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Implicit and explicit notions of valorization in genomics research

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ABSTRACT *Valorization of knowledge has been defined as a major challenge in the context of genomics as an emerging strategic research field. Valorization is a Dutch science policy concept for what is elsewhere called science impact or the third mission of universities. This article describes the institutionalization of valorization policy in the Dutch genomics research system as a specific manifestation of a changing social contract between science and society, which mainly targets economic value creation and the stimulation of entrepreneurship. A societal debate has emerged in which this focus on economic aspects has been strongly criticized as one-sided. In response, policy makers are willing to adopt a broader definition of valorization. On the basis of an analysis of valorization policies and practices in Dutch medical genomics, this article draws attention to two myths in this valorization debate.*

KEY WORDS valorization, genomics, policymaking

Introduction

With the rise of genomics, biomedical research is developing towards large-scale consortia, characterized by multidisciplinary collaboration, use of high throughput technologies, strategic public investments and public-private relationships (Martin 2001, Hopkins 2009). This may be put in contrast to the practice of clinical genetics, where genetic laboratory research and diagnosis are closely linked with clinical patient care and counselling in regional clinical genetics centres that developed in the 1980's (Stemerding 1993, Nelis 1998, Hopkins 2006). The rise of genomics then involves a shift from local, bottom-up modes of innovation driven by clinical problems, to global, more top-down and data-driven modes of innovation guided by general promises of scientific and societal progress.

In this context, valorization of knowledge has become a new challenge. In Dutch innovation policymaking 'valorization' was introduced as a concept at the end of the 1990's. It has been defined as the process to create value from knowledge by making it available for economic and/or societal use and by translating it into competitive products, services, processes and new business (IPKI 2009). In the context of the EU Lisbon and Stockholm Summits in 2000 and 2001, policies of valorization have been increasingly institutionalized in the Dutch innovation system, especially in promising strategic sciences like genomics (Van Lente 2006). The Netherlands Genomics Initiative has designated valorization as an important justification for funding national genomics centres, based on public-private partnerships, and firmly aims to realize economic and societal benefits from their research (NGI 2002, NGI 2007). These efforts suit the ambition of the Dutch government to play a prominent role in the European knowledge and innovation agenda (Wijffels 2001).

Although valorization is a typical Dutch concept, it refers to similar and familiar notions in the international innovation discourse, as science impact, knowledge transfer or the third mission of universities. These notions represent a broad shift in national innovation systems since the 1970s, which has been described as a changing 'social contract' between science and society (Hessels et al. 2009, Hessels 2010). In the academic literature, this changing contract has been analysed in different terms, including the 'new production of knowledge' (Gibbons *et al.* 1994), 'academic capitalism' (Slaughter & Leslie 1997), the 'triple helix model' (Etzkowitz & Leydesdorff 2000), and the 'entrepreneurial university' (Etzkowitz 2003). Most characteristic for this change is an increase of academic researchers' orientation towards the production of 'relevant' knowledge, supporting the solution of societal problems, innovation and economic growth in interaction with government and industry (Hessels 2010).

The growing emphasis in science policymaking on the instrumental and commercial value of scientific research has caused concern among scientists, the public and policymakers, about the potential compromising impact of this development on the independence and broader public value of science (Stengel *et al.* 2009). This concern has been voiced also about the move to valorization in Dutch innovation policy (de Jonge & Louwaars 2009). A group of young Dutch scholars, organized in the Young Academy (a branch of the Royal Netherlands Academy of Arts and Sciences), persistently criticized this move in newspaper articles and web columns, arguing that the emphasis on instrumental values denies other values of science, like truth finding, contributing to the quality of life, and giving voice to underrepresented perspectives (Robeyns 2010). Moreover, in the context of this valorization debate, indicators are being developed, in national as well as international projects, which should allow for a more inclusive measurement of societal relevance (Maassen van den Brink *et al.* 2010, Spaapen *et al.* 2010). While these indicators were initially meant to apply valorization targets to the social sciences and humanities, they are now also referred to in the debate as a way to complement economic valorization with societal valorization in the natural sciences, thus conforming with the criticism of the Young Academy.

Research question and structure of our argument

In this article, we will focus on developments in the field of medical genomics in the Netherlands to explore more in detail the ‘struggle for relevance’ which characterizes the general dynamics in current systems of innovation (Hessels 2010). The establishment of the Netherlands Genomics initiative in 2002 is an interesting case for the study of this struggle for relevance, because it was the first time in the Netherlands that policies of valorization were explicitly leading in a national science funding program. Starting from a simple model of the innovation system, we will describe policies and practices of valorization in Dutch medical genomics on two different levels: the system level of the social contract between science and society on the one hand, and the level of scientific practice in medical genomics research on the other. The question that we want to address in this article is how policies of valorization on the system level have affected practices of research in medical genomics.

As a first step in our analysis, we present a short history of valorization showing what the changing social contract entails for Dutch research and innovation policy in general. We then turn to the national strategy for genomics and the explicit and implicit notions of valorization which have informed this strategy. In a third step we will contrast these policies of valorization on the system level of the Netherlands Genomics Initiative with visions from scientists struggling for relevance in the practice of medical genomics research. In conclusion we will, on the basis of our observations, critically assess as ‘myths’ two persistent claims in the Dutch valorization debate. One claim is that in recent policies of valorization indeed attempts are made to promote broader conceptions of value in science. We will argue that, on the institutional level of the innovation system, valorization policies continue to be predominantly based on economic indicators. The second claim is that this one-sided focus on instrumental and commercial values compromises other values of scientific research. We will argue that, on the level of scientific practice in medical genomics, researchers search for relevance in many directions, despite increasing pressures to economically valorize scientific knowledge.

Our research data and methodology

Our analysis of ways in which policies of valorization have affected practices of research in medical genomics builds on earlier work in which we used the notion of ‘research regimes’ to compare two fields of genetic research, one focusing on Duchenne Muscular Dystrophy and the other on Alzheimer’s disease. Research ‘regimes’ we described in terms of five dimensions: scientific collaborations; relations with the clinic; relations with industry; relations with public policy; and coordination rules. Using data from large collections of scientific papers, we showed that the fields of Duchenne and Alzheimer research are guided by clearly different research regimes (Nahuis & Stemerding 2013). In the present article we focus our analysis more specifically on experiences with valorization in these different fields and in the broader context of Dutch valorization pollicymaking. Our study includes experiences from the fields of Duchenne and Alzheimer as well as from depression and arthritis, fields which are all prominent in the research program of the Centre for Medical Systems Biology, a major Dutch genomics centre in the field of health.

Our analysis of valorization policies in Dutch genomics is based on key policy documents and in-depth interviews with five high-profile actors involved in genomics policymaking. Interviewees held strategic positions in an interdepartmental task-setting group, a national executive body for genomics policy, an external evaluation consultancy group, and one of the national genomics centres. They were selected according to their capacity to oversee main events and developments in the changing genomics landscape. The interviews took an average of 1,5 hour, were tape-recorded and transcribed. The interview data were used to select the most relevant policy documents and to understand the impacts of documents and policies and the dynamics of policymaking and execution. In addition we had in-depth interviews with five leading Dutch researchers in different genomics fields and a valorisation manager from a university. In these interviews we extensively discussed experiences with valorization in the practice of medical genomics research. We finally also organized a half-day workshop on *valorization in medical genomics research,* to discuss the findings and conclusions from our study with genomics researchers, policymakers and scholars from the field of science and innovation studies (Utrecht, 15 June 2011).

A new social contract

The move to valorization in Dutch innovation policy we have considered in the introduction as an expression of a new social contract between science and society. In order to explain this notion of social contract we have presented in figure 1 a simple model of the innovation system derived from Callon's concept of techno-economic networks (Callon 1991, Callon *et al.* 1992, see also Nahuis & Stemerding 2013).

Figure 1 about here

According to Callon's concept, *innovation networks* are organized around different poles, whereby each pole is characterized by the kind of goods that actors in different network positions produce and exchange. In figure 1 we have represented the innovation system in the bio-medical field as a network between four poles of activity that are well-established in our society:

- *Science:* research contributing to the knowledge base of (bio-medical) scientific fields
- *Industry:* R&D oriented at commercial (bio-medical) applications
- *Clinic:* activities of clinicians, patients, patient groups and reimbursement agencies oriented at prevention, diagnosis, prognosis and therapy

- *Public policy*: regulatory and funding activities of actors professionally involved with the governance of (bio-medical) innovation

In Callon's concept of innovation networks *poles* are conceived as networks themselves with their own history and forms of institutionalization. In other words, poles are 'punctuated' networks with a relatively strong coherence, irreversibility and autonomy (Callon 1991). Each pole is characterized by its own activities and co-ordination mechanisms, such as scientific norms, technical standards, or clinical guidelines. In an innovation network, knowledge and products are exchanged between different poles.

For our own analysis it is important to note that the relations in which knowledge and products are exchanged, are shaped in different ways and on different levels. Exchange between the poles of an innovation network will take place on the level of research practices through flows of information and materials and through forms of interaction between scientists, clinicians, firms and policymakers. But this exchange may also be facilitated through 'contractual' relationships on the level of the innovation system, in the form of measures, arrangements and institutions which support particular forms of exchange and collaboration. Callon refers to these institutionalized relationships between poles as 'intermediary poles' (Callon *et al.* 1992). An example are clinical genetic centers which in the Netherlands have been established as a link between research and patient care on the level of the biomedical innovation system. Another example is the establishment, from the 1980's, of technology transfer offices at universities as a liaison between academic research and industry (Zomer 2011, Miller *et al.* 2009).

As the notion of a 'changing contract' between science and society suggests, we may see the innovation system as an evolving system in which new intermediary configurations are developing between the different poles. A general feature of this changing contract is a shift to more intertwined relationships between academic research and commercial development, a shift which also has been observed in sectors like biotechnology and genomics (Coriat *et al.* 2003, Hopkins *et al.* 2007, Cambrosio *et al.* 2009, Cooke 2009). This shift has been deliberately shaped through interventions in the innovation system from the public policy pole, stimulating the societal relevance of academic research and moves to commercialization, and thus aspiring to accelerate processes of innovation (Stengel *et al.* 2009). A new contract has emerged in which "the assumption that scientific knowledge is beneficial in its own right attracts lip service rather than funding, and [in which] there is little willingness to wait for the utility of knowledge to reveal itself over time" (Atkinson-Grosjean & Douglas 2010, p.311). In this context, valorization has been introduced in Dutch policymaking as a new mode of governance which both expresses and further shapes the changing contract between science and society.

A short history of valorization

In Dutch policymaking moves to a new social contract between science and society became visible from the 1970's (de Jong 2010, Zomer 2011). One of the first initiatives to increase the orientation of the science system towards the production of 'relevant' knowledge was the creation of 'sector councils' involving societal stakeholders in Dutch science policymaking (Van der Meulen & Rip 2001). The publication in 1979 of a white paper on innovation by the Ministry of Economic Affairs marked the start of Dutch innovation policies whereby, from the 1980's, several instruments were introduced which should promote the transfer of knowledge between science and industry and public-private cooperation (MEZ 1979). In the annual Science Budgets of the national government an increasing orientation to innovation became apparent in the way in which scientific research was explicitly defined as key for the economic development, international competitiveness and quality of Dutch society (MOCW 1985 and 1987). In the 1990's the Dutch government started to use the huge natural gas incomes of the state for substantial investments in strategic science funding programs which should encourage public research institutions to engage in relationships with private companies and the commercialization of research. In the past fifteen years, over one billion euros has been invested through this funding in university-industry research consortia (Zomer 2011).

At the end of the 1990's 'valorization' began to emerge in the Dutch innovation policy discourse as a notion which referred to the translation of results of scientific research into economic value and which was seen as especially significant in the context of the European Lisbon 2000 agenda for a knowledge economy (de Jong 2010). Important for the promotion of a valorization policy was the establishment of the Innovation Platform in 2003, which brought together representatives from the government, the business sectors and academia (www.innovatieplatform.nl). Its mission was to strengthen the innovation potential of the Netherlands with the aim to become a frontrunner in the international knowledge economy. Moreover, in 2005, the Ministry of Education, Culture and Science officially announced valorization as a third mission for the universities (MOCW 2005). Thus, the funding of universities was increasingly framed, both in the Netherlands and internationally, as support for a ‘healthy national research system’. In this perspective, “support for university researchers is accompanied with the expectation that they actively interact with other actors in the innovation system, and contribute to the process of ‘valorization’ by writing patents or by founding spin-off companies” (Hessels, 2010, p.77).

However, as we have seen in the introduction, the aim of valorization has become a controversial issue in the Netherlands, which also becomes evident in a gradual shift in the policy debate about valorization. Indeed, as the Ministry pointed out in the letter announcing valorization as a third mission for the universities, valorization should not be conceived only in terms of economic value, even though it had been explicitly introduced that way in earlier policy documents. In accordance with this vision, the Innovation Platform broadly defined valorization as the translation of knowledge into *economic* and *societal* value. In 2009 the platform published a Dutch Valorization Agenda in which it explicitly stated to have decided upon a broad definition a valorization as “the process of value creation from knowledge by making it suitable and/or valuable for economic and/or social use”. Yet, in spite of the intentions implied in these definitions, there remained in the implementation of the valorization agenda a strong focus on issues of commercialization and entrepreneurship, as we will now see from our analysis of the Dutch genomics field.

A national strategy for genomics

From early 2000 genomics has been stimulated by the Dutch government through a series of initiatives with the aim to establish a leading position in the field (Van Lente 2006, the following account is from Nahuis & Stemerding 2013). At that time, scientists, industry representatives and policymakers began to promote genomics in the Netherlands as an exciting new and promising field which needed special support from the government (interview former science policymaker from the government). In response to these promotional activities, the Dutch government established, in November 2000, the *Temporary Advisory Committee Knowledge Infrastructure Genomics* (the Wijffels Committee). The committee had the task to advise the Minister of Education, Culture and Science about the way in which the knowledge infrastructure in the field of genomics might be strengthened.

In its advice, the committee made clear that genomics unmistakably was one of the new scientific ‘frontiers’ with strategic relevance for Dutch society (Wijffels 2001). Accordingly, a *national* *strategy for genomics* was proposed which should cover the complete innovation chain from fundamental research to product development, including the protection of intellectual property and measures which should stimulate the commercial exploitation of knowledge. In this way, according to the committee, additional investments in genomics could indeed benefit society as fast as possible. The proposed national strategy strongly emphasized the need for new forms of institutionalization of genomics, concentrating research activities in a few centres of excellence, which should be able to connect to current economic strengths and to important international developments in the field. Special incentives for the valorization of research were also needed according to the committee in order to advance the flow of knowledge from science to practical application. Active involvement in public-private collaboration and active support of knowledge protection and transfer were seen as crucial in this respect.

In line with the advice of the Wijffels committee, a *Netherlands Genomics Initiative* (NGI) was founded in 2002, which involved the establishment of several centres of excellence under the umbrella of a National Directorate Genomics and which was supported on a five-year basis by significant additional funding from the natural gas incomes of the state. According to its mission statement, the NGI should “develop a world class knowledge infrastructure within five years, which is firmly embedded in society and in which pioneering and innovative research can be performed with a view to yielding a continuous influx of new commercial applications” (NGI 2002, p.2). To achieve that aim, the NGI developed, in the first five years of its existence, a policy in which valorization managers were made responsible for facilitating the commercialization of results in each centre, thus also creating a change of mind-set among its researchers towards valorization of research (interview director NGI).

Although NGI’s role generally was perceived as successful in this respect, it was also concluded, at the start of its next five-year period, that for the realization of a truly optimal valorization infrastructure, a significant further effort would be required (NGI 2007). For the next period a significant amount of funding was reserved for valorization activities and all NGI genomics centres explicitly had to include valorization targets in their business plans (interview chief valorization manager NGI). Moreover, as part of the current NGI valorization policy, valorization targets are clearly set in terms of quantifiable output indicators, including numbers of invention disclosures, patents, licenses, spin-off companies, and industrial collaborations (NGI 2007). Strengthening technology transfer offices in the field of the life sciences and a start-up support program, offering coaching, financing and networking to young entrepreneurial scientists, are two other core focus areas in the current NGI valorization strategy (NGI 2008).

Contested notions of valorization in genomics policymaking

The way in which genomics has been institutionalized in the Netherlands clearly reflects the changing contract between science and society which we have described as a more general development on the level of the innovation system. In this context, valorization has been introduced as a mode of governance which strongly promotes entrepreneurial activities of value creation. As the history of the Netherlands Genomics Initiative makes clear however, valorization policies also reflected an ongoing struggle for relevance in which parties involved in genomics policymaking took different positions towards the aims of valorization. As explained by a former science policymaker from the Ministry of Education, Culture and Science, different ministries had different stakes in the negotiations which led to the establishment of NGI:

> we were promoting the value of science-driven research, while the Ministry of Health emphasized the needs of the clinic and the Ministry of Economic Affairs wanted to boost commercial activities (interview)

In his view, the creation of NGI was an 'addition sum' of various interests, whereby the notion of valorization primarily served as a 'binding agent' in forging coalitions between different ministries. Another interpretation of what happened was provided by an observer of the field who was involved in an evaluation of NGI policymaking:

> valorization has become dominant as a result of the colonization of genomics by the Ministry of Economic Affairs (…) the Ministry of Health was on the side of translational research, but stood isolated (interview science policy consultant)

The struggle for relevance which preceded the foundation of NGI also left its marks in the first strategic plan for the Initiative (2002-2006). In accordance with NGI's mission statement to yield a "continuous influx of new commercial applications", an ambitious *valorization plan* had to be drawn up to support the registration and licensing of intellectual property and the establishment of business start-ups. On the other hand, according to the strategic plan, *translational research* should also be supported. Translational research was described as research which did "not entail any form of commercialization or new business development activities", but pertained to the development of "promising clinical or health care applications" (NGI 2002, p.7). In a similar vein, two 'aspects' of valorization were distinguished in one of the annual reports of the Centre for Medical Systems Biology, the major NGI genomics center in the field of health. In this report, valorization was defined both in terms of *societal value*, created by contributions to improved clinical practice, and *economic value*, created by collaborations with business partners (CMSB 2004).

Thus we see that, in addition to economic values, other values and meanings have been assigned to valorization in genomics policymaking, especially in terms of 'translational research' as an activity which enables and improves diffusion of knowledge from basic science into the clinic (Martin *et al.* 2008, Wainwright *et al.* 2009). Indeed, in the Netherlands, these different routes for valorization have also been deliberately pursued on the level of the (biomedical) innovation system. Dutch policymaking in the field of biomedical research did not only seek to strengthen relationships between science and industry, but also forged more close relationships between science and the clinic by establishing Academic Medical Centers as an important 'intermediary pole' bringing together medical research and patient care under one roof (RGO 2007, see figure 2).

Figure 2 about here

As we have seen in the foregoing history, broader notions of valorization have likewise been adopted in the high-level strategic policy documents of the Dutch Innovation Platform. Yet, in its implementation as a new mode of governance, valorization remained to be predominantly targeted on the creation of economic value. An evaluation of valorization activities in the first five years of NGI concluded that "translational research did not get sufficient attention, even though it can be an important valorization route for health related genomics research" (Boekholt *et al.* 2007, p.7). In the earlier mentioned annual report of the Centre for Medical Systems Biology a structural lack of funding for translational research was identified as a "major stumbling block" (CMSB 2004, p.3). Moreover, in NGI policymaking, valorization has been first and foremost defined as 'value that can be measured', that is, in terms of quantifiable output indicators with a clear focus on commercial targets. As pointed out by one of the local valorization managers of NGI:

> our activities are mainly focused on intellectual property, collaborations with companies and licensing out of knowledge and technologies (interview)

In a recently published future vision for genomics policymaking in the Netherlands, the authors emphasize that a country which has the ambition to become or remain one of the top bioregions of the world “has to act aggressively in order to stay ahead of its competitors” (Wiedhaup *et al.* 2009, p.227). Thus, with the institutionalization of genomics as a new and promising strategic science, genomics researchers have more and more to face the pressure of policy initiatives to reform and shape links between different poles of the innovation system, in particular stimulating collaborations between science and industry. In this context, other observers of the field have noted with some concern that “preserving the culture of productive openness alongside the culture of market science is one of the big policy challenges in the years ahead” (Angrist & Cook Degan 2006, p.93). How then are genomics researchers dealing with these challenges in the practice of medical genomics research?

Notions of valorization in genomics research

The foregoing discussion brings us to the main question we want to address in this article, namely, the extent to which policies of valorization have indeed affected practices of research in medical genomics. In our previous study we already found clearly different orientations towards valorization in the context of two different research regimes in medical genomics (Nahuis & Stemerding 2013). We compared the dynamics of research in the field of Alzheimer’s disease with research focusing on Duchenne Muscular Dystrophy (DMD). Alzheimer is being studied in a typical genomics research setting, shaped by the junction between epidemiology and genetics as the basis for understanding of multifactorial disease. In this setting, research is shifting from candidate gene studies to genome wide association studies to whole genome sequencing, based on large population studies and the use of high throughput technologies. In the Alzheimer field today, genomics research is more and more driven by international scientific collaborations which exploit the power of aggregated data from different biobanks to address a variety of research questions. Developments in the field of Duchenne, on the other hand, have been shaped by a clinical genetics regime of translational research, focusing on the predictive diagnosis of monogenetic disease. The finding of a DMD gene in the mid-1980’s was followed by long-lasting research efforts aiming at the understanding of the pathological mechanism of Duchenne and the development of a therapy. This research has been driven by a strong and longstanding involvement of a patient organization, commercialization on the basis of patents, and more recently, the establishment of a spin-off company.

In comparing both fields, we see a striking contrast in terms of valorization. Genomics researchers in the Alzheimer field do not have strong links with clinical actors and there is no involvement from industry, despite the emphasis on economic valorization in NGI policymaking. In the Duchenne field researchers actively pursued the commercialization of knowledge, even though DMD research has largely been developed independent from the system-level pressures channelled through NGI's valorization policy. But it was only after long-lasting efforts, showing the therapeutic potential of their research, that scientists in the Duchenne field began to see the need and opportunities for commercial development as a way to realize this potential. In other words, *field specific conditions* were more important than general *system-level pressures* in explaining the willingness of researchers to valorize their research. This also becomes apparent from observations of a genomics researcher in the Alzheimer field, who compared her work to developments in Duchenne research:

> That was one of the fields in which it [economic valorization] was possible … but please mind that this has been a really long trajectory … we are talking about a disorder of which the gene has been known for thirty years. It is fine to hold researchers accountable for their valorization. It is crazy to think that that is possible within five years (interview)

Another researcher working in the Alzheimer field made a similar comment:

> If you see valorization as taking a patent and then starting a spin-off, it just can be a long way away (interview)

This is not to say, however, that researchers in the Alzheimer field do not perceive other and more immediate opportunities in the struggle for relevance. The first researcher quoted above thus added to her observations:

> I am not such a patent-minded person. But, what I could imagine indeed are future possibilities for translation. For me this has two aspects. Real opportunities for translation I see as very important and this is what we have always been supporting. So, if there are possibilities for clinical useful predictive tests, we should do it right away. On the other hand, I also find it important to explain to the public what cannot be done … the nonsense of (commercial) predictive testing … this is what we also have been doing (interview)

Obviously, in their work, researchers search for relevance in various directions and what they try to achieve crucially depends on (changing) opportunities and conditions in their particular field of research. This also became evident from interviews with scientists working in two other fields of medical genomics: *depression* and *arthritis*. In the table below we have listed quotes taken from interviews with researchers in both fields, again clearly showing different orientations towards valorization.

Table 1 about here

One of the researchers involved in depression research emphasized that she was mainly driven in her work by a search for a deeper understanding of genetic susceptibility for this disease. She also explained that depression seemed to be one of the hardest cases to understand, implying that it is just too early to expect valorization from this research in terms of clinical applications. Nonetheless, patients and their families are clearly interested in the findings from this research because it tells them that they need not be personally blamed for suffering from a psychiatric condition. Thus, participants in this research, from a large registry of twins, are regularly informed about new results through an annual newsletter produced by the researchers involved.

A researcher from the arthritis field, on the other hand, described valorization as a real and exciting opportunity. His work suggested a clear relationship between the expression of a particular gene product and the development of the disease. On the basis of research results and ensuing patent applications, he was now considering possibilities for the establishment of a spin-off company. Such steps towards commercialization were vital in his view for the development, through a well-designed trajectory of translational research, of a clinically useful and marketable product. Moreover, results from this research are also being directly communicated on a regular basis to patients involved in a cohort study run by the rheumatology hospital department.

Again we see that field specific conditions are more important in shaping researchers' attempts at valorization in medical genomics than general system-level pressures. A most striking observation from the fields of depression and arthritis research, is perhaps that researchers in neither of these fields appeared to be very much aware of measures or pressures originating from policies of valorization on the level of NGI's Centre for Medical Systems Biology supporting their research.

Occasional enquiries from the Centre's management about activities and results of valorization were felt by the researchers neither as incentives nor as a charge to which they should respond. This was also pointed out indeed by a researcher from the Alzheimer field:

> If you can tick-box indicators for valorization, it might add to our score-list. But will that make any difference for what we are doing in our research? I think, I am sceptical about that (interview).

Conclusion and discussion: two valorization myths

In this article we have analyzed at two different levels the nature and impact of Dutch policies of valorization in the field of medical genomics. We have shown how, on the system level of genomics policymaking, valorization has been introduced in economic terms and as such was contrasted, in the first NGI's strategic plan, with translational research as more closely linked with clinical patient care. In subsequent years, a shift occurred to more broadly defined notions of valorization which were also adopted in some high-level science and innovation policy documents. On the level of implementation in NGI's valorization strategy, however, valorization targets have been defined in terms of measurable indicators which clearly emphasize the economic output of research. Policies of valorization which claim to promote more than just economic value, thus serve a myth rather than a reality and it need not surprise us that in the Netherlands valorization has remained a contested concept.

On the other hand, claims by critics of Dutch valorization policies (like the members of the Young Academy) suggesting that broader values of science are compromised by the pursuit of economic valorization, may be questioned as another myth in this valorization debate. On the second level of our analysis, focusing on various genomics (and clinical genetics) research practices, a more complex picture does emerge. Researchers search for relevance in more than one direction and will only seize upon incentives for economic valorization if they see opportunities to do so in their particular field of research. Even then, researchers will continue to engage themselves with other activities of 'valorization' as well, including for example direct forms of communication and interaction with patient communities (see table 1). In this respect, our research confirms the findings of Atkinson-Grosjean and Douglas, who studied an international network of genomics scientists and categorized their research activities in terms of clinical, commercial and so-called civic utility. The last category refers to the involvement of scientists in science-policy discussions, or their engagement with patient communities and larger publics about the relevance of their research. From their analysis it appears that especially senior scientists are often committed in diverse ways to activities comprising all three kinds of utility (Atkinson Grosjean & Douglas 2010).

Valorization on the level of research practices obviously includes a greater variety of activities than is acknowledged in policies dedicated to economic valorization (Molas-Gallart & Castro-Martinez 2007). What are the implications of this conclusion for policymaking in this field? On the one hand, policies of valorization can be understood as a specific stimulus for activities which translate science into economic value and which for a long time have been mostly neglected by academic researchers in universities. Stimulating such activities may indeed help researchers to actively explore ways in which knowledge can be commercialized and translated into marketable products and services; however, in order to avoid ambiguity and conflict, implementation of economic valorization in terms of specific and measurable indicators should take into account important, time- and context-dependent ways in which (medical) research fields may differ in opportunities for the commercialization of knowledge. If the government sees valorization mainly as an instrument for economic policy, then these indicators should indeed only apply to research fields that have something to commercially valorize. On the other hand, if valorization targets are being applied to (genomics) research in general, a more than symbolic implementation of such policies can only be expected if these targets take into account the larger variety of activities that may contribute to societal valorization in a broad sense and that currently too often remain hidden in policies of valorization.

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Figure 1

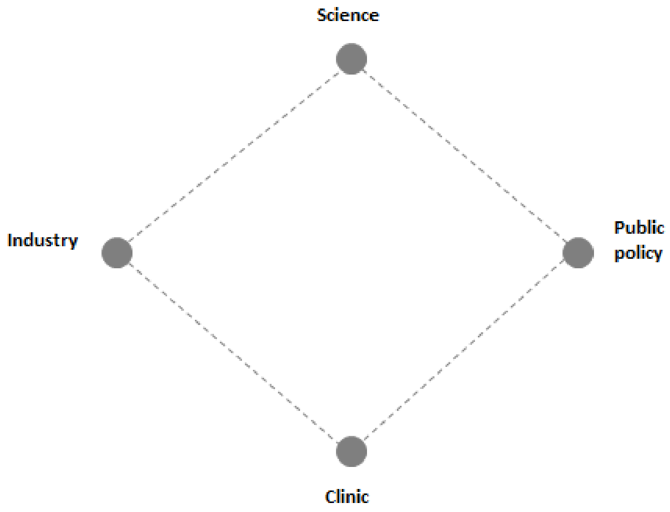

Figure 2

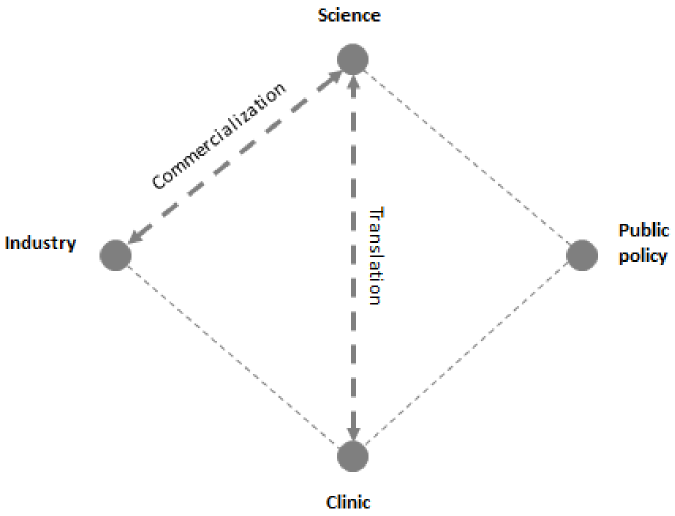
Science
Commercialization
Translation
Industry
Public policy
Clinic

Table 1

Interview data	
Depression researchers (N=2)	**Arthritis researcher (N=1)**
• In terms of NGI's definition, there hasn't been much that we can valorize … we are just not that far in the field • But we are quite active in letting our results trickle down to the subjects from whom we acquire all our data • The mere findings of our research … are indeed very liberating for all the subjects involved • It seems to me very important to recognize that valorization is more than just the economic aspect • Questions about valorisation are regularly passing by, but do not really weigh upon me	• mRNA profiling seems to be an excellent option for preventive health care … we have applied for a patent on this • We try to find out if we can develop this into a spin-off from the university • But … a long trajectory to go in order to validate this result and to have it convincingly introduced in the clinic • We have regular evenings to inform patients about the results • [is valorization a must?] Not really, I am not very much in touch with the whole CMSB business

Figure 1: Simple model of the (biomedical) innovation system

Figure 2: Major valorization routes in the Dutch system of (biomedical) innovation

Table 1: Views about valorization in depression and arthritis genomics research