able to adapt its ways of working and support conditions within the constraints of the basic agreement.
5. Through this, *PFF* and *ffp* created a series of necessary but inadequate conditions for the impacts that were observed within the industry, research and the agencies. These impacts were actually dependent on complete cohesion between other simultaneous measures and R&D and demonstration programmes, making it difficult to distinguish what the specific effect of *ffp* has been.

   By the same token, this is an argument for a strategically well-reasoned *policy mix* in an area where the government wishes to achieve certain results. The government's role is to make an assessment of needs and supply a combination of relevant incentives to facilitate prudent action from various actors in the innovation system. R&D programmes or funding instruments have been observed enabling both companies and the academic research system to select the combinations which best correspond to their respective needs. In addition to a *combination of R&D programmes*, incentives may be required in the form of tax relief, stimulus and standardisation measures, public acquisition, training initiatives etc. Strictly speaking, a more complete impact analysis would therefore require a synthesis or meta-analysis to be conducted of, at minimum, all research programmes (production technology, traffic systems, environmental impact etc.) directly or indirectly affecting the future of the automotive industry. Knowing this and given the current crisis in the automotive industry, urgent efforts should be made to try and assess which total policy mix would strengthen the impact of the support currently being given to automotive research. In that context, the question might be: What can/should the government do in order to push a development of the research infrastructure which strengthens the future prospects of the Swedish automotive industry? What types of efforts are required in addition to things like ffp in order to strengthen small and medium-sized supplier companies' capability to contribute to the development?
6. A potentially beneficial side-effect of research programmes of this kind, regard-

less of the future fate of the automotive industry, is a kind of organising impact contributing to the creation of what might be called a *knowledge value collective,*[3] relating to relevant automotive technical issues. Such impacts have been observed in other, similar studies. It is an open question as to whether *ffp* made an adequate contribution to this. An important subsequent issue is of course the extent to which this organisational process can be influenced and whether the usage of such human resources can be influenced if the immediate driving force – the presence of domestic passenger car manufacturers for example – ceases or diminishes.

7. Another observation is that *ffp*, in conjunction with the other programmes being operated through *PFF*, has been beneficial for some of the *subcontractors,* primarily the larger supply companies with sufficient individual absorption capacity. Using the rules it had designed, *PFF* was able to participate in a range of projects from which it would otherwise have been excluded and thus enhance its expertise. There is still the impression that this was not enough for the supplier side, since the huge majority of subcontractors did not participate in *ffp*. In practice, the guiding factor has been the vehicle manufacturers' research agenda and the huge majority of supplier companies have not had the same absorption capability and opportunity to participate as the vehicle manufacturers and the small number of Swedish-based suppliers on tier-1. They therefore found it harder to benefit from *ffp*. In view of the Swedish supplier sector's structure (many small, tier 2/3 companies with weak profitability, no R&D tradition and low absorption capability) *ffp* is hardly the most suitable instrument for achieving increasing competitiveness. Other types of government initiative are needed for that purpose.

Impact

The overall argumentation concerning the impact of *ffp* 1 and 2 is something of a "presumptive target". In pretty much all the changes noted in this study, there are ***several conceivable causes***, not just *ffp*. And it is not possible to know for sure what would have happened had the government ***not*** terminated the agreement with the automotive

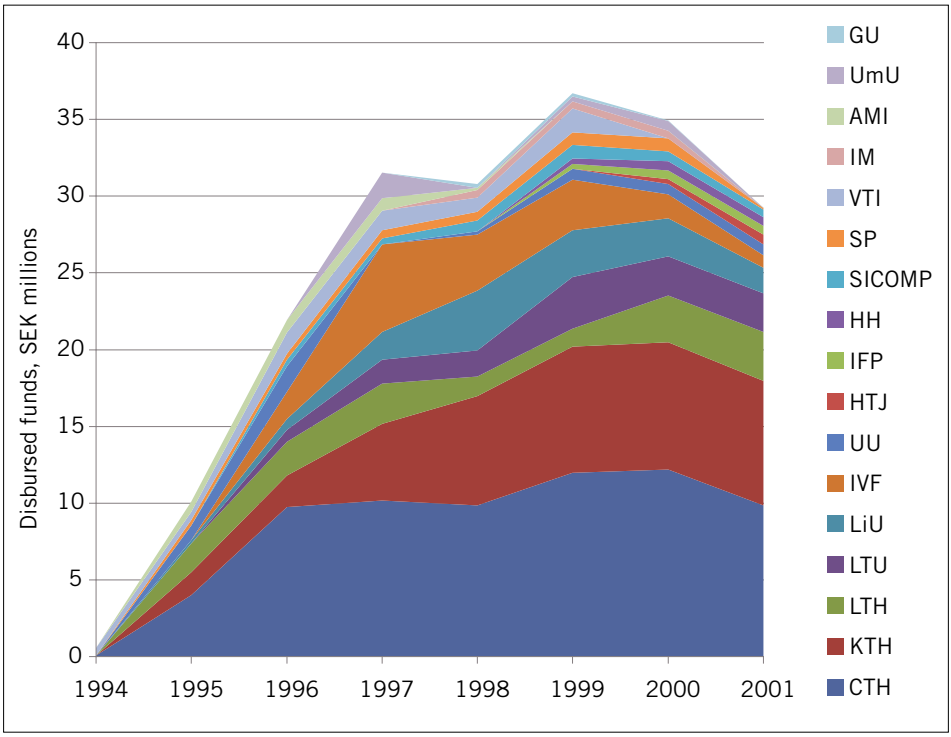
3 *Knowledge Value Collective* or *KVC* in this report indicates the volume of people in industry and other research organisations working within a given knowledge field of industrial or social relevance. *KVC* is often linked to a given geographical area, such as an industrial district – like the combustion and engine design grouping in Gothenburg or the IT/telecom cluster in Kista. A *KVC* comprises a labour market and individual people move between organisations and can build up new ones. Essentially, a *KVC* is more resilient than the individual organisations which happen to host it. For example, Ericsson's large-scale layoffs of research personnel in Kista did not lead to the disappearance of the *KVC*, but to the removal of expertise from Ericsson into a lot of small manufacturing and consultancy companies and to some of its competitors.

industry and thereby created *ffp*. Bearing these reservations in mind, if we nevertheless put together what it has been possible to observe, a wholly convincing picture emerges showing the *ffp* effort from 1994-2001 to have had the following impacts. For the sake of logic, the first description is of the impact on university research, then on the automotive industry and finally on society:

University research

- Relevant applied university research for the automotive industry within the fields of quality, environment and safety received a significant *net contribution of funds*, which was enhanced chiefly by the vehicle manufacturers putting in at least as much in the form of their own time, equipment and even money. These funds were over and above already very wide-ranging government funding to automotive-related university research under the auspices of programmes run by various government agencies (particularly the former *Nutek* (the Swedish Agency for Economic and Regional Growth), former *KFB* (Communications Research Board), Swedish Road Administration and Swedish Environmental Protection Agency). The contribution from *ffp* was distributed between a number of research environments of priority and significance to the automotive industry and several different educational establishments. The disbursement of state contributions to various educational establishments etc. under ffp 1 and 2 is shown in figure 1.
- In the main, the distribution of funds for automotive research to these research milieus as a whole has *continued to increase* since that time, both through *ffp* having continued in two further programme stages after 2001 and through funding of other programmes, under both *PFF* and the Swedish Energy Agency and VINNOVA. The result has been a number of new research collaborations with industrial companies and other academic research milieus which have endured through continuation projects, co-publications and other national funding. In several cases, *ffp* has also contributed to the ability of research environments to build up critical mass and create new collaborative relationships in projects under the EU framework programmes and, in some cases, to the ability to build up an international reputation and attract foreign vehicle manufacturers.
- Through *ffp*, the expansion of university research has been guided into *areas of benefit* to society and has attracted additional interest from researchers and students interested in applications. The external funds have also gained internal benefit in universities by attracting faculty funds for defence of doctoral theses and in some cases also licentiate diplomas. This has strengthened the *structuring impact* of the external contributions as they have helped profile the relevant

Figure 1 Distribution of disbursed funds by fund recipient, period 1994–2001.



institutions/departments. This, in turn, has marked out certain "tracks" which research students and financiers follow and which can generate positive feedback. Examples of genuine structural changes within academic automotive research include a new research area and new services at Chalmers and a new centre at the Royal Institute of Technology (KTH), all partially attributable to the *ffp* effort. A downside to this would seem to be that the automotive research boom may have created a major dependence on external funds and a certain "lock-in effect" which, in this context, would mean that researchers focusing on applications and suited to *ffp* are the ones staying in the research context or even department concerned. One possible such impact is particularly clear at Chalmers. The question is also whether the structuring impact has been adequate or whether the research milieus have remained too fragmented to be able to create the world-class research which might be required. This is a crucial question, particularly in regard to the current state of the automotive industry.

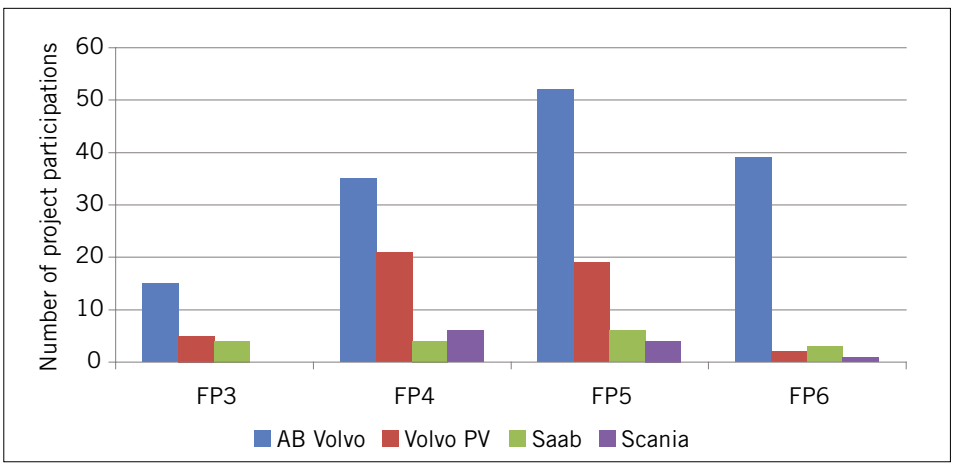
- The collaboration with industrial companies has also partially changed the *working method of university researchers* more in the direction of needs-driven research aimed at application and problem-solving. At the same time, most consider that academic output and quality has been maintained or increased. In addition, the

basic training of engineering graduates has been influenced in the same direction through degree projects, course development, textbooks and by research contributing examples and linking tuition to reality.

The automotive industry

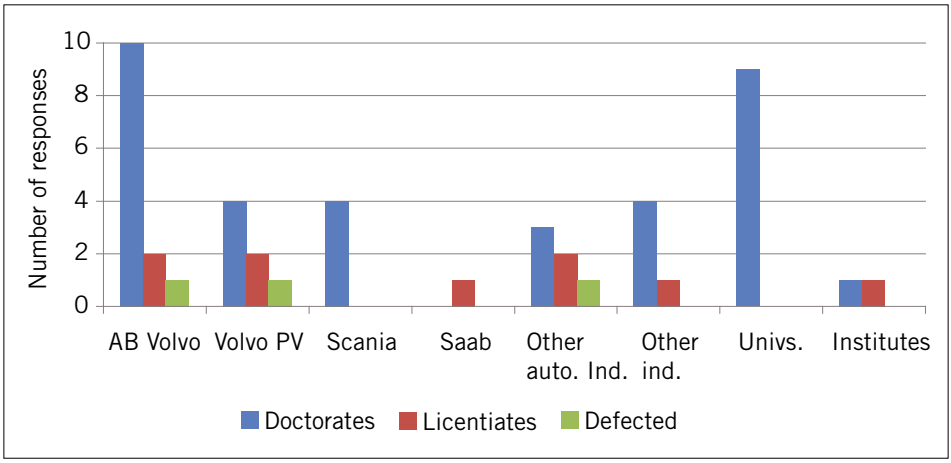
- It has been possible to strengthen *networks* between the industry and universities/institutes and form entirely new ones. Thanks to the government funding and the more open attitude to research and researchers created by ffp, networks have been expanded and generic knowledge disseminated amongst involved parties. Companies have been able to concentrate more on applications which are a little further into the future, instead of "yesterday's problems" and development work has been brought forward. It has been possible to start some projects which would otherwise not have come about, often as horizontal projects involving more than one vehicle manufacturer.
- Basic R&D work at national level has been possible through *ffp*. This has made companies and universities as well as research institutes more competitive within the *EU framework programmes*. However, this impact is very unevenly distributed within the industry and amongst the R&D implementors, chiefly because certain actors have made a conscious choice to remain outside the framework programmes. As is apparent from figure 2, AB Volvo (most often through Volvo Technology) is the most dominant participant amongst the companies. Chalmers is the most commonly occurring Swedish participant on the universities and institutes side. KTH is also a recurring collaborative partner.
- The contribution of funds under *ffp* 1 and 2 has also led to the training of a significant number of *researchers focusing on automotive technology*. This is a direct

Figure 2. Corporate framework programme involvement (FP3–FP6).



result of projects during this period most often being implemented as doctoral projects, defined by the industry and implemented in close collaboration with companies and universities. The majority of these new researchers are currently working in research or development within the automotive industry, either as managers or specialists. Some also remain at educational establishments and research institutes, see figure 3.

Figure 3. ffp doctoral students' current or most recent employer. Total responses: 46.

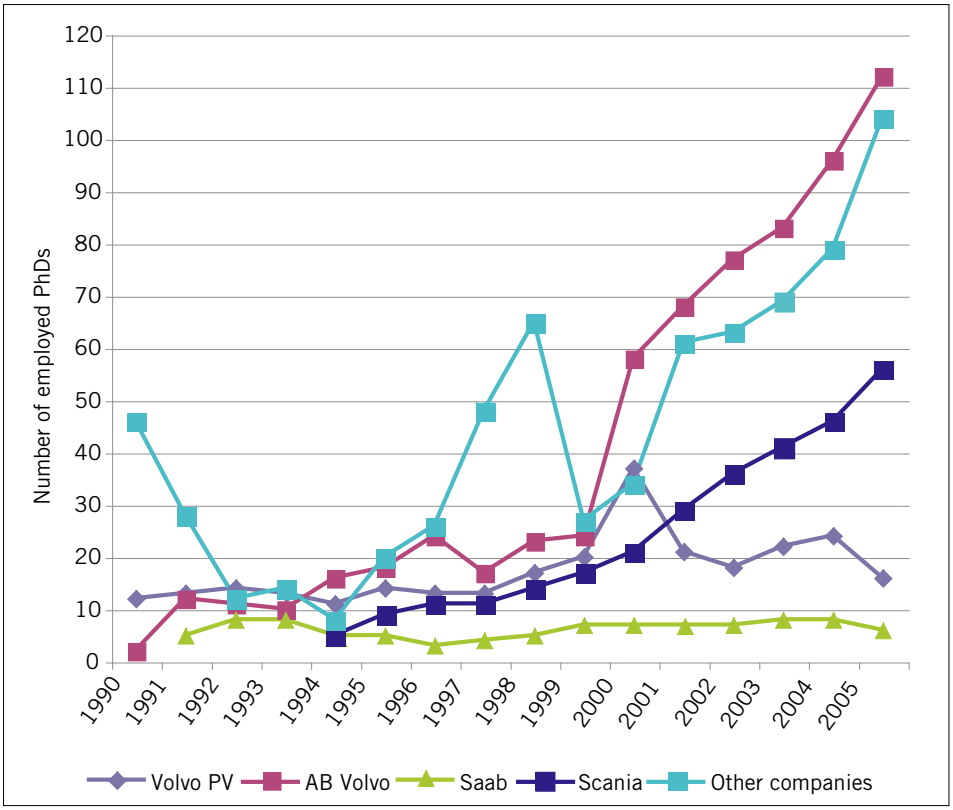


- Companies had already begun recruiting researchers early on, which represents something of a paradigm shift for the Swedish automotive industry. The total number of doctorates in the automotive industry is shown in figure 4 (the number of employed licentiates is of corresponding size and has developed correspondingly). The Vehicle Research Programme came in at the right time and greatly strengthened that trend. This is one of the most important impacts of *ffp*. It means that collaborative relationships between the automotive industry and academia have been substantially strengthened and that companies' interest in and capacity for taking on board and utilising external research results in their own R&D operations (known as absorption capability) has been fundamentally changed, partly as a result of the ffp effort.

So, why is the automotive industry not better equipped to meet the current crisis? This is a supremely well-founded question and involves what might be called the passenger car manufacturers' "Catch 22". This issue will be addressed later on.

- At any rate, for the automotive industry's part, this development in expertise means it has been possible to take important developmental steps through the R&D that has been conducted in collaboration with universities and institutes. The working methods concerned became more methodical, scientific and long-

Figure 4. Number of PhDs employed in each company and rest of the automotive industry.



term, meaning that when the *passenger car manufacturers* were foreign-owned the internal R&D resources could be built up and receive assistance in surviving and developing further. Through government support from such quarters as *ffp*, these gained the opportunity to build up and maintain their own research resources, including through the formation of a number of internal Centres of Excellence. Over and above the financial resources, the Swedish government support has also had strong symbolic value in relation to the foreign owners. Thus, the government support strengthened their group-internal competitive power in various ways and without it they would have been far more poorly equipped than they are now. For *manufacturers of heavy vehicles*, the reformed working methods have meant that they are still in a strong position on the global market because they have gone on being able to develop their increasingly complex products.

- Regarding the development of expertise, it is apparent that *AB Volvo* and *Scania* made a clear increase in their research expertise during *ffp* 1 and 2 (see figure 4), which can partly be attributed to ffp. For Volvo PV, the development was the same until the company was sold to Ford after which the number of research-

trained and graduate engineers stagnated or diminished. Saab shows a significantly weaker increase in research expertise and, after GM became the sole owner of Saab, there was a clear decrease in the number of graduate engineers. The decline for the passenger car manufacturers could probably be attributed partly to them having to drop certain technical fields and rely on other developments within each group, partly to a strong trend towards outsourcing of design work, and partly to the fact that the total number of employees within each company reduced. Other companies within the automotive industry show a very strong increase of both research-trained people and graduate engineers. This can largely be explained by the fact that the technical consultants actually conducting the outsourced design work (and the largest system suppliers) have recruited them.

- There are also a large number of *tangible examples* of what *ffp* has meant to the vehicle manufacturers. Aided by *ffp*, AB Volvo was able to maintain its expertise in hybrid technology between the sale of Volvo PV in 1999 and the start of the Green Vehicle National University Programme in 2001. Scania developed considerable expertise on how paint layers behave under high pressure and was thereby able to stipulate different requirements of paint suppliers as well as revising the design of painted joints. Volvo PV developed new protective safety systems and commenced development of a new diesel engine. Similarly Saab, in its development of the Vepsilon engine, benefited from ffp projects. As stated, aided by *ffp* both Volvo PV and Saab were able to maintain group-internal Centres of Excellence in critical technical areas.
- *In summary*, since it began in 1994 the Vehicle Research Programme has had a reinforcing effect primarily on the vehicle manufacturers' long-term research and development. This might be expressed in terms of *ffp* having resulted in a significant behavioural additionality in relation to the automotive industry. This has been achieved through a development of expertise in companies' own personnel, recruitment of people with relevant researcher training, collaboration with ever more internationally competitive research milieus and the production of utilisable research and development results. The programme also created better prospects for companies to work with Swedish research environments in the EU framework programmes. It is generally understood that all this has strengthened both the foreign-owned passenger car manufacturers' internal competitiveness and the international position of heavy vehicle manufacturers.

Society

What all this in its turn may have meant for Sweden's economy or environment, or for society as a whole, is more difficult to determine or calculate unequivocally. It seems highly probable that *ffp* contributed to hastening the introduction of new, more

environmentally friendly and above all safer cars and to (at least temporarily) keeping employment up in a number of areas. A look at the export share (15%) and employment across the board occasioned by the automotive industry serves as a reminder that everything which positively impacts its competitiveness or capacity to survive and adapt to changes from outside can have enormous significance nationally. Furthermore, there is a fairly wide perception that, strictly speaking, the Swedish automotive industry is subcritically sized for being consistently at the technical forefront and producing at competitive prices, especially against competitors in the new car producing countries.[4] Consistent with this, it has even been claimed that (current crisis in the sector notwithstanding) the Swedish automotive industry should really have been beaten long ago.

Seen in this light, the direct and indirect impacts of *ffp* on society seem highly significant and valuable.

On the other hand, there is the question of whether *ffp* has fulfilled its purpose, or whether other simultaneous coordinated programmes and efforts were needed. As stated, a contiguous issue is whether there have been negative side-effects in the form of being locked into certain developmental lines, or an actual forcing aside of even more vital long-term or radical research.

The answer to these questions relates to what was earlier called the Swedish automotive industry's (or at least the passenger car manufacturers') "Catch 22". As was apparent, Volvo PV and Saab Automobile would probably have found it harder to survive the internal competition without ffp support. If, at the same time as *ffp*, the Swedish government had invested even more robustly in research and development of new drivelines (hybrid electric and fuel cell vehicles) and thus forced the pace of technical development, then the researchers might have been able to make even quicker progress. However, the foreign-owned (and Swedish-based) manufacturers would still not have had full freedom to utilise these advances without the consent of their parent companies in Detroit and Dearborn! On the other hand, and purely hypothetically, if Volvo PV and Saab Automobile had not been foreign-owned, they may well have had their freedom but they would have been so small that they could barely survive outside a major group with opportunities to share component volumes, platforms, development costs etc.

Nevertheless, at the time of writing there are no "ready answers" concerning the future fate and development of the Swedish automotive industry. Still, we already know that the essentially positive development of the Swedish automotive industry in recent years will break in 2008. Indications are that the recession of the next few years will

4 J. Wormald, "R&D in the automotive industry and the role of countries" in S. Faugert, E. Arnold, M.-L. Eriksson, T. Jansson, H. Segerpalm, I. Thoresson-Hallgren and T. Åström, "Collaboration for sustainable competitiveness – An evaluation of the Vehicle Research Programme and Green Vehicle National University Programme", Program Board for Automotive Research, April 2007.

probably be deeper than the one which took place during the downturn at the start of the 1990s.

It has also been observed that *ffp* had a number of *specific impacts on a societal level*, or at least for the most closely involved agencies and their work:

- Through *PFF*, which operated for a full 15 years, a close collaborative platform was built up between the government in the form of its most closely involved agencies and the automotive industry. This platform may be regarded as a win-win solution, benefiting the agencies in their work of driving the development towards safer and more environmentally friendly vehicles, and the automotive industry in its efforts to be well ahead in the development.
- The programmes analysed in this report were not the only ones specifically targeted at the automotive industry. However, they acted as a "springboard" for subsequent programmes such as the Green Vehicle National University Programme, which had major direct impacts on the automotive industry's development and competitiveness. Through *ffp* 1 and 2, the necessary organisation, rules of involvement, good collaborative relationships, mutual take on reality and frames of reference, plus a general trust between the relevant parties on the industrial and official sides had already been established. The overall capability in Sweden to run major mutual development programmes for the automotive industry had been strengthened and they were "ready to go" when the new efforts were made, which meant significant time savings.

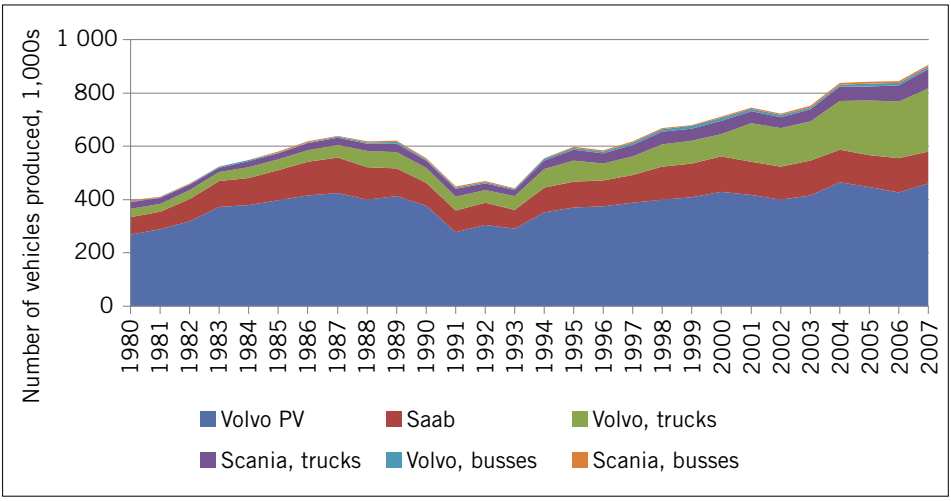
Background

The background to the whole introduction of the Vehicle Research Programme is that, like today, at the start of the 1990s the automotive industry in Sweden was generally in crisis. Vehicle manufacturers were subject to strong international competition, mainly from other vehicle manufacturers in Europe and Japan. External competitive pressure, linked to the financial crisis of the day and culminating in the autumn of 1992 in a 500% marginal interest rate, had dramatic consequences, as reflected in figure 5. This situation created a strong incentive for restructuring, including a much faster pace of development which the vehicle manufacturers realised they could not meet by themselves.

The vehicle manufacturers realised that robust investment in R&D was required in order to safeguard their long-term competitiveness. They therefore made their move on the government regarding this in the autumn of 1992.

In the research bill the following spring, the government proposed introduction of an automotive technology research programme with a maximum annual ceiling cost of SEK 30 million, provided that the automotive industry contributed at least as much.

Figure 5. Number of vehicles produced. AB Volvo's truck production from 2000 includes Mack and Renault Trucks and from 2007, Nissan Diesel. Source: Bil Sweden, 2008.



The Swedish parliament approved the proposal and in the spring of 1994, following negotiations, an agreement was signed between the government and automotive industry. The Program Board for Automotive Research (*PFF*) was set up to implement the Vehicle Research Programme (*ffp*).

The programme continued from that time and up to the end of 2008.

This report was written at the request of VINNOVA as one of the Agency's series of impact analyses commissioned by the government. Its task was to describe and analyse the impacts of two stages of *ffp* taking place during 1994-2001 on the industries concerned, on research and society at large, and on agencies operating in the area.

The work was carried out by a team within the Technopolis Group under the direction of its Swedish company, Faugert & Co Utvärdering AB. The report is based on a number of subsidiary studies, including studies of statistics, questionnaires, in-depth interviews and case studies. The following subsidiary studies have been carried out:

- Documentation studies in regard to general literature, documents about *ffp* and in *PFF's* archives.
- A simple comparative study of types of funding and the formulation of research problems.
- Interviews and documentation studies related to research funding from other simultaneous research programmes.
- A compilation of data regarding grants under *ffp* 1 and 2 to various research environments.

- A questionnaire to research milieus which received contributions under the constraints of *ffp* 1 and 2.
- A series of brief interviews and a questionnaire to doctoral students who have been wholly or partly funded by *ffp* during their research training.
- Compilation and analysis of training data from the SCB database.
- Compilation and analysis of data on participants in EU projects in the CORDIS database.
- Compilation and analysis of financial data and details of the number of employees from participating companies' annual reports and the *FKG* (Scandinavian Automotive Suppliers) database.
- Compilation and analysis of the automotive industry's production from the US Department of Transportation and Bil Sweden.
- Compilation and analysis of the automotive industry's importance to the Swedish economy from Statistics Sweden's corporate database.
- In-depth interviews with key people in the automotive industry.
- In-depth interviews with key people in academic automotive research.
- In-depth interviews with key people in agencies and departments.
- Case study relating to the Department of Energy Science's Division of Combustion Engines at Lund Institute of Technology and in collaboration with AB Volvo, Volvo PV, Scania and Saab Automobile.
- Case study relating to the SAFER research Centre at Chalmers and its collaboration with various educational establishments, companies and agencies.
- Case study relating to the collaboration in the Ytmekanikgruppen, between Scania and above all KTH.

The story of the Swedish automotive industry concerns two corporate groups which, in conjunction with a handful of others, built Sweden up during the post-war period. The Volvo and Saab-Scania groups have many similarities and both have at times been major corporations producing such things as passenger cars, trucks, buses and aircraft or aircraft engines. Both have subsequently sold off their respective passenger car divisions but remain strong global actors within heavy vehicles.

In 1999, Volvo Cars was sold to Ford and AB Volvo made an unsuccessful attempt to purchase Scania. Instead, Volvo purchased Mack Trucks and Renault Trucks in 2000 and Nissan Diesel in 2007 and became an international supplier of heavy vehicles to an even greater degree than previously.

In 1990, after a couple of decades of recurrent financial difficulties for the passenger car division, a 51% share of the newly formed Saab Automobile was sold to General Motors, which in 2000 purchased the remaining shares. In 2000, Volkswagen acquired

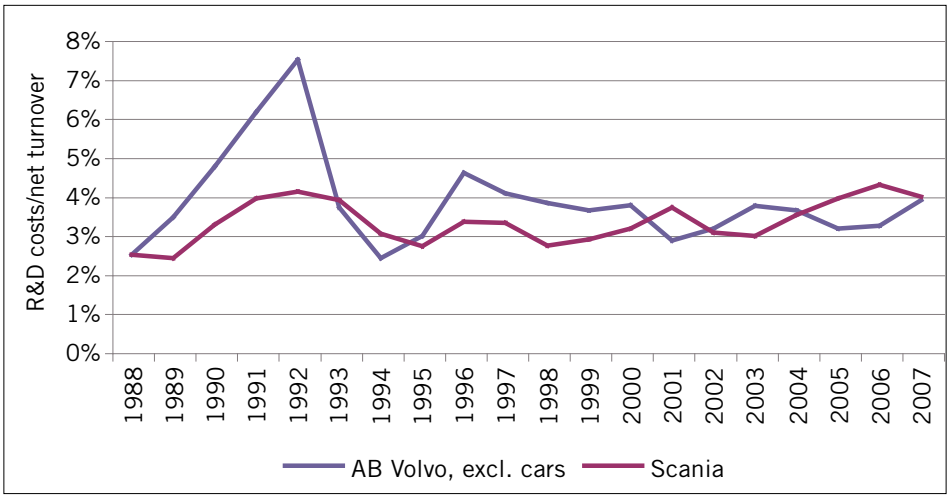
34% of the shares and 17.7% of the capital in Scania and in 2008, Volkswagen purchased the Wallenberg-controlled Investor's share block in Scania, following which Scania was controlled by the Volkswagen group.

Although the Swedish automotive industry is very important to Sweden, it is significantly less important on the world market. The Swedish passenger car industry is almost negligible from a global point of view, with around 0.6% of world production. On the other hand, AB Volvo and Scania are considerably larger in relative terms in the markets where they are active, as shown by their 14.6% and 13.5% respectively of the European market for 2007.

The Swedish automotive industry does not merely consist of four vehicle manufacturers but also of approx. 1,000 subcontracting companies. Of an estimated total of nearly 140,000 people working in the automotive industry in 2004, just under half were with subcontractors. The vehicle manufacturers' whole process, from product development to manufacturing of finished vehicles, depends on competent subcontractors. In 2006-2007, the automotive industry as a whole[5] accounted for 6.1% of the entire industry's production, 15% of Sweden's total exports and 1.8% of jobs.

With the exception of clear rises at the start of the 1990s, due in part to greater absolute investment in R&D plus the subsequent major fall in net turnover (particularly for AB Volvo), the R&D costs for the manufacturers of heavy vehicles swings between 3-4% of net turnover, see figure 6.

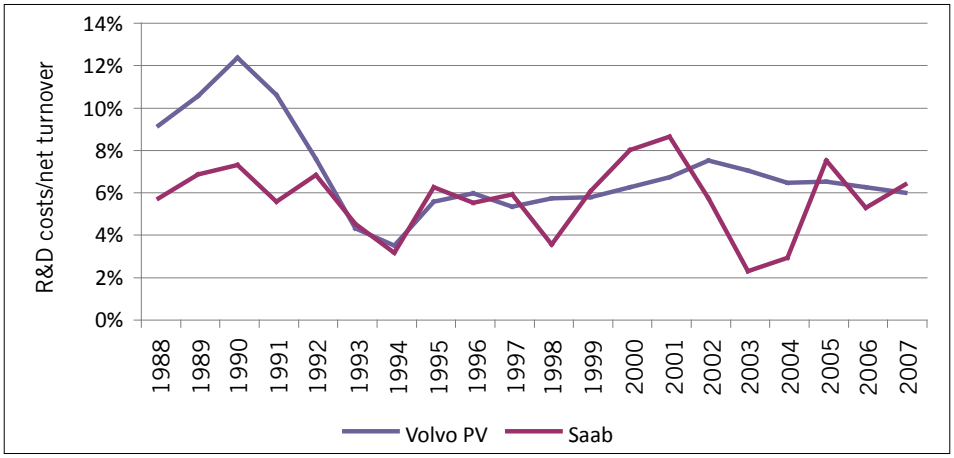
Figure 6. R&D costs divided by net turnover for AB Volvo excluding passenger car operation and Scania. Source: company annual accounts reports.



5 Here defined as Swedish Standard Industrial Classification code 34, Motor Vehicle And Trailer Industry.

R&D needs seem much higher on the passenger car side, approx. 5-6%, see figure 7. The vehicle manufacturers are increasingly expecting their subcontractors to be able to take on product development and innovation; something which many small Swedish subcontractors cannot manage. Many of them have no R&D tradition and thus a weak absorption capability, in addition to which most of them have such tight financial margins that they do not have the funds and resources to consider the long term.

Figure 7. R&D costs divided by net turnover for Volvo PV and Saab.[6] Source: Information from Saab and annual reports for AB Volvo 1998, Volvo PV Holding and Ford VHC.



In practice, *ffp* was new in several respects. Essentially, the constituents were as follows:

- an economic framework for the government contributions which was not staggeringly huge – during the period in question, *ffp* was around SEK 30 million per year in government contributions,
- a special agreement between the automotive industry and the government to implement the programme for the purposes of creating a skills and recruitment base at the highest international level and research results beneficial to the activities of the contractual parties,
- a dedicated organisation under the government but outside of the normal agency organisation, and a preparation procedure which was new and transferred the traditional power of the agencies or research community to determine the direction of research to the contributing industrial companies.

Furthermore, *ffp* was something new inasmuch as it was an early example of a Triple helix collaboration between the government, industry and the research system. Broad involvement from a number of agencies made it possible to monitor several public inter-

6 Volvo Cars' information up to and including 1998 relates to net turnover and R&D costs for the passenger car section of AB Volvo. Information from and including 1999 is for Volvo PV Holding.

ests simultaneously. Through the preparation process, research was steered towards the short and medium-term needs of companies and the university research made an active contribution and was developed in purely scientific terms whilst being adapted to the needs of society and industry.

Thus, the whole idea of the programme (the programme theory, as we perceived it, appears in figure 8) was to contribute to better and more competitive products and more

Figure 8. Programme theory for ffp

Element of programme logic	***ffp's* programme logic (- theory)**	**Fundamental assumption, conditions for impacts at next stage**
Problem and overall goal of *ffp*	**Problem**: Efficiency, safety and environmental problems within the road transport system Lack of research-trained personnel in the automotive industry Risk of falling behind in product development Risk of losing attractiveness in regard to localisation of development and manufacture **Goal**: Generate expertise and recruitment base, generate research results to benefit the industry and society	Correct analysis of "threat scenario" and national opportunities.
Content of *ffp* initiative corresponding to the problem	Financial framework Prior allocation of budget to industrial partners Organisation (*PFF* board, working group, offices etc.) Procedure for initiating and financing of projects etc. Project portfolio (company-controlled university projects with large number of doctoral students)	Efficient procedures, correct staffing in the organisation, appropriate subsidy terms.
Result/output from the programme	Academic publications Industrially useful technical results Research-trained (lic. and PhD) with relevant focus on automotive technology	Trust between the parties, strategically orientated corporate management, other complementary R&D programmes and sources of funding
Impacts of first arrangement (in short/medium term)	New R&D projects in the industry Increased expertise/more research-trained people in the industry New collaborative relationships (within and between the industry, agencies, academia) Product improvements	Successful R&D projects in the industry, strategically orientated university management, other incentives and instruments from the government side
Impacts of second arrangement (in longer term)	New products Increased absorption capacity Strong competitive position within international corporations Structural adaptations in the research system	Transport, environment, growth politics etc. which promote development of the automotive industry

competitive and robust companies. This was to be achieved through the method of generating and controlling projects at university which would lead to industry-relevant and useful results, beneficial collaborative relationships with interesting research milieus of the companies and research-trained people specialising in automotive technology who could be employed in companies or go on to research at universities and institutes on issues of importance for companies. This in turn would lead to new R&D projects within the industry and, in collaboration with universities and institutes, a raised level of expertise in companies and an increased capacity to take on board research results. Strictly speaking, it ought also to lead to a number of structural adaptations in the research system.

It should be noted that the whole *ffp* initiative came about as a result of needs and problems within the automotive industry and that the programme theory outlined was also focused on the situation of the automotive industry. At the same time, the programme was also prepared in such a way as to have significant impact on the most closely involved agencies and the research system, even if these were not the primary intentions. With the aid of this study and the knowledge otherwise available today, it should be entirely possible to draw up programme theories concentrating on either the agencies or academia.

Accordingly, this study aims to recognise impact of *ffp* not only for the industry but also for the research system and society. In the light of this, the types of impact sought in this study – ones which, by and large, we have been able to substantiate with more or less certainty – affect the following:

For **the automotive industry**, impacts on:

- R&D direction (in collaboration with the four vehicle manufacturers and the subcontractors),
- strategy (for R&D and for briefing the operation at large in an international perspective),
- personnel/skills supply (industrial doctoral students, licentiates, PhDs),
- working method within R&D (more scientific, more international collaboration, better capacity for participating in the EU's framework programmes),
- forms of collaboration and relationships (within and between companies including subcontractors, with academia and the agencies),
- performance/output (products, investments, jobs, deals),
- competitive position (within the foreign-owned groups – on the whole, foreign ownership changed/increased very greatly during the period in question).

For **the research system,** especially academic research, changes in:

- infrastructure (new research groups, faculties, centres, networks),
- personnel (new type of more "employable" doctoral student and researcher),
- working method (more applied projects, increased international information),
- collaborative relationships, within academia, with the automotive industry and with others,
- performance/output in quantitative and qualitative terms (publications, degrees, patents, spin-offs).

For **the agencies** (*Nutek* and *KFB* – and now VINNOVA, the Swedish Road Administration, Swedish environmental protection agency, and Swedish energy agency), impacts on such things as:

- strategy and working method in individual operations in environment, energy, traffic safety, industrial and innovation policy (better knowledge and adaptation to circumstances in the industry),
- collaborative relations between and with the industry (from opponents to development partners),
- influence on traffic safety (Swedish Road administration),
- influence on the environment (Swedish Environmental Protection Agency).

Naturally, changes in these respects have also had other causes than *ffp*, such as:

- the generally much greater government research initiatives relevant to the automotive industry, already under way before and during *ffp* 1 and 2,
- the situation in companies and groups in regard to a shift in competition and strategy etc.,
- events at the time, in the form of a deep economic crisis and impending EU membership,
- ongoing changes in the university sector.

With *ffp*, the government chose what was in part a new route for research funding. The ends and means largely resembled other needs-driven initiatives, but the design involving a dedicated programme board was unique. Through *PFF*, an arena was created in which the companies and agencies both drew deeper benefit from collaboration than previously, since important priority decisions would be taken by companies at the same time as being accepted by the agencies. Where it concerned academia, a new source of funding and new funding opportunities were opened up which required a certain adaptation to ways of working etc. When the programme was launched, it was in principle

an open issue as to how it would work in practice; whether it would influence the direction of decisions and whether it would influence the relationship between the parties over time.

This impact study has been limited to activities during the first two periods of the Vehicle Research Programme, 1994-2001 (ffp 1 and 2) and the projects supported at the time. The main reason is that enough time has now passed for impact in various quarters to be visible. As stated, partly during the same period other initiatives were taken which were directed at the automotive industry. Still, we have, as far as possible, attempted to isolate the impact of *ffp* 1 and 2. In practice, a number of these other initiatives were facilitated by *ffp* 1 and 2 and can thus be called impacts of that initiative. They in turn have gained, and may be expected to gain, a number of important types of impact which have been studied in other evaluations.[7]

7 An example is the evaluation of *ffp* 3 and 4 and the Green Vehicle National University Programme we carried out on the instructions of *PFF*: S. Faugert, E. Arnold, M.-L. Eriksson, T. Jansson, H. Segerpalm, I. Thoresson-Hallgren and T. Åström, "Collaboration for sustainable competitiveness – An evaluation of the Vehicle Research Programme and Green Vehicle National University Programme", Program Board for Automotive Research, April 2007.

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VINNOVA´s mission is to promote sustainable growth
by funding needs-driven research
and developing effective innovation systems

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