Summary

This paper sets out to review the conduct and immediate impacts of a recently-completed two-year national technology foresight exercise conducted in one of Europe’s smallest and wealthiest countries, Luxembourg. The country’s small size brings into sharp view many of the underlying tensions present in those foresight exercises that explicitly attempt to set national priorities. These tensions include the ability (or otherwise) to underpin the foresight process with sufficient and appropriate 'objectivised' knowledge (including national statistics, international benchmarking data, and future-oriented ‘intelligence’), the organisation of dialogic spaces that are not solely 'hijacked' by special interests, and setting the 'granularity' of emergent priorities at a level that makes them 'operationalisable' in informing R&D funding programmes.

The exercise was organised by the FNR, the only research council in Luxembourg. The paper shows that the position of the FNR in the research landscape had both benefits and drawbacks during the conduct of the exercise as well as for the follow-up implementation.

The paper builds upon an earlier FTA conference paper (Glod et al, 2006) which described the first phase of the FNR Foresight exercise. The current paper extends this analysis to the second and third phases of the exercise, as well as to the immediate implementation phase after the publication of its results. By doing so, it covers the evolution of the foresight exercise over its two-year life span, highlighting the different meanings given to the exercise by different stakeholder groups as the process unfolded and interim results were made known. The paper draws lessons not only for other small countries and regions hoping to use foresight, but also highlights principles for using foresight for priority-setting more generally.
1 Introduction

In 2005, Luxembourg began to embark upon a ‘national’ technology foresight exercise, with the primary aim of identifying new research domains for the National Research Fund (FNR) to support (FNR 2006). As with other small countries, Luxembourg has limited public resources devoted to research and has a small (and young) public research base. However, it is also rather unique in that it has enacted sizeable increases in spending on R&D over the last decade and is set to increase budgets further over the next few years. Thus, the challenge for Luxembourg lies not in distributing limited funds among its existing science community. Rather, it is looking to identify new areas in which to invest much of the spending increases with a view to developing future national champions.

The paper has the following structure. In an opening section, the general contours of STI policy in Luxembourg are traced, with a view to contextualising the FNR Foresight experience. In Section 3, a number of generic priority-setting ‘dilemmas’ are set out, to be picked up again when considering the conduct of FNR Foresight. In Section 4, a brief outline description of FNR Foresight is provided, followed in Section 5 by a more detailed analysis of the conduct of the exercise. Section 6 considers the impacts of the foresight exercise, whilst a final section draws some summary conclusions and highlights lessons for future foresight practice.

2 STI Policy in Luxembourg

Before the 1980s, Luxembourg lacked a public science, technology and innovation infrastructure. R&D carried out in Luxembourg was largely the preserve of the private sector – particularly the steel industry – and even today, a key feature of the research landscape remains the dominant role played by the private sector. Early public investments in R&D and innovation were influenced by private sector activities and largely sought to support them. These included the founding of Luxinnovation in 1984, an agency for supporting innovation; and the establishment of several public research centres in 1987, with the primary aim of supporting technological innovation in firms.

However, with increased recognition of the role of research and innovation in contributing towards the future development of the country, the Luxembourg government decided in 1999 to increase the level of publicly funded research. Accordingly, the government went on to develop a focused science, technology and innovation (STI) policy, which began with the establishment of several new institutions, including: the Ministry of Culture, Higher Education and Research (MCHER) as the key policy centre with respect to Luxembourg research; the National Research Fund (FNR) as a source of prioritised funding for multi-annual research programmes. These

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1 As part of the general interest in technology foresight, many small countries have also set up and run exercises. Notable examples from Europe include Ireland, Hungary, Czech Republic, Slovenia, and the Nordic countries. The EC has also sponsored pilot foresight exercises in Malta, Cyprus, and Estonia as part of the eForesee project (see Crehan and Cassingena-Harper, 2008). Outside of Europe, the Commonwealth Science Council has funded work examining design and implementation of foresight in small islands, using Jamaica and the Seychelles as pilot countries (see Wehrmeyer et al, 2004).

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developments were followed up in 2003 by the establishment of the University of Luxembourg. In addition, the government increased spending on public R&D from 0.08% of GDP in 1999 to 0.3% in 2004 and plans a further increase to 0.58% by 2010.\(^2\) Figure 1 outlines the increase in public funding for public R&D in millions of Euros. These unprecedented budget increases possibly place Luxembourg in a unique position among its partners in Europe, although the level of gross expenditure on R&D (GERD) in Luxembourg – at 1.25% of GDP in 2006 – still remains one of the lowest in the European Union. A fuller review of the recent evolution of the Luxembourg research system is offered by Meyer (2008).

It is important to understand that the institutional changes and budget increases of the last few years represent attempts to shift public research away from a largely ‘responsive’ and mostly industrially-oriented mode to a more long-term, strategic mode. The establishment of the University is a clear sign of this, but other recent initiatives (see Box 1) are also meant to contribute to upgrading Luxembourg science, as well as to improving its governance.

\[\text{Figure 1: Public Funds to Public R&D, 2000-2007, Euro}\]

\[\begin{array}{|c|c|c|c|c|c|c|c|}
\hline
\hline
\text{Expenditure on Public Research (Euro)} & 100,000,000 & 120,000,000 & 140,000,000 & 160,000,000 & 180,000,000 & 200,000,000 & 220,000,000 & 240,000,000 \\
\hline
\end{array}\]

Source: MCHER

\(^2\) As the GDP of Luxembourg has increased by 50% (from 22 to 33.1 Billion €) between 2000 and 2006, these are sizeable budget increases for public research.
Box 1: Parallel strategic initiatives

The OECD Review of Innovation Policy was conducted in 2006 and commissioned by the MCHER. The Review report (see OECD, 2007) suggested a number of needed reforms in the system of public sector research governance in order to better ensure that additional public investment in R&D will yield expected economic and social benefits. The central OECD recommendation was the establishment of multi-annual performance contracts between the MCHER and public research actors (including the FNR) with a view to enhancing the latter’s accountability and efficiency.

The University of Luxembourg was established in 2003 and implies a shift of paradigm, as it was always considered to be a national strategic advantage that Luxembourg students had to go to foreign countries to study. The University has been created by merging 3 existing higher education institutes and its remit has been shifted from an almost purely educational role to one that has a stronger focus on research.

The City of Science is an initiative of the MCHER to regroup the University of Luxembourg and the Public Research Centres on a single new site in the south of Luxembourg near the town of Esch-sur-Alzette. This site will accommodate the activities of more than 1600 FTE researchers and aims to house the related research activities of the various research actors in purpose-built infrastructures. The construction of this new quarter will be finished by 2013 with costs exceeding 600 M€.

The Centre of Competence in Molecular Medicine was launched in 2008 as an initiative of the Ministry of Economic Affairs, the Ministry of Health and the MCHER. The Centre is to be set up in cooperation between 3 US institutions, 3 Luxembourg public research centres, and the University of Luxembourg. Research activities will mainly cover the topic of molecular diagnostics with a 5-year budget of 140 M€.

Just as significant as all the developments set out in Box 1 is the establishment of the FNR. With an annual budget of 18 M€ in 2007, the FNR serves as Luxembourg’s national funding agency in supporting the development of research competences in topics of national interest through multi-annual programmes. It is also mandated to provide advice and suggestions for priority action that should be taken in order to achieve the objectives of national R&D policy.

An important aspect of FNR support is its main conditionality on scientific excellence. In other words, FNR funding is intended to shift the Luxembourg research system towards conducting more leading-edge science and to improve its integration with leading centres of knowledge production from around the world. This is not to say that FNR support is without strategic direction; on the contrary, funding is directed through multi-annual research programmes. So the FNR has faced the challenge of identifying ‘appropriate’ programmes that will not only attract sufficient high-quality proposals from Luxembourg scientists but will also steer them to conduct more leading-edge research in topic areas that are likely to be important for Luxembourg’s future socio-economic development. As we will show below, this was the original rationale for FNR Foresight: to identify topic areas around which new FNR programmes could be articulated. But the identification of such ‘priority’ topic areas is rarely straightforward in any context, and Luxembourg has been no exception. In the section that follows, we discuss some of the generic dilemmas that characterise prioritisation processes before examining how these played out in the Luxembourg context.
3 Generic priority-setting dilemmas

Priority-setting is, more often than not, an implicit activity that permeates all policymaking and implementation. An important attraction of technology foresight has been its promise to make such processes more explicit, and, by extension, better informed through the involvement of a wider set of actors taking into account longer-term futures.

Explicit S&T priority-setting is commonly performed at different levels, including the policy (government) level, the strategic (research funding agency) level and the operational (research performing institutes) level (OECD, 1991). Furthermore, different sorts of things might be prioritised, including scientific fields, industrial areas, research facilities, types of research performing institutes, and so on. The OECD (ibid.) has therefore distinguished between thematic priorities – concerned with scientific fields, technology areas, industrial sectors, issues, etc. – and structural priorities – concerned with issues such as research infrastructures, higher education teaching programmes, innovation promotion initiatives, venture capital markets, system networking and community-building, and so on. It is not unusual for these priority-setting exercises to set out to identify only thematic or structural priorities to at the outset, but then cannot help but to stray wider and to consider both types of priorities.

Picking up on this point, the following ‘dilemmas’ around the framing and conduct of prioritisation need to be borne in mind (Keenan, 2003):

1. **Scope of prioritisation**: Priority-setting exercises should include consideration of both thematic and structural priorities from the outset, given their close interdependence. Yet, this often fails to happen – particularly when exercises profess to cover only thematic priorities – and instead, structural priorities enter ‘through the back door’ later in the process. However, the type of priorities desired is not the only factor to consider when framing the scope of prioritisation. Another important consideration is whether the results of priority-setting are intended to apply across the total funding landscape or whether they are meant to inform new or marginal funds. In reality, it is more typical for the latter to occur, as mature S&T systems are marked by extensive ‘lock-in’ that are better suited to evolution than revolution. In fact, what tends to happen is that priorities take account of this ‘lock-in’ when they are assessed for their ‘feasibility’ so that evolution is nearly always the outcome, even if revolution might have been intended! A further related consideration concerns the need to maintain ‘variety’ in the S&T system, so that there is flexibility to change and a capacity to absorb knowledge across a wide range of global knowledge networks. But in small countries, this is particularly difficult to achieve across the board as many S&T areas lack sufficient ‘critical mass’ to keep pace with all the latest developments. Variety therefore meets ‘natural’ limits and there is a tendency instead to speak of the need to identify ‘niche areas’ with the help of prioritisation processes. We will return to this point below.

2. **Institutional positioning of prioritisation**: Historically, institutions – whether ministries, funding agencies, or research performers – have tended to keep priority-setting in-house. But with the use of techniques like foresight, these processes have been opened up. However, many institutions feel uncomfortable to be bound by the results and recommendations of such open exercises and therefore tend to position them as stand-alone and semi-detached from normal decision-making processes. This is often justified by the need to provide ‘space’ for ‘free’ and open debate to take place, which might otherwise be constrained by political considerations within an organisational setting. But such positioning can also lead to certain implementation problems, as institutions are free to ignore priorities and recommendations,
and in some instances, may not even have much sense of ownership of an exercise’s findings.

3. **Granularity of areas to be prioritised**: There is an inherent tension between, on the one hand, a desire to identify topic areas sufficiently focused as to yield specific policy implications, and on the other hand, a need to avoid generating an inordinately long list of topic areas requiring excessive amounts of effort to appraise. This tension is particularly acute at the national level, simply because of the breadth and possible number of potential topic areas. Many exercises have also had difficulties in formulating topic areas of comparable granularity, an area where there tends to be extensive disagreement among foresight participants.

4. **Criteria for prioritisation**: A further tension revolves around the criteria for prioritisation, both in terms of their breadth and depth. In terms of breadth, for example, should participants be asked to assess S&T topic areas against non-scientific criteria? In terms of depth, to what level of detail should criteria be formulated? The finer the criteria, the better the assessment – at least in theory. But in practice, too many criteria make assessment a mammoth task and few participants will have the time (or patience) to devote to this. Furthermore, many participants will probably lack the requisite knowledge to make such detailed assessments. This is an important (and often under-reported) limitation in many priority-setting exercises. In addition to the contribution a particular topic area might make to scientific understanding, socio-economic development, etc., a further important factor to bear in mind when priority-setting is a country’s ability to make the most of this potential. This is often referred to as the ‘feasibility’ to exploit a topic area, and it can also be assessed by a similar battery of broad and deep criteria – and therefore involves a process with similar challenges to those just described. This is often the moment when the importance of structural priorities is ‘discovered’, since future investments in research infrastructures or future changes in policies / regulations, for example, can make a significant difference to a country’s ability to exploit a particular S&T area.

5. **Who prioritises**: Finally, there is the dilemma around who should participate in priority-setting, and whether the views of chosen participants can be considered representative of their communities (and whether these individuals can carry their communities with them). In large S&T systems, this is particularly important, but is perhaps less important in small systems, such as Luxembourg, where in theory, it is possible to engage almost everyone in the prioritisation process. Rather, the major limit in places like Luxembourg is the breadth and depth of local expertise to make prioritisation assessments. A related issue here is whether existing scientific communities alone are best placed to set S&T priorities. An emerging consensus seems to suggest not, and it is now generally accepted that the users of S&T knowledge and artefacts, including social and commercial interests, should somehow be engaged in priority-setting processes.

### 4 Outline of FNR Foresight

FNR Foresight has been delivered as a two phase process (FNR 2006, FNR 2007a and FNR 2007b) where the first phase consisted largely of defining the current position of the Luxembourg research landscape, analysing international trends in research priorities, and identifying possible priority tracks for research (see Glod et al (2006) for a fuller account of the conduct of Phase 1).
Based on these results, the second phase of the foresight focused upon a set of broad themes with the aim of identifying national priorities for research funding. The approach used is set out in Figure 2 and is briefly described below.

Figure 2: Phases and steps of FNR Foresight

In the first part of Phase 1, an initial ‘diagnostic’ step focused on mapping the Luxembourg research landscape. This consisted of several activities, including an evaluation of ongoing FNR programmes; the collection of statistical data and bibliometric data; and a series of face-to-face interviews with stakeholders, including senior researchers within Luxembourg and abroad, as well as companies and public administrators. These were all focused upon identifying future research directions for Luxembourg. In parallel, key trends and thematic research priorities were collected from 13 countries. The latter was combined with the findings of interviews to generate an initial ‘long-list’ of topics to be ‘tested’ by the research community. This list was not supposed to be definitive, but was rather intended to ‘seed’ discussion and debate in the following step.

In the second part of Phase 1, the long list of research domains was first tested in five thematic junior researcher workshops. But their full assessment was undertaken through an online questionnaire survey of much of the Luxembourg research landscape (around 300 participants), where respondents were asked to rate research domains against a battery of ‘attractiveness’ and ‘feasibility’ criteria. The results of this survey were then fed into an Exploratory Workshop.

3 The following groupings were used: environmental sciences, bio-medical sciences, information and communication technologies, physical sciences and engineering, social sciences and humanities

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(EWS), where researchers and research users were brought together in broad S&T area groupings for the first time to discuss and validate the emerging analysis and ranking of the research domains.

Phase 2 of the exercise was devoted to establishing possible priorities for public research in Luxembourg. For this purpose, 13 workshops – one Stakeholder Workshop and two expert workshops for each of six thematic fields\(^4\) – were conducted. As a starting point for assessing research domains, representatives from Luxembourg society, business and research were invited to the Stakeholder Workshop with the aim of identifying the main challenges facing Luxembourg over the coming decade.

The subsequent series of thematic field workshops aimed to (re-)define or review\(^5\) the research domains identified in Phase 1, to frame tentative research priorities in concrete terms, to finalize their definitions, to review the underpinnings for their objectives and rationales in view of the challenges identified in the stakeholder workshop, and to identify important implementation issues.

5 Conduct of FNR Foresight

Foresight exercises tend to face a number of generic challenges in their conduct and the FNR Foresight has been no exception in this regard. Among these challenges are the need to keep within time and budget; to open up the process to genuinely new perspectives; to avoid short-termism; to collect necessary background data and to ensure its use in the process; to minimise participants merely using the exercise to defend predefined territory; to instil creative thinking; to overcome suspicions of some of the methods common to foresight; to ensure sustained, consistent participation; to manage expectations of (policy) impacts; to identify and mobilise champions to drive the process forward and to help deliver on foresight’s findings; and to remain relevant while pushing at the ‘normal’ boundaries of debate (Keenan and Miles, 2008).

A few of these challenges are touched upon in this paper, but for the most part, we have sought to deliberately focus upon those that we feel have been more unique to Luxembourg. Accordingly, the following sections are limited to discussion of the various and changing meanings given to FNR Foresight by a mix of stakeholder groups; issues of granularity of S&T areas for prioritisation; the availability and use of background data; and the nature of processes of deliberation.

5.1 Variety and change in the meanings of Foresight

The FNR Foresight was born out of the necessity for the FNR to define new research programmes. While some of the first generation research programmes (7 programmes were

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\(^4\) The single Social Sciences and Humanities group of the first phase has been replaced by two groups: Law, Economy and Finance and Social Sciences and Humanities

\(^5\) Since the thematic fields had been analysed and structured to different levels of depth during the first phase, the workshops had unequal starting points and their methodology had to be adapted to the progress so far.
launched in the period 2000-2003) were still ongoing by 2007, the FNR needed to develop the next generation of programmes well before the first generation expired. The FNR therefore sought the help and advice of an international group of eight science policy experts (including one of this paper’s authors) through a one day workshop. A two-pronged approach emerged: first, to call on the public research institutes to submit ideas for new research programmes; and second, to use a foresight exercise to identify and develop those domain areas that might be of interest, but that are still weakly developed in Luxembourg. The international group of experts also emphasised the need to balance any discussion of thematic priorities with a strong consideration of structural priorities.

However, it is important to bear in mind that the FNR is not the only important actor in the formulation of FNR programmes. There is also the MCHER, which not only provides the budget for the FNR, but is also responsible for setting policy across the whole of the research system. Finally, there is the research community, which not only submits proposals, but also shapes the detail of programmes and their calls. As we will see, these different groups sometimes held varying views on priority-setting and the scope and conduct of the FNR Foresight exercise in particular, which often led to confusion and misunderstanding.

Following its roadmap, the FNR first issued a call to the research community to submit ideas for new programmes. The FNR Board was critical of what they saw, particularly of the seeming lack of vision in the proposals and an apparent weakness in reflecting economic and societal needs. The research community’s ideas were therefore dismissed and the proposed foresight exercise was given the go-ahead by the Board, on the understanding that it would provide a more participative (involving knowledge users as well as producers) and future-oriented (visionary) approach to identifying topic areas suitable for new FNR programmes. At the same time, and again following the advice of its international group of experts, the FNR proposed to use the foresight exercise to define not only thematic priorities, but also to consider the structural aspects and funding mechanisms and instruments of public research. This broad perspective rightly anticipated problems that would be faced by any approach that sought only to identify thematic priorities without taking into account structural factors.

These intentions were communicated to the MCHER at the outset, which was supportive of the idea of a foresight exercise. Later on, it even requested the Fund to broaden the scope of the analysis from the ‘mere’ definition of new FNR programmes to the identification of nationwide research priorities i.e. ‘research domains in the public sector with short-term and/or long-term socio-economic interest for Luxembourg society’. In a coordinated approach with other elements of public policy, FNR Foresight was to provide the basis:

- to assist the development of outstanding centres of science and technology excellence in Luxembourg,
- to ensure the specialization of public research centre (PRC) facilities into centres with a limited number of specific areas of high level expertise, and
- to determine appropriate investment levels through support instruments such as the FNR programmes.

6 Other elements included the review analysis by the OECD on Luxembourg’s public research apparatus, the multi-annual development programmes of the public research centres and the University of Luxembourg, and the economic development priorities in the various sectors of the economy.
However, the MCHER also asked the FNR to limit the exercise to identification of thematic priorities only with the argument that structural aspects would be analysed by the OECD. Thus, while the MCHER clearly expanded the scope of the exercise on the one hand, it also consciously restricted it on the other by carving off the structural aspects. This ‘negotiation’ around the remit of the exercise had some immediate effects on both its planning and execution. Moreover, since the MCHER’s intentions emerged after the process had got underway, the exercise blueprint had to be adapted on a number of occasions.

These adaptations in approach and scope were sometimes misunderstood by the FNR Board and led also to a considerable amount of confusion in the research community. This was particularly apparent in the Exploratory Workshop (EWS), which presented the first opportunity that Foresight participants had to discuss the future of the research system together. Several participants rightly made the point that consideration of domain priority areas could not be done in isolation from discussions of research infrastructures, the new University, and so on. The steering away from structural issues therefore caused some malcontent among the participants.

In fact, uncertainty around MCHER follow-up unnerved many researchers, who voiced their fears about running out of funding if their research was not to fall under identified research priorities. In order to mitigate these fears, the FNR Secretariat assured participants that the foresight exercise was not constructed around a “winner takes all” competition between research domains. Rather, all research domains presently investigated in Luxembourg would continue to benefit from at least current levels of financial support but that substantial budget increases were to be reserved for a few priority domains. Such assurances, however, only partially abated researchers’ fears, particularly as changes in the exercise’s remit and scope created uncertainty around its consequences.

5.2 Dealing with issues of granularity and identifying ‘competence niches’

The dilemma around the level of ‘granularity’ of research topics to be prioritised – already highlighted in Section 3 – was well understood by the FNR and its consultants from the outset. Thus, a four-level granularity schema quickly emerged during Phase 1 (FNR 2006) and was applied for ‘nesting’ research domains in the ‘long list’ (see Table 1). The FNR was most interested in Level 3 – research domains – as this was considered the most ‘natural’ level at which to formulate new FNR programmes. It was at this level that respondents to the online survey were asked to make their ‘attractiveness’ and ‘feasibility’ assessments, with a view to formulating a ranked list of research domains. But the FNR was also interested in Level 4 – research axes – since these could be used to structure and populate future FNR programmes. Accordingly, the online survey and subsequent workshops invited participants to nominate new research axes as well.

Despite its apparent elegance, there were problems with this schema. To begin with, the ‘long list’ was prepared by the Phase 1 consultants, who generally lacked the breadth of domain knowledge to reliably position S&T topics into the schema. While programme officers from the FNR Secretariat tidied up the schema the best they could, domain expertise and deliberation would be required before the community could come to an agreement on appropriate positioning. A critical flaw in Phase 1 was to present a ranked list of research domains – an apparent fait accompli based mostly on the results of the online survey – to the community in the EWS without giving them the opportunity to debate the integrity of the domains included in the
list. Subsequently, the ranked research domains within thematic fields were often considered to be poorly-framed, incomparable for ranking purposes, unrepresentative of the interests of researchers, or even irrelevant to Luxembourg. In other words, the research community had difficulties relating to the ranked research domains being offered by the consultants, even though the list was derived almost solely from the responses of that same community to the online survey.

Table 1: Levels of ‘granularity’ for mapping research areas (few examples are shown)

<table>
<thead>
<tr>
<th>Thematic field</th>
<th>Research area</th>
<th>Research domain</th>
<th>Research axis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
</tr>
<tr>
<td>Environmental sciences</td>
<td>Global change and ecosystem</td>
<td>Water management</td>
<td>Drinking water</td>
</tr>
<tr>
<td>ICT</td>
<td>Infrastructure</td>
<td>Telecoms</td>
<td>VoIP</td>
</tr>
<tr>
<td>Social &amp; human sciences</td>
<td>Economy, policies, institutional framework</td>
<td>Economy and finance</td>
<td>Dynamics of financial wealth creation</td>
</tr>
</tbody>
</table>

In the subsequent workshops held in Phase 2, larger freedom was given to the participants to deviate from the initial list and to reshape the research topics. Once the topics were established, the panels were asked to build a case for the prioritisation of the topic using SWOT analyses and referring back to challenges identified in the stakeholder workshop. This process led to the selection and reformulation of the research topics into ‘candidates’ for national research priorities. These candidate priorities found the support of the FNR Board, which presented them as the research priorities for Luxembourg to the MCHER.

But an even more fundamental problem lay with the widening of the exercise’s scope to include identification of ‘national’ priorities (i.e. beyond the identification of priorities needed to formulate new FNR programmes). Picking up on the OECD distinction between different levels of priorities (i.e. policy, strategic and operational), the MCHER should have been naturally interested in Level 2 of the schema – research areas. However, these were not explicitly prioritised by the FNR Foresight exercise; rather, prioritisation was being carried out at Level 3. In other words, the exercise was only able to identify Level 2 research area priorities insofar as Level 3 research domain prioritisation implied them.

The rationale for presenting EWS participants with a list of ‘ready-made’ research domains was to prevent discussions starting from scratch. While this would seem to be sensible – particularly given the limited time available – asking participants to rank such a list without giving them the time to debate and agree upon its contents was always going to be a step too far. See Section 5.4 below.

In fact, a significant problem lay with the latter – despite its respectable response rate, it was still only answered by a few hundred people across all thematic areas, with most domain areas assessed by no more than a few dozen researchers at most and usually by far fewer people. The assessment was therefore deemed to be an unreliable basis upon which to rank research domains.

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The extent of this problem became apparent only near the end of the exercise when the MCHER requested the FNR to provide a shorter list of priorities to the eighteen presented by the FNR Board. Rather than further prioritise the eighteen (Level 3) research domain areas, the natural FNR response was to provide the MCHER with a list of six (Level 2) research areas (essentially headings) under which the eighteen research domains fell (see Table 2, FNR 2007a). As we will discuss in Section 6, this was unacceptable to the MCHER, which took matters into its own hands and sought to re-prioritise the research domain areas itself.

To understand why eighteen research domains should be considered too many by the MCHER, it is necessary to take into account recurring discussions in Luxembourg on the need to identify so-called ‘competence niches’, i.e. areas of potential economic success which may only be achieved through a knowledge basis developed in Luxembourg. This expectation is informed by the so-called ‘sovereignty niches’ – areas where the traditional wealth of Luxembourg has been built owing to geographical (steel) or legislative (banking industry) specificities. But it is also influenced by the country’s small size and a belief that this implies the need for specialisation in order to compete. Thus, the expectation of the MCHER was for the exercise to identify a much smaller number of research areas/domains – perhaps just two or three – in which high levels of new investment could be targeted. But this was always going to be near impossible for the FNR Foresight exercise to achieve, for several reasons. To begin with, the exercise was first and foremost designed to identify several domain areas around which to formulate new FNR programmes. It was not supposed to identify just two or three ‘competence niche’ areas, since the FNR is mandated to serve all of the national research community. But perhaps more fundamentally, niches are difficult to plan and their top-down identification is unlikely to lead to success. Instead, niches are emergent and depend upon a specific constellation of technological, legislative or societal factors. For sure, foresight exercises might provide a platform for nascent niche areas to gain greater prominence, but foresight is often unsuited to the identification of niche areas de novo. Instead, a better STI policy strategy is to foster an innovation system that is sufficiently flexible to support such areas at their time of emergence.

9 For the FNR, there seemed little basis for choosing between the eighteen areas. Moreover, this number of priorities – across the whole of the research system – seemed reasonable and was considered a suitable basis upon which to formulate new FNR programmes.
### Table 2: National research priorities in the shape of research areas and research domains

<table>
<thead>
<tr>
<th>National Priorities (Research Areas)</th>
<th>National Priorities (Research Domains)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation in Services</td>
<td>Business Service Design and Innovation</td>
</tr>
<tr>
<td></td>
<td>Fostering the Economic and Legal Environment for Innovation</td>
</tr>
<tr>
<td></td>
<td>Performance and Development of the Financial Systems</td>
</tr>
<tr>
<td></td>
<td>Information Security and Trust Management</td>
</tr>
<tr>
<td></td>
<td>Telecommunications and Multimedia</td>
</tr>
<tr>
<td>Sustainable Resource Management in Luxembourg</td>
<td>Managing Sustainable Development</td>
</tr>
<tr>
<td></td>
<td>Understanding Ecosystems and Biodiversity</td>
</tr>
<tr>
<td></td>
<td>Sustainable Management of Water Resources</td>
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<tr>
<td></td>
<td>Sustainable Uses and Sources of Energy</td>
</tr>
<tr>
<td></td>
<td>Sustainable Agro-Systems Management</td>
</tr>
<tr>
<td></td>
<td>Spatial and Urban Development</td>
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### 5.3 Deliberative processes

Foresight exercises are characterised by deliberation between various stakeholders, often in workshops and working groups. However, such deliberative forums require careful planning and must be appropriately scheduled. While this was understood by the FNR Secretariat, the exercise quickly started to accumulate delays, owing in large part to the aforementioned misunderstandings between the FNR Board, the MCHER, and the Secretariat on the exercise’s scope and remit. As originally planned, the exercise was supposed to have just a single phase – now known as Phase 1 – which was to last about six months and deliver a list of ranked priorities. As we will argue below, this unrealistic time scheduling had major consequences for the scale and quality of deliberative processes.

The consultants employed to coordinate the exercise in Phase 1 did a sterling job in such a limited time to collect baseline data, conduct interviews, and carry out the online survey. But with so little time to work with, they decided to rely upon a single deliberative forum – the Exploratory...
Workshop (EWS) – near the end of the process to validate the domain rankings derived from analysis of the online survey. This was always going to be problematic as it left too much to be achieved in a single one-day meeting. For a start, despite the small size of Luxembourg, it was apparent that many people in the same thematic areas did not know one another. In such situations, it takes time for people to develop a rapport and for mutual trust to grow between participants. On top of this, the workshops were often the first opportunity that people had to discuss the future of the research system together and they understandably tended to veer towards wider discussion of a whole range of structural issues – which, as we have argued above, is in any case a natural tendency when thematic domain areas are being prioritised. Finally, as discussed earlier, EWS participants challenged the validity and reliability of the domain rankings they were being offered, which paralysed discussions in at least two of the thematic groups.

Thus, a major weakness in Phase 1 was the overriding focus on obtaining priorities without due regard to the processes necessary for this to happen in a legitimate and credible way. Indeed, it would be fair to say that there was a questionable commitment to a deliberative and discursive process, perhaps with too little appreciation of the process benefits associated with foresight. Instead, the focus was solely upon the identification of priorities in as quick a time as possible. On reflection, the baseline phase should not have attempted to identify priority areas at all. Instead, full attention should have been given to ensuring the validity of baseline and benchmarking data and more time spent on data collection and analysis. Similar shortcomings have also been noted by Meyer (2008) who comments that current science policy appears to be almost too ambitious, [...] too impatient in wanting to implement change.

Everyone (finally) realised that further discussions would be needed with the research community before agreement could be reached on priorities – although this would also cause delays in the formulation of new FNR programmes. Accordingly, a second phase of the exercise was instigated with a stronger deliberative process. This involved further thematic group meetings, a change of consultants, and a greater emphasis placed upon validating priorities with the necessary analysis and discursive processes built in.

But along with a shift in approach came a host of new challenges that typically characterise group work. First, it was apparent that the course and the outcomes of the workshops depended on the composition of the workshop participants. In some areas, the existence of one (or few) dominant actors influenced the process right from the outset (Thorsteinsdottir, 2000). In these areas, the composition of workshop participants was much more uniform and the level of personal conflicts (trench wars) was much lower. In other sectors where the FNR Secretariat could not rely upon a local ‘champion’, the interests of the participants were much wider spread (reflecting the reality of Luxembourg’s research in that area) and consensus was much more difficult to obtain. This might have been alleviated somewhat by holding more than just two meetings for each thematic area.

It is characteristic of small or micro-countries that there is ‘compacting’ of policy levels together with the ‘many hats syndrome’ whereby stakeholders are playing a range of roles and representing different interests at the same time. However, contrary to previous findings (Crehan and Cassingena-Harper, 2008), this did not make coordination easier in Luxembourg but tended

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10 In addition, a series of young researchers’ workshops were held earlier in the process, but these were judged to have been largely a failure, with the wrong questions asked and an inappropriate workshop format used (see Glod et al, 2006).
to render the conduct of the foresight exercise more difficult as a considerable number of participants defended the interests of their various affiliated organisations. Again, further thematic group meetings might have reduced this behaviour over time.

Many participants also had difficulty in engaging in a visioning dialogue. This might have been due to their unfamiliarity with foresight, but was perhaps made difficult by a perceived situation where stakes were felt to be high (national research priorities were being determined) and people wanted to avoid being left out. Also for the political entities (Ministries, chamber of commerce, etc.), more immediate issues prevailed and seemed to be the main focus for them.

6 Foresight impacts

Given the wide scope of participation in foresight exercises, there is expectation that processes and findings will have some effects on a wide array of stakeholders. In the case of FNR Foresight, these include the FNR itself, the MCHER, the research community, and, to a lesser extent, the business community. Each of these is covered below. But a word on impacts of foresight: first, there may be impacts from the process alone, which means they can conceivably appear before an exercise produces its findings; second, distinction needs to be made between foresight outputs and impacts and it should be acknowledged that there is rarely a direct cause-effect link between the two; third, just as impacts might appear before the generation of final results, they also often appear a long time after the exercise has been completed and are therefore difficult to measure and to attribute to foresight; finally, foresight findings are rarely implemented in a top-down, rational manner – instead, their implementation depends upon enrolment and mobilisation of advocacy coalitions around emergent agendas. This involves processes of persuasion and negotiation on the part of ‘champions’, as foresight results rarely ‘speak for themselves’ (Georghiou and Keenan, 2006).

6.1 Sense-making and the construction of political ownership

As the main S&T policy body in Luxembourg, we have seen that the MCHER played its part in shaping the scope of FNR Foresight. Moreover, as the exercise was broadened to identify ‘national’ priorities, the expectation was that MCHER would use the results to inform a wide array of policies beyond the formulation of new FNR programmes. A couple of problems were, however, encountered: first, the number of priority research domains – at eighteen – went beyond the expectations of the MCHER, which had hoped for a much smaller number of priorities around which to build ‘competence niches’; secondly, there was something of a lack of ownership of the priorities on the part of the MCHER – no doubt due to the fact that the process was organised and driven solely by the FNR. We will now deal with each of these issues in turn.

First, the number of priorities: we have already highlighted the fact that the MCHER was unhappy about the number of priorities identified by the exercise and that the FNR ‘re-packaged’ the eighteen ‘domain priorities’ into six ‘area priorities’. The purpose of this re-packaging was not only to present the results at a granularity level perceived to be more useful to the MCHER, but
also to highlight the interdisciplinarity amongst them.\textsuperscript{11} But this re-packaging was rejected by the MCHER as subterfuge on the part of the FNR. Subsequently, the MCHER asked the FNR to present the eighteen domains identified along 11 ‘new’ criteria of attractiveness and feasibility so that it could see for itself where the most important priorities lay. These criteria, which were assembled jointly by the MCHER and the FNR, were not particularly ‘new’, but had already been employed in one form or another in the online survey (Phase 1) and in the thematic group workshops (Phase 2). This meant that expert assessments of domain areas against the criteria were readily available to draw upon.

An advantage of this late step was that the results were now partly owned by the MCHER, which had not been the case previously. Up until this point, the exercise had been largely conceptualised by the FNR, executed by the FNR and remained, in name, ‘FNR Foresight’. In this way, the ‘new’ assessment can be viewed as a ‘sense-making’ process that conferred ownership of foresight results to the MCHER.

At the same time, the MCHER also came to understand that choices were now largely political in nature. Accordingly, it organised a consultation among the various ministries with a stake in the research domains, offering them the opportunity to further shape (and by implication, further prioritise) the results. It is fair to say that this consultation exercise resulted in little change of the content of the priorities,\textsuperscript{12} testifying to the robustness of the original results. The process did result, however, in the categorisation of the priorities into two classes – ‘essential’ and ‘priority’ domains, where the latter constitutes the more important class – although it remains unclear as to how domains were assigned across the two classes.

The FNR largely adopted these changes when it developed its thematic programmes but chose not to widen the Biomedical Programme to Chronic, Regenerative and Infectious Diseases but instead to develop this Programme along the lines of the topics originally identified by the Foresight. The FNR felt that these topics, being a subsection of the wider topic, were a better means of focusing its resources. This of course begs the question of what other instruments might support the wider development of this particular topic – and of the domain priorities as a whole. This is of particular interest since the FNR represents only about 20% of the public investment in research (see figure 1). So far, beyond the formulation of new FNR programmes, no re-alignment of resources in money or kind by other actors is known to the authors. Moreover, the performance contracts signed between the research performers and the ministry of research do not mention directly the national priorities or the Foresight results, leaving the degree of ownership within the research institutions and the MCHER somewhat unclear for the moment. This might reflect the institutional positioning of the exercise and the questionable ownership by the relevant stakeholders.

\textsuperscript{11} In fact, interdisciplinarity had been somewhat underplayed throughout the conduct of the exercise. It was felt, rightly or wrongly, that the weakness of many of the existing disciplines needed to be first addressed before discussions could fruitfully move to discussion of interdisciplinary opportunities.

\textsuperscript{12} An exception was the Biomedical domain where the focus of the initial Foresight results lay largely on Public Health, Regenerative Medicine and Translational Research and which was subsequently renamed Regulation of Chronic, Degenerative and Infectious Diseases.
6.2 Impact on FNR

One of the main objectives of the Foresight was to inform new FNR programmes in order to replace the existing multi-annual programmes which were about to expire. The internal decision bodies of the FNR were quite satisfied with the results presented at the end of the exercise and thus pressed to develop new programmes on that basis. While the whole process was delayed by the ministerial intervention and their sense-making activities, the FNR was, in parallel, developing a new clearly defined strategy in order to sharpen its impact on the Luxembourg research landscape. After the Government’s agreement on the list of national priorities, this new strategy and the foresight results were then put together in a new approach: a single framework programme reflecting the strategic positioning of the FNR, with the results of the Foresight providing thematic orientation. A first call for project proposals was launched in early 2008, some two years after the initial deadline, with a budget amounting to 12% of the national public R&D budget for this sole programme.

The FNR, as the prime executor of the exercise, also benefited in other respects. Within the research community, the reputation of the FNR in matters of transparency and openness was further enhanced, with some describing FNR as the ‘union’ of researchers. Thus, the exercise strengthened the link between research performers and the research funder. The exercise also helped the FNR to better comprehend the Luxembourg STI environment while putting the thumb on the dearth of statistics and analyses associated with the system’s novelty. Furthermore, the FNR and the other public research actors benefited from a strong presence in the national media, thus familiarizing the wider public with the stakeholders as well as with the role of science in a modern society.

6.3 Impacts on the research community

As mentioned in the previous section, the FNR launched a call for project proposals based on the Foresight results at the beginning of 2008. The FNR received the highest number of proposals (in absolute terms and in relation to the available budget) across all priorities. Perhaps unsurprisingly, the number of proposals in domains newly identified by the Foresight exercise was lower in comparison to the domains were there had been research activities for several years. But as we indicated earlier, foresight is more about evolution than revolution, and shifts towards new areas understandably take time.

Besides the identified priorities, the exercise in itself has produced associated process benefits – for example, in terms of networking between participants and agenda-building by coalitions of participants which will help to sustain the development in the domains identified. Furthermore, some of the public research centres have conducted their own mini-foresight studies, influenced and inspired by the FNR exercise.

Overall, the successful conduct of the Foresight exercise and its implementation, together with all the other ongoing structural changes, indicate a growing maturity of the Luxembourg STI environment, particularly around public governance, thus generating a strong signalling effect to the outside world.
6.4 Impacts on the private sector

It is unclear whether the private sector will find direct use for the results of the Foresight exercise and to what extent the exercise has influenced its strategic aims. On the other hand, the private sector clearly welcomed the opportunity for dialogue with public sector researchers, and some consortia seem to have spun out of the exercise that have gone on to submit proposals to the European Commission. The exercise has clearly demonstrated the need and fruitfulness of such dialogue platforms between the private and public sector.

The exercise has also exploded the myth that the private sector is interested only in short-term research. Many senior scientific personnel from the private sector used the exercise to underline the need for high quality public research as a prerequisite for innovation and mutually rewarding cooperation between both sectors.

7 Summary conclusions

For those familiar with running foresight exercises, the experiences of Luxembourg are likely to be all too familiar. But the small size of Luxembourg also brings into sharp view many of the underlying tensions present in those foresight exercises that explicitly attempt to set national priorities. Some of these are summarised below.

7.1 Setting the scope of prioritisation

Restricting the exercise to the identification of only thematic priorities was a mistake, since consideration of structural aspects is necessary to set priorities. Moreover, this restriction also tended to isolate the exercise from the other strategic initiatives highlighted in Box 1, when in fact there should have been stronger integration. As it happens, participants in the exercise could not resist sometimes identifying structural priorities; moreover, they often raised parallel structural developments when discussing thematic priorities in their working groups. Nevertheless, the exercise’s compartmentalisation almost certainly weakened its potential to directly inform developments in other parts of the research system.

This is also related to the issue as to whether the exercise was intended to set FNR or national priorities. If the latter, then it needed to be much better integrated with parallel initiatives going on elsewhere. Despite claims to the contrary, the exercise was in reality about little more than identifying FNR priorities, a fact confirmed by the scope of priorities implementation seen to date.

A final issue concerns the degree to which the exercise was supposed to identify new domains (regardless of existing competences) or to build on existing strengths. Discussion around this point tended to get tied up with the idea of identifying new ‘competence niches’ for Luxembourg to exploit. A related point was the apparent tension between the need to maintain thematic ‘variety’ in the research system and the need to build ‘critical mass’ in a few selected niches. This issue was never satisfactorily resolved, owing to a lack of common vision among the various stakeholders on the position and contribution of S&T to Luxembourg’s socio-economic development.
7.2 Setting the 'granularity' of priorities

The priorities identified by the exercise were set at a level of granularity that made them suitable for informing FNR’s R&D funding programmes. But confusion set in when the status of the priorities as ‘national’ priorities was challenged by the MCHER. Expectations around competence niches dictated that national priorities had to be fewer in number, and the FNR sought to comply by re-packaging its programme priorities into higher-level national priorities. However, this was unacceptable to the MCHER, which wanted fewer priorities at the same level of granularity as the FNR programme priorities.

7.3 Setting the criteria for prioritisation

The criteria for prioritisation were largely borrowed from international practice (imported by the various consultant groups brought in to help deliver the exercise) and were broadly framed to assess the attractiveness and feasibility of ‘candidate’ research domains. There were, however, a couple of major weaknesses: first, the already-mentioned lack of vision of the role of S&T in Luxembourg’s development meant that some of the criteria were used rather blindly. Secondly, it is clear that a forward-looking process like foresight needs to be underpinned by sufficient and appropriate ‘objectivised’ data, e.g. publication data, statistics on the national R&D environment, reports on the state of economy, environment or society, outcomes of comparable foresight exercises, etc. This was problematic in the Luxembourg setting, as much national data was missing while international benchmarking was of limited use owing to Luxembourg’s small size. This therefore made assessment against some of the criteria very difficult and probably unreliable.  

7.4 Who prioritises?

A further tension appeared in discussions of who should be involved in the process. Some participants – particularly those who were already critical of the performance of the public research centres – believed that the exercise was flawed by relying so heavily upon the ideas and visions of existing researchers. Some even went so far as to claim the exercise had been ‘hijacked’ by the special interests of such researchers and that it should have started with a stronger voice from knowledge users – both societal and commercial. While the exercise did bring in the latter, the levels of engagement by the private sector and other branches of government were disappointing, though perhaps unsurprising, as they saw little stake in the direct outcomes of the exercise. The exercise also brought in foreign experts to challenge any ‘narrow’ thinking on the part of local researchers, though with mixed results.

The importance of ‘champions’ in the thematic groups also became apparent. These individuals (or sometimes groups) were able to channel a strong idea into the exercise and push it to the

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13 At the same time, however, overwhelming participants with large amounts of generic data would have lead to confusion and frustration. A productive use of data requires a thorough scanning of what’s available; its analysis and preparation in order to capture its essence; and its introduction into the foresight process at specifically designed points in order to supply participants with the necessary data as and when required.
end. The results (ideas) of an exercise can only be translated into reality if there is somebody ready to act on it, either directly if the champion is a research performer or indirectly if the champion is a ministry or a funding organisation. Of course, the foresight practitioners need to channel and control the influence of such local champions during the conduct of the exercise, in order to challenge their views and to increase consensus and commitment. On the other hand, the champions are the sole guarantors of a truly effective implementation of results. In research domains that are newly identified (where there are few activities and little resources), an important role of champions is to mobilise the necessary support and resources.

7.5 The institutional positioning of prioritisation

The position of the FNR in the research landscape had both benefits and drawbacks during the conduct of the exercise, as well as for the follow-up implementation. But the expanded scope of the exercise has raised the question whether the FNR was the appropriate executor or whether the MCHER would not have been better suited to perform the study itself. This point was made by some participants in the exercise, as well as by the OECD (2007), which recommended a clearer distinction between policy formulation (the preserve of the MCHER and other ministries) and policy implementation (reserved for agencies such as FNR and Luxinnovation). As previously highlighted, such decoupling of the foresight process from centres of policy formulation / implementation is not unusual, but the risk associated with this is loss of some sense of ownership.

7.6 Mistakes were made, but the exercise has been a success

Thus, conducting foresight in smaller countries is neither easier nor more difficult than in larger countries. Many of the challenges are the same, though perhaps exaggerated in some respects by the system’s small scale. In the context of the FNR Foresight, it is clear that more time should have been devoted to setting its objectives and agenda. The exercise should also have employed a more realistic timeframe, as well obtaining better buy-in from MCHER. Nevertheless, despite these problems, the exercise is widely viewed as a success. Although a lot of difficulties were encountered, for example, in terms of scope, conduct, ownership and implementation, the exercise has become a success due to the commitment of the FNR. There was simply no fall-back solution for the FNR and it relied solely on the exercise for the development of its new thematic programmes. Furthermore, the initiative has been broadly welcomed by the research community (in a survey of participants at the EWS, more than 80% expressed a positive opinion of the exercise) and has also received favourable press coverage. Finally, there is a strong commitment from policy makers to build a more forward-looking and strategic culture across the public research base and an acknowledgement that the FNR Foresight has contributed to this goal in no small part.

References