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EU financing and innovation in Poland

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Abstract

Since the collapse of communism, Poland has distinguished itself as one of the best performing economies in the European Union. However, the recent deceleration of total factor productivity growth in Poland has raised concerns about a "middle income trap". Poland ranks among the lowest in the European Union on all measures of innovation, and the Polish innovation system is weak even by the low standards of the CEE region. In this context, the large-scale injection of EU funds focused on novel product R&D by private firms represents a valuable opportunity to transform the Polish innovation system. The main fear arising from the analysis in this paper is that this EU-funded "innovation tsunami" might prove to be more detrimental than positive. Accordingly, we conclude with a few policy recommendations that the Polish government could follow under the constraints imposed by an already agreed upon EU programme.

Keywords: Poland, European Union, Structural and Cohesion Funds, Innovation Policy, Middle-income trap, Innovation, Economic Growth, Venture capital

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1. Introduction

Since the collapse of communism, Poland has distinguished itself as one of the best performing economies in the European Union. Per capita income increased from roughly one third of the EU-15 average in 1990 to 69 per cent by 2015. Unlike its counterparts in central and eastern Europe (CEE), balanced growth enabled Poland to avoid a recession in the wake of the 2008 financial crisis and growth has remained robust to the present day. For example, per capita income expanded at more than double the EU average in 2014 and 2015 (Eurostat, 2016).

While Poland's performance has been impressive, risks remain. Growth so far has been based, in part, on low labour costs, which provided Polish exporters with an advantage on international markets and which have transformed the country into an attractive destination for foreign direct investment. Real unit labour costs declined by approximately 20 per cent between 1996 and 2012, undercutting regional peers such as the Czech Republic and Hungary, as well as paragons of wage restraint such as Germany (Bogumil and Wieladek, 2014: 2). While a flexible exchange rate and decentralised collective bargaining may continue to curb wage growth in the future, this may prove more challenging as the country develops.

In addition, so far productivity increases have been based largely on the import of foreign technology and know-how. Not surprisingly, innovation policies have been overwhelmingly focused on investment in foreign technology (Bogumil and Wieladek 2014: 11; Kapil et al. 2013: 19). As recently as 2008, 87 per cent of enterprise innovation expenditure was devoted to the acquisition of software and equipment, exceptionally high even by the standards of the CEE region (59 per cent) (Kapil et al., 2013: 11). While Poland's capital stock remains significantly lower than its western European counterparts, particularly in transportation infrastructure (IMF 2016: 27), the gains from continued capital investment can be expected to diminish over time.[1]

In fact, the recent deceleration of total factor productivity growth in Poland and CEE more generally has raised concerns about a "middle income trap". As per capita income exceeds 50 per cent of the EU-15 average, Poland has reached the point where most middle-income countries experience a marked slowdown in economic growth (Bogumil and Wieladek, 2014). Countries that escaped the middle income trap, such as the late-developing Nordic countries or East Asian tigers, did so by entering more knowledge-intensive activities within low- and high-technology industries alike (Dahlman et al., 2006; Wade, 1990). This transformation was not based principally on wage restraint, investment in equipment, or the import of foreign technology, but rather the development of a robust, indigenous innovation system, supporting the development of new products, production processes and organisational forms (Breznitz, 2007; Ornston, 2012).

[1] For example, highway coverage in Poland is a 10th of that in France, Germany or Spain and the country fares even worse on measures of air transportation, including both the number of passengers and the transport of goods (Krajewski, 2014: 103).

Here, the current growth pattern of Poland is worrisome. Poland ranks among the lowest in the European Union on all measures of innovation, from private sector research and development (R&D) expenditure to patenting (Krajewski, 2014). Further, the share of innovative enterprises (23.0 per cent) was the second lowest in the European Union in 2012 and less than half the EU mean of 48.9 per cent (Eurostat, 2016). In short, the Polish innovation system is weak even by the low standards of CEE (Krajewski, 2014). Accordingly, it is by no means clear that it can deliver the kinds of productivity gains that would enable the country to converge with its western European counterparts.

In this context, the large-scale infusion of structural funds under the European Union's new perspective represents a valuable opportunity to transform the Polish innovation system between 2014 and 2020 (see Table 1). This is especially true since this perspective devotes unprecedented attention to indigenous innovation, especially novel product R&D by small and medium-sized enterprises (SMEs). While the previous perspective allocated €8.3 billion to innovation, expenditure was heavily focused on capital investment. For example, 52.9 per cent of innovation expenditure in the Polish 2007-13 perspective was devoted to public research infrastructure and private capital investment, while just 12.4 per cent of funding was spent on private sector R&D and only 2.4 per cent was allocated to new company formation. A similar breakdown applies to the regional funds, which invested €2.3 billion in innovation but spent just €250 million on private sector R&D (Kapil et al., 2013: 24-26). This paper looks at the opportunities and risks this new financial injection brings with it. To do so, it also draws on interviews with 36 Polish policy-makers, investors, industry representatives and academic experts conducted between 12th and 18th May 2016.

Poland is now scheduled to receive a new round of €77.6 billion in structural funds, an annual amount representing 2.7 per cent of GDP and 54 per cent of public investment (European Commission, 2016: 12).[2]

Table 1: Operational programmes, 2014-20

Operational programme	Budget (€, billion)
Infrastructure and environment	27.4
Smart growth	8.6
Knowledge, education and development	4.7
Digital Poland	2.2.
Eastern Poland	2.0
Technical assistance	0.7
Regional operational programmes (16)	31.2
Total	77.6

While innovation expenditure appears only marginally higher under the 2014-20 perspective, the structure of this spending is radically different. As Table 2 shows, the new, €8.6 billion "Smart Growth" operational programme drastically reduces capital investment and nearly quadruples spending on private sector R&D. Most (approximately

[2] In addition to this €77.6 billion, Poland will receive €8.6 billion from the European Agricultural Fund for Rural Development and an unspecified allocation from the European Maritime and Fisheries Fund. Since these funds are not earmarked for innovation, we do not consider them here.

80 per cent) of this will be dedicated solely to SMEs.[3] In addition, another €6.6 billion, focused on more or less the same theme with the same emphasis on SMEs, is to be channelled through 16 regional programmes and the special Eastern Poland programme. To these amounts, one should, at a minimum, add Poland's €1.6 billion national contribution to the smart growth programme and an anticipated €4.4 billion in private sector co-investment.

Table 2: Funds devoted to innovation, 2014-20

Priority axis	**Budget (€, billion)**
SG I. Support for enterprise R&D	3.8
SG II. Support for enterprise R&D capacity	1.1
SG III. Support for innovative enterprises	2.2
SG IV. Increasing research potential	1.2
SG V. Technical assistance	0.3
Total Smart Growth	**8.6**
Regional programme (total of 16)	5.9
Eastern Poland	0.7
Total 2014-20 perspective*	15.2

*Excluding national and private sector contributions

Consistent with other evaluations (Kapil et al., 2013), we applaud efforts to shift funding from capital investment to research and development, particularly since such programmes seemed quite effective under the 2007-13 financial perspective (European Commission, 2015b). That said, we question the pace and scale of this "innovation tsunami". As summarised in Table 3, our report describes how this massive injection of EU funding would nearly double private enterprise expenditure on R&D and more than double R&D expenditure by small and medium-sized enterprises. The effects in venture capital markets are even more dramatic, where one could observe a sevenfold increase in total venture capital investment and even faster growth in seed and early stage risk capital markets.

[3] Of the funding allocated to R&D infrastructure in the Smart Growth operational programme, just 567 million is reserved for universities and other public bodies, a far lower share than under the 2007-13 perspective.

Table 3: An "innovation tsunami", in euros

	Total Polish investments, 2014	Projected annual injection from Smart Growth OP[4]	Projected annual injection from all sources[5]	Total annual projected investments
Business R&D expenditure	1,800,000 million	542 million	1,336 million	3,136,000 million
R&D expenditure by SMEs	700 million	433 million	1,069 million	1,769,000 million
Venture capital investment	22 million[6]	77 million	143 million	165 million

This innovation tsunami has few international precedents in innovation policy. The nearest analogue may be Finland and Israel, which aggressively increased public and private funding to transform themselves from low-technology, resource-based economies in the 1970s into some of the most research-intensive economies in the world by the late 1990s. Careful examination of the Finnish and Israeli cases (Breznitz, 2007; Ornston, 2012) suggests several key differences with Poland. First, Finland and Israel increased R&D expenditure at a much slower rate than Poland plans to. During Finland's "big leap" into new, high-technology industries, R&D expenditure doubled every 15 years (Eurostat, 2016). This comparatively "incremental" approach to innovation enabled Finland to develop its stock of human capital and private sector research capacity, which was already more developed than its Polish counterpart when it began its transition (Dahlman et al., 2006).

Second, Finnish and Israeli innovation policy was consistent. Because innovation is a risky, long-term endeavour, enterprises are sensitive to any large-scale disruption or shift in public support. While Finnish and Israeli innovation policies evolved over the 1980s and 1990s, they also exhibited considerable continuity. Institutions like Tekes in Finland and the Office of the Chief Scientist (OCS) in Israel maintained a central role with their respective innovation systems, were consistently funded, kept on using many of the same programmes even when they created new ones, and continued to prioritise technological R&D even as they developed other policy instruments and new actors entered the innovation system (Breznitz, 2007; Murto et al., 2006). Indeed a clear lesson from all past cases of successful policy-led, rapid-innovation-based growth has been that institutionalisation and continuity over a long period of time, is significantly more important than massive injections of capital (Breznitz, 2007; Breznitz and Ornston, 2014; Wong, 2011).

Poland, on the other hand, exhibits little continuity. In addition to frequent changes in national priorities and weak coordinating mechanisms, innovation policy is heavily

[4] Estimate only includes the European Union's contribution to the Smart Growth OP. We assume the funds will be spent in a seven-year period. While some funds may be spent after 2020, the Polish government has also gotten off to a late start in administering these funds.
[5] Includes contributions from all sources including the European Union, the national government, regional funds and private sector co-investment.
[6] Figure includes seed, early and late stage investments (EVCA 2015: 21).

supported by EU funds and influenced by any shift in priorities in Brussels.[7] Furthermore, since rapid economic growth may limit future access to EU funds, most actors in the Polish innovation system treat the 2014-20 perspective as a one-time bonanza, instead of a base to build upon.

Third, Finnish and Israeli policy-makers worked closely with private sector actors. This is clearest in formal, institutional structures, from the governing board of Tekes to the Finnish Science and Technology Policy Council, all of which have included industry and labour representatives.[8] It also extends to informal institutions, where intense dialogue between policy-makers and private sector representatives was *integral* in educating private sector actors about the importance and logistics of conducting R&D, alerting public sector actors to key bottlenecks or policy flaws and coordinating different aspects of the innovation system. Robust, inter-firm cooperation also enabled private sector actors to pool their own resources and accelerated the diffusion of technological innovations (Breznitz, 2007; Ornston, 2012).

Fourth, while Finnish and Israeli innovation policies were highly coordinated, linking R&D support to educational reform, tax policy, risk capital markets and other domains, Finnish and Israeli policy-makers also granted small agencies sufficient freedom to experiment with unorthodox policies at the periphery of the innovation system (Breznitz and Ornston, 2013). In fact one of the lessons of the Finnish experience is that excessive centralisation can create more problems than it solves, not only by mobilising resources around a single firm (Sabel and Saxenian, 2008), but also by blinding policy-makers and firms to alternative forms of innovation (Ornston, 2016). In Poland, the ability for meaningful experimentalism is severely limited, not only due to the country's dependence on Brussels, but also due to recent reforms to the Polish national innovation system.

Why should Polish and EU policy-makers care about this? The dangers of an innovation tsunami are manifold. In an underdeveloped innovation system, such as Poland, a large increase in R&D could drive up the cost of scarce resources like researchers (since wages are sticky, these may remain elevated even after the funding has dried up). Generous funding could also be squandered as SMEs struggle to identify and execute viable projects without a strong tradition of innovation-based growth or supporting public or private sector institutions. This danger is even more acute if enterprises feel compelled to

[7] While Finland, like Poland, is also an EU member, it did not rely heavily on external funding in developing its national innovation system. The most important decisions were taken before Finland became an EU member in 1995. Indeed, the European Union was not heavily involved in innovation policy at this time.

[8] The Finnish Science and Technology Policy Council, which has been relabelled the Research and Innovation Council, has recently been transformed into an exclusively public sector body. This reflects the current administration's pronounced shift away from innovation policy towards fiscal austerity and labour market reform. This approach may have its merits, but it is not a good model for countries like Poland seeking to rapidly increase private sector research expenditure. Also, peak-level institutional reforms have not altered the underlying pattern of intense, informal consultation between agencies like Tekes and private sector actors.

focus on short-term projects, anticipating a massive decline or shift in innovation funding after 2020.

Risks are even greater in early stage risk capital markets, where the average annual VC funding of new technology- based SMEs is slightly below €20 million. Here, the gap between viable opportunities and the vast, short-term, future supply of EU funds appears enormous (EVCA, 2015). Indeed, the tepid success of past EU-funded VC policies in Poland, where only 3 out of 15 ostensibly technological VC funds created under the KFK (National Capital Fund) scheme are operating as VCs, and where several other funds have not managed to commit to one investment even after several years, points to another looming danger: politically, poorly executed policies could discourage foreign investors and reduce Polish enthusiasm for innovation.

To be clear, some of the dangers that we identify stem from Brussels rather than Warsaw. It is difficult to ensure consistency in innovation policy and collaborate with private sector actors when strategic decisions (such as the shift from technological absorption to R&D and SMEs) are made abroad.[9] Further, bureaucratic EU processes and the risk that the EU or Polish policy-makers may retroactively demand repayment discourage experimentation by civil servants and entrepreneurs.[10] That said, we identify several areas where Polish policy-makers could more effectively dispose of EU funds, despite these constraints. To do so, we begin by briefly characterising Poland's position in the international economy and the state of innovation in the private sector. We then review Polish innovation policy, beginning with the process of policy-making and implementation. We devote two sections to risk capital markets and enterprise R&D, the two biggest priorities in the Smart Growth programme and then briefly discuss other framework conditions that might influence the effectiveness of the 2014-20 perspective**.** Analysis is based on official documents, secondary literature, statistical databases and interviews with 36 Polish policy-makers, investors, industry representatives and academic experts conducted between 12 and 18 May, 2016.

We conclude by suggesting how policy-makers could more effectively utilise the funds devoted to innovation between 2014 and 2020, while limiting their negative impact. First, Polish policy-makers should distribute funds as widely as possible, instead of targeting a handful of instruments or actors (for example, venture capital or SME R&D). Second, Polish policy-makers should prioritise inter-firm collaboration, which plays a particularly important role in innovation systems dominated by SMEs. Third, Poland would benefit from greater public sector coordination, including greater consistency in innovation instruments and funding over time and the more rigorous and systematic evaluation of innovation policy. Fourth, any effort to promote policy coordination or inter-firm

[9] Because Polish innovation policy is so heavily dependent on EU funding, Brussels exercises unusual influence over national policy decisions. Even when the European Union grants national governments considerable latitude in the allocation of structural funds, EU-level discourse has an outsized impact on immature innovation systems by defining relevant objectives and best practices (Suurna and Kattel, 2010).
[10] While the Finance Ministry indicates that only 0.12 per cent of EU funds were retroactively returned since accession in 2004, the fear of retroactive repayment was a recurring theme in interviews with policy-makers and industry representatives.

collaboration should leave sufficient space for experimentation (for example, pilot programmes) at the periphery of the public sector.

Because Polish dependence on EU funding limits its capacity to unilaterally restructure its innovation policies, this report also identifies some EU-level reforms that might improve the effectiveness of national innovation policies in CEE. First, we encourage policy-makers in Brussels to grant national governments considerable latitude in defining national priorities and policy instruments. Second, while the European Union is understandably concerned about the misuse of structural funds, efforts to improve accountability can stifle experimentation when bureaucratic procedures become too cumbersome. This is *particularly* problematic in innovation policy, which demands speed, flexibility and a capacity to assume risk. Third, although we generally discourage burdening national governments with additional requirements, the European Union should prioritise the (national) evaluation of innovation policy. Fourth, we expect evaluations to lead to policy reforms, but we would discourage any radical, large-scale adjustments of the sort outlined in this report.

2. Industry and innovation in Poland

As noted above, Poland has performed exceptionally well since the collapse of communism. Purchasing power-adjusted, per capita GDP increased by 440 per cent between 1991 and 2014, outpacing neighbouring countries such as the Czech Republic (268 per cent), Hungary (304 per cent) and the Slovak Republic (405 per cent) (World Bank, 2016b). Poland's recent performance has been attributed, in part, to its large, internal market, which insulated it from the post-2007 financial crisis (Allington and McCombie, 2014). Viewed over a longer period, however, growth reflects Poland's deeper integration into global production networks. While less internationalised than the Czech Republic, Hungary or the Slovak Republic, FDI stocks increased from virtually nothing in 1991 and 9.3 per cent of GDP in 1997 to 48.8 per cent of GDP by 2013. Meanwhile, domestically owned Polish firms reoriented themselves towards international markets. The value of exported goods and services increased from 21.6 per cent in 1991 to 47.4 per cent by 2013 (OECD, 2016b).

Foreign direct investment, and internationalisation more generally, has been a "crucial" driver of productivity growth in the CEE region exposing firms to new markets, technologies, equipment, organisational arrangements, managerial practices and marketing strategies (Havas et al., 2015: 5).[11] Poland-specific studies also find that integration into global production networks has contributed to movement into higher value-added activities (EBRD, 2014: 41). For example, Jan Hagemejer and Marcin Kolasa find that all forms of internationalisation, including ties to multinational companies, are positively associated with a range of favourable characteristics, including capital intensity, productivity and wage levels. Perhaps even more importantly, these benefits are not confined to individual firms but spill over to their entire sector (Hagemejer and Kolasa, 2011). These efficiency gains appear robust, even when controlling for selection effects (Hagemejer and Tyrowicz, 2012).

If Poland has benefited from internationalisation, what can we say about its position in global production networks? The Polish economy is remarkably diversified, even by the standards of a large country. Similarly to the rest of the CEE region, Poland is characterised by a "segmented" economy in which foreign multinationals coexist with state-owned enterprises, large, privatised firms and entrepreneurial, small and medium-sized enterprises (Martin, 2013: 227). However, the Polish economy is even more heterogeneous, with foreign multinationals playing a less prominent role than other CEE countries, such as Hungary or the Slovak Republic. Meanwhile, Poland's largest, domestically owned firms are relatively small by western European standards, while indigenous industry as a whole is heavily skewed towards small and medium-sized enterprises (Kapil et al., 2013: 91; Martin, 2013: 107).

Partly a result of this distinctive industrial structure, Polish exports are more diversified than its neighbours'. Whereas automotive products represent well over a quarter of Czech

[11] A partial literature review by Havas, Izsak, Markianidou and Radosevic (2015) identifies no fewer than 33 separate sources.

and Slovakian exports and Hungary is similarly dependent on electronics, it is difficult to identify a similar flagship industry in Poland. The country has a thriving auto parts industry, but it also exhibits strengths in other transportation products such as aviation and shipbuilding, as well as a wide range of other industries including agricultural products, cosmetics, minerals, plastics and textiles, and service industries such as tourism and banking (Bogumil and Wieladek, 2014; Kapil et al., 2013; Martin, 2013).

This diversified structure is an asset, insulating the country from disruptive shocks (Ornston, 2016), although it also complicates efforts to define Poland's position in global production networks. Poland has clearly specialised in low- and medium-technology industries. While it has grown in recent years, the share of high-technology exports (7.9 per cent), trails the EU average (15.7 per cent), the Czech Republic (15.3 per cent), Hungary (14.5 per cent) and the Slovak Republic (9.9 per cent) (Eurostat, 2016). The gap is even more pronounced when one broadens the scope of the analysis to include medium-high technology industry and measures of value-added (Bogumil and Wieladek, 2014: 4-5). Moreover, growth within high-technology industries is rarely based on continuous, radical product innovation, but rather "second generation" innovations that involve the introduction of incrementally better products or superior production processes. For example, industry representatives indicated that the Polish pharmaceutical industry excels in the development of generics rather than breakthrough drugs. Similarly, investors argued that the Polish IT industry has thrived by developing innovative solutions for local markets, but not by introducing transformative products or platforms. Both analysts and the Polish government have expressed concern about these developments (Bogumil and Wieladek, 2014: 5; Ministry of Development, 2015: 12).

We do not see Polish weakness in high and medium-high-technology industries as intrinsically problematic for several reasons. First, high-technology growth does not necessarily drive knowledge development or technological spillovers. If countries specialise in relatively low value-added activities such as basic assembly and export operations, levels of innovativeness may remain low. Mexico's experience in the high-end electronics sector stands as a stark reminder of this fact (Samford and Breznitz, 2016). Second, by entering a crowded field with low transportation costs, aspiring high-technology leaders, such as Hungary, can find themselves surprisingly vulnerable to cost competition (Havas, 2014). Even leading knowledge producers such as Finland have found themselves highly susceptible to disruptive technological shocks when they relied too heavily on a single firm or industry (Ornston, 2014).

Lastly, it is important not to equate innovation with radical, science-based product invention. Indeed, if the policy aim is to have sustained and equitable economic growth, Silicon Valley offers the wrong lessons compared with Taipei China, Germany and China (Breznitz, 2007; Breznitz and Murphree, 2011; Breznitz, 2014; Havas, 2014; Lundvall, 2002). This is especially the case for Poland which not only lacks the basic human, capital, physical and legal infrastructure necessary to develop a Silicon Valley-like ecosystem around high-tech companies aiming for quick, high-multiplier, financial exits, but is already witnessing a political backlash against growing, regional inequalities. It makes sense for Poland to develop conditions that are more favourable to the

development of specialised niches such as generic pharmaceuticals or gaming, but we see no reason to prioritise high-technology industry per se.

In fact, Poland could go far by upgrading existing, low and medium-technology industries to compete in more knowledge-intensive and higher value-added activities. Economies such as Austria, Germany and Switzerland, for example, have thrived by introducing incremental product and process innovations into established, century old medium-technology industries such as steelmaking, machine tools and watches (Hall and Soskice, 2001; Herrigel, 1996; Herrigel and Wittke, 2004; Katzenstein, 1984). The Nordic countries are in some respects even more impressive, developing effective national innovation systems within relatively low-technology, resource-based economies (Dalum, 1992). While Finland and Sweden have received attention for rapid, radical product innovation in high-technology industries such as mobile communications, enterprises have also innovated in traditional industries by "doing, using and interacting" (Lundvall, 2002). Poland could benefit considerably from upgrading mature industries and we find the government's commitment to traditional manufacturing in its Smart Growth strategy and public communications encouraging.

That said, Poland is poorly equipped to capitalise on these opportunities. At 0.94 per cent in 2014, the share of expenditure devoted to R&D is well below the EU average of 2.03 per cent and significantly less than the Czech Republic (2.0 per cent) or Hungary (1.37 per cent). Indeed, Poland is doing especially badly in the European Innovation Score Board where, with a score of 0.29175, it is far behind leaders such as Sweden (0.70), significantly behind CEE leaders such as Slovenia and Estonia, moderately behind Hungary, the Slovak Republic and Serbia, and above only Lithuania, Latvia, Croatia and Romania in the whole of the European Union (Hollanders et al., 2016). Moreover, approximately half of this research is conducted by universities and public research institutes, with limited relevance to the private sector. Private enterprise expenditure on R&D represents just 0.44 per cent of GDP, less than half of the EU average and about 10 per cent of the world's leading innovators (Eurostat, 2016).

There is evidence that cumbersome statistical procedures and an absence of tax benefits discouraged Polish enterprises from reporting R&D expenditure until recently (Kapil et al., 2013: 9). That said, other measures paint a similar picture. Researchers represent just 0.6 per cent of the labour force, the fifth lowest in the European Union, and two-thirds of these are employed in the public sector. In 2013 Poland filed 12.7 patents per million inhabitants with the European Patent Office, less than a tenth of the EU average (113.3) and less than half as many as regional counterparts such as the Czech Republic (23.2) and Hungary (25.3) (Eurostat, 2016); and these figures are even lower once we look at triadic patents (patents that were deemed important enough by their owners to be filed in all three major patenting offices of the European Union, the United States and Japan). Over a third of Polish patents are held by public sector institutions and the quality of these patents, as measured by citation counts, is very low (EBRD, 2014: 19).

Further, while in 2013 total enterprise expenditure on *innovation* (1.42 per cent of GDP) was much closer to the EU average (1.98 per cent) of GDP (European Commission,

2015a: 84), expenditure was overwhelmingly focused on capital investment (Kapil et al., 2013: 11). Although such investments are important for the transitional economy and can lead to important process and organisational innovations, very little such innovation appears to have been stimulated as a result of this investment in Poland (World Bank, 2016a). The share of turnover from innovation has declined continuously since 2004 and stood at 6.3 per cent in 2012, the sixth lowest in the European Union. The share of innovative enterprises (23.0 per cent) increased between 2010 and 2012, but is the second lowest in the European Union and well below the EU average of 48.9 per cent (Eurostat, 2016). A recent World Bank report stated that: "Polish enterprises seem to be particularly struggling with both product and process innovation" and found that only 8 per cent of Polish manufacturing firms (in all sectors) introduced any product or process innovation in the period 2010-12 (World Bank, 2016a: 6). Even if we expand our definition of innovation to include marketing and organisational changes, only 15 per cent of SMEs introduced any innovations, placing Poland last or second-to-last in the European Union in each of these categories (European Commission, 2015a: 83-84).

Viewed in this light, Poland's poor performance in innovation is not simply a story about the country's weakness in high-technology industries such as mobile communications, biotechnology or semiconductors (Bogumil and Wieladek, 2014). Rather, it reflects an enduring reliance on capital investment and low labour costs in mature and emerging industries alike (Kapil et al., 2013: 14). Any efforts to promote innovation should not be restricted to research-intensive firms aspiring to engage in radical, product innovation (especially since very few of these enterprises exist, even in high-technology niches), but rather address a broader array of innovative activities, including incremental and second generation product innovation, process innovation, marketing innovation and organisational innovation (EBRD, 2014).

To do so, policy-makers need to prioritise a wider range of supply-side inputs. Low levels of private research expenditure represent just one of several weaknesses within the Polish innovation system. Given the small number of radically innovative, high-technology enterprises in Poland, we are not particularly concerned about low levels of venture capital funding or university spin-offs. Rather, we would emphasise more basic resources integral to second-generation innovation, such as machinery and other forms of equipment. While there is little question that the 2007-13 financial perspective focused excessively on the import and adoption of foreign technology, Poland still possesses significantly less capital than its western European counterparts and there is scope for continued investment in this area (IMF, 2016: 27; Krajewski, 2014: 103). For example, Poland has the lowest share of firms using Cloud Computing within the OECD (OECD, 2016a; P. 41), and one of the industry associations shared with us the results of its surveys that shows that 23 per cent of Polish SMEs do not use any ICT, of whatever form, at all.

To utilise this equipment effectively, Poland requires human capital. Poland exhibits clear strengths here, ranking very highly in the quality of its secondary education (EBRD, 2014: 55) and the share of the labour force graduating with a tertiary education (European Commission, 2015a: 84). But the country produces a relatively small number of

doctorates, university students do not always graduate with a skillset that aligns with industry needs, vocational training is underdeveloped and Poland performs poorly on measures of continuing education (European Commission, 2015a, 2016; Eurostat, 2016; OECD, 2016a; World Bank, 2011). This has important implications for innovation. Even in mature industries, high quality human capital is crucial for incremental product and process innovations, enabling managers to introduce new technology, production processes and organisational patterns, using high quality feedback from shop floor workers (Culpepper and Finegold, 2001; Lundvall, 2002). One international businessman remarked:

> "The Polish plant is the most automated and the equipment is the most sophisticated of all. France is probably the least modernized. But that being said, if you looked at the process itself, the French have squeezed a lot out of the process, because they don't have equipment. And the guys in Poland enjoy the benefits of EU money that enable them to invest in equipment. But it's not the most efficient or optimal process." (Interview, industry representative, Warsaw, Poland, 16 May 2016.)

Finally, innovation is constrained by Polish universities and public research institutes. Those do not perform particularly well on international rankings. No Polish institutions rank among the top 300 universities in the world and the country exceeds just five other EU member states in per capita-adjusted measures of high impact publishing (European Commission, 2015a). No such rankings exist for the country's public research institutes, but evaluations suggest that there is room for improvement (World Bank, 2011: 49-50) and interviewees did not cite them as a consistently important resource like the Fraunhofer Society in Germany or the Advanced Technology Group (GTS) institutes in Denmark. Indeed, many interviewees did not even rank them as a suitable partner, preferring instead to work with foreign research institutions and universities when developing new products and processes. These weaknesses are particularly problematic in light of Poland's reliance on SMEs. Unlike large enterprises, these firms often lack the resources to generate knowledge, manage research projects, invest in expensive capital equipment or develop specialised skills.

Developments in each of these areas are compromised by consistently low levels of cooperation across the Polish innovation system. Evaluations repeatedly comment on the low level of coordination in Polish innovation policy (Havas et al., 2015; Kapil et al., 2013). In interviews, private sector representatives exhibited little awareness of what government was doing or planned to do in this space. Indeed, even government agencies operating in the innovation space using EU funds admitted to having very little capacity to cooperate across ministerial boundaries. To a lesser extent, this extends to other public sector bodies as well. While the share of innovative firms that listed universities as an important source of information was relatively high (7 per cent), Poland ranks among the lowest in the European Union in other measures of cooperation like business funding of university R&D and co-publishing rates (European Commission, 2015a: 84; Havas et al., 2015: 28). A mixed picture also emerges with public research institutes. While the share of innovative enterprises relying on public research institutes for information was the

highest in the European Union at 7 per cent in 2012 (Havas et al., 2015: 28), evaluations suggest that these bodies could develop closer links with private industry (World Bank, 2011: 49-50) and several interviewees identified barriers to cooperation. In the words of one industry representative:

> "You can use [equipment at research institutes] today as a company, but the cost is really high and it's way too expensive. Companies prefer to call institutions abroad, in Germany or the Netherlands, where they usually are granted permission of: 'Yes, you can come in a few days and use it for free.' While in Poland, it's not accessible and [it's] expensive." (Interview, industry representative, Warsaw, Poland, 16 May 2016.)

Nor is industry capable of developing collective goods independently. Interviewees suggested that levels of inter-firm cooperation were also relatively low. Almost all of our interviewees commented that Poland is a "low trust society". Those observations are strengthened by the fact that Poland ranks third to last in the European Union in the share of innovative SMEs collaborating with others (3.9 per cent) and well behind countries with a strong, innovative system of SMEs such as Austria (15.3 per cent), Denmark (17.3 per cent) and Germany (11.5 per cent) (European Commission, 2015a: 83-84).

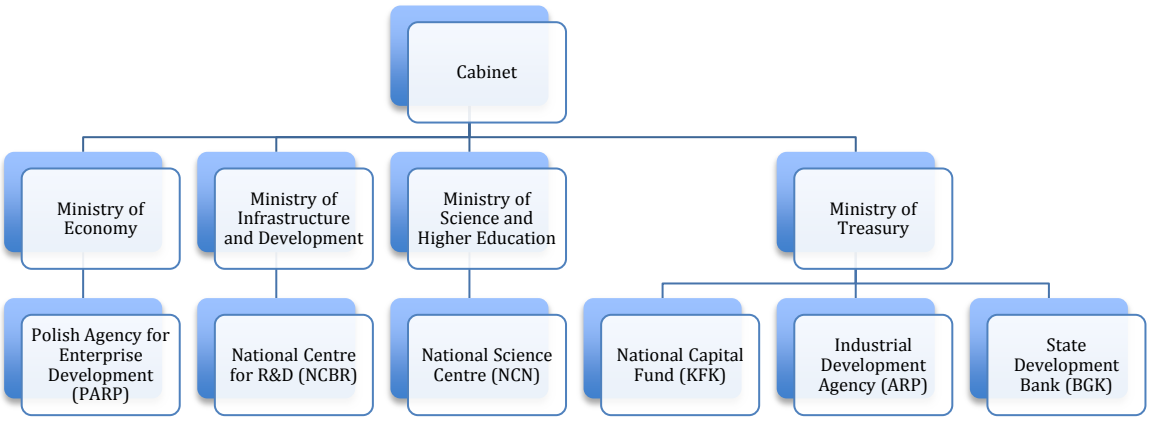
In short, this brief overview of Polish industry suggests that low levels of innovativeness cannot be blamed on the country's reliance on relatively low and medium-technology industries. Poland not only lags in radical product innovation, but measures of incremental product, process, marketing and organisational innovation as well. This also does not reflect a single bottleneck such as low levels of research expenditure or a dearth of early stage risk capital, but weakness across a wide range of areas, from public research to human capital and even investment in equipment and machinery. These shortcomings are exacerbated by consistently low levels of cooperation across all levels: within the government, between public sector bodies and industry and among enterprises themselves. The following sections examine how Poland is tackling this innovation deficit, beginning with the policy-making process and continuing to examine developments in early stage risk capital markets, applied research and human capital. At each step, the paper questions the wisdom of an "innovation tsunami" focused narrowly on early stage risk capital and R&D expenditure in SMEs.

3. The innovation policy-making process

Poland's ability to leverage EU funding depends crucially on its administrative capacity and the quality of its policy-making process. Finland, for example, relied on the Science and Technology Policy Council (now the Research and Innovation Council) engaging the prime minister, major ministries and leading private sector actors to coordinate competent public sector agencies such as Finnvera and Tekes (Dahlman et al., 2006). Until recently, Poland was one of just two countries in the CEE region without a similar coordinating body (Havas et al., 2015: 7). Frequent restructuring within the government of Poland makes it difficult to generalise, but in 2015 responsibility for national innovation policy was divided between four major ministries, the Ministry of the Economy, the Ministry of Infrastructure and Regional Development, the Ministry of Science and Higher Education and the Ministry of the Treasury. Once again, these agencies face restructuring and it was not clear at the time of writing who the new actors would be or who would supervise which EU funds.

Within Polish innovation policy, the Polish Agency for Enterprise Development (PARP) disposed of most investment grants until recently and continues to focus on the development of SMEs. It is accompanied by the Industrial Development Agency (ARP), which was instrumental in the creation of science and technology parks in Poland and remains an important player in SME development and innovation. The National Science Centre (NCN) supervises institutes of higher education, the Polish Academy of Sciences and the public research institutes. The National Centre for Research and Development (NCBR) has assumed primary responsibility for the promotion of enterprise R&D. It is flanked by KFK, a fund of funds designed to increase venture capital funding and the State Development Bank (BGK), which, among other activities, extends credit and loan guarantees for technological investment and development (Kapil et al., 2013: 40-51; Klincewicz, 2015: 2-4). As of the summer of 2016, however, the newly elected government had announced its intentions for a complete restructuring of this policy apparatus.

Chart 1: National Polish innovation policy at the end of 2014*



Note: *Adapted from Klincewicz (2015), page 3

Frequent institutional changes and the absence of a powerful, coordinating body have had predictable consequences for innovation policy. In 2007 the Ministry of Regional Development identified no fewer than 406 government strategies with no common vision and often working at cross-purposes (Rybinski and Kowalewski, 2011: 647). A more recent evaluation by the National Bank of Poland reached similar conclusions, struggling to delineate responsibility for innovation policy, failing to identify a single, overarching strategic vision and expressing concern about contradictory policies (NBP, 2016).

This is not to imply that Polish innovation policy is completely chaotic. Because the national innovation system is dominated by a relatively small number of actors, the government has been able to respond to recent evaluations by the World Bank and European Union, which recommended shifting support away from capital investment to R&D support (European Commission, 2015b; Kapil et al., 2013; World Bank, 2011). EU structural funds have also played an important role in precipitating coordination at both the national and regional levels (Rybinski and Kowalewski, 2011: 647), as evidenced by the adoption of a Smart Growth strategy in 2014 (Klincewicz, 2015: 4).

As subsequent sections relate, however, Poland's capacity to develop ad hoc responses to foreign pressure, funding and suggestions *does not substitute for an effective, long-term, strategic vision*. By failing to develop a clear, national strategy, Polish policy-makers are more susceptible to real or perceived shifting of EU priorities. This may explain why Poland focused so narrowly on investment in equipment and research infrastructure in 2007-13 and has now developed an extreme emphasis on SME research and venture capital funding.[12]

The new government, to its credit, has attempted to remedy these deficiencies, merging the Ministry of the Economy and the Ministry of Infrastructure and Development into a

[12] This point was confirmed by an analysis of RIO reports (https://rio.jrc.ec.europa.eu) and interviews with innovation policy experts in Greece (1 July 2016) and Portugal (12 July 2016), both of which are heavily dependent on EU funds.

single Ministry of Development responsible for coordinating both national and regional economic policy. At the beginning of 2016 the government attempted to further improve coordination between the newly created Ministry of Development and the Ministry of Science and Higher Education with the introduction of the Innovation Council, engaging five ministries, three of whom are deputy prime ministers. Finally, the government has proposed merging several agencies and funds, including PARP, KFK and ARP, into a single Polish Development Fund. The specifics remained unclear as of July 2016, but the single entity would presumably eliminate duplication and more effectively coordinate innovation policy.

We applaud these recent developments, but see several barriers to the effective use of EU funds, and innovation policy more generally. First, the creation of the Innovation Council is a positive development, but it does not rival other, leading innovators in its profile and resources. The Finnish Innovation Policy Council, and similar bodies in other countries, engages the prime minister in order to elevate innovation to the top of the government's agenda, strengthen the organisation's recommendations and increase coordinating capacity. The Finnish council's effectiveness was historically enhanced by a well-trained, permanent secretariat (Dahlman et al., 2006).[13] The Polish Innovation Council, by contrast, was dismissed by every private sector representative we contacted. While it is too early to assess the council's performance, interviewees expressed scepticism. The view below is representative of all industry leaders we interviewed:

> "It is always beautiful to address an issue by forming a council but it goes nowhere. If you take a look at the names in this council, you will have your answer of how ineffective it will be." (Interview, industry representative, Warsaw, Poland, 18 May 2016.)

Private sector scepticism towards the Innovation Council is partly a consequence of the decision to conceptualise the organisation as an exclusively public sector institution. The Finnish Innovation Policy Council included representatives from the major industry associations, trade unions and the country's largest research-intensive firms (Murto et al., 2006). This was important for two reasons.

First, private sector participation helped the government identify key bottlenecks (Ornston, 2012). For example, Polish enterprises were exasperated with the time it took the government to introduce tax incentives for R&D, while financial actors argued that public risk capital was ineffective as venture capital investments were subject to double taxation.[14] It is not clear how sensitive the Polish government is to these challenges as enterprises (and some policy-makers) repeatedly characterised the national government as aloof, opaque and inaccessible. In the words of three private sector representatives:

[13] This secretariat was recently abolished. As noted above, this represents a broader shift *away* from innovation towards fiscal and labour market reform in Finland and, as such, does not represent a particularly good role model for Poland.

[14] This tax barrier was actually addressed in a government reform in January 2016. However, the fact that leading venture capital investors were not aware of this in June 2016 highlights the poor state of communication between the public and private sectors.

> "[The government] is not in dialogue with the people with real market experience … We are a pan-European brand and we never talk with the Polish government. I consult for the EU [but not Poland]." (Interview with industry representative, Warsaw, Poland, 13 May 2016.)

> "Business has taken the changes the new government has made… very negatively, since we think they make the civil service even less professional and effective. Good [civil servants] replaced with inexperienced youngsters, amateurs who cannot, or want, to have dialogue with business." (Interview with industry representative, Warsaw, Poland, 18 May 2016.)

> "When we start to talk to the new government… [pauses and smiles] It's hard to say that, because it seems like they don't want to talk to anyone." (Interview with industry representative, Warsaw, Poland, 16 May, 2016.)

Second, private sector participation would enable the government to more clearly communicate its plans and expectations to industry, as well as raise general awareness about the importance of innovation. In Finland, the government relied on the Innovation Policy Council, as well as short courses, to educate corporate executives, journalists and other stakeholders on the benefits of innovation (Ornston, 2012). Similarly, a leading architect of Iceland's transition from a resource-based economy to a relatively research-intensive nation underscored the challenges of boosting innovation in a low-technology economy during the 1980s: "We had to set up committees to educate [firms] on product development – what's innovation? How do you approach it? I had to run courses to teach project management." (Interview with former policy-maker, Reykjavik, Iceland, 24 May 2016.)

Consultants and industry associations familiar with Polish industry suggested that enterprises, while interested in innovation, were risk-averse and reluctant to devote resources to R&D or similar projects. This reluctance reflects several EU- and national-level dynamics. First, continued uncertainty over whether innovation will be funded in the same way and to the same degree in the next financial perspective discourages long-term research. Second, EU and national regulations subject applicants to onerous bureaucracy and retroactive decision-making. Several interviewees shared stories of funding that was pulled retroactively because projects were not deemed sufficiently innovative or failed to meet other technical requirements.[15] Finally, concerns about EU funds were exacerbated by continued confusion over what the *national* government defines as "research" or "innovation" for tax- and grant-giving purposes.

More generally, interviewees complained about the bureaucratisation of Polish innovation policy and EU-funded initiatives in particular. One industry representative remarked: "The EU-related procedures are so complex and onerous that I will not touch

[15] While data from the Polish Ministry of Finance suggest this is not common, it was certainly perceived as a widespread problem by many of our interviewees.

them." (Interview with industry representative, Warsaw, Poland, 17 May 2016). Another commented:

> "I would never look for support from the EU-funded projects because then I would have to hire two or three people just to file the papers properly. So I think there needs to be money for SMEs and you shouldn't need to prepare a full tract of papers before you get it, because not many companies have the resources to go through all of this." (Interview with industry representative, Warsaw, Poland, 18 May 2016.)

Still others noted that in order to have any chance of being approved applicants needed to hire professional grant writers. This is a cost that most SMEs, a priority under the new financial perspective (see below), cannot afford.

While some of these bureaucratic hurdles were introduced by Brussels in a bid to improve accountability in the distribution of structural funds, other regulations appear to be self-imposed. Comparative studies have expressed concern about the amount of regulation and legalistic nature of Polish governance (European Commission, 2015b; Kapil et al., 2013; Rybinski and Kowalewski, 2011). Interviewees suggested that extensive regulation, and the arms-length attitude toward the private sector, stemmed from an effort to combat corruption that could do more harm than good. Much as the legalistic application procedures under the 2007-13 financial perspective favoured larger, well-organised firms (Kapil et al., 2013: 50), interviewees suggested that civil servants might fail to move quickly and take risks of the sort necessary to stimulate innovation. An industry representative remarked:

> "People are so afraid of losing their jobs in the public sector now, that the result can be stagnation. I'm not worried about the money being wasted by going to strange projects, I worry that it will be wasted because it will not be used, and it could and should be used. Because of fear, civil servants will never allow true innovative projects. The risks of failure are too high … If [the government] says they'll be fighting corruption and business links, there will be paralysis that results from the current risk-taking in the civil service." (Interview with industry representative, Warsaw, Poland, 18 May 2016.)

These points, from the coordination of innovation policy, to the importance of engaging private sector representatives and the bureaucratisation of innovation policy might be clearer if the Polish government developed a more systematic capacity to monitor and evaluate innovation policy. While it has worked with organisations such as the World Bank on an ad hoc basis and done an excellent job of incorporating its recommendations, no standing body is responsible for evaluating Polish innovation policy. In fact, innovation studies as a field is conspicuously underdeveloped in Poland relative to other western European societies such as Denmark (Lundvall, 2002), Finland (Schienstock, 2004) or Sweden (Eklund, 2007). While this is perfectly understandable as the transition from communism led policy-makers and academic economists to prioritise

macroeconomic policy (Kattel and Primi, 2014: 285), where Poland has excelled (Allington and McCombie, 2014), it should now become a high priority.

The underdeveloped state of innovation studies and the absence of a permanent, high-profile organisation responsible for evaluating Polish innovation policy provide additional evidence that low levels of innovativeness in Poland are not simply a question of capital scarcity. To fully capitalise on EU structural funding, Polish policy-makers need to improve administrative capacity and the policy-making process (McCann and Ortega-Argilés, 2013a: 408). This analysis has highlighted the need for several changes. First, we recommend improved consistency and coordination of public sector innovation, beginning with greater continuity among the key actors and extending to greater coordination across different policy domains. Second, greater coordination of innovation policy should include a more robust capacity to monitor and evaluate innovation policies, preferably by a permanent body.

Any coordination or centralisation of innovation policy should not come at the expense of our other recommendations, which are arguably more fundamental to the long-term development of the Polish innovation system. Third, policy-makers need to involve private sector actors more fully at *all* stages of the policy-making process, from peak-level bodies such as the Innovation Council to the application process at the agency level. Fourth, Poland should continue to de-bureaucratise the innovation funding process, which requires speed, flexibility and a willingness to assume risk. An overzealous campaign to maximise accountability or minimise corruption could stifle public and private sector innovation.

Our fifth recommendation is to preserve enough space at the periphery of the public sector for small agencies to experiment with novel policy instruments, much along the lines of Sitra and the Office of the Chief Scientist (OCS) in Finland and Israel, respectively (Breznitz and Ornston, 2013).

Having identified general guidelines to improve the policy-making process, we now turn to the particular content of the Smart Growth operational programme, focusing specifically on efforts to boost venture capital and enterprise research.

4. Venture capital

Consistent with the emphasis on technological innovation in SMEs, the 2014-20 financial perspective has prioritised venture capital. In this light it is important to look at the structure of the current financial markets. Polish financial markets were among the most stable and well-developed in central and eastern Europe in the wake of the financial crisis (EBRD, 2014: 67). That said, market capitalisation as a share of GDP (26.9 per cent in 2013) remains modest by western European standards and is endangered by a 2010 pension reform that threatens to hamstring pension funds, one of the only large-scale institutional investors in Poland (EBRD, 2013). Many western European countries with small equity markets rely on banks to allocate capital to firms, but Polish lending (66.2 per cent of GDP in 2013) is less than half that of credit-based financial systems such as Germany (124.8 per cent) or Italy (157 per cent) (Geodecki et al., 2013: 77). Capital constraints appear to be particularly pronounced for aspiring innovators (EBRD, 2014: 69). This is not surprising as banks have a harder time evaluating and collateralising innovative projects.

In mature financial systems, venture capital markets perform this role. Polish venture capital, however, is even less developed then bank lending. In 2014 Polish venture capital investments represented just 0.00534 per cent of GDP, exceeding only Italy and crisis-afflicted Greece within the OECD (OECD, 2016b).[16] This weakness was also evident in interviews with industry experts who remarked that, while many organisations defined themselves as venture capital, only a handful of funds targeted genuinely new, technology-intensive enterprises. One investor remarked: "I think it is a problem to find more than one VC [venture capital] firm, which is actually VC in Poland." (Interview with Polish investor, Warsaw, Poland, 17 May 2016.) Another industry veteran was only slightly more optimistic: "You can find only one or two with a real VC background. The others are consultants and bankers." (Interview with Polish investor, Warsaw, Poland, 18 May 2016.) The same view was expressed in all of our interviews with the multiple agencies that distribute funds. One of them bluntly stated: "There is one real VC fund in Poland, three more that also do some VC investments, and all the rest are mainstream private equity with no interest or knowledge of technology." (Interview with a director of a development agency, Warsaw, Poland, 18 May 2016.)

Preoccupied with investment in basic infrastructure, new equipment and technological absorption, early stage risk capital markets received limited attention until recently. KFK, established in 2005 as a venture capital fund of funds with €300 million, represents one of the first and most important large-scale initiatives in this area. More commonly, policy-makers sought to assist new, growth-oriented firms by investing in incubators, technological parks and other supporting services rather than through equity investments. The 2007-13 financial perspective invested over a €1 billion in these types of business environment institutions at both the national and regional levels. Less than a quarter of that, just 2.4 per cent of the operational programme, was devoted to private equity and venture capital instruments (Kapil et al., 2013: 26).

[16] In addition, only roughly half of this sum was allocated to young technology companies.

The 2014-20 financial perspective differs sharply from its predecessor in this respect. The Smart Growth operational programme alone more than doubles the share of public funds dedicated to national-level venture capital and private equity-related programme from less than a quarter of a billion euros to over half a billion euros. Moreover, these funds are heavily oriented towards seed and early-stage venture capital investments. While smaller than support for applied R&D (see below), venture capital investments are much larger in relation to the existing industry, dwarfing past and present investments. Again, all these plans are now ambiguous as it is not clear what, if anything, the new government will change, what the European Union will agree to, the timeframe by which these negotiations will be concluded and the long-term future of EU structural funds in Poland.[17]

For example, the NCBR's Bridge Alfa programme is a new initiative designed to promote university spin-outs and start-ups by subsidising early stage venture capital investments. Spread out over seven years, this €100 million programme would, *by itself,* more than double the €11,520,000 that private and public investors allocated to seed and start-up stage projects in 2014 (EVCA, 2015: 21). This programme is flanked by half a dozen other initiatives, including: Bridge VC, which subsidises R&D projects by VC-funded enterprises; Starter, which invests directly in innovative start-ups; Biznest, which facilitates angel investment in SMEs; and several other programmes designed to support technology transfer, innovation and capital market access.

Further, the list above only represents instruments associated with the Smart Growth operational programme and does not include regional operational programmes, KFK, the State Development Bank (BGK), the EBRD (European Bank for Reconstruction and Development) and other actors who are, or may become, involved in this space. Viewing all of these programmes collectively, interviewees expected Polish venture capital markets to be flooded with more than €1 billion in public funds over the next seven years. At roughly €150 million a year, *this support would increase venture capital investment more than tenfold.* Since, in principle, all these funds are to be matched by private financing, *the current framework could lead to a twentyfold increase in VC investment*.

We agree that a robust venture capital market can play an important role within a competitive innovation system and we believe that policy-makers should, at some level, continue to support the industry in Poland. That said, we believe that flooding the system with a tsunami of cash may create more problems than it solves. First, it is by no means clear that Poland has the human capital to dispose of these funds. As noted above, interviewees could identify only a handful of organisations with the knowledge and experience to identify, evaluate and support risky, innovative projects. In the words of one industry participant:

> "We don't have experts who really work on technology investment… We lack, as a country, competencies and expertise of how to commercialise

[17] Needless to say, this environment is hardly conducive to risky, long-term investment in new enterprises and innovation more generally.

different technology-based projects." (Interview, venture capital industry representative, Warsaw, Poland, 18 May 2016.)

The story of KFK is a stark example of this. Of the 15 funds that KFK funded, roughly half never managed to make one investment, and only three developed a real VC business model and were still operational in 2016. By all accounts, KFK managed its funds too actively, but the organisation's decision to do so also reflected its inability to identify and delegate authority to experienced and knowledgeable fund managers (interview, venture capital industry representative, Warsaw, Poland, 18 May 2016). Further, KFK managers were, rightly, worried that the European Union's retroactive inspection of investment decisions might lead to demands of full repayment by the investee if the EU inspectors deemed the projects not innovative enough. Of course, KFK did support several successful funds and even its failures contributed to the development of a larger, more experienced and more sophisticated cadre of venture capital investors. That said, all interviewees agreed that the pool of talent within Poland was very thin and not sufficient to effectively dispose of hundreds of millions of euros a year.

Moreover, even if Poland developed a large pool of talented, world class venture capital investors, it is unclear whether they could find enough high-quality targets to effectively invest up to €200 million a year in venture capital funds. To be clear, the start-up scene has improved in Poland in recent years, supported in part by public initiatives and private venture capital funds, like GIZA Polish Ventures, MCI Capital and Biznest. Interviewees argued that investments like Google's new, Warsaw-based campus has created a critical mass for entrepreneurs in IT and other high-technology industries. That said, Poland does not currently possess the research institutions, human capital or international linkages that characterise other IT leaders like the United States, Israel, Taipei China, Sweden or Finland (Breznitz, 2007; Ornston, 2012). On the contrary, we identify significant and systemic weaknesses throughout this report.

While we find developments in the Polish high-technology industry to be very encouraging and we believe the venture capital industry deserves greater public support, we saw no evidence that Poland possesses enough viable targets to support even a three or fivefold increase in venture capital funding, let alone a ten or twentyfold increase. On the contrary, KFK's funds' strikingly high failure rate to even invest reflects the difficulty of identifying viable projects. Even the most optimistic investors we interviewed suggested that Poland's most successful high-technology enterprises excel at second generation innovations targeted at regional markets, which do not necessarily require a large and sophisticated venture capital industry.

When Poland's limited experience with venture capital and relatively small number of targets are taken into account, these massive venture capital investments could do more harm than good. Public funding could drive out private investment, already prompting one successful fund manager to exit the industry.[18] As this flood of capital chases a limited number of viable targets, it could drive down returns. Low returns would make it

[18] Anticipating a flood of VC and an increasing demand for viable targets in the coming years, this investor has decided to focus on developing new projects at the incubation stage.

harder to attract foreign investors, already discouraged by poor returns from a large wave of investments in 2007 (interview with venture capital industry representative, Warsaw, Poland, 16 May 2016).

Where does this leave policy-makers that want to promote the high-technology industry and venture capital investment in particular? First, all interviewees recognised that the public sector could play a constructive role in venture capital markets, and it makes sense to gradually increase funding. But we would argue that public support should be increased at a slower and more sustainable pace.

Instead, we encourage the government to invest European funds more broadly. While the €1 billion allocated to accelerators, incubators and technology parks under the previous perspective represents another case of excess, we believe there is scope for investing in a wider array of enterprises and activities. For example, BGK's loan guarantee programme represents a scalable initiative with relatively low administrative requirements that enables innovative enterprises to access capital, without focusing exclusively on a relatively small subset of high-technology firms. Also, the government could relax its emphasis on technology intensive firms to target a broader array of innovative enterprises, including firms that specialise in the kinds of second-generation and process-based innovations that have underpinned Polish growth to date, and led other countries, such as Taipei China and Korea in their sustained and rapid growth stage (Amsden, 1989; Breznitz, 2007; Noble, 1998).[19]

[19] Under the current programme NCBR has decided to distinguish itself from KFK by focusing exclusively on "technology-intensive" firms (interview with government agency, Warsaw, Poland, 17 May 2016). We would encourage the fund to consider a wider range of enterprises and business models.

5. Encouraging enterprise R&D

In contrast to early stage risk capital markets, which are a relatively recent development, Poland has a much longer history of supporting research. Under communism, however, R&D was virtually monopolised by state-controlled universities and research institutes. This is not to suggest that Polish enterprises could not be innovative. They often excelled at process innovation, developing creative solutions to persistent shortages. But they were not involved in formal research and communist-era incentives discouraged other forms of experimentation, including product development and any type of radical innovation (Kattel and Primi, 2014: 286; Martin, 2013: 59).

This situation, hardly conducive to enterprise R&D, was exacerbated by reforms during the early transition period. During the early 1990s, in response to macroeconomic imbalances, public research support was sharply reduced across the CEE region. In Poland, the Academy of Sciences' budget was slashed, while several research institutes were closed (Martin, 2013: 60). Macroeconomic concerns were so prominent that policy-makers neglected innovation policy (Suurna and Kattel, 2010: 650-51).[20] Some reforms, such as the decision to weaken public research institutes, made sense when viewed as part of a broader campaign to privatise Polish industry and increase reliance on market competition. Unfortunately, these measures did little to increase in-house R&D or innovation more generally (Kattel and Primi, 2014: 286). Polish R&D expenditure fell from roughly 1 per cent of GDP in the early 1990s to less than 0.6 per cent of GDP a decade later (Eurostat, 2016; Kravtsova and Radosevic, 2012).

The relative inattention to innovation changed in the 2000s, but policy-makers focused overwhelmingly on the importation and absorption of foreign technology. As noted above, the €8.3 billion "Innovative Economy" operational programme spent over €4 billion on public research infrastructure and private sector equipment between 2007 and 2013 (Kapil et al., 2013: 26). This EU-backed programme was flanked by separate, national programmes, such as the favourable tax treatment of enterprise investment in new equipment (interview with industry representative, Warsaw, Poland, 16 May 2016). This decision to promote investment in new equipment and technological absorption was entirely sensible for a capital-scarce, transitional economy.

That said, these sensible ideas may have been scaled to unhealthy extremes (Kapil et al., 2013). While research suggests that technological absorption plays a crucial role in catch-up, R&D also plays an important role in late developers (Verspagen, 2001). With little public support and no favourable tax treatment, investment in new equipment crowded out in-house R&D. For example, Polish enterprises devoted 87 per cent of innovation expenditures to technological absorption, as opposed to 60 per cent in similar countries such as the Czech Republic (Kapil et al., 2013: 11). As a result, private sector investment in research, and R&D expenditure more generally, remained limited in Poland. At the beginning of the 2007-13 financial perspective, Poland was spending just 0.56 per cent of

[20] This point was confirmed in interviews with several economists (17 May 2016), who argued that innovation is an underdeveloped field in Poland.

GDP on R&D and this was heavily oriented towards public sector actors. Business expenditure on R&D, at 0.17 per cent of GDP, was the third lowest in the European Union (Eurostat, 2016).

The situation has improved in recent years, particularly after 2011. Under the 2007-13 Innovative Economy Operational Programme and the run-up to the 2014-20 financial perspective, expenditure on R&D has increased to 0.94 per cent.[21] Business expenditure on R&D has grown particularly rapidly in the last couple of years, reaching 0.44 per cent of GDP by 2014, the eighth lowest in the European Union (Eurostat, 2016). We believe that these are encouraging developments and welcome the government's efforts to increase support for enterprise R&D under the 2014-20 financial perspective. Indeed, small-scale support for R&D appeared highly effective under the 2007-13 financial perspective (European Commission, 2015b)

That said, we worry that the new financial perspective focuses too narrowly on enterprise R&D, much like its predecessor focused too heavily on investment in new equipment (Kapil et al., 2013). As noted above, the €8.6 billion "Smart Growth" operational programme allocates €3.8 billion to enterprise R&D. Spread out over a seven-year period, this €540 million annual infusion of public funding would increase Polish private sector expenditure on R&D in 2014 (€1.8 billion) by nearly a third (Eurostat 2016). This is an ambitious, but reasonable, plan to elevate private sector research and innovation, particularly in light of the excessive focus on capital investment in early programmes.

However, the true scale and scope of this initiative is much larger; first, there are 16 EU regional and special eastern Poland operational programmes that would nearly double the above-mentioned amount by injecting further €417 million a year. Furthermore, when we look beyond EU structural funds to consider complementary funding resources, Poland's government plans to contribute €1.6 billion to the Smart Growth operational programme. Because these initiatives require private sector co-investment, they are also expected to leverage a minimum of €4.4 billion in additional, private funding, which translates to yet another €379 million. Thus the true sums would be around €1.336 billion, moving expected total business R&D investment to €3.136 billion per annum, which is closer to twice the current total sum of private sector R&D expenditures. This may be too ambitious, particularly when one considers that, unlike the 2007-13 financial perspective, these investments *are now explicitly linked to R&D projects* rather than R&D investment more generally, where capital investment was by far the majority in the 2007-2013 perspective. Thus, the true magnitude of change in business investment on project R&D should be at least triple the above conservative estimates. In short, we should expect significant waste and massive inflationary pressure on the price of R&D factors.

This rapid rise of private sector R&D would tax the government's administrative capacity and the absorptive capacity of the private sector under the best of circumstances, but the

[21] While the Innovative Economy operational programme was heavily oriented towards capital investment, it allocated €2.2 billion to research and €1 billion to private sector R&D. These are not insignificant sums considering the underdeveloped state of the Polish innovation system, and business R&D in particular, in 2007.

situation is even more extreme because 80 per cent of funds are reserved for SMEs. SMEs in Poland are responsible for just 40 per cent of R&D expenditure in Poland (OECD, 2012: 403) or roughly €700 million in 2014 (Eurostat, 2016). Under the most conservative projections above, the Smart Growth funds alone would more than double research expenditure by SMEs by from €700 million to at least €1.1 billion a year. When national, regional and private sector co-funding is taken into account, the 2014-20 financial perspective would more than double annual SME R&D expenditure, from roughly €700 million in 2014 to €1.769 billion a year under the 2014-20 financial perspective.[22] Even this figure *understates* the magnitude of the increase because it does not include massive, multi-billion euro commitments to software, equipment and other investments that have been explicitly linked to enterprise R&D by SMEs under the Smart Growth operational programme. When these programmes are taken into account, the picture becomes even more worrisome.

While we applaud the decision to support enterprise R&D and believe the public sector can play an important role in incentivising and disseminating information about the importance of applied research, we worry about Poland's ability to efficiently dispose of these funds. We have three concerns.

First, even under the most conservative projections, this massive increase in R&D funding threatens to tax the Polish government's administrative capacity. PARP struggled to allocate €5 billion in EU investment subsidies under the 2007-13 Innovative Economy operational programme. The agency was criticised for adopting an excessively formulistic and bureaucratic approach to evaluating applications (Kapil et al., 2013: 41). If the Polish government struggled to administer billions of euros in investment subsidies, we worry that R&D support, which is harder to evaluate, could prove even more challenging.[23]

Optimists would point to reforms in the application process, which reduce reliance on technical criteria and enable evaluators to meet with applicants (Klincewicz, 2015: 7). The government has also shifted responsibility to the NCBR, which has been hailed as one of the most nimble, flexible and efficient organisations in the Polish national innovation system (Kapil et al., 2013: 48). That said, NCBR flourished as a small organisation, with staff of just 179 and a budget of €149 million in 2011, and some of its most experienced managers were dismissed by the new government. It is by no means clear that the agency will be as effective in disposing of half a billion euros or more in innovation-related funding within the context of a much larger organisation. Privately, interviewees also expressed concern about whether the new management at NCBR could replicate past successes. In the words of one executive:

[22] Polish innovation policy is more balanced than it appears because the government plans to introduce a tax credit for R&D to incentivise research by large firms. This complements nicely the narrow focus on SMEs, but it does not change the fact that Polish SMEs are poorly positioned to dispose of €1.06 billion in new R&D funds.

[23] As noted in other evaluations (Kapil et al., 2013) and elsewhere in our report, the fight against corruption has led policy-makers to adopt a very conservative, overly technical approach in evaluating applications by private sector actors. This conservative approach is even more problematic in the case of R&D projects, which by their very nature entail a higher degree of risk.

> "They just fired the most professional and capable manager we had in innovation policy in this country, and they are doing the same at other levels. Worse, they are being replaced by party loyalists who are professionally inexperienced." (Interview with industry representative, Warsaw, Poland, 17 May 2016.)

Even if the NCBR's new management successfully expands the agency, the private sector's ability to deliver enough viable projects to government evaluators represents a second item of concern. As described above, business expenditure on R&D was, and remains, exceptionally low and this situation is even more pronounced among Poland's SMEs. Interviewees described a situation where many enterprises were not even clear on what, exactly, constituted R&D, much less how to effectively manage a research project. Indeed, the success rate has already plummeted as the government has shifted from capital investment to R&D. Whereas approximately two-thirds of proposed projects were approved for funding by PARP under the 2007-13 financial perspective, the success rate for applications to a pilot R&D programme managed by the NCBR was just 12 per cent (interview with representative, government agency, Warsaw, Poland, 17 May 2016). One could look at this as a positive development, arguing that the government is more selective in distributing support. Industry representatives, however, expressed concern that this outcome is a clear indicator of a different problem: private sector actors are poorly equipped to prepare and manage R&D projects. This is exacerbated by the limited amount of dialogue between government and industry (see above), continued uncertainty over the definition of what exactly constitutes "R&D" and onerous bureaucracy designed to reduce corruption and improve accountability in the administration of public innovation funds.

Third, even if government officials can efficiently process applications and private sector enterprises can identify enough viable projects, it is unclear whether they possess the resources to complete that research. To be clear, this massive infusion of EU funds ensures that there will be no shortage of capital. But Poland possesses a relatively small number of research personnel, the majority of whom are employed in the public sector (see below). Interviewees, for example, suggested that those in Poland with PhDs and even engineers lacked the business experience and acumen of their western counterparts (interview with consulting industry representative, Warsaw, Poland, 17 May 2016). And while Polish industry used the 2007-13 financial perspective to upgrade its software and equipment, research infrastructure is less developed than in western Europe, particularly in SMEs. There is the danger that a massive increase in private sector research expenditure could introduce distortions into the market, generating shortages or rapidly increasing the cost of scarce resources.

Collectively, we are concerned that Poland's ambitious programme to increase enterprise R&D will produce the same kinds of programmes and success rate as if it were to increase VC investment. If Polish firms, and SMEs in particular, are poorly prepared to invest in R&D, policy-makers could find that much of the money goes unused. Or, even worse, the money could be wasted on inefficient projects. The danger here, much like in

venture capital markets, is that poor returns could have negative, longer-term repercussions, souring policy-makers and industry on research and innovation more generally. We believe that Poland would benefit from more research and we applaud the government's efforts to increase funding in this area, but we worry that channelling such a massive volume of funding in such a short time with no viable programmes for continued investments into one of the weakest parts of the national innovation system will create more problems than it solves.

What could policy-makers do to reduce these risks? Polish policy-makers should use learning feedback loops to adjust the Smart Growth programme to distribute EU funds more broadly. As described below, policy-makers could target other important inputs, from technological absorption and capital investment (still an important source of growth in a transitional economy such as Poland) to human capital accumulation (see below).

If the government is determined or obliged to spend such a large sum on enterprise R&D, we think it would make sense to distribute the funds more broadly rather than focusing almost exclusively on the actors with the weakest capacity to engage in R&D.[24] Of course, these recommendations are more relevant for future operational programmes as the national government is not in a position to reform the Smart Growth programme at this point.[25]

That said, we believe the government could make several adjustments without significantly altering the composition of the Smart Growth programme or spending additional money. For example, policy-makers could adopt a broad definition of R&D and innovation, rewarding incremental, second generation process, marketing and organisational innovations in addition to radical product innovations. We think a wider net would better reflect the strengths of Polish industry and reduce the risk of developing bottlenecks in the supply of viable R&D projects.

Polish policy-makers could address limited resources among SMEs by rewarding cooperation. Cooperation between different actors is integral to innovation within liberal and coordinated market economies alike (Lundvall, 2002; Saxenian, 1994). It is particularly important for SMEs, who frequently lack the human and financial capital to conduct expensive R&D (Amin and Thomas, 1996). Many of the most successful innovation-based economies, from Taipei China to Denmark and Germany, developed an array of mechanisms to directly solve these issues and induce cooperation between actors (Breznitz and Cowhey, 2012).

Given exceptionally low levels of university-industry and inter-firm cooperation in Poland (European Commission, 2015a: 83-84; World Bank, 2011: 49-50), it is remarkable that the Smart Growth operational programme allocates just €383 million, or

[24] Consistent with EU regulations, we think it makes sense to require large firms to collaborate with universities, research institutes, smaller enterprises and other organisations.

[25] According to policy-makers, the Smart Growth operational programme also reflects the European Union's own interest in enterprise R&D and SME development. In this sense, the Polish government has limited room for manoeuvre.

4.4 per cent of its budget, to clusters, networking and other cooperative arrangements. This is even more peculiar since evaluation of past EU programmes in Poland found them to have a high positive impact on collaboration and network creation. However, under the new perspective, small and medium-sized grant recipients do not have to cooperate with other actors. According to policy-makers, even the NCBR's sectoral programmes, designed to stimulate the formation of research consortia, do not require applicants to collaborate with one another. While we understand the government's reluctance to burden applicants with additional requirements, we think it is important to encourage cooperation, which some would argue is even more important to a healthy, well-functioning innovation system than formal R&D (Breznitz, 2005; Lundvall, 2002).

The government could stimulate cooperation without modifying the Smart Growth programme or the application process by fostering dialogue with the private sector. As noted above, this would address a key weakness in the Polish innovation system, enabling the government to more clearly define what exactly constitutes R&D and educate enterprises on the importance of innovation. Meanwhile, the government could use private sector feedback to tailor R&D support programmes and identify other barriers to innovation. These initiatives do not have to involve large fiscal outlays. Denmark upgraded its innovation system very cheaply by using sectoral councils to eliminate regulatory barriers to innovation and facilitate collective action within the private sector (Morris, 2005; Ornston, 2012). While results might be more modest in a much larger economy with lower levels of social capital, this dialogue could ensure that EU funds are spent more effectively and begin to develop the kind of private-public and inter-firm linkages that characterise a robust innovation system. What is worrying, however, is the fact that the new Polish government seems to go the opposite way. As of the summer of 2016, it prefers an approach that is much more top down, without any attempt to foster dialogue or collaboration.

6. Improving innovation in Poland: other framework conditions

We have focused on enterprise R&D and venture capital as the focal point of the 2014-20 perspective, but we expressed concerns that this narrow focus may not remedy broader deficiencies in the Polish national innovation system. In this section we identify several potential bottlenecks that could inhibit the effective allocation and utilisation of European funding. In an ideal world, structural funds would be distributed more broadly to address a wider range of actors and resources. That said, policy-makers do not have to restructure the operational programmes, or even spend significant money, in order to strengthen the Polish innovation system.

As noted above, Poland relied almost exclusively on universities and public research institutions to perform R&D under communism. Even after 1989, public research institutes and universities continued to perform a disproportionate amount of R&D (Krajewski, 2014: 116). Partly a result, the Polish government invested heavily in these institutions under the 2007-2013 financial perspective, supporting research and upgrading infrastructure (Kapil et al. 2013: 26).

These investments were not particularly effective in increasing innovation in Poland, in part because funds were allocated to infrastructure and equipment and, in part, because of persistently low levels of cooperation between public sector institutions and private industry (World Bank, 2011). In the words of one interviewee: "At the universities, in the science world, they have R&D equipment worth 30 billion (zloty) from the previous perspective, but most of this equipment is gathering dust." (Interview with industry representative, Warsaw, Poland, 17 May 2016.) Another remarked: "All of this state-of-the-art equipment is standing there dusty. The problem is the equipment wasn't bought for a specific reason, they bought it without a specific plan of how to use it because they were told we have funds and we have to use them now and only to buy equipment. This is a big problem." (Interview with industry representative, Warsaw, Poland, 18 May 2016.)

In response to these concerns, the current financial perspective has reoriented support to industry. The €8.6 billion Smart Growth operational programme earmarks less than 10 per cent of its funds, €757 million, to universities and public research institutions. The Knowledge, Education and Development operational programme is no exception in this respect, focusing more heavily on labour market reform than higher education (or public research institutes). Clearly these public institutions benefit from generous support, but it pales in comparison to funding received under earlier financial perspectives and in relation to the resources dedicated to enterprise R&D. It is here that Poland's recent success in Horizon 2020 programmes should be built upon with more government support to compensate for this sudden shift while continuing the move of focusing the higher education system on higher-end, high-quality research.

We believe this sudden, exaggerated move away from universities and public research institutes towards private enterprises is unfortunate. While private industry is the most

important actor in a competitive innovation system (Breznitz, 2007), universities and public research institutes can also play a constructive role. This is particularly true for countries with a relatively large number of small and medium-sized industries. In Denmark, Taipei China and Germany, organisations such as the Approved Technological Service Institutes, the Industrial Technologies Research Institute (ITRI) and the Fraunhofer Society have enabled SMEs to overcome resource constraints by accumulating expertise, equipment and research capabilities and diffusing knowledge to SMEs. While public research institutes have not performed as effectively in Poland (World Bank, 2011), we believe they merit continued support.

This could involve a reallocation of resources within the Smart Growth operational programme, but it could also be achieved by non-financial means. The Polish government is currently working to reform the public research institutes, which could increase cooperation with industry. As noted above, enterprises reported having an easier time accessing equipment in Germany and the Netherlands, which suggests significant barriers to collaboration within Poland. Meanwhile, private sector actors identified several regulatory obstacles to deeper industry-university cooperation. Commenting on the "dusty" equipment at Polish universities, a consultant remarked:

> "One of the biggest challenges is how to make it possible for the universities to commercialise this [knowledge]. There is an issue with the VAT, which has been co-financed with the EU money. That will be lost if they start to earn money from external services." (Interview with industry representative, Warsaw, Poland, 17 May 2016.)

This applies to human capital as well, which is arguably an even more important bottleneck in the campaign to increase venture capital funding, private research expenditure and innovation in Poland. The Polish educational system exhibits many strengths. Communist governments generally performed well at basic education, and Poland is one of the very strongest performers in the CEE region as measured by PISA scores (EBRD, 2014: 55). Investments in tertiary education have paid dividends as the country also exceeds the EU average in the number of university graduates (European Commission, 2015a: 84). In this respect, Poland is following in the footsteps of other innovation leaders such as Denmark, Finland and Taipei China (Breznitz, 2007; Kristensen and Lilja, 2011).

That said, there is reason to believe that human capital could constrain investment in research or innovation more generally. The share of 20-29 year olds pursuing a doctorate in science, technology or engineering (0.2 per cent in 2013) is less than half the EU average and tied for second lowest in the European Union. The share of researchers employed in the labour force (0.66 per cent in 2013) is half the EU average and sixth lowest in the European Union (Eurostat, 2016). Industry representatives who have worked abroad suggest that Polish academics are less well-equipped than their foreign counterparts for working in business (interview with consultant, Warsaw, Poland, 17 May 2016). Studies confirm that the quality of Poland's expanded tertiary education is uneven and skills are not always aligned with industry needs (OECD, 2016a: 44-45, 67).

While the recent emphasis on formal research and high-technology competition naturally leads one to focus on skill shortages and mismatches in tertiary and post-graduate education, vocational training is arguably even more important for a country that has grown by relying on second generation and process-based innovations in low and medium-technology industries. Unfortunately, the picture is even weaker here. The Polish vocational training system has languished. Further, its quality is questionable. For example, the employment rate for new graduates was the fourth lowest in the OECD in 2013, despite a buoyant labour market (OECD, 2016a: 66). Poland also performs very poorly on measures of continuing education (European Commission, 2015a; World Bank, 2011). This is a serious issue as a large portion of the adult labour force lacks basic skills. For instance, over 40 per cent of active adults have no ICT experience, by far the worst in the OECD (OECD, 2016a: 70). If Poland does not make more progress on this front, Polish manufacturing enterprises will have difficulty utilising their new equipment and the country will struggle to boost TFP.

If Poland wants to increase innovation, we would favour a broader approach in which heavy investments in enterprise R&D are complemented by significant investments in human capital (both university and vocational education), much like other late developers such as Finland or Ireland (Breznitz, 2007; Dahlman et al., 2006). For example, distortions that would follow from the OECD's recommendations to improve vocational teacher training and pay are less significant than the massive "innovation tsunami" directed at early stage venture capital markets and research-intensive SMEs (OECD, 2016a: 67). Similarly, efforts to bolster basic skills, from problem-solving to ICT fluency, are unlikely to encounter the kinds of crucial bottlenecks we identify in this report.[26] At this stage, this is a more appropriate target for future perspectives. That said, policy-makers can make adjustments to improve the quality of education even without changing current operational programmes or investing significant fiscal resources.

For example, the government could more closely align existing tertiary and post-graduate university programmes with industry needs, either at a national level through the creation of a broader innovation council that includes private sector representatives or at a more micro level by including industry representatives on university boards. Employer participation is arguably even more important when it comes to vocational education. While public funding plays an important role even within mature, well-developed systems such as Denmark or Germany (Thelen, 2014), the government could begin to lay the groundwork for future reform by engaging industry and encouraging inter-firm cooperation in this area. Recent sectoral-level councils are an encouraging step in this direction (European Commission, 2015c). We encourage the government to build on this initiative by improving coordination within government and with the private sector.

Lastly, while this analysis has focused on supply-side inputs, Polish policy-makers could ensure that European funds were used more effectively by tackling broader, framework

[26] The Knowledge, Education and Development operational programme invests €4.7 billion in related initiatives, but it is just half the size of the Smart Growth operational programme. This ratio seems misplaced given the issues outlined in this report.

conditions that discourage innovation (NBP, 2016). For example, Polish policy-makers are seeking to foster firm creation and growth by investing aggressively in venture capital, but the country is one of the worst in the European Union in terms of the cost and time it takes to start a new business, owing in part to some of the highest administrative burdens in the OECD. It is only marginally better in other areas, such as the cost and time to resolve insolvency (NBP, 2016: 153; OECD, 2016b; World Bank, 2016a). While a promising, venture-backed, high-technology enterprise might be able to navigate these constraints, this regulatory structure is clearly incompatible with the government's stated goals to foster enterprise creation and growth.

Similarly, efforts to increase research expenditure and foster rapid, innovation-based competition in particular, are undermined by persistently high levels of market regulation and low levels of competition. For example, Polish product markets are among the most heavily regulated in Europe, exceeded only by Greece and Slovenia (OECD, 2016b). Europe's most successful small states have historically combated limited domestic competition with international openness (Andersen et al., 2007). However, in Poland, exports represented less than 50 per cent of GDP in 2013. Much like venture capital markets, relatively low levels of competition contradict the government's stated objective of increasing research expenditure. In fact, we would argue that R&D subsidies are more likely to be wasted if enterprises do not face strong incentives to innovate in product markets.

In both cases, the government could bolster innovation without completely restructuring the Smart Growth operational programme or spending large amounts of money. Of course, any effort to reduce the administrative burden on new enterprises or increase product market competition is politically difficult. Many of these regulations were introduced to compensate powerful constituencies. But this is an excellent example of where greater engagement with private sector actors within national- and sector-level councils can generate the political support to tackle difficult reforms by reframing regulatory barriers as an obstacle to innovation and improving coordination among those who would benefit from reform.

Ultimately, this brief overview of other framework conditions that might reduce the effectiveness of large-scale investments in venture capital and R&D is not designed to present a comprehensive checklist of necessary reforms. Rather, it underscores several themes that underpin this entire report. First, one cannot expect to bolster the performance of the Polish innovation *system* by flooding money into one or two areas, like early stage risk capital markets or enterprise research. Countries that escaped the middle-income trap to become innovation leaders, such as Finland, Israel and Taipei China, adopted a more balanced approach to innovation policy and economic development. We would encourage the Polish government to distribute resources more widely whenever possible and, absent that, address other framework conditions that constrain innovative performance.

Second, any efforts to do so would benefit from greater coordination in public policy-making and greater dialogue between the Polish government and private sector actors.

Low levels of cooperation emerge as a recurring weakness in formal evaluations (NBP, 2016; World Bank, 2011) and our own interviews. While the government might possess limited fiscal flexibility in the middle of the 2014-20 financial perspective, it could begin to build cooperation by investing the Innovation Council with greater authority, incorporating private sector representatives into the organisation and launching other forums for cooperation, such as the sectoral councils that were used to identify and resolve weaknesses in the Danish innovation system in the mid-2000s (Morris, 2005; Ornston, 2012). Poland has exhibited a willingness to employ similar strategies within specific policy domains, such as vocational training (European Commission, 2015c), but we would encourage the government to engage the private sector more systematically in crafting and implementing innovation policy.

7. Conclusions

In this report we show that Poland needs to boost innovation to support future growth and avoid being mired in a "middle-income trap". To this end, we support the government's efforts to bolster venture capital funding, R&D expenditure and research by SMEs. These are all laudable goals and will help transform Poland into a more knowledge-intensive economy. That said, our report suggests that the Polish innovation system suffers from a wide array of limitations, from a weak governance system to low levels of cooperation, human capital bottlenecks and regulatory barriers. Massive investments in early stage risk capital markets and technology-intensive SMEs will not solve these very real constraints.

In fact, injecting massive amounts of capital into enterprise research, venture capital markets or entrepreneurship may do more harm than good. Our analysis raised questions about the government's capacity to effectively administer this massive increase in funding and the private sector's capacity to generate viable projects. Furthermore, without addressing human capital, regulatory barriers and other obstacles to innovation in Poland, these ambitious initiatives may introduce distortions, crowding out private sector investment or inflating the price of scarce resources. If these funds are squandered, this "innovation tsunami" could have the paradoxical effect of *inhibiting* innovation. Low returns during the 2014-20 financial perspective would discourage private sector investors and make it more difficult for policy-makers to justify public investment in innovation in the future.

What can Polish policymakers do to address these dangers?

First and most obviously, Polish policy-makers should distribute national, regional and EU innovation funding as widely as possible instead of privileging a handful of activities (for example, R&D), actors (for example, SMEs) and instruments (for example, venture capital investment). At a minimum, policy-makers should define innovation as widely as possible and refrain from targeting a narrow class of actors. This should be feasible without any major changes to the Smart Growth and regional operational programmes. We would discourage agencies from focusing exclusively on high-technology enterprises given Poland's relative weakness in this area, the limited number of investment opportunities and the country's existing strengths in low and medium-technology sectors. Instead, policy-makers should take care to address low and high-technology enterprises alike, supporting product, process, organisational and marketing innovations.

Second, we would like to see more fundamental changes to the Smart Growth and subsequent operational programmes, in which innovation funding is distributed more widely. Over the course of this report we identify several possible targets. While policy-makers clearly focused too heavily on imported technology, research infrastructure and business incubators in the 2007-13 perspective, there is no need to overcorrect and reduce funding so drastically. Policy-makers could also target other bottlenecks identified in this report. For example, BGK's loan guarantee programme appears to be a promising way to alleviate credit constraints without taxing the government's administrative capacity or targeting a narrow class of firms. There also appears to be ample scope to invest in

human capital, either post-graduate education or vocational training, without introducing the kinds of bottlenecks that characterise venture capital markets.

To be clear, this paper is not designed to suggest how, exactly, Poland should spend its innovation funds. In fact, this should not be decided by an external evaluation. Instead, we would encourage the Polish government to develop its own innovation policy-making capacity. The government could begin by improving its own capacity to monitor and evaluate innovation policy. Adding a permanent secretariat to the Innovation Council would be a promising initial step, although ideally this would be flanked by broader investments in innovation studies, an underdeveloped field of study in Poland. Stronger competencies in this area could help Poland develop a coherent, consistent innovation policy and reduce its susceptibility to trend-chasing (Suurna and Kattel, 2010). This alone could reduce the exaggerated policy shifts we document in this report.

Fourth, Poland needs to improve its capacity for policy coordination within the public sector to capitalise on this information. While excessive policy coordination can generate risks, most notably overspecialisation (Ornston, 2016), we see no risk of this in the Polish case. Instead, evaluations suggest that Poland suffer from a proliferation of poorly coordinated initiatives, often working at cross purposes (NBP, 2016; Rybinski and Kowalewski, 2011: 647). Ideally, a stronger coordinating capacity would improve consistency across ministries and over time, eliminating the large-scale institutional and policy shifts that confuse private sector actors and discourage risky, long-term investment in innovation.

Any move to centralise Polish innovation policy should not undermine our next three recommendations, which are arguably even more important for Poland's long-term development as a knowledge-intensive economy.

Fifth, policy-makers should take care that any coordination of Polish innovation policy does not result in new bureaucratic requirements or other administrative hurdles. Our report and other evaluations (European Commission, 2015b; Kapil et al., 2013) identify cumbersome application requirements as a key impediment to the effective distribution of innovation funding. While the European Union's efforts to increase accountability has contributed to this, the Polish government's own anti-corruption campaign may do more harm than good in innovation policy, discouraging civil servants from making quick decisions and taking risks.

Sixth, coordination of Polish innovation policy should preserve space for experimentation by public and private sector actors at the margins of the national innovation system. While major government programmes should work collectively towards a single, consistent strategic vision, the government should also give agencies the flexibility to introduce small-scale pilot programmes, testing out new policy instruments and business models. These kinds of programmes do not consume significant resources, but can have a big, long-term pay-off (Breznitz and Ornston, 2013). These initiatives are also more likely to fit the Polish context than ideas developed in Brussels. This process of local

experimentation is more likely to succeed when coupled with a stronger monitoring and evaluation capacity (see above).

Seventh, local experimentation and peak-level policy coordination *requires greater private sector input.* The government's apparent inability or unwillingness to consult with private sector actors represents perhaps the most glaring weakness in the Polish innovation policy-making process, particularly when compared with innovation leaders such as Finland and Israel (Breznitz, 2007; Ornston, 2012). Greater engagement with the private sector would not only enable the Polish government to develop policies that better fit the Polish economic context, but also introduce greater continuity into innovation policy and help the government communicate its goals and plans to the private sector. At a minimum, the government should broaden the Innovation Council to include private sector representatives. Ideally, it should encourage civil servants to engage in greater dialogue with industry at all levels of government (Kapil et al., 2013).

Lastly, as collaboration is an integral feature of all successful innovation systems (Edquist, 1997; Lundvall, 1992), the government should prioritise cooperation among all actors within the innovation system, most notably among firms themselves. This is doubly important in the Polish case, because the SMEs that dominate the economy often lack the resources to unilaterally invest in research or innovation more generally. Successful innovators with a large number of SMEs such as Denmark and Taipei China have relied heavily on inter-firm cooperation and collective goods, for example public research institutes, to pool resources (Breznitz, 2007; Lundvall, 2002). Obviously the Polish government could support cooperation financially by subsidising cluster programmes or other network-based initiatives. But it can also encourage cooperation on a shoestring, as evidenced by the Danish sectoral councils of the early 2000s which identified regulatory barriers and common interests without significant public outlays (Morris, 2005; Ornston, 2012).

At the same time, an analysis that focuses exclusively on Polish policy decisions would be incomplete. Throughout this report we suggest that model cases such as Finland and Israel relied on a slower but broader injection of public funds, designed and administered in close collaboration with the private sector, to transform themselves from low-technology economies into high-technology leaders. Poland, however, is not Finland or Israel. Poland is more heavily dependent on EU funding, which rivals total public R&D expenditure under the 2014-20 financial perspective, than Israel or even Finland. As a result, the European Union influences Polish innovation policy in a way that it did not in Finland or Israel.

First and most obviously, the European Union exercises an outsized influence on the objectives and content of Polish innovation policy by determining how structural funds will be used. All Polish plans to use the structural funds must be cleared by Brussels, which establishes new priorities with each financial perspective. As noted above, increasing coordination within the Polish innovation system emerged in response to EU requirements after 2007 and the "smart specialisation" strategy developed in 2014 is also an EU requirement. It is no coincidence that Polish investment in research infrastructure

between 2007 and 2013 occurred under a financial perspective that prioritised R&D infrastructure. Polish priorities have since shifted under the 2014-20 financial perspective, which emphasises innovation by SMEs (McCann and Ortega-Argilés, 2013a: 419).

One might, correctly, note that EU priorities are very broad and grant countries considerable latitude in how they administer their funds (McCann and Ortega-Argilés, 2013b). The European Union, however, may still exercise a disproportionately important role in countries with immature innovation systems. In countries such as Poland that have a relatively small number of innovation scholars, a weak strategic vision, limited private sector input, poor coordinating capacity and little consistency over time, the European Union may play an important role in determining what "good" policy looks like (Suurna and Kattel, 2010). In this context, EU-level recommendations, prioritising cluster initiatives under one financial perspective and enterprise R&D under another, can trigger large, disruptive swings in national policy.

Third, and at a more micro level, the European Union clearly imposes constraints on how countries dispose of their structural funds. EU rules, for example, limit the amount and type of support that countries can allocate to large enterprises. Even where small enterprises are concerned, the European Union limits grants as a percentage of eligible costs and imposes additional reporting requirements to ensure that funds are disposed of legally and efficiently. Many of these regulations are perfectly sensible, but they also constrain Polish innovation policy in ways that do not apply to countries that do not rely on structural funds, such as Israel or even Finland.

Lastly, and directly related to this point, Polish dependence on EU structural funds introduces considerable uncertainty into Polish innovation policy. At a micro level, interviewees repeatedly expressed concern that they might be audited and forced to retroactively repay EU funds allocated to innovation if they did not comply with complicated requirements. At a more general level, Poland's rapid growth raises questions about the sustainability of its innovation policies. If the country continues to grow at its current pace, Poland may receive less support for certain goods, for example infrastructure, or even see EU funding fall after 2020. It is not clear whether the government is willing to pick up the slack. Needless to say, this is not particularly conducive to risky, long-term investment in innovation.

This analysis thus raises questions about the European Union's administration of its structural funds, as well as Polish innovation policy. While most of our policy recommendations have focused on the Polish government, our analysis suggests that Brussels could consider some adjustments as well. First and most importantly, we would encourage EU-level policy-makers to grant national governments considerable discretion in the allocation of their structural funds, particularly as it applies to innovation. Because innovation policy is highly context-specific and evolves as part of a gradual, cumulative co-evolutionary dialogue between the public and private sectors (Breznitz, 2007; Lundvall, 1992), we would encourage the European Union to defer to national- and regional-level actors wherever possible. By attaching new priorities to the use of

structural funds, the European Union not only limits the use of local information, but also interrupts the gradual, co-evolutionary process described above and introduces considerable uncertainty into the innovation policy-making process.

Second, while we understand why the European Union is concerned about the misuse of structural funds, we can also see that efforts to improve efficiency can backfire, particularly where innovation policy is concerned. By burdening businesses with cumbersome reporting requirements, the European Union unwittingly penalises SMEs that it seeks to help. By incorporating new requirements into EU-funded programmes, the European Union slows down the decision-making process and discourages policy-makers from investing in genuinely risky, innovative new approaches and business models. The concern with efficiency and corruption is understandable, but as far as innovation is concerned, we would encourage the European Union to adopt a light touch.

Third, while we are generally sceptical of any move to burden national policy-makers with additional requirements, we believe the European Union should prioritise the monitoring and evaluation of innovation policy, particularly at a national level. The gradual, co-evolutionary process described above will vary from country to country, but functions more effectively when countries develop a robust capacity to monitor and evaluate their policies. Evaluations of EU regional and cohesion policy suggest that the Polish experience is not unusual. While the European Union has made tremendous progress in improving the ex-ante design of innovation policy and prioritised evaluation, the two are not yet well integrated into the kind of co-evolutionary process that characterises successful innovators such as Finland and Israel (McCann and Ortega-Argilés, 2013b: 437) If the Polish experience is typical, the European Union could do more to encourage the development of stronger analytical capabilities in its member states.

Lastly, while we would expect the more effective monitoring and evaluation of innovation policy to lead to policy reforms, we would discourage any radical, large-scale adjustments of the sort outlined in this paper. While radical institutional reform is sometimes warranted and pays dividends, the academic literature suggests that innovation systems function most effectively by building on existing institutions and strengths rather than trend chasing. This applies to not only sectors (as recognized in the European Union's Smart Specialization strategy), but also policy objectives and instruments.

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