A PRODUCTION NETWORK MODEL FOR THE SPANISH ECONOMY WITH AN APPLICATION TO THE IMPACT OF NGEU FUNDS

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Abstract

This paper introduces a sectoral model for the Spanish economy that allows a better understanding of the propagation of sector-specific shocks taking into account different network interdependencies. In particular, the model features sector interactions along several dimensions in an open economy setting, either in the provision of intermediate inputs and capital goods or competing in the labour market. This framework is flexible enough to provide insights into the effect of several policy-relevant shocks, such as global value chain bottlenecks, increases in production costs in energy-intensive sectors or large public investment programmes. In order to illustrate the role of such sectoral interactions, we consider a sectorisation of Next Generation EU (NGEU) funds based on Spain's Recovery, Transformation and Resilience Plan (RTRP) which will mobilize €69.5 bn in grants. According to our findings, the average impact over a 5-year horizon is 1.15% of GDP if we consider only the direct effect of the investment programmes and expenditure plans, but it increases to 1.75% if we take into account the increase in the productive capacity of certain sectors and its propagation through the production network. Moreover, the resulting expansion is particularly strong in sectors highly dependent on high-skilled labour, such as IT and professional services, which might lead to shortages of high-skilled workers, reducing the aggregate impact on GDP by 25%.

Keywords: input-output models, industrial policy, public investment, Next Generation EU.

JEL classification: C67, O25, L16, H54, E65, O52.

Resumen

Este trabajo introduce un modelo sectorial para la economía española que permite una mejor comprensión de la propagación de *shocks* sectoriales teniendo en cuenta diferentes interacciones de red. En particular, el modelo presenta interacciones sectoriales a lo largo de varias dimensiones en un entorno de economía abierta, ya sea en la provisión de insumos intermedios y bienes de capital o compitiendo en el mercado de trabajo. Este marco es lo suficientemente flexible como para proporcionar información sobre el efecto de varias perturbaciones relevantes para la política económica, como cuellos de botella en las cadenas de valor mundiales, aumentos de los costes de producción en sectores de alto consumo energético o grandes programas de inversión pública. Para ilustrar el papel de estas interacciones sectoriales, consideramos una sectorización de los fondos de la *Next Generation* EU (NGEU) basada en el Plan de Recuperación y Resiliencia (PRR) de España. Según nuestros resultados, el impacto medio en un horizonte de cinco años es del 1,15 % del PIB si solo consideramos el efecto directo de los programas de inversión y los planes de gasto, pero aumenta hasta el 1,75 % si tenemos en cuenta el aumento de la capacidad productiva de determinados sectores y su propagación a través del tejido productivo. Además, la expansión resultante es especialmente fuerte en sectores muy dependientes de la mano de obra altamente cualificada, como la informática y los servicios profesionales, lo que podría provocar una escasez de trabajadores altamente cualificados y reducir el impacto agregado sobre el PIB en un 25 %.

Palabras clave: modelos *input-output,* política industrial, inversión pública, *Next Generation EU.*

Códigos JEL: C67, O25, L16, H54, E65, O52.

1 Introduction

The sectoral dimension is essential to better understand certain dynamic phenomena shaping economic activity across countries. The resilience of an economy in the face of sector-specific disturbances as well as their aggregate impact crucially depend on the different interactions across sectors in the markets for goods and services, capital and labor. These sector linkages might prove to be relevant both in the case of shocks of a more permanent nature, such as climate change or digitalization, and in the case of shocks of a more exogenous and transitory nature, such as a pandemic or a war. The aim of this paper is to provide a model for the Spanish economy that features a rich interdependence structure between economic sectors. To be more concrete, these interactions across sectors are captured in our model along four dimensions.

First, the model includes a production network that captures the customer-supplier relationships between different industries in the market of intermediate inputs. Thus, through the input-output matrices, each industry is exposed to changes in other sectors, either as their supplier or their customer. In general, taking into account these production networks implies an amplification of the aggregate effects that an industry-specific shock has on the economy. In particular, the presence of complementarities between different intermediate inputs plays an important role in amplifying the aggregate effects of negative shocks. To build this block of the model we rely on Carvalho and Tahbaz-Salehi (2019) and Baqaee and Farhi (2019a).

Second, sectors also interact between them in the market of capital goods. The model includes an investment network that relates the capital stock accumulation of each sector to the ones providing the capital goods demanded by the former. Accounting for the so-called investment network has two important implications in the propagation of sector-specific shocks: (i) an increase in the productive capacity of the capital-supplying industries will have a positive impact on the capital stock of the rest of the sectors; (ii) when a sector faces an expansion in its demand level, it will increase its demand for such capital-supplier industries. To build this block of the model we follow Foerster *et al.* (2019) and Vom Lehn and Winberry (2022), which show the importance of this channel in the case of the US economy.

Third, in order to account for the high integration of Spanish industries within global value chains and, in particular, with the rest of the European economies, our model is constructed in a framework of open economies. This allows us to take into consideration the effects on the trade balance of relative price changes between sectors or the dependence on third countries for the construction of the stock of certain types of capital goods. International linkages in our model are based on Baqaee and Farhi (2019a).

Fourth, the model also takes into account sectoral interactions through the labor market. Each sector uses a particular combination of different types of workers whose aggregate supply is limited. This gives rise to a labor supply matrix capturing the competition between sectors in the labor market that induces increases in production costs of one sector when another competing sector expands its labor demand. This effect will be larger the greater the overlap between the two sectors in terms of the types of labor each uses. Contrary to the previous cases, this interaction attenuates the aggregate effect of investment and demand sector-specific shocks. Given a limited quantity of productive resources such as labor, the expansion of one sector will take place at the expense of the rest. This is a novel contribution to the existing literature that typically assumes that all sectors employed a single type of labor or they employ sector-specific labor but without competing with each other.[1]

Turning to the calibration of the model, we obtain data on trade flows between sectors and countries to construct the I-O matrix from the World Input Output Database (Timmer *et al.* (2014)). The capital supply matrix is built from data taken from EUKLEMS (O'Mahony and Timmer (2009), Bontadini *et al.* (2021)) on sectoral investment in different types of capital goods and from WIOD on trade flows in investment goods. As for the labor supply matrix, we obtain data from EUKLEMS, which provides us with information on the demand for different types of labor at the sectoral level, enabling us to identify the sectors and countries that supply capital goods to each of the sectors of the economy. Finally, both WIOD and EUKLEMS databases provide comparable information across countries and with a consistent sector classification, which allows us to calibrate the open economies version of the model capturing the different national origins and destinations of intermediates and capital goods. Appendix A provides more details on the data.

Armed with a calibrated version of the model, we analyze the economic impact of the Next Generation EU (NGEU) program, which is particularly suitable for exploring the role of sector interactions embedded in the model given the focus of the program in certain sectors related to the digitalization and the green transition. To be more concrete, we identify the typology, amount, and beneficiary sectors of the different projects in the Spanish Recovery and Resilience Plan (RRP), and we embed the resulting sector-specific shocks into our model. The Spanish RRP includes the investment plans referred to the execution of grants, worth €69.5 bn, which is the object of analysis in this work[2]. Depending on their nature,

[1] Baqaee and Farhi (2019a) includes an extension in which the interaction through the labor market occurs because sectors employ a share of generic and a share of sector-specific labor. In our case all job types are mobile across sectors but sectors demand each of them in different proportions. Thus, in our case the level of competition is different between different pairs of sectors. Barrot *et al.* (2021) considers occupations' characteristics like remote working with heterogeneous incidence across sectors, but they do not include endogenous labor reallocation.

[2] It is worth noting that, on June 30 2022, the European Commission updated the amounts that will be allocated to Spain within the framework of the Recovery and Resilience Facility due to the revision of the final data on GDP growth in European countries in 2020 and 2021. Spain will receive €7.7 bn more than initially planned. Likewise, Spain can also request almost €70 bn in the form of loans. We do not consider these amounts since there is no detailed information on how this money is planned to be spent.

we label the so-called NGEU shocks into three categories: public expenditure interpreted as demand shocks to the different sectors, capital transfers interpreted as supply shocks that increase the capital stock and thus the productive capacity of the different sectors receiving the transfers[3], or productivity-enhancing public infrastructures interpreted as a supply shock. Therefore, through the lens of our model, NGEU funds represent either demand or supply shocks to the different sectors that propagate through the production and investment networks.

According to our results, the NGEU funds can have an important effect on both Spanish aggregate output and its sectoral distribution. In particular, the direct effect of the investments and its propagation through the capital matrix result in an estimated average impact on Spanish GDP of around 1.15% over a five-year horizon. However, if we also take into account the propagation through the production network of the supply shocks induced by the increase in the productive capacity of certain sectors, the average impact over a 5-year period increases to 1.75%[4]. Moreover, our model allows us to uncover that these effects are very heterogeneous across sectors. For example, in the case with both demand and supply shocks propagated through the I-O and capital matrices, the sectors that would grow the most would be those that provide capital goods and services, particularly those oriented towards digitalization and the knowledge economy (information and communication, professional services, and education) as well as durable manufacturing and construction. Finally, we also find that an important risk to the materialization of these macroeconomic effects is the capacity of the labor market to provide the high-skilled workers demanded by the NGEU-induced expansion in certain sectors. In particular, the shortage of skilled workers could lead to limiting the effect of the funds by a quarter, from 1.75% to 1.3%.

Regarding the relation to the literature in terms of empirical applications, several papers have already highlighted the importance of some of these sector-level inter-dependencies for the case of the Spanish economy in the context of different shocks with a strong sector-specific component. For example, the Covid-19 pandemic with a focus on input-output propagation in intermediates (Prades and Tello (2020)), sector-specific regulations in certain industries with a focus on intermediates and international propagation (Izquierdo *et al.* (2022)), the energy shock resulting from the war in Ukraine focusing on intermediates at the international level (Quintana (2022)), and the role of policies to curb climate change within the Spanish input-output network (Aguilar *et al.* (2022)). However, to the best of our knowledge, this is the first model considered for the Spanish economy featuring all the four layers simultaneously. With respect to the NGEU, the closest reference is Pfeiffer

[3]Note that these supply shocks also imply a demand shock for the sectors providing the capital goods, which are captured in our model by the propagation through the investment matrix.

[4]Two remarks are worth highlighting with respect to this estimate. First, the role of international spillovers due to the NGEU stimulus in other EU countries is found to be rather small for Spain. Second, this impact does not consider the role of structural reforms, which are also a crucial component of the NGEU programme. See Cuadrado *et al.* (2022) for an estimation of such an impact in the case of Spain.

et al. (2022), which quantifies the spillovers of NGEU investments for all EU countries. While Pfeiffer *et al.* (2022) consider aspects not included in our setting such as the role of monetary policy with a more detailed analysis across countries, our work provides a richer analysis of the sectoral distribution of the NGEU impact as well as the different mechanisms through which they operate for the particular case of Spain.

2 Model

In this section we outline the nuts and bolts of our sectoral model[5]. This a general equilibrium model of production networks with open economies. In our framework there are C countries, each of them consisting of S sectors. In every country $c \in C$ there is a representative firm producing the local variety of sector $s \in S$. Throughout the paper we refer to each sector-country pair as an industry, and we refer to N as the total number of industries ($N = C \times S$). In every country there is a representative household.

Industries use capital, labor and intermediate inputs to produce their output. Each industry is competitive and firms sell their output at their production cost. Prices are flexible and equal to marginal costs. They sell their output as intermediate inputs or capital goods for other industries, as final consumption by households or to the government as public expenditure. Households supply labor and they expend their income[6] on a consumption bundle made of the products by each sector and its different national varieties.

The entire model is described using exact hat algebra[7], which implies that the variables are expressed as deviations from their value in the absence of shocks.[8] In such an economy various types of shocks are introduced, affecting either the supply or the demand side. The new equilibrium of the model is set by the clearing conditions of the goods market and the labor market. The output of each industry is equal to its sales as intermediate inputs or capital goods to the rest of the sectors or as final private or government consumption. The labor market clearing condition sets the total demand for labor by the sectors of an economy is equal to the labor supply of households as a function of the real wage offered to them.

In our framework the representative firm in each industry is competitive, so factor payments are equal to its total revenue and it has no economic profits. In turn, households own the capital and labor factor in the country and use the payments to these for their

[5] For the construction of the model we closely followed several state-of-the-art references in the literature. The general model of production networks in open economies follows Baqaee and Farhi (2019a), while the capital module is inspired by Foerster *et al.* (2019) and Vom Lehn and Winberry (2022).

[6] In our framework, each country's households own the firms of their respective countries, therefore their income equals the nominal GDP of the country.

[7] This method computes the solution of the model in terms of deviations from the existing equilibrium. The main advantage of this method is that it saves the need to have absolute values for the trade and input variables, but only the percentages of such data. See Dekle *et al.* (2008) as a seminal reference for the use of *exact hat algebra*. Barrot *et al.* (2021) solves a production network model using the *exact hat algebra* method.

consumption. These two facts imply that, in the absence of government spending, each country's balance of trade is adjusted.

2.1 Production Side

Industries produce using intermediate inputs, capital and labor. They do so following a nested CES production function and they piece together different production factors with a Hicks-neutral productivity level z and constant returns to scale. Their production function is nested with three different layers. In the first layer of the production function, they combine the value-added component (a) with the bundle of intermediate inputs (M). The value-added component is produced out of labor (l) and capital (k) bundles.[9] [10]

$$\widehat{y}_i = \widehat{z}_i \left(\eta_i \widehat{a}_i^{\frac{\theta-1}{\theta}} + (1-\eta_i) \widehat{M}_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta-1}{\theta}} \tag{1}$$

In the second layer, industries combine different types of labor, different types of capital goods and intermediate inputs coming from each of the different sectors. Finally, in the third layer, industries combine the different national varieties of each capital good and the intermediate input coming from each sector.

2.1.1 Value-Added Component

Firms combine labor (l) and capital (k) inputs to produce the value-added component with a capital-labor elasticity of substitution of γ:

$$\widehat{a}_i = \widehat{d}_i \cdot \left(\alpha_i \widehat{l}_i^{\frac{\gamma-1}{\gamma}} + (1-\alpha_i) \widehat{k}_i^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{1-\gamma}} \tag{2}$$

where the labor share in the sector i is represented by α_i, calibrated as the ratio of payments to labor over the value added of an industry.

Importantly, We also include a productivity term $\widehat{d}$ in value-added creation. This term can be interpreted as the improvement of sector-specific infrastructures that cannot be considered as proprietary capital of the companies in the sector. Thus, we calibrate this sector-specific productivity as $\widehat{d} = \widehat{D}^{1-\alpha}$, where $\widehat{D}$ equals the investments in sector-specific infrastructures normalized by the existing stock of capital in the sector. This specification

[9] The parameter η_i is calibrated as the initial ratio of value added over the total gross output of an industry.

[10] For simplicity, we drop the time subscripts from the equations.

for the elasticity between public capital and productivity equates its marginal contribution to the one of private capital in the sector. Alternatively, one can also consider a calibration based on the elasticity of public infrastructure to total output (see e.g. Calderon *et al.* (2015)), but the overall contribution of public infrastructure to sector-specific value added should be similar to the one from our calibration.[11]

Labor

Firms combine T different types of labor, $l_{i,t}$, to produce their aggregate labor input l_i. The importance of each type of labor $t \in T$ for a particular industry i is captured by $(\iota_{i,t})$. Different types of labor can be substituted with an elasticity σ_l.[12]

$$\hat{l}_i = \left(\sum_{t \in T} \iota_{i,t} \cdot \widehat{l_{i,t}^{\frac{\sigma_l - 1}{\sigma_l}}} \right)^{\frac{\sigma_l}{\sigma_l - 1}} \tag{3}$$

Capital

The capital stock of each industry is made up by different capital goods $g \in G$. The importance of each type of capital good g is captured by $\kappa_{i,g}$. Firms can substitute across different types of capital goods with an elasticity σ_k.[13]

$$\hat{k}_i = \left(\sum_{g \in G} \kappa_{i,g} \cdot \widehat{k_{i,g}^{\frac{\sigma_k - 1}{\sigma_k}}} \right)^{\frac{\sigma_k}{\sigma_k - 1}} \tag{4}$$

Moreover, industries source their supplies of capital from different countries. Thus, industries demand different national varieties of each of the capital goods with an elasticity of substitution across national varieties equal to ξ_k.

$$\hat{k}_{i,g,c} = \left(\sum_{c \in C} \kappa_{i,g,c} \cdot \widehat{k_{i,g,c}^{\frac{\xi_k - 1}{\xi_k}}} \right)^{\frac{\xi_k}{\xi_k - 1}} \tag{5}$$

[11] Specifically, Calderon *et al.* (2015) estimate an elasticity of 0.1 between public infrastructure at the country level and aggregate output. Given the sectoral nature of our analysis, we estimate the impact of the funds received by each sector by normalizing them by their total capital stock. Thus, although the elasticity of sectoral output with respect to the infrastructure funds we assume is higher -the same as for private capital-, due to data availability, we normalize these funds by the total capital stock and not only the infrastructure capital stock.

[12] In our setting we distinguish between skilled and unskilled workers.

[13] This parameter is important for our analysis of the model since, for values $\sigma_k < 1$ a public subsidy for the acquisition of a certain type of capital good implies a positive private multiplier on investment in the rest of the capital goods.

The accumulation over time of each type of capital is driven by new investments, $\widehat{I}_{i,g,t}$, and the depreciation of the existing stock.[14] The depreciation rate, δ_g, is specific for each type of capital-good.[15] [16]

$$\hat{k}_{i,g,t} = \widehat{I}_{i,g,t-1} + (1-\delta_g)\left(\hat{k}_{i,g,t-1} - 1\right) \tag{6}$$

Sector investment is determined by the expected discounted future returns of each sector, the cost of capital and the amount of capital that public funds dedicate to the sector. In addition, we assume that there is a one-period time-to-build, so that the demand for capital goods is realized one period before they enter the production function.

2.1.2 Intermediate Inputs

Industries use an intermediate input bundle (M_i) that consists of inputs produced from other sectors' output ($m_{i,j}$). The (i,j)th element of matrix Ω captures the relative importance that inputs from sector j have on the production of industry i.[17] Those intermediate inputs are combined with an elasticity of substitution ω_m. When inputs from different sectors are complement among each other, ($\sigma_m < 1$), a drop in costs of any sector s is followed by a drop in the nominal expenditure of industries in the input by that sector.

$$\widehat{M}_i = \left(\sum_{j=1}^{S} \Omega_{ij} \widehat{m}_{i,j}^{\frac{\sigma_m - 1}{\sigma_m}}\right)^{\frac{\sigma_m}{\sigma_m - 1}} \tag{7}$$

Also, for the inputs sourced from each sector, firms combine the different national varieties of the sector ($m_{i,j,c}$). The parameter $\lambda_{i,j,c}$ shows the importance that the national

[14] $I_{i,g,t}$ represents the investment of industry i on capital good g at time t. This value is normalized by the initial stock of such capital good in the industry

[15] Since we are solving the model in deviations from the initial equilibrium, we only consider the depreciation of the capital stock that deviates from the initial equilibrium level.

[16] It is important to note that since there is no complete depreciation of capital in each period, the deviation of the capital stock is not equal to the investment in that period. For this reason, we include the time subscript in this equation.

[17] Each element of the matrix Ω is calibrated as the share of expenditure in sector j by industry i, $\Omega_{ij} = \bar{p}_{ij}\bar{x}_{ij} / \sum_{j \in S} \bar{p}_{ij}\bar{x}_{ij}$.

variety c has in the bundle of the input from sector j for producer i.[18] Firms can substitute different national varieties of a particular good or service j with a trade elasticity ξ_j.

$$\widehat{m}_{i,j} = \left(\sum_{c=1}^{C} \lambda_{i,j,c} \cdot \widehat{m}_{i,j,c}^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}} \tag{8}$$

2.2 Households

Households supply endogenously different types of labor and use their income for the final consumption of the output produced by each industry. The composition of the representative household in each country is equivalent to the breakdown of different types of labor within the economy.[19]

Similarly to firms, households maximize a consumption bundle made up by the products of each sector and for every type of product they combine the different national varieties. Households combine the output of each sector with elasticity σ and put a weight ψ to each sector. [20] [21]

$$\widehat{C}_i = \left(\sum_{j=1}^{S} \psi_{ij} \widehat{c}_{ij}^{\frac{\sigma - 1}{\sigma}} \right)^{\frac{\sigma}{\sigma - 1}} \tag{9}$$

In turn, the consumption of each type of good or service s combines the national varieties of each sector, weighting them by λ and substituting across them with a trade elasticity of ξ_s.

$$\widehat{c}_{ij} = \left(\sum_{h=1}^{C} \lambda_{ijh}^{cons} \widehat{c}_{ijh}^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}} \tag{10}$$

Households supply labor endogenously proportionally to the real wage offered to each type of labor. The disutility for labor might be different for each type of workers, giving place to a Frisch elasticity ρ_t for each type of labor t within a country. [22]

[18] Each element $\lambda_{i,j,c}$ is calibrated as the initial share of expenditure on the national variety c over the total expenditure of industry i on inputs from sector j, $\lambda_{i,j,c} = \bar{p}_{j,c}\bar{x}_{i,j,c} / \sum_{c \in C} \bar{p}_{i,j,c}\bar{x}_{i,j,c}$

[19] Since the consumption function maximizing households is homothetic and there are no saving decisions, this assumption is equivalent to assuming that there are different households offering a single type of labor.

[20] Each element $\psi_{i,j}$ is calibrated as the share of expenditure in sector j by households in country i, $\psi_{ij} = \bar{p}_{ij}\bar{c}_{ij} / \sum_{j \in S} \bar{p}_{ij}\bar{c}_{ij}$.

[21] Each element $\lambda_{i,j,c}^{cons}$ is calibrated as the initial share of expenditure on the national variety c over the total expenditure of households from country i on goods from sector j, $\lambda_{i,j,c}^{cons} = \bar{p}_{j,c}\bar{c}_{i,j,c} / \sum_{c \in C} \bar{p}_{i,j,c}\bar{c}_{i,j,c}$

[22] We assume that labor cannot move across different countries but it can move seamlessly across sectors, which implies a different level of wages and employment for each type of workers in every country.

$$\widehat{L}_t = \rho_t \cdot \left(\frac{\widehat{w}_t}{\widehat{\pi}_t} \right) \tag{11}$$

2.3 Equilibrium

Following any supply or demand shock, industries adjust their production and households their consumption to the new equilibrium. Given that each industry is populated by a representative competitive firm, they demand intermediate inputs, capital goods, and labor equating their marginal productivity to their price, which at the same time is equal to their cost.

The market clearing condition implies that the production of each firm is used for the final consumption of each countries' households (f), as intermediate inputs ($m_{j,i}$) or investment goods ($\widehat{I}_{j,i}$) by every other industry j, or as public expenditure by any country (G). Given that we are outlining the model in percentage deviations, we need to weight the change of each of the elements of the demand.[23]

$$\widehat{y}_i = \sum_{j \in C} \phi^C_{j,i} \cdot \widehat{c}_j + \sum_{j \in N} \Delta^m_{j,i} \cdot \widehat{m}_{j,i} + \sum_{j \in N} \Delta^k_{j,i} \cdot \widehat{I}_{j,i} + \sum_{j \in C} \phi^G_{j,i} \cdot \widehat{G}_j \tag{12}$$

The element ϕ^C_{ji} shows the weight of the final consumption of households from country j on the total demand of sector i. Similarly, the matrix Δ^m shows the share of the sales of sector i that are sold as intermediate input for sector j.

Finally, the matrix Δ^k is of key importance for our analysis. The element shows how much the demand of sector i changes when sector j increases its capital stock. The values of matrix Δ^k are the result of two components. First, it takes into account the type of capital that sector j demands and, second, whether sector i is a supplier of that type of capital goods.

Markets also clear for the labor supply. The total demand for each type of labor in every country equates the endogenous supply of it by households.

$$\sum_i \phi^l_{it} \widehat{l}_{it} = \rho_t \cdot \left(\frac{\widehat{w}_t}{\widehat{\pi}} \right) \tag{13}$$

where ϕ^l_{it} is the weight that a particular sector i has on the demand of particular type of labor t in the country.

[23] The financing of RRPs is not explicitly modeled since the return on funds far exceeds the time horizon of this exercise.

3 Mapping NGEU funds into the model

The health crisis triggered by Covid-19 has had a profound economic impact throughout Europe. Against a backdrop of an unprecedented fall in GDP in 2020 and major divergences between northern and southern Member States, the EU approved an unprecedented fiscal response to the crisis. Next Generation EU (NGEU) represents the largest package of economic stimulus measures launched by the EU to boost, through investment and reform financing, the recovery of European economies after the Covid-19 outbreak. It should also be noted that this programme is intended to provide greater support to the countries hardest hit by the pandemic shock, so as to avoiding any economic fragmentation in the EU as a result of the crisis. Moreover, the NGEU objective is not only to mitigate the economic and social fallout of the pandemic, but also to increase the economy's growth potential by helping European economies to be more resilient and better prepared for the challenges of ecological and digital transitions.

The key instrument of the NGEU programme is the Recovery and Resilience Facility ("RRF"), which involves 750 billion euros –390 billion in grants and 360 billion in loans– to help to carry out the reforms and investments the different EU-member countries deem necessary.[24] In this context, Spain will mobilize an unprecedented volume of investment given the allocation of €69.5 bn in grants and up to €70 bn in loans from the RRF, which approximately account for 5.6% of Spain's 2019 GDP each. To implement these €69.5 bn in grants, the Spanish Government drafted a "Recovery, Transformation and Resilience Plan" (Plan de Recuperación, Transformación y Resiliencia or PRTR), which was approved by the European Council in June 2021.[25]

In order to embed the details of the PRTR and the so-called NGEU shock into our model, we break down the plans published by the Spanish government for each of these programs to identify their typology, amount and beneficiary sectors. In particular, there are three different paths through which NGEU funds enter the model. They can be considered as current public expenditure to certain sectors, they can increase the stock of capital of productive sectors, or they can be productivity-enhancing public infrastructures. Hereunder we explain the implications, in terms of the mechanisms of the model of belonging to each of the three categories.

First, some components are classified as increases in public spending.[26] These components operate only on the demand side of the model, as they do not improve the productive

[24] Another relevant and novel aspect of the NGEU programme is the conditionally of the disbursements on certain milestones such as structural reforms. While the complementary of such structural reforms and the investment projects may substantially amplify the economic impact of the programme (see Albrizio and Geli (2021)), we do not analyze the role of structural reforms in this paper. Cuadrado *et al.* (2022) provide such an analysis.

[25] See https://ec.europa.eu/info/files/spains-recovery-and-resilience-plan

[26] According to the breakdown in Appendix B, these funds are those categorized into categories 1 and 2.a

capacity of any particular productive sector. In this case, we identify which is the sector providing the goods or services, which benefits from a positive demand shock. This shock is then transmitted upstream to its suppliers through the input-output matrix. There are several examples in Spain's recovery plan of this type of shock such as spending on consulting services or the financing of legal reforms to public awareness campaigns of the health damage caused by smoking and alcohol, which benefit sectors such as professional services.

Second, capital transfers to certain sectors may have both supply and demand effects.[27] On the supply side, the increase in the capital stock (k) enters the production function and improves the productive capacity of the beneficiary sector. On the demand side, the transfers to increase the capital stock of a given sector i are also a demand shock to the sectors that produce the capital goods invested by i. This relationship appears in the market clearing condition of the capital goods supplying sectors through the Δ^k matrix. There are many examples of this type of investment projects in the PRTR: aid schemes to incentivize the renewal of vehicle fleets towards electric vehicles and the roll-out of recharging infrastructure, projects to modernize and upgrade the irrigation system for the agri-food sector, or the electrification of car factories (including the construction of a battery factory) all fall into this category. The renewal of old and inefficient vehicle fleets will enhance the productivity of the transport sector, but it will also increase the demand mainly in the manufacturing sector in order to produce the new electric vehicles. The upgrading of irrigation systems will enable to increase the production of the agri-food sector while lowering the use of water and it will also induce a demand shock to manufacturing industries producing the required machinery. Lastly, the capital transfers to increase the capital stock of the automotive sector are also a demand shock to other sectors ranging from construction and other manufacturing sub-sectors (i.e. metals or auto components) to information and communications services (as electric vehicles are way more intensive in the use of microchips than combustion engine ones).

Third, sectors can also increase their productive capacity thanks to public investments in infrastructure.[28] In this case the increase in sector output is produced by the improvement in sector productivity (d). The benefits in terms of productivity are also passed on to the rest of the sectors through the Ω matrix. Again, in addition to the supply effect, these programs enter the model through an increase in demand for the sector supplying the infrastructure, captured by an increase of G. For instance, projects aimed at improving the railway infrastructure are of particular relevance in the Spanish recovery plan. They entail not only the construction of new rail tracks but also the upgrading of train stations in the main cities.

Appendix B provides a more detailed description of the sectoral breakdown of the PRTR.

[27] According to the breakdown in Appendix B, we put these funds into category 2.c
[28] According to the breakdown in Appendix B, we put these funds into category 2.b

4 Results

In this section, we present the average change in GDP for the aggregate as well as in value added for the different sectors over a five-year horizon. Needless to say, this annual average impact masks year-specific heterogeneity depending on the time profile assumed for the execution of the funds. However, we present these average impacts for two reasons: first, our interest here is on the role of sector interactions in shaping the long-term impact of NGEU funds in Spain rather than the particular timing of such impact. Second, there is ample uncertainty around the speed of the actual spending of these funds in the current juncture.

We present the results in sequential steps to illustrate the mechanisms of the model. First, we consider the direct effect of the capital transfers and investment programmes, increasing the capital stock and productivity of different sectors, and the demand shock for capital good producers through the investment matrix, and we label this channel as the direct impact. Second, we consider the propagation through the input-output matrix of the increase in the productive capacity of the different sectors resulting from the direct shock, and we label this channel as the I-O multiplier. Third, we analyze the spillovers to the Spanish economy of the funds disbursed in the rest of the countries. Finally, we compare the above results with the case where high-skilled labor has an inelastic supply and how taking into account the sector-specific demand for different types of labor affects the sectoral distribution.

4.1 Direct impact of NGEU funds

We first consider the role of the direct demand shocks as well as demand shocks induced by the investment network. In particular, we look at the current expenditure and direct capital transfers allocated to the different sectors, as well as the demand shock induced to the sectors that provide such capital and based on the investment matrix. This matrix allows us to identify the sectors that provide the capital goods mentioned above.

Figure 1 shows the results.[29] The blue bar shows the so-called direct effect without considering the indirect effects of the supply shock through production networks. This effect accounts for both the direct capital transfers ($\widehat{k}$) and the positive shock for sectors' infrastructures ($\widehat{d}$). On the other hand, the red bar shows the effect of the demand shock for capital supplier industries and the orange one the demand shock due to the current expenditure plans.

Over the five-year horizon, the average annual impact of the NGEU shock without input-output propagation in Spanish GDP would be around 1.15%. In particular, direct supply

[29] For the sake of clarity of the results, we present the sectoral results aggregated by 1-digit groups. Total value added equals the sum of the changes weighted by the weight of each sector in GDP.

shock of capital transfers and sector investments accounts for 53% of this effect, current expenditure accounts for 10%, and the demand shock induced by the investment matrix accounts for the remaining 37%.

Moreover, we also find that the production of NGEU-related capital goods and services is concentrated in a few hubs. In particular, the sectors that benefit the most through the demand-driven NGEU shock are information and communication (IT), education and professional services, given the bias of the funds towards digitalization and modernization of the economy. However, it is also worth highlighting the case of the construction sector, which, it is also strongly benefited from the NGEU-driven demand given the transmission through the investment matrix since it is a large supplier of capital goods demanded by other sectors.

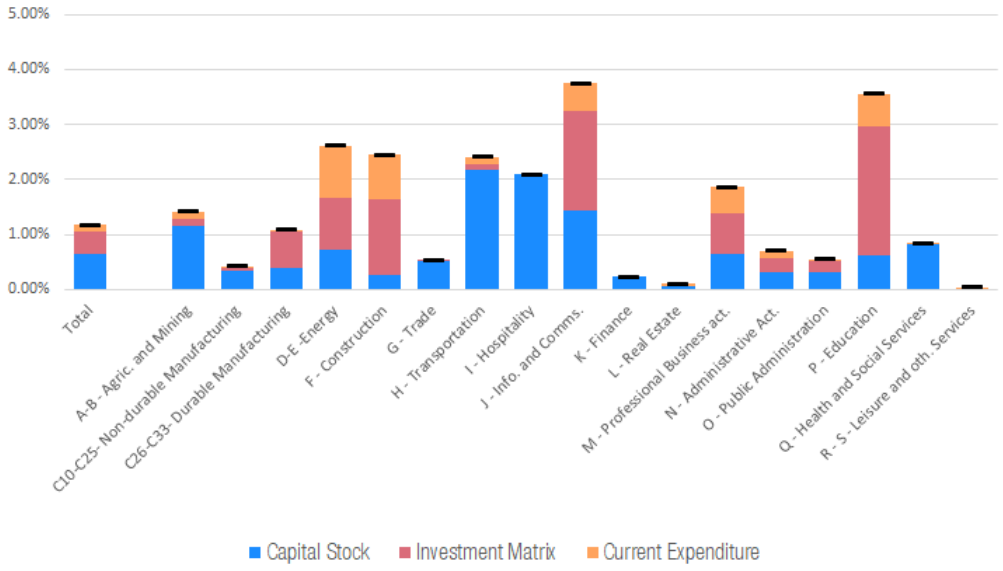

Figure 1: The bars show the changes in value added in real terms at the sectoral and aggregate level. The blue bars show the changes due to capital transfers to industries and public investments. The red bar shows the additional contribution of considering the investment matrix. Orange bars show the effect of demand of current expenditure. The black mark shows the total.

4.2 Multiplier effect and propagation through the input-output network

The previous section illustrated the positive effects of the direct capital transfers increasing the capital stock of different sectors and the resulting demand shock for capital-supplier sectors, as well as the the direct increase in demand due to current expenditures from NGEU. We now turn to the propagation of this shock, labeled for simplicity as demand-driven direct shock, through the input-output matrix in intermediate goods. As discussed in previous sections, considering that sectors use other sectors' output as inputs to their own productive processes has a multiplier effect of increases in the productive capacity of the different sectors (i.e. productivity shocks).

Figure 2 shows the results. The blue bar shows the so-called direct effect without considering the indirect effects of the supply shock through production networks. This effect accounts for the direct public expenditure shock, the direct capital transfers and its propagation through the investment matrix, and the positive shock for sectors' infrastructures. The red bars show the additional impact of the NGEU funds due to the propagation through production networks of capital transfers and sectors' infrastructures that can be considered supply shocks.

The first thing to notice is that, contrary to the direct effect, most sectors increase their value added in real terms due to the propagation. This is because, although there are sectors that do not receive direct transfers, they do benefit from the productivity improvements of the sectors whose products and services they use as intermediate inputs. Thus,

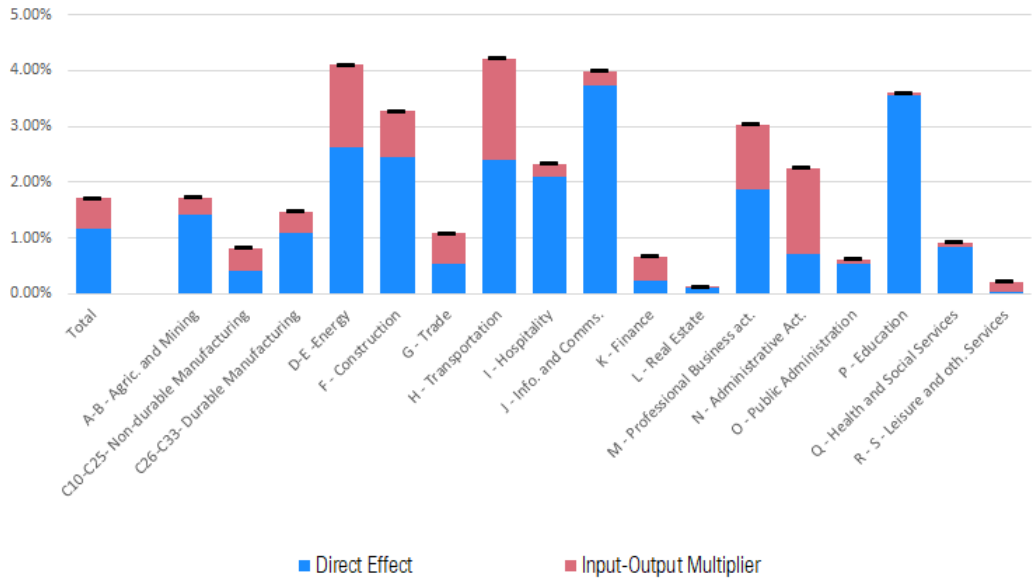

Figure 2: The bars show the changes in value added in real terms at the sectoral and aggregate level. The blue bars show the changes due to direct effects as shown in fig. 1. The red bar shows the additional contribution of the input-output multiplier. The black mark shows the total.

capital transfers do not increase aggregate output only through the sectors that increase their capital stock, but also through the increase in value added of the sectors that benefit from a greater availability of intermediate inputs. In particular, sectors such as professional services and administrative activities benefit the most through this channel due to the large positive shock to the information and communications sectors. For other industries such as manufacturing or construction, the main source of gains is the increased productivity of the transportation sector.

The second noteworthy element is the magnitude that this multiplier has on aggregate output. As 2 shows, the multiplier effect of the input-output matrix is substantial. Over a five-year horizon, once the input-output multiplier is taken into account, the Spanish GDP

level would be on average 1.75% higher because of the NGEU related investments, as opposed to the 1.15% in the absence of the I-O propagation.This change underlines the fact that the direct effect underestimates the positive supply impact of the investment programmes. Once that we consider the input-output propagation of the direct supply shock, its effect doubles. This value is consistent with the fact that the value of intermediate goods transactions is approximately equal to the total value added of the economy (Baqaee and Farhi (2019b)). In other words, on average, an increase in the capital stock of a sector has the same effect by increasing the value added of the sector itself as in increasing the output of the other sectors to which it supplies cheaper intermediate inputs.

4.3 International spillovers

We address an important facet of the NGEU program that we have not discussed such as the role that the funds received by other countries and the impact they may have on the Spanish economy. To obtain information on the use of NGEU funds received by other countries, we use the classification made by Bruegel. This classification provides information on the amount, sectoral destination and time horizon of the investments.[30] [31]

Figure 3 shows the additional effect of including funds received by other countries versus the effects estimated in Figure 2. As can be seen in the figure, international spillovers are limited at the aggregate level. The main reason is that, in most cases, Spain is not a significant supplier of capital goods to other countries, so the demand received from other countries is limited. In addition to that, even if Spanish producers could benefit from the productivity gains of their suppliers from other EU countries, there is also the counterbalancing effect of increasing competition from foreigner producers.

However, it is interesting to note the case of durable manufacturing. In this case, there is a positive effect on the value added of this sector in Spain due to the funds received from other countries. This is driven by the transport equipment manufacturing sectors and there are two reasons for this. First, because these sectors do have an important export content.

But also because in this case it reproduces the positive effect of the input-output matrices shown in Figure 2, but in this case at the cross-border level. These sectors have production chains that are particularly integrated at the European level, so that when their counterparts in other countries receive capital transfers, they take advantage of the significant benefit from the improved productivity of their suppliers of intermediate inputs (Izquierdo *et al.* (2022)).

[30] Among the rest of European economies, Italy is, together with Spain, the largest recipient of funds, with approximately an amount of 70 billion € each in grants. Since we do not have as exhaustive a classification of the funds used in the rest of the countries as the one we use for Spain, we consider that the rest of the countries use their funds entirely as capital transfers to the sectors.

[31] See an updated version here.

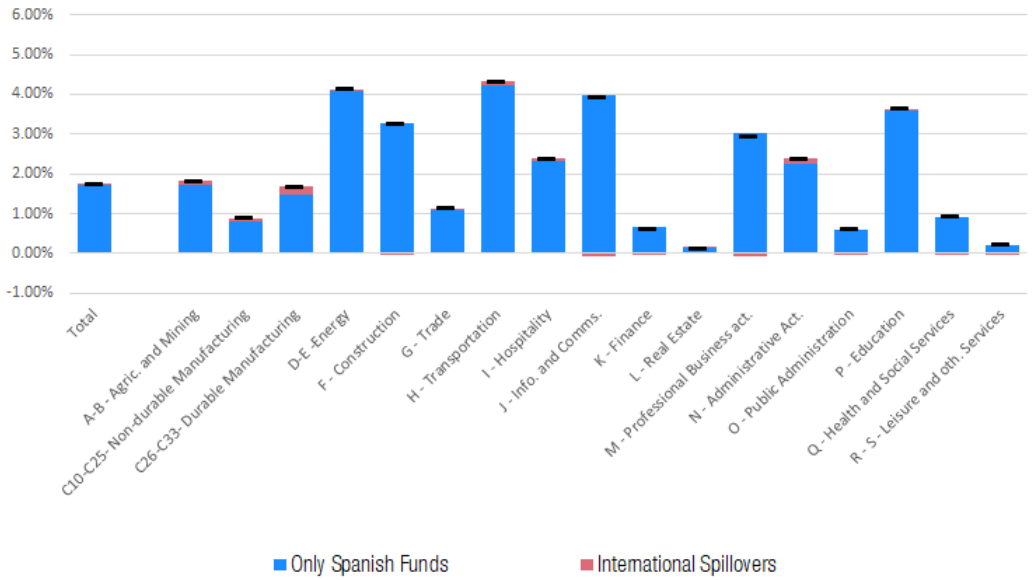

Figure 3: The bars show the changes in value added in real terms at the sectoral and aggregate level. The blue bars show the changes considering only the funds received by Spain, as shown in fig. 2. The red bar shows the additional contribution of the funds received by the rest of EU countries. The black mark shows the total.

4.4 Labor Network

The previous sections have explored the role of sector interactions in the markets for intermediate inputs and capital. We now turn to sector inter-dependencies in the labor market. To be more concrete, the previous exercises are all based on the assumption of an relatively elastic supply of labor, given the baseline Frisch elasticity (ρ_t) equal to 4 for all the types of workers.[32] As a result, the labor market interactions across sectors did not play a significant role in determining the aggregate impact of the NGEU funds. This is because, given the availability to attract new workers to the labor market, the increase in demand from expanding sectors did not alter significantly the labor costs of the other sectors.

While the assumption of elastic labor supply is reasonable at the aggregate level, especially given the high Spanish unemployment rate, it may be controversial once heterogeneity across workers and sectors is considered. In particular, the focus of NGEU projects on sectors relying on high-skilled workers such as IT together with the fact that the unemployment rate for high-skilled workers is four times lower than that of low-skilled workers in Spain, make it reasonable to think that labor elasticity for high-skilled workers may well be substantially lower than that of low-skilled workers in the current circumstances. Moreover, if this elasticity is low enough, competition for skilled workers can induce labor shortages implying not only reallocation effects between sectors but also important aggregate effects.

[32] Existing estimates for macro-Frisch elasticity put this value within the interval of 2 and 4 Chetty *et al.* (2011). Given the large cyclical fluctuations in Spanish unemployment, we choose the high-end of the interval.

Figure 4 shows the results when considering a lower elasticity for high-skilled workers. In particular, we consider a elasticity for high-skilled workers equal to one ($\rho_h = 1$), calibrated to the ratio of low-skilled to high-skilled unemployment rates in Spain that is 4. That is, given the unemployment rate for low-skilled workers is four times larger than that of high-skilled workers, we assume that the labor elasticity for low-skilled workers is also four times larger to proxy the higher availability of this type of workers in the Spanish labor market. Given this calibrated elasticity and taking into account the labor matrix that relates the different sectors according to the similarity in the type of work they demand (in terms of the share of high-skilled workers), we find that the positive effects of the NGEU funds may be significantly lower in aggregate terms. More concretely, the average impact on GDP over a 5-year period could be reduced from 1.75% to 1.25% (see Figure 4). The reason is

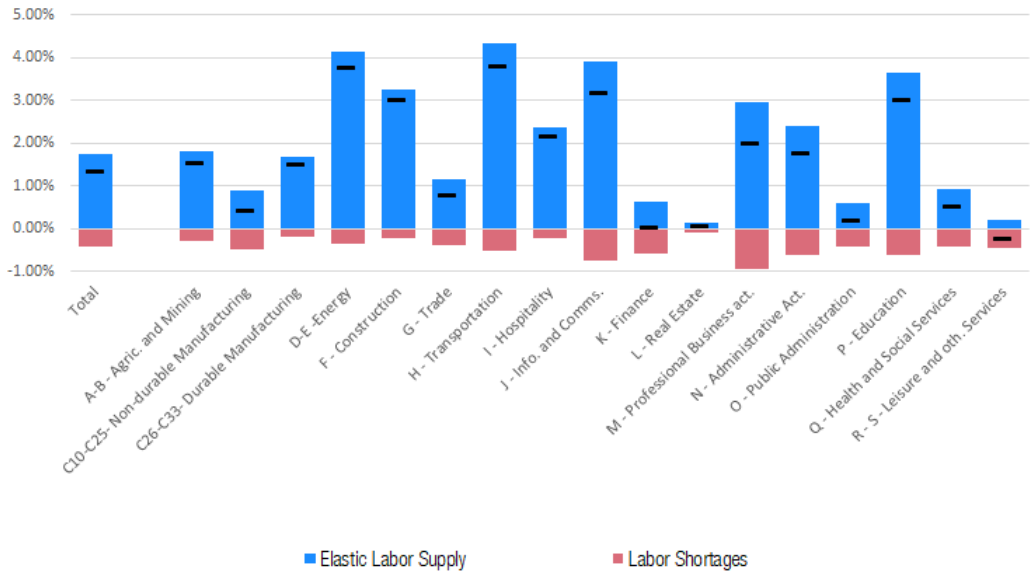

Figure 4: The bars show the changes in value added in real terms at the sectoral and aggregate level. The blue bars show the changes assuming that all types of labor have a Frisch elasticity equal to 4, as shown in fig. 3. The red bar shows the additional change by assuming that the Frisch elasticity for high-skilled workers equal to 1. The black mark shows the total.

that the expansion of sectors receiving capital transfers is limited by the competition for labor and the higher wages required to attract the new workers needed to expand production.

Figure 4 also illustrates that in the case of NGEU funds this attenuation is more important in skill-intensive sectors, even if the rest of sectors also take a hit in their level of value added. The reason for this is that the demand for such workers increases significantly due to the expansion of sectors such as information and communication or education. Thus, sectors whose labor demand is oriented towards skilled workers will see their costs increase and their production decrease.

5 Conclusions

In this paper, we introduce a production networks model for the Spanish economy. A novel feature of the model with respect to previous literature is that sectors interact along three different dimensions in an open economy setting, either by supplying other industries with intermediate inputs and capital goods or by competing for labor. Considering the NGEU programme as a case study, we show that these sectoral interactions are relevant both for the sectoral distribution of shocks and for their aggregate impact. In particular, considering input-output networks amplifies the positive effect of the NGEU funds, raising the average impact on GDP from 1.15% to 1.75% over a 5-year period. However, the existence of labor shortages, especially of high-skilled workers, could severely attenuate the positive impact of the funds.

Finally, it is worth highlighting that the estimated effects of the NGEU programme presented in this paper encompass the direct impact of the funds through demand as well as the long-run impact through input-output amplification of the supply shock to certain sectors in the form of higher productive capacity. However, the potential role of structural reforms, which are also an important element of the NGEU programme given the conditionality of the disbursements on certain reform-related milestones, are not considered in this paper. The interaction between such structural reforms and the propagation through the production network is left for future research.

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A Data and variable definitions

A.1 Elasticities and parameters

During our exercise we use the following values for the parameters in the model:

The elasticity of substitution between the value-added component and the bundle of intermediate inputs is $\theta = 0.5$. Within the value-added component, capital $(\widehat{k})$ and labor $(\widehat{l})$ are weak complements, with $\gamma = 0.9$. Diffent capital goods and different types of labor aggregate following a Cobb-Douglas, with $\sigma_k = \sigma_l = 1$. Also, the different national varieties of each capital goods are aggregated with an elasticity of substituion $\xi_k = 1$.

For the intermediate inputs bundle, we assume complementary between different inputs, with $\varepsilon_m = 0.2$. We take the values for trade elasticity between the national varieties of a given sector, ξ_m, from Caliendo and Parro (2015).

We assume that households have a certain degree of complementarity in the consumption of different goods, with $\sigma = 0.9$. For the trade elasticity between the national varieties of a given sector, ξ, we rely again on Caliendo and Parro (2015).

A.2 Input Output Matrix

We use data from the World Input Output Database to calibrate the input-output matrix in the model. This database provides us with the information about trade flows between every pair of country-sector. In our data, we have a disaggregation of 54 industries for 44 countries (including every country in the European Union). We use this data to calibrate the weights that each intermediate input has on the production function of each sector, as well as the importance of each national variety of such input. Similarly, this data allows as to calibrate the preferences of final consumers over different types of goods and their national varieties.

A.3 Labor

We consider two different types of workers: with or without a college degree. We use the information in the Labor module of the EUKLEMS database to obtain information about the importance of each type of worker for each pair of country-sector. With that information we can also calibrate the importance of each sector on the total national demand for each type of workers. We consider a Frisch elasticity, (), equal to 2 for non-college workers and 0 for college workers, showing the relatively lower slack in the job market for skilled workers.

A.4 Capital Goods

We consider nine different types of capital goods. We consider four of them as digital-oriented investments (Computer hardware, Communication equipment, Computer software

and databases and Research and Development) and the other five as non-digital (Transportation equipment, Other machinery and weapons, Cultivated assets, Dwellings, and Other Buildings and structures).

Using the Capital module from the EUKLEMS database we obtain data on the investment and stocks of each type of capital goods by sector. We use these data to compute the demand for each type of capital good when a sector receives funds to increase its capital stock as well as to calculate the percentage that this investment represents over the previous stock levels. We obtain from the same source specific depreciation rates for each type of capital good.

A.5 Capital Supply Matrix

A fundamental element in our analysis is matrix Δ^k. This matrix helps us capture what is the demand shock to sector i when sector j receives a positive shock to its capital stock. In this way, in our analysis we can capture not only the positive effect on the output of the sector that receives the aid to increase the capital stock, but also the demand shock on the sectors that provide the investment goods.

This matrix is constructed in two steps. First, we need to know which capital goods each sector invests in. With this, we have for each country how much the demand for each type of capital increases once sector i increases its aggregate capital stock. The second step is to know which sectors supply each type of capital goods. In this way we can portion the demand we have obtained in the first step and obtain what is the demand shock for capital-supplier sector j.

To construct the first step we use the data described in the previous section. For the construction of the second step we use data from the World Input-Output Tables. These tables allow us to identify the sales of each of the sectors that are used as capital goods in each of the countries. In this way we can identify which are the country-sector pairs that supply each types of capital goods to any given country. A limitation of these data is that they do not allow us to identify the recipient country-sector, but only the country. This implies, for example, that we can identify which sector-country pairs provide telecommunications goods to the Spanish economy. However, we must assume that all sectors within the Spanish economy obtain their telecommunications goods from the same mix of suppliers.

B Sectorization of investments in Spain's Recovery, Transformation and Resilience Plan

In this appendix, we provide details on how the Spanish "Recovery, Transformation and Resilience Plan" (PRTR in Spanish) is used to break down the €69.5 bn of NGEU-related public spending into the different economic sectors. The PRTR encompasses 30 investment programmes ("components"), 26 of which entail some expenditure, and provides individual cost estimates for all investments, as well as for those reforms for which associated costs have been specified. Each component contains a detailed description and the time profile of the planned investment and reform projects. Lots of these components are horizontal, i.e. for the economy as a whole; however, some of them specifically target the modernization of particular sectors, such as tourism, agri-food, health, education, the automotive industry, or the public administrations themselves. The PRTR also provides the contribution of each component to the green (40%) and digital (30%) objectives and the 2022 Spanish budgetary plan offers the breakdown of the spending from the RRF into public consumption and investment spending[33]. Spending declared by the PRTR as 'green' and 'digital' complies with the relevant taxonomy on the basis of Annex VI and Annex VII to the RRF Regulation.[34]

With this information in hand, for each of the 110 investment projects (and those reforms with associated costs) within the 26 components that entail spending, we identify firstly the type of spending and secondly which sectors of activity are the main beneficiaries both from the demand and the supply (i.e. in terms of increases in their productive capacity or capital stock) perspectives.

The first step is to classify each investment project into the spending categories described below (see also Table 1):

1. Public consumption expenditure: all government current outlays for purchases of goods and services.

2. Public investment: outlays whose productive life extends into the future, expanding the economy's productive capacity.

   (a) Grants for non-production-oriented investments: government support programmes labeled as investments in normal budgetary classification terms, that do not affect the production function of any sector, since they impact GDP only in the period these outlays are executed, such as plans to renovate residential buildings or restore ecosystems.

   (b) Investment in public infrastructures: public investment projects that increase the stock of public capital and benefit to a greater extent the productive capacity

[33] 2022 Budgetary Plan: capital spending financed via the RRF accounts for 86,4% of total spending.

[34] Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility.

Type of spending		Impact on GDP	Examples	Total RRF Spending 2020-2026 (€ bn)	% TOTAL
1. Public consumption expenditure		Demand shock	Consulting services, law reforms	9,0	13%
2. Public investment	2.a Grants for non-production oriented investments	Demand shock	Support for housing renovation, Ecosystems restoration	13,2	16%
	2.b Investment in public infrastructures	Demand and supply shocks	Road and rail networks, ports	19,5	31%
	2.c Capital transfers to firms (digital and not digital)	Demand and supply shocks	Car factories, irrigation systems, firms' digitalization plans	27,9 digital: 12,3 no digital: 15,6	40% digital: 18% no digital: 22%

Table 1: Breakdown of spending in the PRTR

of certain sectors. Unlike capital transfers, these investments are not directly appropriable by companies, since they are public infrastructures, such as roads and ports.

(c) Capital transfers to firms: investments that increase the productive capacity of one or several economic sectors through an increase in their capital stock, in many via public–private partnership. Additionally, we identify what part of these capital transfers are of digital content (technological capital), based on the contribution of each component of the PRTR to the digital transition objective. For example, sectoral investment plans such as battery factories, improvement of irrigation systems, company investments in digitalization.

With this classification, spending on public investments (2.a + 2.b + 2.c) is estimated at around €60.5 bn, which represents 87% of total spending, which is in accordance with the 2022 Spanish budgetary plan. In turn, some €47.4 bn will be allocated to spending on productive capital (2.b + 2.c), which represents 71% of the total, with capital transfers being the most important item.

The second step consists of categorizing each line of investment according to the sectors of activity.[35] The one-digit NACE classification (21 sectors) is used, since it is an adequate disaggregation level in view of the detail of the projects described in the PRTR, in addition to facilitating cross-checking with the EUKLEMS database other related studies, such as Bruegel (2021).[36]

[35]The directly affected sectors are identified. However, the rest of the sectors of the economy will also be impacted indirectly through the knock-on effects in the value chain.

[36]See Bruegel: European Union countries' recovery and resilience plans.

Specifically, the categorization of the PRTR spending items by sector of activity is carried out both from the point of view of demand (increases in the production of each sector) and supply (increases in productive capacity -capital stock- of each sector). The categorization on the demand side is carried out for all types of expenditure because they imply increases in the demand (production) of some sector[37], while the categorization on the supply side (capital stock) is only carried out for expenditures that also imply an increase in the capital stock (2.b and 2.c). For example, investment projects in new railway lines are an increase in the capital stock of the transport sector that will boost demand in the construction sector.

However, there are several components for which it is not possible to clearly identify the beneficiary sectors, since they are cross-cutting policies, which requires making some assumptions that may be controversial. On the one hand, to determine the beneficiary sector (on the supply side) of the investments corresponding to component 13 to promote SMEs (and which, since they are capital transfers, are part of 2.c), the expenses are distributed using the proportion of the SME turnover of each economic sector over the SME turnover of all sectors[38], while the investments, also on the supply side, of component 7 on the integration of renewable energies and component 16 on artificial intelligence (2.c) are distributed by allocating spending among the different sectors according to the GVA weight in the total economy. On the other hand, to determine the provider sector (that is, on the demand side) of the educational investments of components 19 and 20 (2.b), the expenses are distributed according to the weight of the employment of each sector and those of component 23 of the active employment policies (2.b) are distributed using a sectoral distribution of unemployed.[39]

The distribution of the total expenditure in the PRTR on the demand side is shown in Figures 5 and 6. Note that the sum of the amounts in Figure 5 is less than the total spending of €69.5 bn, since it is estimated that 30% of capital transfers will increase demand from non-resident sectors, according to the information on suppliers of capital goods from EUKLEMS. Therefore, a part of the demand shock of the capital spending in the PRTR will be allocated to the purchase of goods and services outside of Spain. The construction sector would be the main beneficiary, whose demand would increase by around €18 bn. Next, the demand for information and communication and education services would be increased by about €10 bn. In comparison with the sectoral nominal GVA, construction continues to

[37] Due to the lack of sufficient information in the PRTR, the sectoral distribution of capital transfers to firms (2.c) on the demand side is made using the EU KLEMS database, which allows to estimate which sectors have supplied capital goods, both digital and non-digital, of a given sector in the past.

[38] The data, corresponding to 2018, have been obtained from the Bank of Spain's Central Balance Sheet. Very similar results are obtained if the number of SMEs in each sector is used. Investments 1 and 2 of component 13 are considered public consumption.

[39] We use the 2020 average obtained from Economically Active Population Survey (EPA in Spanish) microdata. In particular, we use the ACTA variable, which specifies the NACE classification of the company where the unemployed person was working before becoming unemployed.

lead this sector classification, since the volume of spending provided by this sector represents 26% of its nominal GVA in 2019. The information and communication, energy and manufacturing sectors would also be notably boosted.

On the supply side, Figure 7 shows that €47.4 bn are allocated to increase the capital stock, with the transport sector being the biggest beneficiary, thanks to the investments in public infrastructures that improve the capital stock of the sector's production function. It would be followed by the public administrations and information and communication sector, driven by investments in digital capital, as well as manufacturing, with a greater weight of non-digital capital investments. In terms of the capital stock of each sector (Figure 8), transport continues to stand out as the main beneficiary, followed by health and social services and information and communication.

Lastly, note that the amounts in Figures 5 and 7 are not additive, but reflect two different perspectives of identifying the beneficiary sectors. For example, an investment project to create a battery factory for electric cars would increase the capital stock of the manufacturing sector (reflected in Figure 7) but would boost demand from various sectors, such as the manufacturers themselves, construction, and professional services (Figure 5).

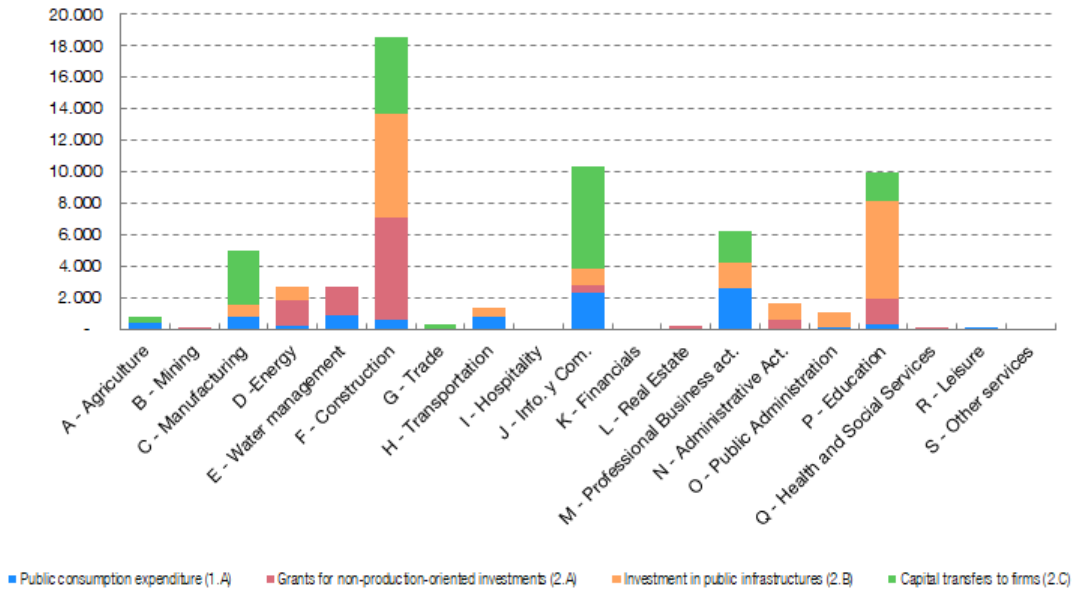

Figure 5: Composition of Spain's recovery plan according to economic activities, demand side (millions of euros)

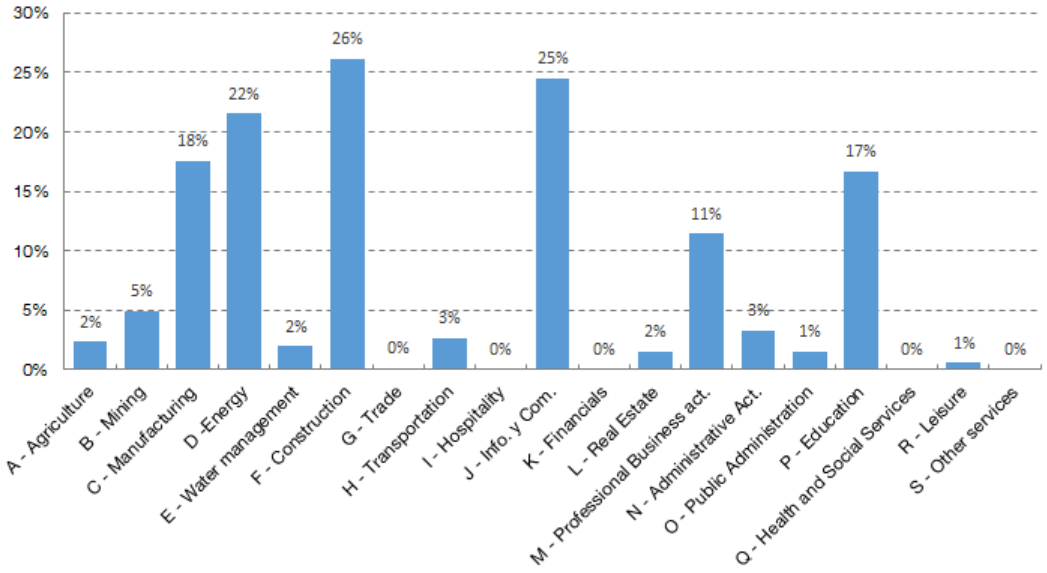

Figure 6: Composition of Spain's recovery plan according to economic activities, demand side (% of gross value added in 2019)

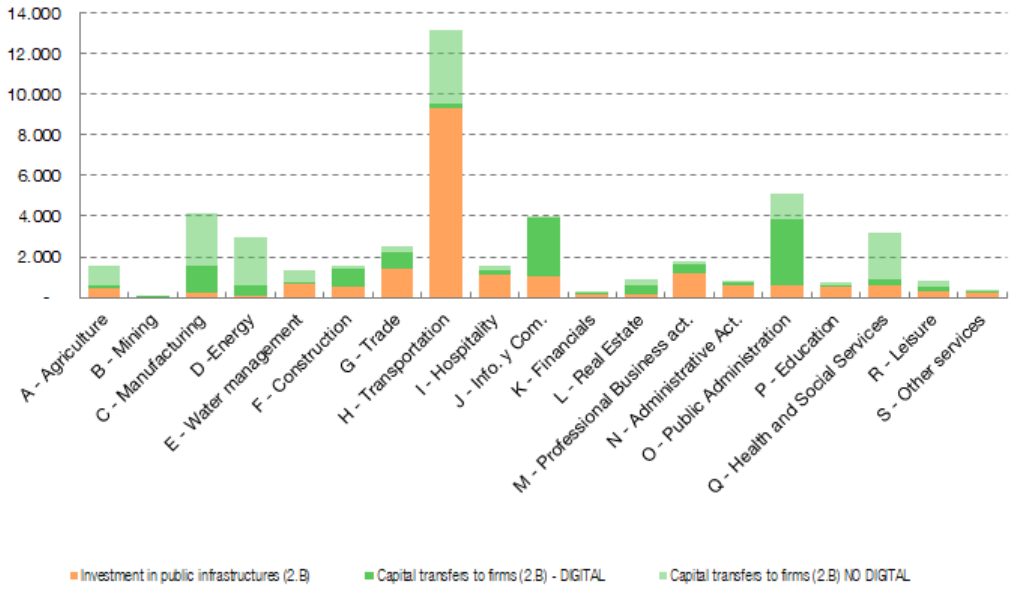

Figure 7: Composition of Spain's recovery plan according to economic activities, supply side (millions of euros)

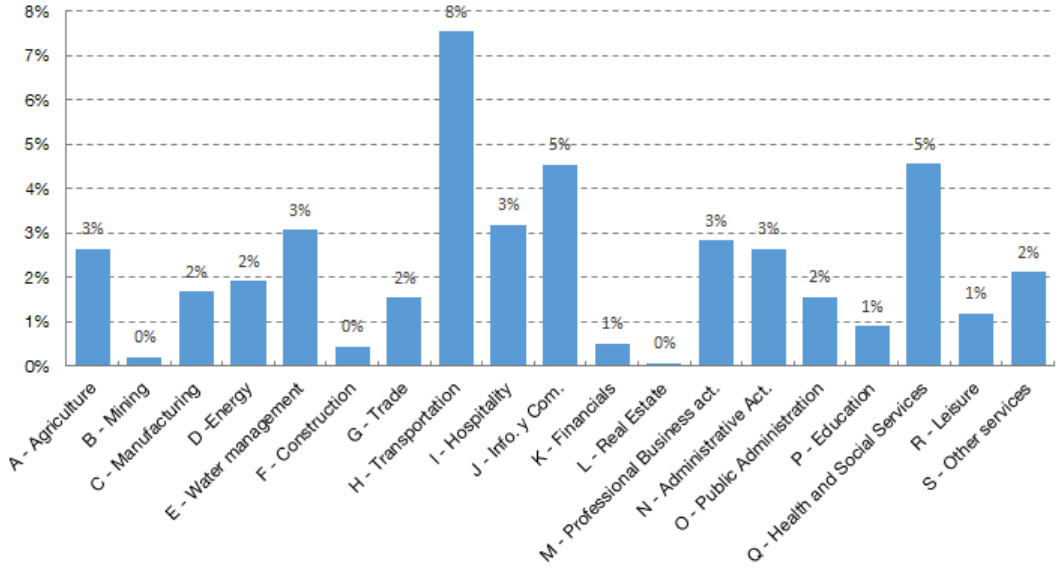

Figure 8: Composition of Spain's recovery plan according to economic activities, supply side (% capital stock)