

Research Report

April 2021

Macroeconomic assessment of the Austrian Recovery and Resilience Plan

Project leader:
Michael Reiter

Project collaborators:
Susanne Forstner, Viola Garstenauer, Helmut Hofer, Zuzana Molnárová, Iain Paterson

Report commissioned by
Bundesministerium für Finanzen



INSTITUT FÜR HÖHERE STUDIEN
INSTITUTE FOR ADVANCED STUDIES
Vienna



INSTITUT FÜR HÖHERE STUDIEN
INSTITUTE FOR ADVANCED STUDIES
Vienna

Author(s)

Michael Reiter, Susanne Forstner, Viola Garstenauer, Helmut Hofer, Zuzana Molnárová, Iain Paterson

Title

Macroeconomic assessment of the Austrian Recovery and Resilience Plan

Original project title: Gesamtwirtschaftliche Bewertung des „Recovery Plan for Europe“

Contact

Michael Reiter

T +43 1 59991-154

E mreiter@ihs.ac.at

Institut für Höhere Studien – Institute for Advanced Studies (IHS)

Josefstädter Straße 39, A-1080 Vienna

T +43 1 59991-0

F +43 1 59991-555

www.ihs.ac.at

ZVR: 066207973

To the best of our ability and belief, all information contained in this publication is accurate and reliable. Nonetheless, all content is provided without any guarantee. The IHS is not liable for the content or contributions of this report.

Summary of the impact assessment of the Austrian Recovery and Resilience Plan

The Institute for Advanced Studies (IHS) was commissioned to conduct an independent assessment of the economic impact of the reforms and investments contained in the Austrian Recovery and Resilience Plan (RRP). The total budget requested for the plan amounts to €4.5 billion (approximately 1.2% of Austrian GDP forecasted for 2021) and consists of reforms and investments in four categories, or “components” – sustainable recovery, digital recovery, knowledge-based recovery and fair and just recovery (“nachhaltiger, digitaler, wissensbasierter and gerechter Aufbau”). The plan should be implemented until the end of 2026.

We use a dynamic stochastic general equilibrium (DSGE) model to estimate the impact of the Austrian RRP on GDP. In the second year of the plan (2022), GDP will be higher by 0.41%, in year 5 (2025) it will be higher by 0.91%, and in year 20 (2040) it will be higher by 1.21%, always compared to the baseline of no policy measures. The estimated impact on GDP in 2040 is approximately €6.5 billion (expressed in 2021 euros). We estimate employment to increase by 0.29% in year 2, 0.54% in year 5, and by 0.61% in year 20. Under the assumption that there are no changes in tax rates, the increase in economic activity will lead to a positive budget balance for the Austrian government of 0.20% of GDP in year 2, 0.34% in year 5 and 0.56% in year 20.

The Austrian RRP increases public and private investment demand and leads to substantial increase in GDP in the short and medium run. In particular, grants and subsidies stimulate a substantial increase in private investment. In the short run, this generates strong demand effects that are important for a fast economic recovery of the economy from the Covid-19 crisis. Investment also builds up the capital stock, which increases potential output, raises employment through higher productivity and wages, and leads to higher GDP in the medium and long term. The long-term effect on the economy is mostly driven by efficiency gains coming from research and innovation. As the main driver we identify the digital transformation, which includes the provision of the infrastructure (increase in broadband penetration) as well as investments into digital skills, and digital reorganisation of both private business and the public sector. The plan contains many other investment measures that have the potential to spur long-term innovation and growth, but where we do not have a strong basis for quantification of the long-term effects.

Government spending on education, social services, health care, and in other sectors contributes to short- and medium-run output and employment effects. Long-run economic effects of the increased human capital are included in the assessment.

Moreover, the measures in the RRP have potential long lasting impact on welfare of households that go beyond the quantitative economic evaluation. In particular, the evaluation does not take into account the indirect effects of green investments, resulting from the environmental impact on household wellbeing and economic productivity.

The macroeconomic impact of the Austrian RRP was assessed using the IHS multi-industry New Keynesian dynamic stochastic general equilibrium (DSGE) model of Austria as a small open economy within the Euro Area. The model features an extensive government sector which conducts fiscal policies and interacts with the rest of the economy. The model contains different household types (credit-constrained and non-credit constrained) and a highly disaggregated industry structure with integrated input-output relationships. Thus, the model is able to differentiate between various types of investments and consumption expenditures, which increases the accuracy of the impact estimates especially in the short and medium run. For medium- and long-run effects of investments in R&D, digitalization and connectivity, as well as education and human capital, the productivity effects were calculated based on the existing empirical literature and channeled back into the model.

Since Austria is a small open economy, and because investment goods contain a large import component, the demand effects of the RRP measures imply important demand spillovers to other EU countries. Similarly, the RRP of other European countries will most likely generate an increased demand for Austrian exports. These international effects are not included in our assessment.

Table of Contents

Summary of the impact assessment of the Austrian Recovery and Resilience Plan	4
1 Methodology of the evaluation	8
1.1 The dynamic economic model	8
1.2 Productivity and Externalities	11
1.2.1 Investment in ICT, broadband internet and the digital transformation	11
1.2.2 Investment in Research and Development	12
1.2.3 Investment in Training and Education	13
1.3 The channels at work	14
1.3.1 Channels of short-run impact	14
1.3.2 Channels of long-run impact	14
1.4 Extended literature review	15
1.4.1 The Productivity effects of Public Investment in R&D on the wider Economy	15
1.4.2 The Returns to ICT investments	17
1.5 Assessment procedure	18
2 Information on model evaluation of individual investments and reforms	20
1 - Nachhaltiger Aufbau	20
1.A.2 Förderung des Austauschs von Öl- und Gasheizungen	20
1.A.3 Bekämpfung von Energiearmut	21
1.B.3 Förderung emissionsfreier Busse und Infrastruktur	22
1.B.4 Förderung emissionsfreier Nutzfahrzeuge und Infrastruktur	23
1.B.5 Errichtung neuer Bahnstrecken und Elektrifizierung von Regionalbahnen	24
1.C.2 Biodiversitätsfond	25
1.C.3 Investitionen in Leergutrücknahmesysteme und Maßnahmen zur Steigerung der Mehrwegquote für Getränkegebinde	26
1.C.4 Errichtung und Nachrüstung von Sortieranlagen	27
1.C.5 Förderung der Reparatur von elektrischen und elektronischen Geräten	28
1.D.2 Transformation der Industrie zur Klimaneutralität	29
2 - Digitaler Aufbau	30
2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit besonderen sozioökonomischen Schwerpunkten	30
2.B.2 Bereitstellung von digitalen Endgeräten für Schülerinnen und Schüler	31
2.C.2 Digitalisierungsfonds öffentliche Verwaltung	32
2.D.1 Digitalisierung der KMUs	33
2.D.2 Digitale Investitionen in Unternehmen	34
2.D.3 Ökologische Investitionen in Unternehmen	35
3 - Wissensbasierter Aufbau	36
3.A.2 Quantum Austria – Förderung der Quanten Sciences	36

3.A.3 Austrian Institute of Precision Medicine	37
3.A.4 (Digitale) Forschungsinfrastrukturen - zur nachhaltigen Entwicklung der Universitäten im Kontext der Digitalisierung	38
3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen	39
3.C.2 Förderstundenpaket	40
3.C.3 Ausbau Elementarpädagogik	41
3.D.1 IPCEI Mikroelektronik und Konnektivität	42
3.D.2 IPCEI Wasserstoff	43
4 - Gerechter Aufbau	44
4.A.2 Förderung von PVE-Projekten	44
4.A.3 Entwicklung der Elektronischen Mutterkindpass Plattform inkl. der Schnittstellen zu den Frühe Hilfen Netzwerken	45
4.A.4 Nationaler Roll-out der „Frühen Hilfen“ für sozialbenachteiligte Schwangere, ihre Kleinkinder und Familien.....	46
4.B.3 Klimafitte Ortskerne	47
4.B.4 Investition in die Umsetzung von Community Nursing	48
4.C.3 Sanierung des Volkskundemuseums Wien und der Prater Ateliers	49
4.C.4 Digitalisierungsoffensive Kulturerbe	50
4.C.5 Investitionsfonds „Klimafitte Kulturbetriebe“	51
3 Tables with Quantitative Results	52
4 References	57

1 Methodology of the evaluation

1.1 The dynamic economic model

The evaluation of the macroeconomic impact of the measures of Austrian RRP is based on the macroeconomic model ATMOD of the Austrian economy, which has been developed by a team of researchers at the Institute for Advanced Studies as a part of a broader research agenda of modelling the Austrian economy, for the purpose of policy analysis and forecasting. Some specific model adjustments were implemented in order to facilitate the macroeconomic evaluation of the plan.

ATMOD is a state-of-the-art multi-industry New Keynesian dynamic stochastic general equilibrium (DSGE) model of a small open economy within the Euro Area. The model is calibrated such that it resembles the economic environment in Austria to the highest possible degree. Since the focus of the model is on economic policies and public finance, it features an extensive government sector which interacts with the rest of the economy.

DSGE models attempt to explain the macroeconomic phenomena based on the microeconomic principles of optimizing agents and general equilibrium theory. In this way they avoid the Lucas critique (Lucas 1976), and are therefore suitable for policy analysis. The agents in DSGE models form expectations about the future rationally and act according to these expectations. This approach restricts the model structure and makes modelling more demanding in terms of matching empirical evidence and computational complexity. On the other hand, medium-size DSGE models are well equipped to explain the economic phenomena in an intuitive and tractable manner. The economic relationships identified by general equilibrium models can be directly related to the microeconomic behaviour of the agents, thus making the mechanisms behind the model outcomes transparent.

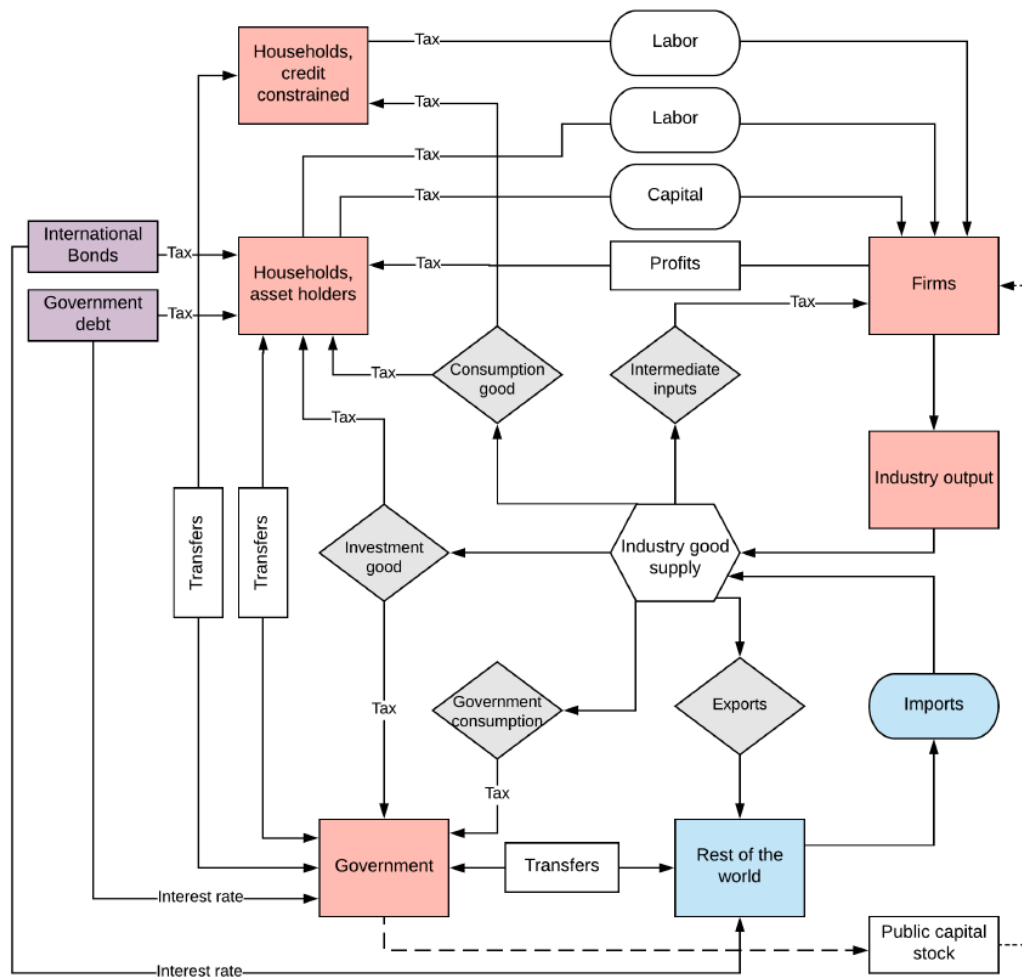
The effects of the policy measures in the model are best described separately for short and long run. In the short run, the model response is driven primarily by the demand side – directly by increased public demand and through endogenous private demand effects typical for New Keynesian models (Smets and Wouters, 2007). In the long run, potential output of the economy increases due to effects on capital stock and total factor productivity.

The model economy consists of domestic (Austrian) households, firms, government, and the rest of the world. The agents trade goods, production factors and financial assets. Austria is modelled as a small open economy within a monetary union. Figure 1 depicts the model environment in a simplified manner. The detailed technical documentation of

the model is available in a separate Appendix. The main components of the model include:

- Households, differentiated into credit constrained and non-credit constrained type.
- Production firms, differentiated into 74 industries that are connected through the input-output network.
- Government (public sector) which includes:
 - A tax system that resembles the most important taxes as well as revenues from the social security system.
 - Public expenditures, including public consumption, investment, subsidies, and transfers which act as automatic stabilizers (e.g. unemployment benefits).
- International trade of goods and financial assets with the rest of the world.
- Monetary policy, set by an (external) monetary authority.

Figure 1: Model structure. Domestic agents (red), rest of the world (blue), uses of industry goods (grey), and financial assets (purple). Full lines represent financial transfers, which in most cases happen in exchange for goods, production factors



Source: IHS

1.2 Productivity and Externalities

The DSGE model describes the short-, medium- and to some extent also the long-term economic effects of public expenditures and subsidies on economic activity. However, some of the measures included in the RRP have additional effects that are not automatically captured by the model. On the one hand, there are the effects on environmental quality and CO₂ reduction, which improve household welfare, help to achieve climate goals and direct economic development to a more sustainable path, but are not necessarily reflected by a larger measured GDP. Our analysis is not supposed to capture these effects. On the other hand, there are additional long-run effects on economic productivity, which are particularly strong for three types of measures: investment into research and development (R&D) in a broad sense; investment into human capital; investment into information and communication technology, which is a key prerequisite for innovation and knowledge accumulation. For these types of investments, it is typical that only a part of the returns accrues to the economic agent, firm or organization that undertakes the R&D investment. Often an even larger part goes to other agents in the economy in the form of knowledge spillovers. This means that the social returns to these investment activities are much higher than the private returns. Modeling the process of knowledge creation and its economic consequences is the aim of endogenous growth theory, but quantifying the effects is very difficult due to the unobserved nature of the involved externalities.

1.2.1 Investment in ICT, broadband internet and the digital transformation

The importance of information and communication technology (ICT) for economic efficiency is obvious at the firm level. Moreover, the literature estimates that the use of ICT has positive spillover effects on other market participants, mostly through network effects. Our calculations are based on an estimate that the positive externality is equal to 44 percent of the private returns (for details, cf. Section 1.4.2). The effect of the capital increase itself is of limited duration, however, because the estimated annual depreciation rate is 11.5 percent.

Beyond the use of more equipment to increase current productivity, the digital transformation in the business, household and public sector is a key prerequisite for future innovation and growth. Modern information technology is crucial for the development of new ideas, products and services. However, profiting from the digital transformation requires big investments into infrastructure, human capital and organization. The necessary infrastructure is, among others, the technical access to high-speed internet, measured by the broadband penetration rate. Investment into human capital includes the training in digital skills, starting in school, but also involving a large

part of the active work force. The digital transformation in private business and in the public administration needs substantial organizational effort.

The RRP includes measures along all these dimensions. These efforts are complementary, and the long-run growth impact that can be attributed to the digital transformation is the joint outcome of these measures. For technical simplicity and clarity, we assign the entire permanent increase in total factor productivity to the measure "2.A.2 Gigabit-fähige Zugangsnetze", i.e., increase in broadband penetration. Thus, our results for measure 2.A.2 show a high effect on GDP in 20 years, while other digitalisation measures show a much smaller long-run impact. The reason for this way of presenting the results is that the empirical literature has concretely estimated the causal effect of broadband penetration on economic growth. Nevertheless, since these results do not control for complementary investments in digital transformation, which would naturally go together with investments in the infrastructure, it is reasonable to assume that the estimates capture the total effect of all these investments together.

Some prominent papers in the literature estimate very high growth effects of broadband. We follow a conservative strategy and follow a recent paper with estimates on the lower side of the spectrum. According to our calculations based on the measure description, the Austrian RRP measure 2.A.2 leads to a 17.5 percent increase (from a base of 40 percent) in the gigabit-capable broadband penetration of households in Austria. From the estimates in Koutroumpis (2018), this implies a 0.8 percent increase in GDP. We therefore scale the productivity gain such that, after the completion of the measures, the general equilibrium effect on output is 0.8 percent. As mentioned above, the interpretation of this effect is that access to the digital infrastructure is the driver of a permanent technological progress. We therefore assume that this productivity gain continues afterwards at the same level.

1.2.2 Investment in Research and Development

There is a large empirical literature trying to estimate the private as well as social returns on investment in R&D. The majority of the papers conclude that social returns to R&D investment are very high, but the estimates also differ widely across different types of investment. A more detailed literature overview is given in Section 1.4.1.

A very recent and prominent study is Jones and Summers (2020). The authors find that the social returns to R&D activity are very high, as indicated in previous R&D studies. The calculations in the assessment of the Austrian RRP are based on the assumption that the annual rate of return, which sets in 5 years after the investment, is 15% on average, and growing over time by 1 percent per year. This is below the range that Jones and Summers have estimated for average returns, and at the lower end of marginal returns. We assume no depreciation of this effect, so the above numbers are interpreted as net rates

of return. The time pattern of returns is chosen to reflect the fact that the stock of knowledge created by research, in particular basic research, needs some time to become economically productive at all, and afterwards its economic relevance increases for some time, extending to the forecast horizon of assessment. An alternative interpretation is that the stock of R&D capacity contributes to the growth rate of productivity, which also means that the productivity effect increases over time. We assume that the persistent social returns of the R&D expenditures in the plan apply to the full size of these expenditures. This does not preclude that these expenditures, by adding to different types of capital stock in the model, crowd out or crowd in other forms of tangible and intangible investments, creating further productivity effects in general equilibrium. However, we assume that the projects funded from the RRF are designed such that they have higher spill-over effects on aggregate productivity than the activities they might crowd out. The rates of return accrue to the whole Austrian economy in the form of additional output generated by an increase in total factor productivity.

1.2.3 Investment in Training and Education

There is a large empirical literature measuring the returns to education, which are reflected in higher earnings over the life cycle. Classical references are Heckman (2000) as well as Card (1999 and 2001), who establishes that the effect of schooling on later income is actually causal. Generally, the literature estimates of returns are high. A recent study (Patrinos 2016) estimates the return to schooling in European countries of around 8 percent. Most likely, education has a higher return the earlier it happens in life (the famous “Heckman curve”; this is questioned by Rea and Burton (2020), who also find high returns for education later in life). In this study we therefore assume that preschool education has an annual rate of return of 10 percent, starting 15 years after the education takes place. Investment into education in the last school years has a return of 8 percent, starting with a delay of 3 years. Interpreted as social returns, these numbers can still be considered conservative; Hanushek and Woessmann (2015a) estimate large growth effects of education, which we did not consider here. Training programs of adults have a return of 6 percent, becoming effective with a delay of 1 year. Card et.al. (2018) establish the effectiveness of this type of active labor market policy.

The literature mostly estimates the rate of return on time (foregone income) spent on education. Our analysis implicitly assumes that the same rate of return applies to the money spent on education, which can be interpreted as an investment into the quality of education. We model the effects of education as an investment into a stock of capital that can be interpreted as human capital.

1.3 The channels at work

It is useful to classify the channels through which the RRP measures work into short-run and long-run channels.

1.3.1 Channels of short-run impact

The short-run impact works through government subsidies or grants that are funded from the RRF as well as through RRF funds that are directly used for expenditures on investment or public consumption. These channels can be classified as follows:

- a) Subsidies or grants stimulate private investment.

This includes fixed investment in the business sector, as well as investments related to the improvement of residential construction, undertaken by private households. This has a direct demand effect and increases GDP. However, some investment goods, for example machinery, equipment, and vehicles, have a relatively large import component, which reduces their direct effect on GDP.

- b) RRF funds increase investments directly by public sector or through 3rd party institutions, e.g. via grants.

The demand effects are similar to the effects of business investment.

- c) Subsidies or grants stimulate consumption of goods and services by private households.

The increased demand has an immediate demand effect on GDP.

- d) RRF funds are used for public consumption of goods or services, contributing to GDP.

It should be noted that consumption of services generates comparatively high employment effects due to the high labor share in the public service sector.

1.3.2 Channels of long-run impact

The long-run impact can also be understood as the effect on the potential output of the aggregate economy. The change in potential reflects either increased capital formation, or some form of technical progress that persistently changes the productivity of the aggregate economy. Investment in human capital (education) in the model also contributes to total factor productivity.

The more traditional forms of capital formation can be classified as follows:

- a) Private investment, which increases potential output through an increase in the capital stock.

The persistence of this effect depends on the depreciation rate of the respective type of capital. The current productivity of construction, both residential and non-residential, is small but long-lasting. In contrast, investment in equipment and machinery has a strong but relatively short-lived effect.

b) Consumption of private households induces private investment.

An increase in consumption demand stimulates investment, and in this way also has a small, but persistent effect on potential output.

c) Public investment increases productivity.

Investments into the quality of public infrastructure directly affect the productivity of private economic activity. In addition, they stimulate further private investment (crowding-in effect), leading to additional gains in productive capacity.

The three forms of capital formation are automatically captured by the model. In addition, the externalities described in section 1.2 further increase the long-run effects of investment.

1.4 Extended literature review

1.4.1 The Productivity effects of Public Investment in R&D on the wider Economy

The RRF plan puts strong emphasis on the role of innovations and R&D sector for future economic growth. The effects of public and private investments to R&D have been widely researched in the last 25 years. Although private capital is intensively used for R&D, an extensive literature on public investment exists documenting the additional economic benefits. The rationale for public investment and subsidies derives from the non-rival and non-exclusive nature of knowledge (despite some mitigation through patent protection), a ‘market failure’ that, along with increasing returns to scale and the uncertainty surrounding innovations, was identified by Arrow (1962).¹

National public support for R&D focuses on the one hand on productivity increases accountable to the capital used by private firms for R&D which leads on to profitable product innovations, and on the other hand on the role of ‘spillovers’ i.e. the additional

¹ More broadly, early empirical work of Aschauer (1989, for G7 countries) and Munnell (1992, US) among others studied public non-military investment, including physical infrastructure projects, and found large effects on productivity growth directly and indirectly through complementarity to private sector production. A meta-analysis of this literature by Bom and Ligthart (2008), which accounted for corrections such as publication bias still shows a marginal productivity of public capital of 17 percent in 2001.

productive use that may accrue to other companies in the same industry – or indeed in other sectors – which derives from the original knowledge production of firms undertaking R&D. Spillover effects are more difficult to identify and their estimates in the literature vary, although many recent studies suggest an even higher productivity effect than for firms' private R&D. A meta-analysis of Hall et al. (2010) finds a distribution of elasticities centered around 0.8, with rates of private firms' return also likely to be between 20 - 30%. Meta-studies reporting high social returns include for example Jones and Williams (1998) and Wieser (2005), who finds average rates of returns to firms' R&D to average 27% (corresponding to elasticities with median of 0.10) over the more than a hundred individual studies analysed. Wieser estimates spillovers in industry studies are on average 2 times higher than private rates of return, reaching a conclusion that social rates of return are in the region of 90-100%. Such high estimates are within the bounds of possibility outlined recently in theoretical contribution Jones and Summers (2020).²

A more critical view on these results has been posed by Ugur et al. (2016), documenting possible biases such as selection bias. Frontier Economics (2014) maintain reservations about high social rates of return from the literature as mentioned above, however they report social returns of 20% on publicly funded research that is channelled through research councils or goes to universities or government labs. A study from the Science|Business network of universities, large industrial corporations, and public organisations (Hines 2017) reports private rates of returns within a range of 20 – 28% for EU funding of basic and applied research.

Public support of innovations and R&D may take the form of grants, but may also be implemented indirectly through tax-relief subsidies. While the effects of these instruments are complementary, some studies have found that the 'additionality' of grants (Guellec and van Pottelsberghe De La Potterie 2003) exceeds the benefits from tax subsidies (Paterson et al. 2009).

Finally, R&D may be on the cusp of being leveraged by parallel use in developments in ICT such as the Internet of Things (IoT). O'Mahony and Vecchi (2005) and Venturini et al. (2013) classify ICT as a general purpose technology (GPT) akin to electricity and automobiles, and broadband extensions may indeed open this perspective wider (Edquist et al. 2021).

² A large majority of studies that estimate productivity gains from R&D employ a Cobb-Douglas production function, as pioneered by Zvi Griliches in the 1980s, e.g. Griliches and Mairesse (1984). The vast literature of hundreds of studies at firm, industry or country level, has given a wide range of results, but these studies themselves have provided data for meta-analyses.

1.4.2 The Returns to ICT investments

The RRF with one focus on digitalisation presents EU countries with an opportunity to benefit from what could be a ‘second wave’ of investments in information and communications technology (ICT). In the period 1995-2007 (roughly the start of the ‘internet age’ to the onset of the financial crisis EU(-28) GDP grew at a healthy annual average of 2.6% while the US achieved around 3%. Van Ark (2014) attributes this gap to ICT capital, which accounted for 18% of EU GDP growth compared to 24% in the US.

After the relatively weak performance since the recessions of 2008/9 economies worldwide have been set back further by Covid-19. Already before the onset of the pandemic, analyses urged at adopting policies for digital technologies in OECD countries – such as high-speed broadband access, cloud computing and software developments, supported by upgrading of skills at various firm levels – in order to harness their productivity potential (Sorbe et al. 2019) not only in manufacturing industries but also in services and for smaller firms. (Gal et al. 2019). The general-purpose technology ICT/digitalisation along with innovations from private firms when adopted broadly should raise total factor productivity through spill-over effects. The chance of productivity revival on exiting the pandemic should not be missed – “once again” (Van Ark et al. 2020).

Empirical estimates of the aggregate rate of return on ICT investments exhibit substantial variation across the literature. For instance, in a survey of the empirical literature, Cardona et al. (2013) report country-level output elasticity estimates ranging from -0.013 to 0.162, and even larger variation of estimates at the industry level. A meta-analysis by Kretschmer (2012) finds similar ranges of estimates, but characterizes their distribution in more detail as exhibiting “a clustering of estimated elasticities around the value of 0.05-0.06, with some notable outliers of either highly positive or even negative output elasticities.” Moreover, the study finds a positive and significant positive time trend for the estimates, suggesting that “the output elasticity of ICT investment increases over time and is now approaching 0.1.”

Given that there is a wide range of estimates, the most robust approach seems to be a combination of growth accounting and production function estimation. Spiezia (2012) estimates an output elasticity with respect to ICT capital of 0.056, using data of 18 OECD countries for the time period 1995-2007. At the same time, the cost share of ICT capital in total output is estimated at 0.039. If the first number measures the social return, and the second number the private return, the social return is 44 percent higher than the private return, which then measures the positive externality of this form of investment. ICT capital, however, has a relatively high rate of depreciation. If we focus specifically on

communication capital, the depreciation rate is estimated to be 11.5 percent annually from EU KLEMS data (Stehrer et al. 2019).

Focusing specifically on the access to high-speed internet, measured by broadband penetration, estimates of output elasticity vary even more than with respect to ICT capital in general. Two prominent papers in the literature found very strong growth effects. Qiang et al (2009) finds that “all else equal, a high-income economy with an average of 10 broadband subscribers per 100 people would have enjoyed a 1.21 percentage point increase in per capita GDP growth.” Czernich et al. (2011) find that “a 10 percentage-point increase in broadband penetration raises annual per-capita growth by 0.9-1.5 percentage points”. Taking these estimates literally would lead to enormous effects if growth rates get compounded over time. To be on the conservative side, we use the recent study Koutroumpis (2018), which estimates an elasticity of the level of output with respect to broadband penetration of 0.046.

1.5 Assessment procedure

The economic assessment of the Austrian RRP conducted by the IHS followed a bottom-up procedure. First, each measure (reform or investment) was evaluated separately. The composition of expenditures included in each measure was categorized according to several dimensions relevant for its economic impact. These include: (1) differentiating between investments of various types and consumption expenditures on goods and services provided by various industries, (2) distinguishing between direct public spending on investment or consumption and subsidies on private investment/consumption and (3) classification of the economic sector or area that benefits from the investment.³

In the second step, the inputs per measure were analysed using the IHS multi-industry DSGE model. The model simulations reflect short-, medium- and long run effects of the measures along standard demand and supply side economic mechanisms. Due to its highly disaggregated nature, the model is able to differentiate between various types of investments and consumption expenditures, which increases the accuracy of the impact estimates especially in the short and medium run. For medium and long-run effects of investments in R&D, digitalization and connectivity, as well as education and human capital, the model results were adjusted in order to account for more specific findings from the literature. The basic information on the classification of the expenditures as well as the channels of impact for each measure are reported in section 2.

³ Notice that the categorisation of expenditures into public investment, consumption, transfers, subsidies, etc., from the point of view of economic modelling might differ from the official classification by national accounts.

Specific effects of the measures differentiated by gender and region are in principle very difficult to quantify. The IHS assessment of the effects along these dimensions therefore primarily relies on qualitative information available in the Austrian RRP. In addition to the qualitative information, a simple quantitative exercise based on the industry composition of produced goods and services was conducted to determine the relative share of female employment in the short and medium run, the results of which are reported in Table 1.

In some cases, the effects of reforms and related investments are highly complementary and it is not possible to evaluate their impacts separately. In such cases the economic impact on GDP, employment and budget balance is included and reported within the corresponding investment, as indicated in Table 2.

In the last step, total effects on the Austrian economy 2, 5 and 20 years ahead are computed by aggregating the effects of the individual measures.

It is important to highlight that while the economic model used for the evaluation includes many dimensions of the economic environment in Austria, it abstracts from other important aspects of the measures. Importantly, the model does not reflect the environmental and climate-related conditions, as well as other dimensions such as individual wellbeing.

2 Information on model evaluation of individual investments and reforms

1 - Nachhaltiger Aufbau

1.A.2 Förderung des Austauschs von Öl- und Gasheizungen

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment on the side of private households, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in dwellings
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the private household sector related to residential housing has persistent effects on economic output through an increase in the capital stock.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Regional distribution of oil-fired boilers and heaters in Austria is uneven - Tirol (35%), Vorarlberg (31%) und Carinthia (25%), on the other side Vienna (1%). The economic effects of the measure partly reflect this distribution.

1.A.3 Bekämpfung von Energiearmut

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment on the side of private households, increasing GDP.
- Subsidies in this measure finance up to 100% of households' total investment expenditure.

Composition of expenditures in quantitative model:

- Subsidy on private investment in dwellings
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the private household sector related to residential housing has persistent effects on economic output through an increase in the capital stock.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.B.3 Förderung emissionsfreier Busse und Infrastruktur

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in transport equipment
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.B.4 Förderung emissionsfreier Nutzfahrzeuge und Infrastruktur

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in equipment and machinery
- Subsidy on private investment in transport equipment

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.B.5 Errichtung neuer Bahnstrecken und Elektrifizierung von Regionalbahnen

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, non-residential construction
- Investments in fixed capital, equipment and machinery

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private productivity.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Investments in regions adjacent to the new/electrified railroads, with national and international spillovers.

1.C.2 Biodiversitätsfond

Channels of short-run impact:

- RRF funds are used for financing projects related to the national biodiversity strategy, generating demand for goods and services.

Composition of expenditures in quantitative model:

- Project grants related to implementing the national biodiversity strategy.

Channels of long-run impact:

- Long-run effects through improvements in biodiversity not quantifiable.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.C.3 Investitionen in Leergutrücknahmesysteme und Maßnahmen zur Steigerung der Mehrwegquote für Getränkegebinde

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in non-residential construction
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.C.4 Errichtung und Nachrüstung von Sortieranlagen

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in non-residential construction
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.C.5 Förderung der Reparatur von elektrischen und elektronischen Geräten

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate consumption of private households, increasing GDP.

Composition of expenditures in quantitative model:

- Price-subsidy on consumption of private households (repair services for digital devices and domestic appliances)

Channels of long-run impact:

- An increase in demand (private or public consumption) generates further stimulus for private investment, which might have a persistent effect on economic potential through an increase in the capital stock.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

1.D.2 Transformation der Industrie zur Klimaneutralität

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in non-residential construction
- Subsidy on private investment in equipment and machinery

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

2 - Digitaler Aufbau

2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit besonderen sozioökonomischen Schwerpunkten

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in **non-residential construction**
- Subsidy on private investment in **equipment and machinery**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- This measure is (or stimulates) investments into digitalization and broadband connectivity, which contributes to the infrastructure for private R&D and is expected to have a positive effect on economic growth through persistent increases in economic productivity, see section 1.2.1 for details.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** The measure is specifically aimed at households and businesses in infrastructure-weak, rural regions.

2.B.2 Bereitstellung von digitalen Endgeräten für Schülerinnen und Schüler

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, equipment and machinery (Notebooks)

Channels of long-run impact:

- This measure belongs to investments in human capital and digital skills, which contribute to factor productivity in the future. Furthermore, digitalization and broadband connectivity measures contribute to the infrastructure for private R&D and are expected to have a positive effect on economic growth through persistent increases in economic productivity, see section 1.2.1 for details.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

2.C.2 Digitalisierungsfonds öffentliche Verwaltung

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **intangible fixed assets**

Channels of long-run impact:

- Investments into digitalization of public sector contribute to the quality of business environment, enhance private investments and are expected to have a positive effect on economic growth through persistent increases in economic productivity, see section 1.2.1 for details.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Positive impact on businesses and population in infrastructure-weak regions.

2.D.1 Digitalisierung der KMUs

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in **intangible fixed assets** (e.g. digital infrastructure, internet security and consulting services)

Channels of long-run impact:

- This measure is (or stimulates) investments into digitalization and broadband connectivity, which contributes to the infrastructure for private R&D and is expected to have a positive effect on economic growth through persistent increases in economic productivity, see section 1.2.1 for details.
- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- Lowering economic “search costs” leads to more efficient allocations of resources and affects consumers’ welfare.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Measures increasing the (digital) accessibility of services and retail sector have potentially stronger impact in infrastructure-weak regions. This is true for both demand and supply side, where both higher search costs and smaller markets contribute to lower economic activity.

2.D.2 Digitale Investitionen in Unternehmen

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in **equipment and machinery**
- Subsidy on private investment in **intangible fixed assets**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- This measure is (or stimulates) investments into digitalization and broadband connectivity, which contributes to the infrastructure for private R&D and is expected to have a positive effect on economic growth through persistent increases in economic productivity, see section 1.2.1 for details.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

2.D.3 Ökologische Investitionen in Unternehmen

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Subsidy on private investment in **non-residential construction**
- Subsidy on private investment in **equipment and machinery**
- Subsidy on private investment in **transport equipment**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3 - Wissensbasierter Aufbau

3.A.2 Quantum Austria – Förderung der Quanten Sciences

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**
- Investments in fixed capital, **equipment and machinery**
- Investments in fixed capital, **intangible fixed assets**

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.
- This measure is (or stimulates) investments into R&D projects which are expected to generate very high long-run social returns, see section 1.2.2 for detail.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Investments in regions with participating institutions, with spillover effects on national and international economy.

3.A.3 Austrian Institute of Precision Medicine

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, non-residential construction
- Investments in fixed capital, equipment and machinery

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.
- This measure is (or stimulates) investments into R&D projects which are expected to generate very high long-run social returns, see section 1.2.2 for detail.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Investment in Vienna with spillover effects on other regions.

3.A.4 (Digitale) Forschungsinfrastrukturen - zur nachhaltigen Entwicklung der Universitäten im Kontext der Digitalisierung

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **intangible fixed assets, R&D investment**

Channels of long-run impact:

- This measure is (or stimulates) investments into R&D projects which are expected to generate very high long-run social returns, see section 1.2.2 for detail.
- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen

Channels of short-run impact:

- RRF funds are used for public consumption of goods or services, contributing to GDP. Consumption of (public) services generates comparatively high employment effects due to the high labor share in the service sector.

Composition of expenditures in quantitative model:

- Government consumption (education sector)

Channels of long-run impact:

- Active labor market policies increase the re-employment probability and thereby the future income of participants.
- Increasing human capital is important driver of potential output in the long run, contributing to total factor productivity, see section 1.2.3 for detail.

Gender and regional dimensions:

- **Gender:** The programs financed through the measure put emphasis on increasing qualification of women. Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3.C.2 Förderstundenpaket

Channels of short-run impact:

- RRF funds are used for public consumption of goods or services, contributing to GDP. Consumption of (public) services generates comparatively high employment effects due to the high labor share in the service sector.

Composition of expenditures in quantitative model:

- Government consumption (education sector)

Channels of long-run impact:

- Education measures are necessary to close the education gap following the COVID-19 crisis and have large effects on social and economic status of students later in life, particularly for less privileged students. See section 1.2.3 for detail.
- An increase in demand (private or public consumption) generates further stimulus for private investment, which might have a persistent effect on economic potential through an increase in the capital stock.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3.C.3 Ausbau Elementarpädagogik

Channels of short-run impact:

- RRF funds are used for public consumption of goods or services, contributing to GDP. Consumption of (public) services generates comparatively high employment effects due to the high labor share in the service sector.
- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Government consumption (education sector)
- Investments in fixed capital, non-residential **construction**
- Investments in fixed capital, **equipment and machinery**

Channels of long-run impact:

- Early education measures have large effects on social and economic status of children later in life, see section 1.2.3 for detail.
- Increasing human capital is important driver of potential output in the long run, contributing to total factor productivity.

Gender and regional dimensions:

- **Gender:** Positive effects on female labor market participation, as women are more likely to take over childcare responsibilities.
- **Regions:** The effects of the measure are concentrated primarily in infrastructure-weak regions with undersupply of kindergarten places.

3.D.1 IPCEI Mikroelektronik und Konnektivität

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**
- Investments in fixed capital, **equipment and machinery**
- Investments in fixed capital, **intangible fixed assets**
- Subsidy on private investment in **non-residential construction**
- Subsidy on private investment in **equipment and machinery**
- Subsidy on private investment in **intangible fixed assets**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- This measure is (or stimulates) investments into R&D projects which are expected to generate very high long-run social returns, see section 1.2.2 for detail.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3.D.2 IPCEI Wasserstoff

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, increasing GDP.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**
- Investments in fixed capital, **equipment and machinery**
- Investments in fixed capital, **intangible fixed assets**
- Subsidy on private investment in **non-residential construction**
- Subsidy on private investment in **equipment and machinery**
- Subsidy on private investment in **intangible fixed assets**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- This measure is (or stimulates) investments into R&D projects which are expected to generate very high long-run social returns, see section 1.2.2 for detail.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

4 - Gerechter Aufbau

4.A.2 Förderung von PVE-Projekten

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the health sector, contributing to GDP.
- Consumption of services generated by public sector contributes to GDP. The employment effects are comparatively high due to the high labor share in the service sector.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**
- Investments in fixed capital, **equipment and machinery**
- Government consumption (publicity campaign, consulting, platforms, staff training)

Channels of long-run impact:

- Investment in the health sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.
- Increased workplace flexibility in PVE will positively affect the labor supply of health professionals and supporting professions specifically in the field of primary health care. These effects are not included in the estimated macroeconomic effects.

Gender and regional dimensions:

- **Gender:** Medium- and long-run effects of increased workplace flexibility are likely to benefit female health care professionals more strongly, as women are more likely to take over childcare responsibilities. Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See table Table 1 for details.
- **Regions:** No specific regional aspects.

4.A.3 Entwicklung der Elektronischen Mutterkindpass Plattform inkl. der Schnittstellen zu den Frühe Hilfen Netzwerken

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **intangible fixed assets**

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

4.A.4 Nationaler Roll-out der „Frühen Hilfen“ für sozialbenachteiligte Schwangere, ihre Kleinkinder und Familien

Channels of short-run impact:

- RRF funds are used for public consumption of goods or services, contributing to GDP. Consumption of (public) services generates comparatively high employment effects due to the high labor share in the service sector.

Composition of expenditures in quantitative model:

- Government consumption (health care, social services and administrative services)

Channels of long-run impact:

- Long-run effects through not quantifiable within the model framework.
- High long-term cost-benefit ratios of the program estimated in a previous evaluation study.

Gender and regional dimensions:

- **Gender:** Additional positive effects on female labor supply through better social and health care services during and following pregnancy. Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Roll-out at national level (at the moment the program is available in 65 out of 116 political districts).

4.B.3 Klimafitte Ortskerne

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the business sector, municipalities, and of private households.

Composition of expenditures in quantitative model:

- Subsidy on private investment in **dwelling**s
- Subsidy on private investment in **non-residential construction**

Channels of long-run impact:

- Investment in the business sector has a persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Municipalities with need for revitalization of municipality centers.

4.B.4 Investition in die Umsetzung von Community Nursing

Channels of short-run impact:

- RRF funds are used for public consumption of goods or services, contributing to GDP. Consumption of (public) services generates comparatively high employment effects due to the high labor share in the service sector.

Composition of expenditures in quantitative model:

- Government consumption (health care and social assistance services)
- Investments in fixed capital, **transport equipment**

Channels of long-run impact:

- An increase in demand (private or public consumption) generates further stimulus for private investment, which might have a persistent effect on economic potential through an increase in the capital stock.

Gender and regional dimensions:

- **Gender:** Positive effect on labor supply of women - women are more likely to take over care responsibilities. Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Focus primarily on infrastructure-weak regions.

4.C.3 Sanierung des Volkskundemuseums Wien und der Prater Ateliers

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.
- Show-case project contributing to creation of platforms and international networks.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** Investments in Vienna region with participation of national and international contributors. Showcase-projects contributing to creation of platforms and international networks.

4.C.4 Digitalisierungsinitiative Kulturerbe

Channels of short-run impact:

- RRF funds are used for investment, either directly by public sector or through 3rd party institutions, e.g. via grants. These investments contribute to GDP directly and by increasing the quality of public infrastructure and economic environment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **intangible fixed assets**

Channels of long-run impact:

- Public investment has persistent effects on potential output through an increase in the stock of public capital, such as infrastructure. An increase in the quality of public infrastructure (more broadly: the economic environment) further stimulates private investment.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

4.C.5 Investitionsfonds „Klimafitte Kulturbetriebe“

Channels of short-run impact:

- Government subsidies/grants funded from the RRF stimulate investment in the sector culture, contributing to GDP and employment.

Composition of expenditures in quantitative model:

- Investments in fixed capital, **non-residential construction**
- Investments in fixed capital, **equipment and machinery**
- Investments in fixed capital, **intangible fixed assets**
- Subsidy on private investment in **non-residential construction**
- Subsidy on private investment in **equipment and machinery**
- Subsidy on private investment in **intangible fixed assets**

Channels of long-run impact:

- Investment in private and public sector has persistent effect on potential output and labor productivity through an increase in the stock of fixed capital. This further increases labor demand and GDP, and improves the budget balance.

Gender and regional dimensions:

- **Gender:** Short term effects of the measure are estimated using the information on industry composition of goods and services produced. See Table 1 for details.
- **Regions:** No specific regional aspects.

3 Tables with Quantitative Results

Table 1: Short- and medium-term gender-specific employment effects based on industry composition of goods and services produced.

Sequential Number	Measure	Approximate share of women in newly generated jobs	
		Short-term (2 years ahead)	Medium-term (5 years ahead)
2	1 - Nachhaltiger Aufbau - 1.A.2 Förderung des Austauschs von Öl- und Gasheizungen	24%	31%
3	1 - Nachhaltiger Aufbau - 1.A.3 Bekämpfung von Energiearmut	-	-
6	1 - Nachhaltiger Aufbau - 1.B.3 Förderung emissionsfreier Busse und Infrastruktur	33%	35%
7	1 - Nachhaltiger Aufbau - 1.B.4 Förderung emissionsfreier Nutzfahrzeuge und Infrastruktur	32%	39%
8	1 - Nachhaltiger Aufbau - 1.B.5 Errichtung neuer Bahnstrecken und Elektrifizierung von Regionalbahnen	16%	25%
10	1 - Nachhaltiger Aufbau - 1.C.2 Biodiversitätsfond	63%	-
11	1 - Nachhaltiger Aufbau - 1.C.3 Investitionen in Leergutrücknahmesysteme und Maßnahmen zur Steigerung der Mehrwegquote für Getränkegebinde	32%	39%
12	1 - Nachhaltiger Aufbau - 1.C.4 Errichtung und Nachrüstung von Sortieranlagen	27%	42%
13	1 - Nachhaltiger Aufbau - 1.C.5 Förderung der Reparatur von elektrischen und elektronischen Geräten	29%	29%
15	1 - Nachhaltiger Aufbau - 1.D.2 Transformation der Industrie zur Klimaneutralität	24%	41%
17	2 - Digitaler Aufbau - 2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit	39%	30%

Sequential Number	Measure	Approximate share of women in newly generated jobs	
		Short-term (2 years ahead)	Medium-term (5 years ahead)
	besonderen sozioökonomischen Schwerpunkten		
21	2 - Digitaler Aufbau - 2.B.2 Bereitstellung von digitalen Endgeräten für Schülerinnen und Schüler	23%	28%
23	2 - Digitaler Aufbau - 2.C.2 Digitalisierungsfonds öffentliche Verwaltung	41%	33%
24	2 - Digitaler Aufbau - 2.D.1 Digitalisierung der KMUs	37%	35%
25	2 - Digitaler Aufbau - 2.D.2 Digitale Investitionen in Unternehmen	37%	36%
26	5 - Digitaler Aufbau – 2.D.3 Ökologische Investitionen in Unternehmen	28%	39%
28	3 - Wissensbasierter Aufbau - 3.A.2 Quantum Austria – Förderung der Quanten Sciences	37%	33%
29	3 - Wissensbasierter Aufbau - 3.A.3 Austrian Institute of Precision Medicine	-	26%
30	3 - Wissensbasierter Aufbau - 3.A.4 (Digitale) Forschungsinfrastrukturen - zur nachhaltigen Entwicklung der Universitäten im Kontext der Digitalisierung	-	-
32	3 - Wissensbasierter Aufbau - 3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen	71%	29%
37	3 - Wissensbasierter Aufbau - 3.C.2 Förderstundenpaket	-	30%
38	3 - Wissensbasierter Aufbau - 3.C.3 Ausbau Elementarpädagogik	43%	-
40	3 - Wissensbasierter Aufbau - 3.D.1 IPCEI Mikroelektronik und Konnektivität	37%	36%

Sequential Number	Measure	Approximate share of women in newly generated jobs	
		Short-term (2 years ahead)	Medium-term (5 years ahead)
41	3 - Wissensbasierter Aufbau - 3.D.2 IPCEI Wasserstoff	37%	36%
43	4 - Gerechter Aufbau - 4.A.2 Förderung von PVE-Projekten	23%	23%
44	4 - Gerechter Aufbau - 4.A.3 Entwicklung der Elektronischen Mutterkindpass Plattform inkl. der Schnittstellen zu den Frühe Hilfen Netzwerken	-	-
45	4 - Gerechter Aufbau - 4.A.4 Nationaler Roll-out der „Frühen Hilfen“ für sozialbenachteiligte Schwangere, ihre Kleinkinder und Familien	-	-
48	4 - Gerechter Aufbau - 4.B.3 Klimafitte Ortskerne	17%	23%
49	4 - Gerechter Aufbau - 4.B.4 Investition in die Umsetzung von Community Nursing	66%	-
52	4 - Gerechter Aufbau - 4.C.3 Sanierung des Volkskundemuseums Wien und der Prater Ateliers	-	-
53	4 - Gerechter Aufbau - 4.C.4 Digitalisierungsoffensive Kulturerbe	-	-
54	4 - Gerechter Aufbau - 4.C.5 Investitionsfonds "Klimafitte Kulturbetriebe"	-	-

Source: IHS own calculations. Shares are not reported for measures with very low total employment effects.

Table 2: Impact of the plan (quantitative)

Table 3b. Impact of the plan (quantitative)												
Please provide a brief description and estimate of the impact of the plan and its components or most important measures (reforms/investments).												
Sequential Number	Component	Channels of impact <i>Detailed description of the channels through which the measures deliver the expected impact</i>	Risks/Challenges	Quantification of the impact (if available) <i>i.e. % difference from policy neutral baseline</i>								
				Short-term (2 years ahead)			Medium-term (5 years ahead)			Long-term (20 years ahead)		
				GDP	Employment	Budget balance (pps)	GDP	Employment	Budget balance (pps)	GDP	Employment	Budget balance (pps)
0	0 - Overall - Overall impact of the plan			0.410	0.286	0.201	0.914	0.538	0.335	1.210	0.611	0.556
1	1 - Nachhaltiger Aufbau - 1.A.1 Erneuerbare Wärmege			quantifiable macroeconomic effects are contained in corresponding investment measure (1.A.2 Förderung des Austauschs von Öl- und Gasheizungen)								
2	1 - Nachhaltiger Aufbau - 1.A.2 Förderung des Austauschs von Öl- und Gasheizungen			0.015	0.008	0.005	0.026	0.014	0.008	0.003	0.002	0.001
3	1 - Nachhaltiger Aufbau - 1.A.3 Bekämpfung von Energiearmut			0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.000	0.000
4	1 - Nachhaltiger Aufbau - 1.B.1 Mobilitätsmasterplan 2030			reform consists of concept/strategy development; quantifiable macro effects depend on future implementation								
5	1 - Nachhaltiger Aufbau - 1.B.2 Einführung der 123-Klimatickets			no macroeconomic effects expected								
6	1 - Nachhaltiger Aufbau - 1.B.3 Förderung emissionsfreier Busse und Infrastruktur			0.014	0.007	0.006	0.047	0.028	0.015	0.002	0.001	0.001
7	1 - Nachhaltiger Aufbau - 1.B.4 Förderung emissionsfreier Nutzfahrzeuge und Infrastruktur			0.017	0.007	0.006	0.008	0.005	0.003	0.000	0.000	0.000
8	1 - Nachhaltiger Aufbau - 1.B.5 Errichtung neuer Bahnstrecken und Elektrifizierung von Regionalbahnen			0.018	0.007	0.008	0.015	0.005	0.006	0.008	0.004	0.004
9	1 - Nachhaltiger Aufbau - 1.C.1 Gesetzliche Rahmenbedingungen zur Erhöhung der Sammelquoten für Kunststoffgetränkeverpackungen und Er			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation								
10	1 - Nachhaltiger Aufbau - 1.C.2 Biodiversitätsfond			0.005	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
11	1 - Nachhaltiger Aufbau - 1.C.3 Investitionen in Leertutrücknahmesysteme und Maßnahmen zur Steigerung der Mehrwegquote für Getränke			0.018	0.010	0.009	0.015	0.010	0.006	0.001	0.001	0.001
12	1 - Nachhaltiger Aufbau - 1.C.4 Errichtung und Nachrüstung von Sortieranlagen			0.009	0.006	0.005	0.004	0.001	0.000	0.001	0.001	0.001
13	1 - Nachhaltiger Aufbau - 1.C.5 Förderung der Reparatur von elektrischen und elektronischen Geräten			0.004	0.003	0.003	0.003	0.003	0.000	0.000	0.000	0.000
14	1 - Nachhaltiger Aufbau - 1.D.1 Erneuerbaren Ausbaugesetz			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation								
15	1 - Nachhaltiger Aufbau - 1.D.2 Transformation der Industrie zur Klimaneutralität			0.012	0.007	0.006	0.008	0.005	0.000	0.002	0.001	0.001
16	2 - Digitaler Aufbau - 2.A.1 Schaffung der Plattform Internetinfrastruktur Austria 2030 (PIA 2030)			quantifiable macroeconomic effects are contained in corresponding investment measure (2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in								
17	2 - Digitaler Aufbau - 2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit besonderen sozioökonomisc			0.046	0.034	0.034	0.486	0.241	0.182	0.891	0.394	0.410
18	2 - Digitaler Aufbau - 2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit besonderen sozioökonomisc			contained in first row of 2.A.2								
19	2 - Digitaler Aufbau - 2.A.2 Gigabit-fähige Zugangsnetze und symmetrische Gigabit-Anbindungen in Bereichen mit besonderen sozioökonomisc			contained in first row of 2.A.2								
20	2 - Digitaler Aufbau - 2.B.1 Fairer und gleicher Zugang aller Schülerinnen und Schüler der Sekundarstufe I zu digitalen Grundkompetenzen			quantifiable macroeconomic effects are contained in corresponding investment measure (2.B.2 Bereitstellung von digitalen Endgeräten für Schülerinnen und Schüler)								
21	2 - Digitaler Aufbau - 2.B.2 Bereitstellung von digitalen Endgeräten für Schülerinnen und Schüler			0.008	0.002	0.003	0.008	0.003	0.003	0.001	0.001	0.001
22	2 - Digitaler Aufbau - 2.C.1 Gesetzesvorhaben für Only Once Novelle des Unternehmensserviceportalgesetzes			quantifiable macroeconomic effects are contained in corresponding investment measure (2.C.2 Digitalisierungsfonds öffentliche Verwaltung); quantifiable macro effects depend								
23	2 - Digitaler Aufbau - 2.C.2 Digitalisierungsfonds öffentliche Verwaltung			0.029	0.007	0.011	0.018	0.007	0.008	0.003	0.002	0.002
24	2 - Digitaler Aufbau - 2.D.1 Digitalisierung der KMUs			0.010	0.003	0.003	0.008	0.004	0.003	0.001	0.001	0.001
25	2 - Digitaler Aufbau - 2.D.2 Digitale Investitionen in Unternehmen			0.015	0.006	0.006	0.023	0.012	0.009	0.003	0.002	0.002
26	2 - Digitaler Aufbau - 2.D.3 Ökologische Investitionen in Unternehmen			0.066	0.038	0.034	0.084	0.052	0.029	0.006	0.004	0.003
27	3 - Wissensbasierter Aufbau - 3.A.1 FTI Strategie 2030			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation								
28	3 - Wissensbasierter Aufbau - 3.A.2 Quantum Austria – Förderung der Quanten Sciences			0.004	0.002	0.002	0.006	0.003	0.003	0.028	0.012	0.013
29	3 - Wissensbasierter Aufbau - 3.A.3 Austrian Institute of Precision Medicine			0.001	0.001	0.001	0.004	0.002	0.002	0.020	0.008	0.009
30	3 - Wissensbasierter Aufbau - 3.A.4 (Digitale) Forschungsinfrastrukturen – zur nachhaltigen Entwicklung der Universitäten im Kontext der Digita			0.000	0.000	0.000	0.002	0.001	0.001	0.008	0.003	0.004
31	3 - Wissensbasierter Aufbau - 3.B.1 Bildungsbonus			quantifiable macroeconomic effects are contained in corresponding investment measure (3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen)								
32	3 - Wissensbasierter Aufbau - 3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen			0.020	0.012	0.010	0.021	0.006	0.008	0.030	0.013	0.014
33	3 - Wissensbasierter Aufbau - 3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen			contained in first row of 3.B.2								
34	3 - Wissensbasierter Aufbau - 3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen			contained in first row of 3.B.2								
35	3 - Wissensbasierter Aufbau - 3.B.2 Finanzierung von Umschulungs- und Weiterbildungsmaßnahmen			contained in first row of 3.B.2								

Table 3b. Impact of the plan (quantitative) - contd.											
Please provide a brief description and estimate of the impact of the plan and its components or most important measures (reforms/investments).											
Sequential Number	Component	Channels of impact <i>Detailed description of the channels through which the measures deliver the expected impact</i>	Risks/Challenges	Quantification of the impact (if available) <i>i.e. % difference from policy neutral baseline</i>							
				Short-term (2 years ahead)			Medium-term (5 years ahead)			Long-term (20 years ahead)	
				GDP	Employment	Budget balance (pps)	GDP	Employment	Budget balance (pps)	GDP	Budget balance (pps)
36	3 - Wissensbasierter Aufbau - 3.C.1 Zugang zu Bildung verbessern			quantifiable macroeconomic effects are contained in corresponding investment measure (3.C.2 Förderstundenpaket)							
37	3 - Wissensbasierter Aufbau - 3.C.2 Förderstundenpaket			0.000	0.000	0.000	0.010	0.003	0.004	0.014	0.006
38	3 - Wissensbasierter Aufbau - 3.C.3 Ausbau Elementarpädagogik			0.005	0.004	0.003	0.000	0.000	0.000	0.004	0.002
40	3 - Wissensbasierter Aufbau - 3.D.1 IPCEI Mikroelektronik und Konnektivität			0.006	0.003	0.003	0.015	0.008	0.005	0.059	0.025
41	3 - Wissensbasierter Aufbau - 3.D.2 IPCEI Wasserstoff			0.006	0.003	0.003	0.015	0.008	0.005	0.059	0.025
42	4 - Gerechter Aufbau - 4.A.1 Attraktivierung der Primärversorgung			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
43	4 - Gerechter Aufbau - 4.A.2 Förderung von PVE-Projekten			0.010	0.006	0.005	0.013	0.009	0.004	0.002	0.001
44	4 - Gerechter Aufbau - 4.A.3 Entwicklung der Elektronischen Mutterkindpass Plattform inkl. der Schnittstellen zu den Frühen Hilfen Netzwerken			0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000
45	4 - Gerechter Aufbau - 4.A.4 Nationaler Roll-out der „Frühen Hilfen“ für sozialbenachteiligte Schwangere, ihre Kleinkinder und Familien			0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
46	4 - Gerechter Aufbau - 4.B.1 Bodenschutzstrategie			reform consists of concept/strategy development; quantifiable macroeconomic effects depend on future implementation							
47	4 - Gerechter Aufbau - 4.B.2 Reform zur Weiterentwicklung der Pflegevorsorge			some quantifiable macro effects are contained in corresponding investment measure (4.B.4 Investition in die Umsetzung von Community Nursing); most quantifiable macro							
48	4 - Gerechter Aufbau - 4.B.3 Klimafitte Ortskerne			0.006	0.003	0.003	0.007	0.005	0.002	0.001	0.001
49	4 - Gerechter Aufbau - 4.B.4 Investition in die Umsetzung von Community Nursing			0.003	0.002	0.002	0.000	0.000	0.000	0.000	0.000
50	4 - Gerechter Aufbau - 4.C.1 Entwicklung eines Baukulturprogramms			reform consists of concept/strategy development; quantifiable macroeconomic effects depend on future implementation							
51	4 - Gerechter Aufbau - 4.C.2 Erarbeitung einer nationalen Digitalisierungsstrategie für das Kulturerbe			reform consists of concept/strategy development; some quantifiable macroeconomic effects are contained in corresponding investment measure (4.C.4							
52	4 - Gerechter Aufbau - 4.C.3 Sanierung des Volkskundemuseums Wien und der Prater Ateliers			0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.000
53	4 - Gerechter Aufbau - 4.C.4 Digitalisierungsoffensive Kulturerbe			0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000
54	4 - Gerechter Aufbau - 4.C.5 Investitionsfonds "Klimafitte Kulturbetriebe"			0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.000
55	4 - Gerechter Aufbau - 4.D.1 Spending Review mit Fokus „Grüner“ und „Digitaler“ Wandel			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
56	4 - Gerechter Aufbau - 4.D.2 Anhebung des effektiven Pensionsantrittsalters			0.060	0.100	0.025	0.060	0.100	0.025	0.060	0.100
57	4 - Gerechter Aufbau - 4.D.3 Pensionssplitting			no macroeconomic effects expected							
58	4 - Gerechter Aufbau - 4.D.4 Gesetzliche Grundlagen und Governance im Bereich Klimaschutz			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation							
59	4 - Gerechter Aufbau - 4.D.5 Öko-soziale Steuerreform			depends on implementation decisions such as tax rates; would need development of very specific model							
60	4 - Gerechter Aufbau - 4.D.6 Green Finance (Agenda)			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation							
61	4 - Gerechter Aufbau - 4.D.7 Nationale Finanzbildungsstrategie			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
62	4 - Gerechter Aufbau - 4.D.8 Gründerpaket			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
63	4 - Gerechter Aufbau - 4.D.9 Eigenkapitalstärkung			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
64	4 - Gerechter Aufbau - 4.D.10 Arbeitsmarkt: One-Stop-Shop für Erwerbsfähige und Ausbau der aktivierenden Hilfe			quantifiable macroeconomic effects depend on future implementation; would need development of very specific model							
65	4 - Gerechter Aufbau - 4.D.11 Liberalisierung von gewerberechtlichen Rahmenbedingungen			reform establishes framework conditions; quantifiable macroeconomic effects depend on future implementation							

Source: IHS own calculations

4 References

- Arrow, K. J. (1962). Economic Welfare and the Allocations of Resources of Invention. In Nelson, R. R. (Ed.). *The Rate and Direction of Inventive Activity* (pp. 609-626). Princeton.
- Aschauer, D. A. (1989). Is public expenditure productive? *Journal of monetary economics*, 23(2), 177-200.
- Bom, P., & Ligthart, J. E. (2008). How productive is public capital? A meta-analysis. CESifo Working Paper Series No. 2206.
- Card, D. (1999). The causal effect of education on earnings. In O. Ashenfelter & D. Card (Eds.), *Handbook of labor economics* (Vol. 3, pp. 1801–1863). Amsterdam: Elsevier.
- Card, D. (2001). Estimating the return to schooling: Progress on some persistent econometric problems. *Econometrica*, 69(5), 1127-1160.
- Card, D., Kluve, J., & Weber, A. (2018). What works? A meta analysis of recent active labor market program evaluations. *Journal of the European Economic Association*, 16(3), 894-931.
- Cardona, M., Kretschmer, T., & Strobel, T. (2013). ICT and productivity: conclusions from the empirical literature. *Information Economics and Policy*, 25(3), 109-125.
- Czernich, N., Falck, O., Kretschmer, T., & Woessmann, L. (2011). Broadband infrastructure and economic growth. *The Economic Journal*, 121(552), 505-532.
- Gal P., Nicoletti G., Renault Theodore, Sorbe S., and Timiliotis C. (2019). Digitalisation and Productivity: in search of the holy grail – Firm-level empirical evidence from EU countries. Economics Department Working Papers No. 1533, OECD, Paris.
- Hanushek, E. A., & Woessmann, L. (2015). *The Knowledge Capital of Nations: Education and the Economics of Growth*. MIT press.
- Edquist, H., Goodridge, P., & Haskel, J. (2021). The Internet of Things and economic growth in a panel of countries. *Economics of Innovation and New Technology*, 30(3), 262-283.
- Frontier Economics (2014). Rates of return to investment in science and innovation, Report prepared for Department for Business Innovation and Skills (BIS), London. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/333006/bis-14-990-rates-of-return-to-investment-in-science-and-innovation-revised-final-report.pdf

- Griliches, Z., & Mairesse, J. (1984). Productivity and R&D at the firm level. In Griliches, Z. (Ed.), *R&D, Patents, and Productivity*. (p. 339 – 374). NBER Books.
- Guellec, D., & Van Pottelsberghe De La Potterie, B. (2003). The impact of public R&D expenditure on business R&D. *Economics of innovation and new technology*, 12(3), 225-243.
- Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the Returns to R&D. In Hall, B. H., & Rosenberg, N. (Eds.), *Handbook of the Economics of Innovation* (Vol. 2, pp. 1033-1082). North-Holland.
- Heckman, J. J. (2000). Policies to foster human capital. *Research in economics*, 54(1), 3-56.
- Hines, P., (2017). Why fund research? A guide to why EU-funded research and innovation matters. Science Business. https://sciencebusiness.net/system/files/reports/Why-fund-research_.pdf
- Jones, B. F., & Summers, L. H. (2020). A Calculation of the Social Returns to Innovation. NBER Working Paper No. 27863, National Bureau of Economic Research.
- Jones, C. I., & Williams, J. C. (1998). Measuring the social return to R&D. *The Quarterly Journal of Economics*, 113(4), 1119-1135.
- Koutroumpis, P. (2009). The economic impact of broadband on growth: A simultaneous approach. *Telecommunications policy*, 33(9), 471-485.
- Koutroumpis, P. (2018). The economic impact of broadband: evidence from OECD countries. Ofcom. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/113299/economic-broadband-oecd-countries.pdf
- Kretschmer, T. (2012). Information and Communication Technologies and Productivity Growth: A Survey of the Literature. OECD Digital Economy Papers, No. 195, OECD Publishing, Paris.
- Lucas, R. E. (1976). Econometric policy evaluation: A critique. In *Carnegie-Rochester conference series on public policy* (Vol. 1, pp. 19-46).
- Munnell, A. H. (1992). Policy watch: infrastructure investment and economic growth. *Journal of economic perspectives*, 6(4), 189-198.
- O'Mahony, M., & Vecchi, M. (2005). Quantifying the impact of ICT capital on output growth: a heterogeneous dynamic panel approach. *Economica*, 72(288), 615-633.
- Paterson, I., Schuh, U., & Graf, N. (2009). Ökonomische Bewertung von Instrumenten der F&E-Förderung. Applied Research Series No. 1, Institute for Advanced Studies - IHS Vienna.

- Patrinos, H. A. (2016). Estimating the return to schooling using the Mincer equation. *IZA World of Labor* 2016: 278.
- Qiang, C. Z. W., Rossotto, C. M., & Kimura, K. (2009). Economic impacts of broadband. In *Information and communications for development 2009: Extending reach and increasing impact*. World Bank (pp. 35-50).
- Rea, D., & Burton, T. (2020). New evidence on the Heckman curve. *Journal of Economic Surveys*, 34(2), 241-262.
- Smets, F., & Wouters, R. (2007). Shocks and frictions in US business cycles: A Bayesian DSGE approach. *American economic review*, 97(3), 586-606.
- Ugur, M., Trushin, E., Solomon, E., & Guidi, F. (2016). R&D and productivity in OECD firms and industries: A hierarchical meta-regression analysis. *Research Policy*, 45(10), 2069-2086.
- Venturini, F., Rincon-Aznar, A., & Vecchi, M. (2013). *ICT as a general purpose technology: spillovers, absorptive capacity and productivity performance* (No. 416). National Institute of Economic and Social Research.
- Sorbe S., Gal P., Nicoletti G., and Timiliotis C. (2019). Digital Dividend: Policies to harness the potential of digital technologies. Economic Policy Paper No. 26, OECD, Paris.
- Spiezia, V. (2012). ICT investments and productivity: Measuring the contribution of ICTS to growth. *OECD Journal: Economic Studies*, 2012(1), 199-211.
- Stehrer, R., Bykova, A., Jäger, K., Reiter, O. & Schwarzhappel, M. (2019). Industry level growth and productivity data with special focus on intangible assets. Report on methodologies and data construction for the EU KLEMS Release 2019. wiiw Statistical Report No. 8.
- Van Ark, B. (2014). Productivity and Digitalisation in Europe: Paving the road to faster growth. Lisbon Council Policy Brief, Vol. 8, No. 1, The Conference Board, New York, Brussels, Beijing.
- Van Ark, B., De Vries, K., Erumban, A. (2020): How to not miss a Productivity Revival once again. NIESR Discussion Paper No. 518, National Institute of Economic and Social Research, London.
- Wieser, R. (2005). Research and development productivity and spillovers: empirical evidence at the firm level. *Journal of Economic Surveys*, 19(4), 587-621.