Summary Record

The 3rd Annual Conference of the
Global Forum on Productivity
Firms, Workers and Disruptive Technologies:
Ensuring Sustainable and Inclusive Growth
June 28-29, 2018
Ottawa, Canada

About the OECD

The OECD is a forum in which governments compare and exchange policy experiences, identify good practices in light of emerging challenges, and promote decisions and recommendations to produce better policies for better lives. The OECD's mission is to promote policies that improve economic and social well-being of people around the world.

About the Global Forum on Productivity

The Global Forum on Productivity (GFP) was launched by the OECD in 2015 to foster international co-operation between public bodies with responsibility for promoting productivity-enhancing policies. The GFP is a platform where participants convene to exchange information and data, discuss best practices and frontier-research findings, and undertake joint productivity analysis. The work programme of the GFP is guided by a Steering Committee of countries and supported by the work of the OECD Secretariat.

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SUMMARY OF THE 3ᴿᴰ ANNUAL CONFERENCE OF THE GLOBAL FORUM ON PRODUCTIVITY

28-29 JUNE 2018, OTTAWA, CANADA

The OECD Global Forum on Productivity (GFP), the Bank of Canada and Innovation, Science and Economic Development Canada co-organized the 3ʳᵈ Annual Conference of the GFP on "Firms, Workers and Disruptive Technologies – Ensuring Sustainable and Inclusive Growth" which took place in Ottawa on 28-29 June 2018. The Conference gathered 170 participants from 29 countries, including: Argentina, Australia, Belgium, Brazil, Canada, Chile, Costa Rica, Denmark, Estonia, France, Germany, Hungary, Italy, Japan, Kazakhstan, Latvia, Mexico, Netherlands, New Zealand, Philippines, Portugal, Russia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States, and 1 regional organisation: European Union. Feedback from participants and the organizers in Canada was very positive.

Introductory remarks

David McGovern (Associate Deputy Minister, Innovation, Science and Economic Development Canada) highlighted that we are in a time of unprecedented technological change affecting many areas of the society and the economy. Some parts of the economy are growing rapidly whilst others are disappearing, increasing the challenge for workers to develop new skills and reinvent themselves to meet the demands of the future. He mentioned policies to tackle these challenges, such as international collaboration on disruptive technologies through the Canadian chair of the G7, the Canadian innovation super-clusters programme and investment in fundamental science.

Lawrence Schembri (Deputy Governor, Bank of Canada) explained that disruptive technologies are of great interest for central banks, through their impact on firms and workers, and how this translates into productivity, employment and inflation. He highlighted several issues facing central banks, including declining potential output growth since the 1980s, an ageing workforce, lower TFP growth and low levels of investment. He drew attention to several key considerations of these technologies, such as whether markets are becoming more or less contestable and their impact on firm dynamics, wage dispersion and price inflation. He highlighted how the nature of investment is changing towards intangibles, raising measurement issues and the puzzle of why we have not seen faster TFP growth from these technologies.

Luiz de Mello (Director, OECD) highlighted that new technologies, such as cloud technology, 3D printing, advanced robotics, gene sequencing and artificial intelligence, will continue to disrupt the production and distribution of goods and services over the next decade. Although new technologies have great potential, we are in an environment of sluggish productivity growth, mirroring the famous Solow ICT productivity paradox of the 1970s and 1980s. He highlighted OECD research showing growing divergence between the performance of frontier and laggard firms and how reducing the divide in digital adoption across firms and sectors may help close this gap. He thanked the Canadian hosts for making the 3ʳᵈ Annual Conference of the GFP a reality.

Eric Bartelsman (Professor and General Director, Tinbergen Institute) provided the background for understanding the role ICT is playing in OECD economies. He started by defining the nature of ICT relative to previous technological revolutions. Taking as a reference patterns of introduction, implementation and penetration of previous technologies (such as internal combustion and electricity) and their consequences for economic and market outcomes (e.g. productivity, prices and wages, investment, disruption, creative destruction and churn), he argued that ICT shared several features of a General Purpose Technology (GPT). He then compared predicted and actual developments in a number of new technologies that were termed "disruptive" in a 2013 study by the McKinsey Global Institute (e.g. Renewable energy, Genomics, 3D printing, autonomous vehicles, cloud technology), showing that they had kept their promise or actually developed faster than expected. He then pointed to a number of newer disruptive technologies whose development is currently ongoing (e.g. solar gigafactories, immune engineering, reusable rockets, AI), noting that most of the new production technologies are intangible. Moreover, using technology becomes easier and allows collecting massive amounts of data that can be used to further improve technology itself. At the same time, a number of worrying trends are continuing: productivity has been slowing down, investment remains weak, the labour and capital shares in income decline and markups are rising, evn though growth at the frontier remains strong. How to explain these trends in the midst of technological change? Professor Bartelsman sketched an answer based on the profound changes that digitalisation is having for production technologies. The growing role of intangibles is changing the economic production technology, making our traditional production function approach obsolete and requiring adaptation in the data and analytical apparatus for designing economic policy. He mentioned in particular alternative models of production in the spirit of Lucas, Hopenaym and Melitz (with intangibles, stochastic productivity and firm dynamics) as well as the network production models by Kortum-Kramarz and Oberfeld. This new production environment has important consequences for the functioning of labour, product and financial markets and for income distribution, with on the one hand volatility and the share of intangibles increasing as new technologies are used and, on the hand, income shares declining and rents increasing. These phenomena go along with the implementation lags of new technologies and rising measurement issues, which affect developments in measured TFP. In this unstable and complex context it is crucial to look at micro data to understand and anticipate developments in productivity, using for instance approaches based on distributed micro data, which allow to focus on sub-populations of firms and explore what happens along the firm-level productivity distribution or for shrinking vs expanding firms. Most importantly, policy-makers need to realise that these micro developments may also have implications for the way we look at macro phenomena an structural policies. For instance, Professor Bartelsman argued that traditional measures of potential output that are used in important relationships such as the Taylor rule may have to be reviewed in the light of the fact that most of investment is now intangible, the reaction to demand shocks may differ across firms, measures of the NAIRU may become less relevant with the diffusion of robots, the labour-

leisure choice may change with rising digitalisation and the channels of transmission of monetary policy may be affected as well (e.g. implying a different interpretation of movement in interest rates). He then closed his keynote pointing at a number of structural policy challenges that may become more relevant in the future -- such as the conflict between IP and open source, how to best encourage adoption of new technologies, how to mutualise rents from winner-take-all rents, how to accommodate new intangible-based forms of employment, how to meet the need for more internationally coordinated policies in a number of domains (including e.g. taxation of intangibles). Finally, on the positive side he also pointed out that big data and use of artificial intelligence could be leveraged to better inform and implement policy.

Panel 1: Policy and economic implications from new technologies

Lawrence Schembri (Deputy Governor, Bank of Canada) chaired the panel and invited panellists to share their views on the policy and economic implications from new technologies. Panellists - **Dirk Pilat (Deputy Director, OECD)**, **Darren Hannah (Vice President of the Canadian Bankers Association and the Vice Chair of the Economy Policy Committee of BIAC)** and **Avvey Peters (Chief Strategy Officer, Communitech, and Adviser to the Supercluster Next Generation Manufacturing Canada)** - agreed that new technologies are promising for future economic growth, even though these gains are not yet showing up in aggregate productivity numbers. They said that digital technologies match the criteria of general purpose technologies, and thus should have a large positive impact once fully deployed, as happened historically when new general purpose technologies became widely available (e.g. steam engine, electricity, computers). However, the diffusion of new technologies is hindered by various obstacles. *First*, panellists called for policy changes and regulatory reforms to facilitate the take-up of new technologies. For instance, issuing digital personal identifications, combined with the extensive use of mobile devices, would reduce the need for face-to-face interventions and boost efficiency in the sector of banking services. *Secondly*, government regulation may hinder the deployment of technologies because of concerns regarding job losses – for instance the deployment of self-driving vehicles such as autonomous trucks is likely to be hindered by political concerns about displaced truck drivers, who are often middle-aged and low skilled – thus hard to retrain. *Thirdly*, panellists complained also about the lack of workers with the skills adequate to handle new technologies, particularly in sensitive sectors such as cyber-security and payment systems. When all firms want to upgrade the same technologies at the same time, this results in a shortage of skills in all countries. The shortage of ICT skills is particularly acute for SMEs, who are less attractive to workers than large firms and where CEOs have little time to devote to technological issues. While traditional SMEs lacking adequate technologies and skills will struggle and many will not make it, other SMEs have the potential to thrive; what policymakers can do to help them is not entirely clear and the debate of good practices should continue in organisations such as the OECD. The panel also discussed the interesting experience of Canada's "superclusters" initiative, which is a high-tech collaboration strategy aimed at fostering growth and creating jobs by bringing together SMEs and large firms that need to modernize with projects of co-investment, co-development and sharing of risks and opportunities. Finally, interest was expressed for the role of alternative lenders and new financial

platforms to raise equity capital, which have a role to play in complement of conventional banking institutions.

Parallel Session 1A: Disruptive technologies, resource allocation, business dynamics and business of the future

Changing business dynamism and productivity: Shocks vs. responsiveness

Ryan Decker (Economist, US Federal Reserve) presented a joint work with Jon Haltiwanger, Ron Jarmin and Javier Miranda on the decline of reallocation in the US since the 1990's and its implication for aggregate productivity. Using several novel empirical facts from business microdata, the authors infer that the pervasive post-2000 decline in reallocation reflects a weaker responsiveness of businesses to productivity shocks in a manner consistent with rising adjustment frictions rather than a lower dispersion of TFP shocks. Indeed, the authors contend that within-industry dispersion of TFP and output per worker has risen, while the marginal responsiveness of employment growth to business-level productivity has weakened. As a result, the responsiveness in the post-2000 period for young firms in the high-tech sector is only about half (in manufacturing) to two thirds (economy wide) of the peak in the 1990s. Counterfactuals show that weakening productivity responsiveness since 2000 accounts for a significant drag on aggregate productivity.

Incumbents' responses to innovative entrants: A multi-country dynamic analysis.

Josephine Dickhof (Economist, Centre for European Economic Research) focused her presentation on the influence of innovative entrants on incumbents – a crucial determinant of technological change – in the context of the global transition towards alternative technology vehicles (ATVs). Her results indicate that entrants' ATV-related knowledge accumulation stimulates average incumbent's ATV-related research. These effects are found to be especially strong for global entrants, supporting previous literature on competitive reactions to entry. Responding to domestic entrants, however, incumbents with low ATV patent stocks increased whereas incumbents with high stocks decreased patenting, suggesting that advanced incumbents outsource research or overtake entrants.

Scale and scope of online retail

Alex Chernoff (Senior Economist, Bank of Canada) analysed the growth of online retail over the period 1999–2012, using confidential firm product-level data for Canada. His work decomposed the revenue of online retailers into the contributions of product scope (the number of product categories) and product scale (average revenue per product category). During this period of rapid online sales growth, product scope dropped dramatically from an average of 59 product categories per firm in 1999 to 5 product

categories per firm in 2012. Using data on Amazon.ca's expansion, he found suggestive evidence that this reduction in product scope may have been driven by increased competition in the online retail sector.

Parallel Session 1B: Technology-driven polarization of the labour market (Gabriel)

The innovation premium to low skill jobs

Antonin Bergeaud (Economist, Banque de France) presented a joint paper with Philippe Aghion, Richard Blundell and Rachel Griffith which analyses the relationship between R&D expenditures and the average wage income for different skills across firms. Using matched employee-employer data from the UK and information on R&D expenditures, the authors show that the wage premium in R&D performing firms is higher for low-skilled workers. This surprising finding reflects the idea that there is a stronger complementarity between high skilled and low skilled workers in innovative firms. This explanation is supported by the fact that errors from low-skilled workers in more innovative firms have more consequences than in less innovative firms where high and low skills are less complementary.

Solving the productivity puzzle: The role of demand and digital

Jaana Remes (Economist and Partner, McKinsey Group) presented the results of a Mckinsey analysis to evaluate the impact of the current digital transition on jobs. Based on expert interviews, the analysis sorted capabilities (e.g. social, linguistic, cognitive, etc.) of currently demonstrated technologies as of 2016 by occupation (e.g. retail salespeople, teachers, health practitioners, etc.) and activities (e.g. greet customers, answer questions about products and services, etc.). According to the current state of capabilities, less than 10% of jobs can be fully automated, but nearly all jobs will be impacted by new technologies. The jobs which are most of risk of being automated (>70%) are sewing machine operators, assembly-line workers, stock clerks, travel agents and dental lab technicians. Among the jobs with low risk of automation (<20%) are chief executives, psychiatrists and legislators. Automation affects occupations with lower educational requirements disproportionately with 55% of jobs requiring less than high school having the potential to be automated against only 22% of jobs demanding a bachelor degree. Moreover, the digital transition may amplify both consumption and investment leakages caused among other things by rising inequality and increasing profit concentration. In this context, policies need to strengthen demand by growing purchasing power, investment and entrepreneurship, as well as invest in human capital though education, training and life-long learning, reinvigorate labour market dynamism by enabling more diverse forms of work and rethinking transition support for all workers.

Technology and inequality

James Bessen (Professor, Boston University) showed that new technologies can have a positive effect on employment if they complement skills and raise productivity. This occurs in markets where there is a large amount of unmet demand, which tends to be the case in less saturated industries outside of manufacturing. Conversely, when new technologies substitute skills and replace existing jobs this leads to job polarization with on the one hand high-skill/high-paying jobs and on the other hand low-skill/low-paying occupations. To help workers transitioning to new industries, occupations and locations and

implement policy makers need to foster training, apprenticeship, certification of new skills and temporary financial support. He also highlighted that policies need to encourage labour markets in new skills allowing for greater employee mobility with non-compete agreements, expanded trade secrecy laws and non-geographic specific occupational licensing.

Parallel Session 2: Technology and institutions

Parallel Session 2A: Business and social innovation in response to disruptive technologies?

Lessons learned from the creative destruction lab

Sonia Sennik (Executive Director, Creative Destruction Lab) sought to explain the reasons of the exceptionally high concentration of high-tech businesses in Silicon Valley depite the fact that patenting is much more globally spread out. She argued that this is due to the presence of very high demand and supply of high-quality judgment by peers. This was the motivation for setting up the Creative Destruction Lab that she discussed as an example of how helping demand and supply meet and match, which is the CDL mission, could encourage high-tech business creation elsewhere. The purpose of the CDL is to encourage seed stage programme evaluation for massively scalable science and high technology startups. To this end CDL organises sessions with experts, businesspeople and successful startup managers. The sessions are organised either on a one on one mentoring basis or in groups, the aim being to discuss and assess the objectives and the readiness for market of new startup proposals. CDL sessions are pure peer-review advice with no obligation to invest for participants. They purpose is to collect ideas, comments and advice form a very diverse set of skills. Sonia Sennik provided several concrete examples of how the CDL was able to facilitate the setting up and accelerate the development of successful startups in various countries.

Social innovation and the public sector: issues and obstacles

Anthony Arundel (Professor, Maastricht University) discussed the concept of social and eco-innovations and provided various examples in the domain of transportation. He defined such innovations as creating value that accrues primarily to society as a whole rather than to private individuals or new forms of collaboration that have a positive social impact. In addition they are also changing power relations in society. These innovation are often technology poor but are user of digital technologies (e.g. platforms). Some remarkable examples include the sharing of electric bicycles, the creation of networks of bicycle lanes in many northern EU countries, the establishment of continuous sidewalks and the creation of apps that support alternative means of transportation (such as those that inform cyclists on rain in real time). He then quoted a number of barriers to social or public sector innovations, including lack of political consensus, (e.g. war on cyclists), unsupportive governance (politicians and higher management do not spur innovation), risk averse culture, insufficient collaboration and failure to use co-creation (i.e. user-centered design of policies). Overcoming some of these obstacles may require synergies: for instance collaborative approaches mey help overcome risk aversion.

Policies adoption and the digital-productivity nexus: micro evidence from EU countries

Christina Timiliotis (Economist, OECD) presented the results of ongoing OECD research on the determinants and effects of adoption of a range of digital technologies (high-speed broadband internet, cloud computing, CRM and ERP). She first focused on capabilities (organisational and human capital) and incentives (framework policies and market settings) as the main drivers of decisions of firms to adopt, exploiting a database on firm-level rates of adoption of these technologies in 25 industries and 25 EU countries and Turkey. The results point to an economically significant effects on adoption of policies aimed at enhancing access to the needed capabilities (e.g. ICT education and training) and raising incentives to adopt (e.g. competition policies and other policies making the reallocation of labour and capital across firms easier). She then reported results on the implications of adoption of the same technologies on firm-level multifactor productivity growth. She showed that looking at this granular level allows solving the so-called modern productivity paradox (that digitalisation progresses while aggregate productivity slows down) as there are significant estimated productivity benefits from adopting. Moreover, these benefits are larger for the least productive and smaller firms, suggesting that facilitating adoption may help reucing the rising dispersion of productivity across firms that has been often mentioned as one of the micro drivers of the aggregate productivity slowdown. Finally, she showed that the productivity gains from adopting digital technologies were largest in firms that are in sectors with a high share of routine tasks and that participate intensely in global value chains.

Parallel Session 2B: Productivity and growth-enhancing institutions

Productivity and growth-enhancing institutions: On innovation-friendly public interventions and institutions in the EU

Mary Veronica Tovšak Pleterski (Director, European Commission) explained the European Commission's vision to help boost innovation and productivity through policy and institutional reform. She said that European regulation tends to be strict and inflexible, and thus not very friendly to innovation. Hence, the European Commission would like to adapt its regulatory framework and make it more innovation friendly. The "REFIT" initiative is part of the Commission's better regulation agenda. It aims at better making sure that regulation delivers the intended benefits for citizens, businesses and society while removing red tape and lowering costs. In practice, this means that regulation is regularly tested to check whether is still fit for its purpose and, if not, how it should be amended. Europe is also addressing the challenge of taxation in the digital area, where taxation based on physical presence is increasingly inadequate, especially when large digital multinational enterprises seek to minimize their tax liabilities by shifting their profits to low-tax jurisdiction. The Digital Services Tax Directive is an interim measure proposed to ensure that all companies contribute fair taxation in the European Union. Finally, Europe is encouraging countries to adapt National Productivity Boards to inform the debate about productivity-related policy challenges, bring country specificities in the discussion, and exchange views about good practices.

The Digital economy and regulatory policy

Jonathan Coppel (Commissioner, Productivity Commission Australia) presented the work of the Australian Productivity Commission which was established as an independent advisory and research body. The Commission responds to government requests and conducts regular reviews of the regulatory burden, in addition to self-initiated research. A recent initiative is to review the disruptions created by the emergence of digital technologies, in particular the consequences for regulation. A recent example is the emergence of FinTech, with potential large benefits for consumers and firms, but also new questions for regulators and supervisors. Regulatory sandboxes are a promising way to experiment with such innovations without regulation standing in the way. Another example is the emergence of new technology in healthcare services, but paradoxically little productivity increase. This is partly explained by the reluctance of doctors to let patients access their electronic medical records. Similarly, banks accumulate large amounts of data, but clients have only limited access to it. Questions for regulators in this respect include the right of consumers to have access to the data that they created and to determine how such data can be traded. Regulators need also to ensure that consumers are able to transfer their data to third party providers, which enhances the power of competition. Regulators also need to introduce processes and mechanisms to file complaint and seek redress.

The rise of robots, employment, income inequality, and optimal Taxation

Patrick Lenain (Assistant Director, OECD) presented a paper addressing a challenge faced by policymakers: how to adapt tax policy to fast technological change? The rise of robots – in other words, automation that results in routine workers being replaced by machines, such as in automobile assembly plants – is bringing large benefits to consumers but with the risk of displacing a large proportion of routine workers and increase the inequality of income distribution. With market frictions prevailing in most countries, such developments are likely to cause long-lasting damages, with regional concentration of joblessness and poverty, as well as related severe social problems. The fear of robots replacing human workers has led to calls for taxing the robots by Bill Gate, Elon Musk and Stephen Hawking, as well as the introduction of universal basic income. Conventional economic theory discourages the taxation of intermediate goods such as machines, but such taxes would distort producer decisions and reduce efficiency. Instead, the taxation of consumption or income is recommended. However, recent economic research has shown that conventional tax models are based on unrealistic assumptions regarding incentive compatibility and the substitutability of routine and non-routine workers. In a model where routine workers are substitutable to machines while non-routine workers are complementary to machines, and where utility depends on consumption and leisure time, automation leads to higher income and tax revenue, but also higher inequality. While this could be addressed by making income taxes more progressive and increasing social transfers, the risk is that non-routine would behave like routine workers and benefit from transfer income and reduced working time. An alternative is to tax the robots and use the proceeds to finance social transfers, such as a universal minimum income. While this solves the incentive-compatibility problem, there is doubt as to whether society is ready to function with a large share of adults not participating in the labour market and living on social benefits. Before using such measure, a lot could be done to improve existing transfer programmes (e.g. better targeting and

simplification of access) and to increase the use of the least distortionary taxes (such as taxation of natural resources). Training routine workers to become non-routine workers improves welfare, but does not reduce inequality and requires post-tax rate of return on education to be sufficiently attractive.

Parallel Session 3: Intangibles, skills and disruptive technologies

Parallel Session 3A: Intangibles, skills and disruptive technologies

From clusters to innovation ecosystems – How technology can help us better measure their impact

Catherine Beaudry (Professor, École Polytechnique de Montréal) presented the challenges of measuring innovation within ecosystems. She highlighted the role of networks of formal and informal links between individuals even across competing firms. These links may not necessarily be only within close geographic proximity, but also between firms in a long distance which will be required to collaborate at some point. In such ecosystems, these networks make difficult to attribute the impact of innovation to an individual stakeholder. She explained that traditional methods of survey data collection to identify innovation within ecosystems can contain bias and showed a proof of concept to rather use the content of keywords on social media and technology firm websites. These keywords were found to be significantly correlated with R&D outcomes.

From clusters and networks to innovation ecosystems: What is the role for policy?

Elvira Uyarra (Reader, University of Manchester) presented a review of cluster policy evaluations, noting there is very little evidence on policy effectiveness. She noted that there are several potential benefits from clusters, stemming from labour pooling, technology or knowledge spillovers or proximity to suppliers and customers. However, there are few historical cases of cluster formation directly as a result of policy. There is widespread use of cluster policies, with many locations trying to emulate Silicon Valley, but the policy heterogeneity makes evaluation difficult through differing definitions of clusters, differing target groups, sectors etc. She noted that many policies lack clear rationale and most evaluations suffer from only focusing on short-term efficiencies, without a control group to compare against, and the few that consider longer-term impacts have inconclusive results.

Anchor firm disrupted: Clusters, resilience and regional labour markets

Tara Vinodrai (Associate Professor, University of Waterloo) presented evidence on the impact of disruption to a cluster's anchor firm – drawing on the example of employment contraction at Blackberry in the late 2000s within the Waterloo area of Canada. Most of evidence concerning anchor firm disruption related to manufacturing firms, whereas the evidence for tech clusters is much more limited. Blackberry was a leader in wireless data technologies and mobile smartphones, but lost market share and ultimately shed employees after the introduction of Apple smartphones in 2007. The study used social media and career platforms to follow individuals who had previously been employed by Blackberry. The research found that most individuals ended up subsequently employed by another large firm within the

same region, or a few other tech clusters abroad, but there was little evidence of starting successful start-ups.

Parallel Session 3B: Skills for the new economies – What is an optimal policy response?

Division, diffusion & coordination of complex knowledge

Frank Neffke's **(Senior Research Fellow, Harvard University)** presentation centred on skill mixes in today's workplaces. His presentation showed that today's complex products/outputs require large teams of workers, where each workers is specialised and contribute to a specific function. In this work model, human capital is highly specific to jobs, workers are interdependent and diffusing capabilities require moving workers from one place to another. Having the right skill mix in a firm implies having several specialised workers rather than having each worker with the same right mix of skills. To access skills, firms often need to bring in people from elsewhere (with consequences for migration). If the required know-how to produce a certain good is too complex, firms need to bring in entire teams from abroad.

Putting faces to jobs at risk of automation

Glenda Quintini (Senior Economist, OECD) presented a recent OECD study on the jobs under risk of automation. In OECD countries about 14% of jobs are highly automatable and another 32% could face substantial change in how they are carried out. Automation mostly affects manufacturing industry and agriculture but some service sectors are highly automatable too. In fact, the highest risk of automotation is concentrated in routine jobs with low skill requirements and often low wages, while the lowest risk applies to a broader range of jobs from professionals to social workers. The study also showed that the risk of automation falls with educational attainment and that young people are the most at risk with disappearing student jobs and entry positions. Policy makers will have to foster programme that equip citizens with the right mix of skills to have a place in the job market of the future. This mix includes general cognitive skills, complementary skills such as problem solving, creative thinking, communication, emotional intelligence, ICT and a strong ability to lifelong learning. Additionally, it is important to ensure social protection, requalification and adult learning for workers whose jobs may disappear.

Automation the future of work: scenarios and policy options

Joel Blit (Associate Professor, University of Waterloo) highlighted that Artificial Intelligence (AI) is a general purpose technology (GPT) and thus will continue improving and will spawn complementary innovations. That said, like other GPTs (e.g. steam engine, electricity, semiconductors, etc.) it will take time to feel AI's full impact on productivity growth, unemployment and inequality. The impact of Artificial Intelligence (AI) on employment is not clear cut with estimations of jobs susceptible to be automated varying between 9% and 47%. Also, it was noted that just because a job can be feasibly automated that does not mean it will. First, automation may not be economic attractive. Second, automation may require organisations to change faster than they can. Finally, automation may not be compatible with current laws and regulations which tend to evolve slowly. Nevertheless, even if jobs still exist new technologies

will put downward pressures on wages of low-skill jobs while rewarding complementary skills (e.g. judgement, critical thinking, leadership, etc.) which are common to high-skill jobs. As a consequence, job polarization (i.e. on the one hand high-skill/high-paying jobs and on the other hand low-skill/low-paying jobs) will become an increasing issue. In this context, policies need to promote new technologies to generate broadly shared gains. This can be done through education and training, solid social safety nets that address the challenges posed by the gig economy and broad taxation systems that respond to the increasing capital mobility and the changing nature of production.

Parallel Session 3C: Collateralising intangible assets: Challenges and Best Practices

Intangible assets and innovation

William Janeway (Co-founder, INET, member of the Board of Managers, CERF) gave a historical perspective of the considerable rise in the range and importance of intangible assets and on the different models to finance intangible intensive firms. Venture capital developed rapidly in the 80s and 90s to finance new firms with little tangible capital, while banks traditionally need pledgeable tangible capital. A key challenge today is how to deal with data, the value of which is important but hard to estimate, and which creates winner-takes-all dynamics. Willam Janeway argued that the current financial environment is overall exceptionally benign for technology firms (we may be in a "unicorn bubble") and that there were signs of over-optimism among certain investors. However, most of these investments are not leveraged meaning that failures may not have systemic consequences.

Collateralising intangible assets: constraints, rationale for policy intervention and lessons learned

Kris Boschmans (Policy Analyst, OECD) argued that collateralising intangible assets can help innovative firms to obtain financing in the development stage. He described the main challenges to collateralise intangible assets, such as valuation difficulties, lack of information, lack of secondary markets, transaction costs. As a result of these challenges, few intangibles (mostly patents) are used as collateral by innovative firms. Kris Boschmans described examples of policies aimed at stimulating the financing of intangible assets, such as government guarantees and incentives, giving examples from China, Japan and Korea. He also emphasized the importance of engaging with the private sector and working on standardised valuation methods.

The financing of intangibles: A practitioner's perspective

Trevor Allibon (Managing Director, Growth and Transition Capital, Business Development Bank of Canada) described the activity of the Business Development Bank of Canada (BDC) which is a government-owned institution which finances about 49000 entrepreneurs in the country. He detailed the range of financial instruments that innovative firms can use, a spectrum going from equity-type to debt-type instruments. He also emphasized that a substantial part of the intangible capital of a small innovative firm is attached to its founder, as it reflects its skills and network.

Slow productivity growth: The new normal?

John Fernald (Professor, INSEAD and Senior Research Advisor, Federal Reserve Bank of San Francisco) explained that many features of recent US productivity growth are similar to US growth seen in the 70s to early 90s, and that his best guess would be that we are returning to a new normal. For example, annual total factor productivity (TFP) growth is similar post-2004 and pre-1995, and that TFP in the EU has been falling since the 1960s. He suggested productivity growth has returned to trend, after a decade of exceptional IT-driven growth until the mid-2000s. He ruled out the financial crisis or measurement as reasons for the slowdown, since productivity slowed before the crisis and there is little evidence that mismeasurement has become worse over time. However, this does not rule out another breakthrough, such as AI or robotics, but there are substantial adjustment costs and it is unclear how quickly these would be realised.

Productivity in a world of disruptive technologies

Carol Corrado (Senior Advisor and Research Director, Conference Board) explained that some of the puzzles can be explained by accounting for intangibles. She also acknowledged that productivity had returned to pre-1997 growth rates. Total investment in intangibles (such as software, databases, R&D, design, organisation) has been growing, whereas tangibles investment has been declining from the 1970s to present. Firstly, these intangible investments have slowed since 2000, which if these have spillovers, may be linked to the slowdown in productivity growth. Secondly, she highlighted that data-related investments have been growing over time, such as computing power in AI training runs doubling every 3.5 months, and data-related R&D or computer design services growing faster than GDP. However, as these data-related investments are not fully measured, productivity may initially be underestimated and then overestimated when the payoffs to the investment are eventually realised. This is an empirical lesson learned from IT-related intangibles in 1990s.

What do we know about the productivity slowdown?

Kevin Fox (Professor and Director of Centre for Applied Economic Research University of New South Wales Business School, Australia) highlighted that despite the productivity slowdown there was a wide dispersion in sectoral MFP growth in Australia, however post-2004 here was a slowdown in productivity growth across all industries. He highlighted the role of mismeasurement, and whilst it is unlikely to be the complete answer for the slowdown, there has been progress made in several areas. Firstly, in terms of valuing free goods and services, such as WhatsApp, Facebook and Skype (which willingness to pay evidence suggests a high value for some demographics). Secondly, in terms of the measurement of the value of new or disappearing goods. Thirdly, in terms of better measurement of time use in the digital era and the opportunity cost of time – the last survey for Australia was in 2006.

Mike Veall (Professor, McMaster University) highlighted the importance of the conference theme to government and central bank policy. He noted that the consensus at the conference seemed to be that a disruption from new technology, such as AI, is more likely than not. Such disruption raises several challenges for policy, such as IP, regulation and public finance (since intangibles that are hard to measure are also hard to tax). He noted differing scenarios for growth and disruption, but noted that AI is likely to mainly affect parts of jobs (and the tasks performed) rather than entire job replacement. He drew attention to public finance as a particular issue, since it affects the ability to compensate those who workers who may lose out from the disruption.

Dan Andrews (Chief Advisor, Australia Treasury) suggested economies seem to be in a transition period with new technologies, highlighting that it took 30 years to exploit the benefits of electricity as a General Purpose Technology. He noted that technological progress was solid, but not diffusing across firms as reflected in productivity and wage divergence. He explained the importance of complementary investments and highlighted some knowledge gaps, such as how management capital is changing over time and financing of intangibles (through debt bias of corporate taxation systems and insolvency barriers). He drew attention to the links between worker mobility and firm dynamism, which may limit the ability of productive firms to expand or less productive firms to contract or exit.

Dan Mawson (Senior Economic Adviser, UK Department for Business, Innovation and Skills) highlighted some of potential challenges of new technologies for the UK. He noted that training and labour market institutions are often culturally entrenched, with high skilled workers not using job centres and universities focussed on graduates, rather than life-long learning. Small firms persist with poor management practices and whilst almost everybody has a smart phone, some firms do not use even basic accounting software. He also noted that we are in an age of anxiety, with many people more pessimistic for future, and consequently workers avoid risk and job to job moves are only now returning to pre-crisis levels now. Over the past 20 years, UK has comparatively poor spending on private investment in physical capital or intangibles and training in comparison to her peers. He noted that good framework conditions do not seem to be enough.

Dirk Pilat (Deputy Director, OECD) highlighted how the GFP conference had taken an inter-disciplinary, macro and micro approach to the challenges of new technologies. However, there is a need for further research on linking macro with firm-level data, research on worker mobility, jobs and skills and gender diversity. Digital intangibles (such as the role of data as a factor input) remain poorly understood and in particular, their challenges around productivity, measurement, analytical frameworks and consumer welfare. He highlighted recent and ongoing work for the GFP concerning M&As, concentration and productivity; GVCs and productivity and Finance and productivity. He concluded by thanking the Canadian hosts, GFP Steering Group and OECD colleagues for making the conference possible.