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New activities of universities in transfer and extension: multiple requirements and manifold solutions

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The third mission encompasses all activities of universities beyond their first and second missions, education and research. An analysis of various countries with different economic, political and geographic features reveals an increased demand for such activities in particular with regard to technology transfer, but also as to the support of the civil society in more general terms. Therefore the universities have to find a new balance between education, research and transfer/extension. However, suitable solutions are often complicated by the orientation of the universities and the policy actors on non-scrutinized paradigms originating in other contexts. The strategies in different countries are embedded in their specific context, making it impossible to determine a best practice. Nonetheless, many interesting approaches can be observed, and mutual learning can be fruitful.

ECONOMIC DEVELOPMENT in the last decade is characterized by increasing globalization and the growing relevance of knowledge-intensive products and services. The term 'globalization' addresses the growing foreign trade and direct investment between and within industrialized countries, on the one hand and, concurrently, the rise of trade with and investment in developing and newly industrializing countries on the other hand. After a long period of stagnation, many of these countries exhibit a remarkable growth pattern and have achieved impacts on the worldwide patterns of innovation activities, reflected in indicators such as R&D expenditures, scientific publications, or patent applications.

The precursor to this development was South Korea with its path-breaking strategy, demonstrating that a developing country could effectively aim at an explicit engagement in R&D-intensive technology. Some countries have successfully followed this path, but today this policy is more difficult to realize, due to the fierce competition between developing and newly industrializing countries. Nevertheless, there is strong evidence that this tremendous growth will continue in the next decades, in particular based on an enormous investment by these countries in education, including higher education at universities. The main target of this effort is the provision of a highly skilled labor force, but the universities are also expected to play a key role in initiating and strengthening innovation in enterprises as well as supporting the development of society at large.

The relationship between higher education and society beyond the first (education) and second (research) missions of universities is generally understood as the 'third mission'. As we can see from the case studies in this issue of *Science and Public Policy*, the exact interpretation of what type of cooperative outreach functions should be included in the definition of the third mission varies considerably, as do the actually implemented policies; from Germany's heavy emphasis on knowledge and technology transfer from universities to enterprises, to the Latin American broader concept of extension of

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the university to serve community needs, for example, activities in support of regional and national policy, in urban planning, health services, legal advice or topics of environment or energy. These latter outreach functions, which may be called societal in contrast to the more overtly technological third mission of technology transfer to industry, are often more important in developing countries and transition economies, as the professional infrastructure for such types of activities is less elaborate than in more industrialized countries.

All in all, it is obvious that both the societal as well as the technological third mission are highly relevant for the dynamics of development. However, there is little consensus on how to perform third mission activities in an apposite way. The international debate on third mission is largely dominated by the paradigm of the United States, where spin-off enterprises from universities in biotechnology and information technology implied a real economic boom. A further US paradigm is the so-called Bayh–Dole Act, which aims at an improved economic use of university knowledge through increased university patenting (Abramson *et al*, 1997). Many countries introduced similar legislation to support university patents.[1] The question may be asked whether these models can be transferred to other countries, or indeed if they are relevant at all, in particular to developing and transition economies. Therefore a specific discourse on third mission is needed, taking the specific conditions of these countries into account.

In this special issue, case studies on third mission activities of universities in different countries are presented in order to give a broader overview of the framework conditions that shape third mission in different countries. It is reasonable to assume that the conception of the first and second mission, the attitude of public policy, or the structure and attitude of the manufacturing and service sectors have a major impact in this regard, and these factors heavily depend on the size and economic status of a country. In Table 1, we list some characteristics of the countries represented in this special issue ranked by GDP per capita.[2]

The overview shows that the sample comprises countries of quite different sizes and income levels. The additional data on human development, infant mortality and literacy illustrate that social welfare is generally, but not always, correlated to economic

Table 1. Some basic indicators for the UniDev countries, 2005

Country	GDP *per capita* (PPP$)	Population (million)	Size (tsd sq km)	Human Development Index	Infant mortality rate (‰)	Literacy rate (%)
Tanzania	744	38.3	945	0.47	98.5	62.2
Vietnam	3,071	83.1	331	0.73	25.9	86.9
Cuba	6,000	11.4	111	0.84	6.3	99.8
China	6,757	1,306.3	9,572	0.78	24.2	86.5
Brazil	8,402	186.4	8,547	0.80	29.6	88.8
Uruguay	9,962	3.5	176	0.85	11.9	98.4
Russia	10,845	143.4	17,075	0.80	15.4	99.2
South Africa	11,110	46.9	1,219	0.67	61.8	85.7
Latvia	13,646	2.3	65	0.86	9.6	99.7
Germany	29,461	82.5	357	0.94	4.2	99.0
Sweden	32,525	9.0	450	0.96	2.8	99.0
Denmark	33,973	5.4	43	0.95	4.6	99.0

Sources: 2007/2008 Human Development Index, UNDP and Albrecht *et al* (2007)

welfare. For reasons of simplicity, we group the countries in the three levels of low, medium and high GDP *per capita*, although we are aware that other elements are relevant as well. We include at the low level Tanzania and Vietnam, at the medium level Cuba to Latvia, and at the high level Germany to Denmark. The intention of this grouping is to elaborate typical patterns of third mission at different standards of development and to compare them with each other.

Third mission in countries at a low economic level

The common feature of the two countries described in this section — i.e. Tanzania and Vietnam — is the modest level of development of the industrial sector, implying a low average level of GDP *per capita*. In consequence, the financial resources of the government are limited as well.

An important consequence of this structure is the low level of innovation activities in industry and services and, therefore, appropriate partners for knowledge transfer from universities are often missing. The research of universities is generally oriented towards research-intensive, complex fields and for that the appropriate counterparts in the productive sector are missing. In classic innovation literature, this situation is labelled on the micro level by missing 'absorptive capacity' of firms (Cohen and Levinthal, 1990). In the case of the countries considered, this structure can be observed on the meso and macro levels as a general characteristic and may be called missing 'structural absorptive capacity' (Meyer-Krahmer and Schmoch, 1998: 849).

This means for technology transfer in these countries that only few technology-oriented interactions relate to more complex issues. In the papers on Tanzania and Vietnam, this situation is considered to be unfavorable; however, a closer look reveals various successful activities. For instance, the Can Tho University in Vietnam is very active in the dissemination of agricultural techniques appropriate for the needs of the farmers at the micro level and of the local communities at the meso level. A special feature of this university is a less explicit orientation to excellent science as in an ideal 'Humboldt university', but a clear reference to the local needs. Also the Hanoi Medical University with a stronger mission in scientific research provides a broad number of services to society, for instance, by supporting communities and hospitals, and its research on traditional medicine is closely related to the needs of the country.

In Tanzania, the support of small and medium-sized enterprises works well and in this context university people are considering a stronger orientation towards low technology to adapt to their needs in a better way. Furthermore, non-technical activities such as fostering cooperation between firms prove to be successful. The strong focus on (high-tech) technology transfer is primarily perceived as an unwarranted request from the policy side.

In Tanzania as well as in Vietnam, the classical university with a strong focus on teaching and basic research is still a strong paradigm, with the obvious difference that, given the scarce public resources, the support of higher education is a major issue in Vietnam. In Tanzania, dependence on foreign support is stronger and brings in a further element of instability. As foreign donors also favor the classic university, the options for alternative approaches are limited. In both countries, the successful transfer activities are generally positioned between societal and technological third mission. Dissemination of new methods to farmers, the support of hospitals, or the initiation of cooperation between firms are not uniquely technological, but have some technological elements.

Third mission in countries at a medium economic level

This section refers to South Africa, Brazil, China, Cuba, Uruguay, Russia, and Latvia. Compared to the countries in the above section, the economic sector is stronger and in consequence more public resources are available for higher education institutions. In these countries, the majority of enterprises work in the field of less complex products and services and the statement of a missing structural absorptive capacity applies as well. But the structural differences between the low and medium economic levels is reflected in a broader demand for highly qualified staff, thus the major request to universities is for the provision of graduates. In this context, the orientation of the first mission on practical needs of the economy proves to be a major issue, again an aspect where the classical Humboldtian university with its unspecific orientation of education is questionable.

A particular approach in South Africa in third mission is the establishment of specific centers for interaction with small and medium-sized enterprises. So the potential contradiction to the classical first and second missions is solved by a separate institutional setting. However, a closer linkage between this third mission and education is looked for, which may lead to a re-orientation of the first mission as addressed above.

In Brazil, the lock-in of the economic sector in old structures seems to be so strong that only radically new solutions are promising. Therefore the establishment of completely new enterprises seems to be the best solution. Although this does not happen in a US–American industrial environment, where for instance new biotechnology firms filled gaps of the established pharmaceutical industry, the Brazilian economy is obviously so strong that sufficient internal demand for the products and services of start-up enterprises exist.

In China, the industrial sector is usually not interested in innovation and the absorptive capacity of the enterprises for complex technology is low. The Chinese solution consists in the establishment of university-owned enterprises with a distinct technology orientation. This model works quite well, at least in some cases such as the Tsinghua University where economic activity is organized in a systematic way. In other cases, the orientation on the classic university model, which may be labelled as Humboldt university or ivory tower, is still strong and the third mission activities are less organized and less successful. All in all, the model of university-operated enterprises seems to be a good entry point for a more knowledge-oriented economy and the triggering of substantial economic growth. However, the article on China clearly states that this system refers to a transition period and that with more economic growth the research and development activities have to be accomplished by the self-contained enterprises themselves.

The example of Cuba represents a completely different approach. As the case study shows, the scarce public resources in university research were focused on synthetic vaccines which are linked to societal needs, on the one hand, and technological innovation, on the other hand. The research in this field can be characterized as complex frontier research with a high risk of failure. In this specific instance, the strategy proved to be highly successful and, in addition to addressing internal health issues at low cost, the emergence of economic activities building on this scientific and technological endeavor can be observed. For broader international success, it may be relevant to find an appropriate partner with technological and economic experiences in the world market, as pharmaceutical markets are extremely complex. It is an open issue whether this strategy is advisable for other developing countries; but the example shows that internationally competitive research can be performed in developing countries, as long as a clearly focused strategy exists.

The situation in Uruguay, Russia, Latvia, and also South Africa may be characterized as disruptive, as substantial changes of the political systems took place not so long ago and the countries still have to cope with the new situational demands. This type of instability can be observed in many developing and newly industrializing countries. In the perspective of universities, this situation can be interpreted as a chance to overcome accumulated path dependencies, lock-in structures and to implement new approaches. However, it must be noted that such processes consume a considerable amount of resources in discussing and implementing new structures.

In Uruguay, the disruption is related to the restoration of civilian rule in the 1980s and linked to the autonomy of the only, very large, university in the country. The discourse is still focused on the appropriate organization and content of the first and second missions. Although the need for third mission activities is clearly seen, substantial initiatives in this direction are not yet undertaken.

In Russia and Latvia, the dismantling of the Soviet Union is the major disruptive factor. In both countries, this is linked to a substantial change of the economic sector and the science system as well. In Russia, the new division of labor between universities, academies and state research institutes is not yet clarified. A further problem is old legal structures that hamper initiatives in technology transfer. This example illustrates that technology transfer cannot be successfully undertaken as an isolated activity, but is embedded in a broader environment of scientific, economic, political and legal structures. Although the potential of scientific institutions, in particular universities, in Russia is substantial, it is blocked by old framework conditions.

In Latvia, the transition towards the new regime is more advanced, although overcoming the former structures, such as the strict separation between universities as pure teaching institutions and the institutes of the Academy of Sciences or a heavy bureaucracy is still problematic. In particular, a closer interaction between universities and enterprises is politically desired, but still only beginning. As to other linkages to society, the collaboration with national authorities in regional planning and other fields, and activities for the popularization of sciences are relevant. Activities for the popularization of sciences primarily aim at attracting young people and have to be seen in the context of an increased lack of a highly skilled labor force for the local economy. This problem is reinforced by a substantial brain drain towards western Europe, a situation which also applies to Russia and all developing countries.

In the countries at a medium economic level, the situation of universities is more stable than in those at a low level, as more resources are available. With regard to third mission, the political rhetoric often claims a closer interaction between universities and society, but in the factual implementation rules, technology transfer towards industrial enterprises dominates. Nevertheless, various activities of societal third mission take place, but often are not ascribed to the third mission. For instance, the universities in Brazil play a relevant role in fields such as legal advice or medical services, and also in other countries such services are self-evident.

Third mission in countries at a high economic level

In the countries with a high economic level considered here — Denmark, Sweden, and Germany — third mission is considered as highly relevant by policy, and is introduced in the university laws as an additional new mission. However, this does not mean that the universities receive additional resources. Rather, it is assumed that third mission can generate external funding and even reduce the need for public money.

In technology third mission, a substantial gap between the culture of the universities and the enterprises can be observed that often hampers a closer interaction

In technology third mission, a substantial gap between the culture of the universities and the enterprises can be observed that often hampers a closer interaction. On the part of the universities, this is due to a strong orientation towards the Humboldtian ideal assuming a separate status of science from industry. The enterprises often deplore the difficult access to universities, but the insufficient absorptive capacity of many firms also plays a role. A relevant improvement of this situation can be achieved by a policy of the universities to actively address enterprises and to engage people in the enterprises as brokers, as shown by the example of the University of Aalborg in the Danish case.

As the possibility of generating external funding is more restricted in societal third mission than in technological third mission, one can hardly expect a relevant level of these third mission activities to be achieved. Moreover, the existing incentive structure in the academic system in effect penalizes attempts by academics to engage in societal third mission. As the careers of scientists are still exclusively based on their performance in the first and in particular in the second mission, young scientists are rarely active in third mission. As a consequence, societal third mission proves to be conducted by philanthropic elder scientists. Universities like to exhibit their societal engagement but, in practice, they are not willing to support these activities in a substantial way.

All in all, the expectations in technological third mission of universities are very highly determined by the US–American paradigm. A further debate on the specific instruments of third mission in the local context and the relation between first, second, and third missions is lacking. The Danish orientation to a regional embedding of the universities is a possible approach. However, a trend towards globalization of university–industry interaction can be observed.

Some salient features

It is quite clear from the articles in this issue that there is no universal or generic one-size-fits-all approach to how the third mission can best be performed, applicable to all countries or even to countries at the same level of economic activity and with similar social and cultural structures. Indeed, each country is unique in terms of institutional set-up and socio-economic context and, accordingly, unique in the prerequisites for addressing the third mission. For good or bad, the framework conditions determine opportunities for change and threats of lock-ins and barriers to change. In other words, a country's history matters greatly in the task of finding appropriate solutions to the role universities should play beyond teaching and research. Therefore, each solution is necessarily unique and negotiated within a national (or regional) context. Having stated this, we feel it is nevertheless possible to derive important knowledge from the experiences of the case country and to draw conclusions that are relevant for local as well as national policy-making.

As a general observation, the university as an independent scientific institution, oriented towards free basic research, is a major target in all countries at low, medium and high economic levels, at least in the perspective of academics. In terms of neo-institutionalist theory, this orientation may be labelled as cognitive institution, thus as a basic orientation which is taken for granted and whereof the legitimation is not called into question. This 'classic order of knowledge' (Spinner, 1994), according to the Humboldt ideal, is based on preconditions which Spinner (1994: 87ff.) calls 'the institutional decoupling of the science sector by four big separations':

- Separation of knowledge and property,
- Separation of ideas and interests,
- Separation of theory and practice, and
- Separation of science and government. (translation by the authors)

This institutional structure can be achieved only in countries with sufficient financial resources to be able to run the risk of investing money in basic research activities without any guarantee that the outcome will be of practical use. Even in countries with a high economic level these separations are being undermined little by little by decreasing institutional funding and increasing contract research on behalf of public authorities and private enterprises. The solution to this dilemma is not the establishment of the contrary situation with an integration of knowledge and property, ideas and interests, etc. Rather, the universities should aim at a sound compromise where they can focus at least a part of their activities on free, independent, basic, non-technical research.

A further cognitive institution, this time on the side of the government, is that universities should engage in knowledge transfer in the context of complex, research-intensive technologies and thus substantially contribute to the solution of economic problems, in agreement with the US–American paradigm. But sustainable transfer is not unidirectional and has to take the situation of the counterparts into account. So the missing absorptive capacity is not only a problem of the enterprises, but also of the universities, which do not sufficiently

adapt to the demand of the enterprises, respond to specific new problems outside the dominant technology pattern in a country and search for solutions beyond the traditional disciplinary borders (Meyer-Krahmer and Schmoch, 1998: 847).

To summarize, it is important to reflect whether the research results of universities are appropriate for interaction with enterprises, in particular in countries with a low level of innovation. A solution may be the change of orientation of university research towards more applied topics or the delegation of transfer activities to other institutions outside the university. For instance, in Germany, the so-called polytechnics or universities of applied sciences with a specific focus on the education of professional practitioners rather than scientists prove to be quite successful in the interaction with small and medium-sized enterprises with less complex technologies. Furthermore, organizations near the university, but legally independent, such as semi-public transfer-oriented institutes or consulting firms owned by university professors, are often more successful in transfer than the universities themselves (Göktepe, 2008; Schmoch *et al*, 2000).

A major advantage of these smaller units outside the organizational framework of the universities is that they are able to react to the demands of enterprises faster and in a more flexible way. Since they do not belong to the classic academic community, they can engage in less complex topics which are not necessarily relevant for excellent science. However, a deeper reflection of practical problems often triggers more fundamental questions in the realm of basic research.

In some country reports, the individual transfer activities of the university staff outside the formal university organization are deplored as problematic. However, the possibility of individual initiatives should be seen as a major driving force of successful transfer. In many university laws in countries at a high economic level, professors are allowed to work for about 20% of their time on their own account and to earn supplementary money. Although this objectively implies a loss of financial resources for the universities, this framework proves to be quite supportive for technology transfer (Abramson *et al*, 1997; Encarnação *et al*, 1997). Many transfer activities would not happen at all without such a stimulus. It is a widespread misunderstanding that regulations like the Bayh–Dole Act in the United States imply that all transfer activities, in this specific case the patent applications of a university, are totally organized and controlled by the university. Rather, a substantial share of patent applications originating in universities are still exploited by individuals, as research for countries such as the United States, the United Kingdom or Germany shows (Noyens *et al*, 2003a,b; Schmoch, 2007; Audretsch *et al*, 1996; Mowery *et al*, 2001). In any case, it is important to establish relevant incentives for individuals with regard to transfer activities.

In many country reports, the existence of public, non-university institutes is addressed as a threat for research and third mission at universities. However, in the context of limited public resources, this can also be perceived as an opportunity for a balanced division of labor. Agreements may be found where different fields may be defined for the non-university institutes and for university research. Again, the duplication of research in different institutions of a country is a 'luxury phenomenon' of rich countries, whereas in the context of limited resources an improved coordination should be aimed at.

In some country papers, the topic is discussed that the second mission, research, is insufficiently developed and that therefore a substantial third mission activity is not possible. Against the background of the Humboldt paradigm, this means that third mission transfers the results of complex research to less competent enterprises. Against the reflections on absorptive capacity, the limitations of this approach are obvious. Rather, it is important to see that the most important transfer activity is still the education of highly skilled graduates. So approaches such as problem-based learning in Aalborg in the Danish example may be more important than direct transfer activities. A further example is Can Tho University in Vietnam with a distinct focus on the education of high-level practitioners in the field of agriculture. This focus on non-scientific professions implies that its research is oriented to the needs of the country and that it engages in third mission in a nearly self-evident way. In a similar way, the Tshwane University of Technology in South Africa thinks about an improved involvement of transfer-oriented technology stations in its teaching activities.

In many papers, the appropriate financing of third mission is addressed, and even in countries with a high economic level the universities are requested to engage in third mission more intensively without providing referring resources. Interestingly, in many countries the official political documents ask for a closer connection of the universities with society, and in the more detailed implementation rules it becomes obvious that the government is exclusively looking at more intensive technology transfer. So behind a philanthropic façade, the primary target is a more intensive support of the economy and the societal third mission appears to be less relevant.

As the technological third mission in advanced industrial countries can refer to contract research for enterprises to a large extent, the problem of financing third mission activities is implicitly delegated to the need of universities to acquire more industrial third-party funding. But from this perspective, societal third mission has much less chance to obtain sufficient resources. For instance, in the case of the German university, societal third mission is officially acknowledged as relevant for the reputation of the university, but receives only minor funding and is primarily based on the initiative of well-meaning individuals. In the cases of Denmark and Sweden,

universities without technical disciplines try to engage in cooperation with local public authorities, but will never be able to generate substantial funding within the present regime.

A further problem is that university research in many developing countries depends to a large extent on funding from advanced industrialized countries where the orientation towards excellent basic research is still dominant. Therefore it is difficult to acquire money for 'simple' third mission projects.

This generally cautious statement as to the role of societal third mission does not mean that it is irrelevant, in particular in countries at low and medium economic levels. Rather, *de facto* societal third mission is very important in many countries, but is not explicitly mentioned in most papers, as the awareness refers to technological third mission. For instance, in Brazil, the engagement of universities in legal advice, medical services, or regional planning is taken as self-evident (De Mello *et al*, 2008) and is not discussed in the country paper of this special issue in further detail.

A specific problem linked to the standing of societal third mission is the reputation of individuals as to such an engagement. With the omnipresent Humboldt paradigm, third mission, in particular societal third mission, is not relevant for the academic careers of university scientists. Therefore the often claimed stronger orientation towards third mission has to be based on improved individual incentives, in terms not only of financial rewards, but also of societal and scientific appreciation.

An interesting point is that the differences between varieties of existing capitalist and communist histories are also visible in the role of universities in the innovation system and in particular technological third mission. In this context, the basic question is not whether a market-orientated economy based primarily on competition or a centrally planned regime is most effective. Rather, a specific feature of some countries with a centralized economy is the organizational separation between research and production; thus the activities of the enterprises in research are quite low. Therefore the requirements for universities to engage in technology transfer are enormous, and at the same time they have to define their role compared to the formerly strong governmental research institutes. It will take a longer transition period until the enterprises integrate more research and, in the Chinese paper, the solution of university-organized enterprises is correctly assessed as an intermediate stage responding to the present needs.

Several times we have raised the point that a universal concept of third mission, whether technological or societal, does not exist and that the uncritical orientation to the Humboldt paradigm obscures the fact that the concepts of third mission have to adapt to the specific national and regional framework. In this context, it proves to be useful that countries with similar features, generally located in the same region, cooperate in conceiving appropriate ideas. A positive example for such an initiative is the cooperation of African countries in this matter, addressed in the Tanzanian paper.

Even with a stronger orientation to local needs, the question remains whether knowledge-intensive, complex technology is an appropriate means to push the economy of developing and catching-up countries similar to the example of South Korea, and Japan 30 years earlier. This would mean that the output of excellent research of universities has a strategic economic relevance and that turning away from the Humboldt paradigm would be detrimental. This position may be supported by the Cuban example, where focusing scarce resources on high technology proved to be successful.

This idea takes up a reasoning of Krugman (1981a,b) that technologically successful countries often run the risk of lock-in effects by sticking to proven technologies. Here, Krugman sees a better chance for developing countries to invest in radically new technologies and thus to outdistance the presently strong countries. He calls this strategy 'leapfrogging', and illustrates it by an economic model. However, such a pure high-tech strategy is quite risky and requires careful long-term planning and strict discipline in the implementation of this strategy. A prerequisite is a societal consensus on such a strategy, together with the necessary state support through quality infrastructure and capabilities. Furthermore, in the present situation, the competition of catching-up countries in the field of technology is much stronger than in the 1970s, the period of the early Korean growth.

It is more realistic to follow a high-tech strategy as complementary to a broader industrial strategy covering all types of technology. Thus the Korean enterprises cover many other fields beyond telecommunications and microelectronics, for instance, cars, consumer goods or basic materials chemistry. The high-tech spin-off firms in Brazil are embedded in a broader industrial environment; the same applies to the university-run enterprises in China.

A closer look at various catching-up countries shows that they do not follow a unique best practice, but that their development is country-specific and path-dependent (Schmoch and Qu, 2009). Their common feature is a greater investment in higher education and, linked to that, in universities. In the global knowledge economy, developing and catching-up countries have to invest in higher education as well. This strategy is important, not only in the context of complex technologies and advanced services, but also for intelligent strategies in solving problems in agriculture, urban planning or financial policy.

Concluding remarks

The third mission of universities — in addition to the first and second missions, education and research — is a highly relevant topic for the global community

of countries. Third mission activities span both the technology-oriented interaction of universities and enterprises, on the one hand, and linkages of the universities to civil society, on the other hand. An appropriate enforcement of third mission is often hampered by an uncritical orientation on excellent basic research according to the Humboldtian ideal, although conducting applied research with reference to the country's needs may often be more useful.

Furthermore, in most cases, third mission activities are not sufficiently funded, as even the fulfilment of the second mission is problematic, due to scarce resources. This situation especially affects the more societal form of the third mission. The stronger orientation of education towards practical professions offers a broad potential of a closer link between the first and third missions, and supports the important task of universities to provide more highly qualified personnel.

The technological third mission has to cope with the problem that firms in developing and catching-up countries generally do not have sufficient absorptive capacity. This means that universities have to come to terms with this situation, for example, by changing their research to less complex topics, or delegating the technological third mission to specific institutions outside universities. Some examples show that university-based outputs can induce high-tech activities and economic growth. However, the expectations of the universities' role are generally exaggerated; it is imperative that other relevant actors, in particular enterprises and the government, also support such a strategy. Universities are embedded in a broader innovation system and cannot solve technological and economic problems in isolation.

Finally, each country has specific features, and operates in contexts which define its own good practices. A global best practice for third mission therefore does not exist. Each country finds its own solutions through an interrogation of the specific conditions which define its selection environment. It is this capacity which should be enhanced in all countries and especially at institutional levels. This consideration means in particular that models developed in the context of more advanced and matured industrialized countries cannot be transferred to developing and catching-up countries in a simple way. Rather, it is necessary to collect more experiences about the innovation systems of these countries and analyze the particular role of third mission in this specific context.

Notes

1. It is perhaps ironic that the US-centric models almost exclusively address the technological third mission and disregard the historically important role the land-grant universities have played in supporting development and fighting poverty in rural communities in the USA since the beginning of the 20th century. The effects of the Bayh–Dole Act are critically discussed by Mowery *et al* (2001).
2. The GDP data of the World Bank differ from the UNDP data used in Table 1 due to a re-calculation of the purchasing power in 2005. In general, the ranking of the countries is not affected. But the levels of China and Vietnam decrease by about 20%, those of Tanzania, Russia and Latvia increase by 60%, 30% and 30% respectively. Cuba is a special case, where the World Bank provides no data, but the CIA World Fact book indicates a value even about 80% above the UNDP figures.

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