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Fiscal Policy, public investment, and structural change: A P-SVAR analysis on Italian regions[1]

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Abstract

This work analyses the regional impact of public investments focusing on three domains that are key for the Italian National Recovery and Resilience Plan (NRRP): green, digital and education/knowledge. Relying on a unique database ('Conti Pubblici Territoriali'), we perform a P-SVAR model showing that fiscal policy shocks have positive and long-lasting effects on GDP and private investments. A relevant heterogeneity is detected, though. In particular, shocks to digital spending only timidly crowd-in private investment while a stronger effect is found concerning the green sector. Second, public investments have a significant impact on regions' 'structural upgrading', i.e., export competitiveness and share of high-tech manufacturing. Third, confirming previous findings, shocks to public spending are found to have larger effects in centre-north regions, in terms of both GDP and private investments. Nevertheless, public spending turns out to have a stronger structural effect in the south than in the centre-north, highlighting the relevant role that the NRRP may play in reducing the Italian north-south divide.

Keywords: Fiscal multipliers; Panel SVAR; Italian regions; North-South divide

JEL: C33, E62, H70, R58.

1. Introduction

One of the major economic consequences of the Covid-19 crisis has been the deepening of territorial divides (Belaid et al., 2022; Ceron and Palermo, 2022). Regions characterized by weak industrial structure, stagnant demand and high unemployment rates proved to be less resilient in the face of the pandemic shock, worsening their relative position and contributing to increase within-country

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polarization (Álvaro and Sicari, 2021; Diemer et al., 2022). This is particularly true in the case of Italy where a long-lasting 'north-south' divide (Cannari et al., 2019; Iuzzolino et al., 2011) was already widening following the 2008 financial crisis (Odoardi and Muratore, 2019). Due to a significantly lower share of exporting firms, paralleled by an at least 10-years-long stagnation of internal demand (particularly concerning private and public investments), the Mezzogiorno's regions fell further behind, experiencing a partial recovery only thanks to a steady growth of the touristic sector (Bürgisser and Di Carlo, 2022)[2].

Against this background, the recently launched National Recovery and Resilience Plan (NRRP) includes regional convergence among its top priorities[3]. About the 40% of the entire NRRP's resources are expected to be spent in the Mezzogiorno (roughly 82bn euro). Similarly, a large share of the projects included in the NRRP's infrastructural, digitalization, green transition-related missions refer to investments that will be realized, in part or entirely, in the Mezzogiorno[4]. Indeed, it is worth underlining that the NRRP represents a significant discontinuity as opposed to the 'austerity agenda' that hegemonized European and Italian policy making during the post-2008 crisis period (Cesaratto and Zezza, 2019; Zezza, 2020). The NRRP is going to provide a substantial demand-side stimulus to the economy, pursuing long-term structural objectives by means of public investments. On the contrary, the across-the-board reduction in public expenditure characterizing the post-2008 austerity phase prolonged the recession and proved particularly painful in the south, leading to a dramatic drop of regional GDP and employment figures[5].

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[2] Bürgisser and Di Carlo (2022) report a rapid increase, starting from 2010, in the contribution of tourism to GDP and employment in Italy, which reached their highest value by 2019, where it accounted for 13% of GDP and close to 15% of total employment respectively. They also note that, contrary to other southern European countries, Italy has not yet implemented a national development plan for tourism, nor has formed a coherent institutional framework, due to the regionally fragmented and un-coordinated governance at the different institutional levels. However, a recent spatial analysis by De Siano and Canale (2022) on Italian provincial data points to possible controversial effects of excesses of tourism on per capita income growth, due to congestion effects on affected and adjacent territories.

[3] Several EU funds are aimed at promoting regional convergence - i.e., European Regional Development Fund (ERDF), Cohesion Fund (CF), European Social Fund Plus (ESF+), Just Transition Fund (JTF) – all falling under the umbrella of Cohesion Policy, totalling 392 billion euro of EU budget for the programming period 2021-2027. The NGEU, however, designed in 2019 to implement the European ecological transition, and expanded in 2020 to sustain government interventions to fight the pandemic, is by far the larger in terms of allocated funds. For more detailed information, see European Commision (https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility/italys-recovery-and-resilience-plan_en) and Ministero dell'Economia e delle Finanze (https://www.mef.gov.it/en/focus/The-Recovery-and-Resilience-Plan-Next-Generation-Italia/).

[4] For more detailed information, see Camera dei Deputati (https://temi.camera.it/leg18/temi/il-mezzogiorno-nel-pnrr.html) and Ministero per il Sud (https://www.ministroperilsud.gov.it/it/attuazione-misure-pnrr/).

[5] Giannola (2014) reports strong asymmetrical territorial effects of austerity regime in the post-crisis period. Between 2010 and 2012, the reduction in GNP in Mezzogiorno due to policy interventions was equal to -2.1% of GNP against -0.8% in centre-north, mainly due to the different impact of cuts in capital expenditures (-1.7% of GNP in Mezzogiorno, against -0.6 in the rest of the country) and increase in taxation (-0.3% of GN in Mezzogiorno against -0.2% in centre-north). Similarly, almost 70% of the total job losses (around 1 million) between 2008 and 2013 occurred in southern

In this context, the NRRP combines two fundamental objectives. First, strengthening the Italian industrial structure by accelerating the two major processes of change that are already underway: green transition and digitalization[6]. In parallel, the Plan aims at reinforcing the health care as well as the education and public research sectors[7]. Second, the NRRP directs a significant share of public investments towards the south so to restore regional convergence and narrow the north-south divide.

However, some recent contributions (see, among others, Lucchese and Pianta, 2021) casted doubts on the actual capacity of the NRRP to achieve both the structural objectives included in it (i.e., pursuing green-transition and digitalization); as well as to restore convergence between northern and southern regions. A number of critical elements are pointed out. First, the amount of resources. Despite the Italian NRRP is the largest in size, if compared to all the other national plans approved by the European Commission (Corti et al., 2022)[8], the resources aimed a narrowing what we may define the 'twin gaps' – i.e., the Italian structural backwardness vis-à-vis EMU's core economies (Celi et al. 2018) and the north-south divide – risk to be inadequate. A risk that has been recently inflated by the worsening of global economic conditions (e.g., growing inflation, disruption in Global Value Chains-GVCs) and the related unfolding of the Russia-Ukraine war (Blanchard and Pisani-Ferry, 2022; Celi et al. 2022). Second, the lack of productive and technological capabilities. If the supply of key technologies and intermediate goods (and services) is lacking, a sudden investment shock as the one implied by the NRRP may very well translate into a growing balance-of-payments deficit, dwarfing the ultimate macroeconomic and structural impact of public investments. Given their fragility in key technological sectors, Italian regions and particularly southern ones face significant risks in this regard. Third, the lack of skills and knowledge-related infrastructures. The latter are crucial to maximize the impact of public investments, both in terms of implementation as well as of broader economic impact. Without the right skills, projects may be delayed, allocation decisions mistaken and the potential of innovation and new capital goods underexploited. In the Italian case, skills and, no less relevantly, administrative capabilities are unevenly distributed across regions, with the south reporting the comparatively worst performances (Lutringer, 2022; OECD, 2021; Rodríguez-

regions (which however only accounted for 30% of total employment). Moreover, Prota and Grisorio (2018) showed that the fiscal consolidation strategies at the regional level led to a change in the composition of public expenditure, with larger decline in capital expenditures.

[6] The NRRP's investments are concentrated in 3 main areas: energy & environmental transition, knowledge, and digitalization.

[7] Main government documentation and data on the NRRP may be found at (https://italiadomani.gov.it/it/home.html).

[8] Given the country (negative) record during the last decade, Italy will be the biggest receivers of funds, totalling 220 billion for the period 2022-2027. Addressing territorial divergences is among the main goals of the National Recovery and Resilience Plan (NRRP) presented by the Government, to be achieved through mission-oriented public investment targeted at driving the digital and ecological transitions.

Pose and Ketterer, 2020). The combination of these elements may turn into a smaller structural and macroeconomic impact of the Plan, as opposed to what the Italian Government has initially predicted (Di Bartolomeo and D'Imperio, 2022). In particular in the Mezzogiorno, where most of the structural and administrative weaknesses tend to concentrate[9].

This work provides an empirical assessment of the regional impact of public investments focusing on three domains that are key for the ongoing NRRP implementation: green, digital and education/knowledge. Relying on a unique database (i.e., 'Conti Pubblici Territoriali' - CPT) which provides detailed information on regional public investments distinguished by domain, we perform a P-SVAR model estimating regional fiscal multipliers; and testing whether and to what extent public investments, realized between 2000 and 2019, have contributed to regional convergence. The contribution to the extant literature is twofold. First, this is, to best of our knowledge, the first attempt to estimate regional fiscal multipliers relying on Italian data and focusing on public investments distinguished by expenditure domain. So far, the lack of regional accounts as the ones included in the CPT has prevented this kind of analysis[10]. Second, by focusing on investments directed at green transition, digitalization as well as to the strengthening of the knowledge-base (e.g., universities, public research institutes, industry-university joint ventures), the evidence provided here represents a solid base to discuss the potential and expected outcome of the NRRP regarding both its structural impact; as well as its ability to restore regional convergence.

The article is organized as follows.

Section 2 briefly reviews the literature focusing on regional fiscal multipliers and on the linkage between public investments and structural change. Section 3 introduces the data used for the empirical analysis and provides some stylized facts on the Italian north-south divide. Section 4 discusses the empirical strategy and presents the main results. Section 5 concludes providing some policy implications.

[9] Heterogeneities in administrative capabilities among Italian regions are deemed crucial in explaining north/south differences public expenditure performance and project implementation, in particular with respect to EU Cohesion Policy (Aiello et al., 2019; Aiello and Pupo, 2012; Polverari, 2020; Terracciano and Graziano, 2016).

[10] A notable exception is Zezza (2022), which uses CPT regional data to estimate fiscal multipliers for public expenditures of the Enlarged Public Sector. However, while the construction of the variables is similar to the one adopted here (i.e., accounting for current and capital expenditures net of transfers), it includes all sectors of spending.

2. Fiscal policy, investments, and structural change

Fiscal multipliers

To assess the values of fiscal multipliers, the macroeconomic literature provides a wide array of instruments. Along with model-based estimates, derived either from DSGE or large-scale macroeconometric models, in recent years there has been a strong revival in the use of Structural Vector Autoregressive (SVAR) models – estimated either with classical or Bayesian techniques – which allows to estimate the impact of exogenous spending shocks, once the appropriate identification strategy has been set[11]. Given the large number of contributions providing comprehensive reviews on fiscal multipliers and related estimation techniques, in what follows we concentrate our attention exclusively on works that are close to ours, i.e., addressing similar research questions (e.g., regional fiscal multipliers, structural factors affecting the size of multipliers); and/or focusing on Italian regions.

Ilzetzki et al. (2013) concentrate their attention on structural characteristics of economies that may affect the size and degree of persistence of fiscal multipliers. According to their analysis, based on a panel of 44 countries observed for a long time span, the size of fiscal multipliers turns out to depend upon: the level of industrial development (the more developed the higher multiplier); the exchange rate regime (lower multipliers for flexible exchange rates regimes); the degree of openness to trade (the lower the propensity to import, the higher the fiscal multiplier); the size of public debt (high-debt countries have lower multipliers, as fiscal stimulus is likely to have negative effects on financial market confidence, possibly leading to lower investment).

Cole and Ohanian (2004) and Gorodnichenko et al. (2012) highlight the role of labor market rules, i.e. the degree of 'labor market rigidity' intended as the strenght of legal safeguards against layoffs. According to their analysis, the more rigid is the labour market the larger the fiscal multipliers tend to be. The interpretation is quite straightforward and relates to the fact that rigid wages tend to amplify the responsiveness of output to demand shocks. On the other hand, Dolls et al. (2012) reported a negative correlation between of the size of automatic stabilizers and that of fiscal multipliers; while Batini et al. (2014) found an analogous negative correlation looking at the relationship between the relative efficiency of public expenditure management and fiscal multipliers (i.e., the lower the degree of efficiency, the lower the size of multipliers).

[11] For a comprehensive survey on fiscal multipliers and their use for policy analysis, see (Batini et al., 2014), Ramey (2011a, 2019) and Castelnuovo and Lim (2019).

When it comes to the Italian case, fiscal multipliers have been analysed through a wide array of models and methodologies. Model-based estimates using both DSGE (Kilponen et al. 2019; Locarno et al. 2014) and large scale models (Bacchini et al., 2013; Bulligan et al., 2017; De Nardis and Pappalardo, 2018) find positive values for fiscal multipliers, with higher ones related to investment. The literature relying on VARs to estimate fiscal multipliers is rich and heterogeneous concerning the adopted identification strategies. Nevertheless, contributions are rather homogenous in terms of results: fiscal multipliers are always positive with the investment component displaying the highest values[12].

A more circumscribed number of studies focus on Italian regions and/or macro areas, estimating 'local fiscal multipliers'. Using a quasi-experimental approach relying on NUTS-3 data, Acconcia et al. (2014) estimate a public expenditure multiplier ranging between 1.5 and 1.9. Applying P-SVAR model and focusing on Italian regions, Deleidi et al. (2021) find that the higher cumulative multipliers (ten years after the idiosyncratic shock) are those associated to investment, equal to 4 in Centre-North and 2.25 in Mezzogiorno,. Their results are confirmed even when fiscal foresights are accounted for. De Stefanis et al. (2022) estimate a Bayesian P-VAR model using annual data for Italian regions, and focus on threes sources of public spending: EU structural Funds, government investment and government current expenditures. Their results are rather heterogenous. Nonetheless, they find, on average, positive multipliers for government investment, even though the larger values are reported for EU structural funds. Lucidi (2021) estimates region-specific multipliers for real government current expenditure (i.e., the sum of public final consumption and social transfers), investment and deficit, using a Bayesian Panel-SVAR identified through sign restrictions, highlighting a misalignment in fiscal multipliers between southern and northern regions. On the one hand, expansionary policies have larger effects in the north, with a peak multiplier of 3.78 against the 1.65 of southern regions. On the other, the contractionary effects of fiscal consolidation are higher in the south. Finally, Zezza (2022) uses a SVAR model to estimate regional fiscal multipliers of the Public Sector, finding strong heterogeneity in fiscal multipliers not only when distinguishing by type of expenditure – with current expenditure multiplier of 0.8 and a capital expenditure multiplier just below 2 – but also at the territorial level – with investment multiplier in centre-north equal to 2.8

[12] Cimadomo and D'Agostino (2016) find values for government spending multipliers between 0.8 and 1.5 using time-varying VAR, while Batini et al. (2012) use regime-switching VAR to find that government spending multipliers range between 0.6 and 0.9, displaying higher values during recession than in expansions. Using threshold VAR, Caprioli and Momigliano (2013) and Alfonso et al. (2018) also finds positive values for spending multipliers, ranging between 0.1 and 1.4, with higher values in highly financially stressed regimes. Finally, SVAR models are used by Deleidi et al. (2020a) and Giordano et al. (2007), who find positive and persistent effects of government expenditures on growth, with peak values for public investment multiplier as high as 4.7.

against 0.7 in Mezzogiorno – and between actors – with Public Corporations displaying zero or negative multipliers.

Piacentini et al. (2016) use a large-scale macroeconometric model to estimate fiscal multipliers in Italian macro areas for the period 2011-2013. In contrast with the previous literature, they find larger values of fiscal multipliers for southern regions for both current and investment expenditures. Canelli et al. (2022), use a large-scale Stock-Flow Consistent macroeconometric model of Campania, estimated with annual data for the period 2001-2017, to investigate the sectoral effects of different shocks. They find that a debt-funded fiscal expansion has permanent positive effects on growth, with an impact multiplier above one and a medium-run multiplier of 0.71. In the case of a balanced-budget rule the same increase in government spending has still positive effects on growth – with a medium-run multiplier of 0.6 – but adverse ones on the private corporate sector.

Public investments and structural change

The number of contributions adopting a 'structural perspective' to analyse the macroeconomic impact of public demand is, so far, relatively scant. Deleidi and Mazzucato (2021) have recently adopted a SVAR approach to study the impact of public demand focusing on those components that can have a 'transformative potential' (e.g., infrastructural investments, public R&D, innovative public procurement, mission-oriented policies). According to this approach, public investments aiming at addressing relevant 'societal challenges'[13] operate *de facto* as industrial policies having the capacity to shape economies' innovative capacity and promoting structural change (Mazzucato, 2018). By creating a context that is favourable to the development of innovations, public investments may also stimulate firms' own innovation efforts. For example, investments strengthening knowledge infrastructures (e.g., universities, public-private research joint ventures) and/or easing technology transfer may reduce innovation-related uncertainty thus increasing the incentive for private R&D expenditures (Mazzucato, 2018; Moretti et al., 2019). Studying the innovation-enhancing role of public investments, Deleidi et al. (2020b) show how the latter are able to induce and positively affect private firms' R&D, potentially contributing to the diffusion of knowledge and innovation opportunities throughout the economy. In other words, by relying on public investments (and, more broadly, on industrial policy strategies) government interventions may go well beyond just 'fixing market failures' (Mazzucato, 2016), creating new markets, raising profit expectations and, thus,

[13] As Mazzucato (2016) repeatedly emphasized, public investment programs designed to solve specific societal problems— e.g., climate change, ageing, digitalization, etc. — tends to mobilize knowledge-intensive lines of production, stimulating company innovation, and generating economy-wide technological spillovers.

crowding-in private companies' innovation efforts. This turns out to be particularly true in high-tech industries, where returns on private R&D are particularly uncertain. Therefore, by producing an exogenous increase in the demand for innovative goods and services, public investments may physiologically stimulate innovation efforts aimed at capturing such demand flows. Deleidi and Mazzucato (2021)'s SVAR model is estimated for the US economy, distinguishing between generic government expenditure and mission-oriented innovation policies (proxied by defense R&D expenditure) to assess the effect on GDP and on private R&D (i.e., crowding-in effect). Their model show that mission-oriented innovation policies generate a larger effect on the level of GDP than generic public expenditures. Similar results are obtained with regard to the private R&D crowding in effect[14].

Along similar lines, Crespi and Guarascio (2019) find that 'innovative public procurement'[15] (i.e., the direct purchase of innovative goods and services by the public sector) has a positive and significant impact on industries' innovation efforts. Relying on industry-level information (24 OECD economies observed over the period 1995-2012), these authors show how public procurement is positively and significantly associated with innovation (proxied by industry-level patenting activities), confirming this result throughout specifications and robustness checks. Remarkably enough, the innovation-enhancing effect of public demand is resized in countries that are characterized by a strong import dependency testifying how the presence of solid productive capabilities is crucial to determine the ultimate macroeconomic and structural effect of public investments.

3. Data and descriptive evidence

The relative lack of empirical assessments of the impact of public investment at local level for Italy is due to the absence of detailed statistical information[16].

[14] Deleidi and Mazzucato (2021, p. 9)'s estimated impulse response functions show that: '(i) mission-oriented innovation policies generate an impact multiplier of 23.957 and a peak effect on GDP equal to 54.941, as well as a response of private investment in R&D of 0.745 on impact, which reaches a peak effect of 6.015; and (ii), conversely, generic public expenditures produce an impact multiplier of 0.741 and a peak effect of 1.866 as well as a non-significant effect on R&D on impact and a significant peak effect of 0.09.'

[15] Crespi and Guarascio (2019) highlighted how the relationship between demand-side policies and innovation has attracted increasing attention (see, among others: Georghiou et al., 2014; OECD, 2011). In this context, public investments explicitly directed at promoting companies' innovation efforts has been identified as a key instrument of innovation policy in both developed and developing countries (Caravella and Crespi, 2021; Edquist, 2015).

[16] In Istat REA, public consumption distinguishes between 10 sectors, following the COFOG definition. With these information, however, it is not possible to distinguish the different categories of expenditures. On the other hand, investment spending is broken down in three sectors only (education, healthcare, other), so the matching between public consumption and investment for each economic sector is not possible.

In this work, we take advantage of a rich database, the CPT, so far used only for institutional analysis and rarely for academic research, providing very detailed information on regional public expenditure (at current prices) distinguished by components. CPT data are published by the Agency for Territorial Cohesion[17] including all categories of current and capital expenditures for all institutional levels (national, regional, and local administrations), and for thirty different sectors of activity. In terms of time coverage, variables are available at annual frequency from 2000 to *t-2* where *t* is the current year.

As our goal is to assess the potential effects of NRRP-related investment expenditure on Italian regions, we selected three key expenditure areas included in the CPT: energy & environmental transition (energy, environment, water utilities, waste disposal), digitalization (R&D, ICT) and knowledge (education, training). Regarding the potential endogeneity of spending due to the presence of automatic stabilizers, the CPT database also comes at hand, as it details the different categories of public spending. Therefore, we can exclude from the analysis all sectors dealing with automatic transfers, such as pension payments and unemployment spending.

Total public expenditure (g_i^j) is thus defined – for every region *i* and sector *j* (total *T*, energy & environment *G*, knowledge *K*, and digital *D*) – as the sum of "wages and salaries paid", "goods and services purchased", "investment in real estates and infrastructure", and "investment in machineries and other movable assets". We thus also exclude all categories of spending which represent the main sources of endogeneity inside our sectors of interest (e.g., interest payments, current and capital transfers, etc.), maximising the orthogonality of our time series with respect to the business cycle.

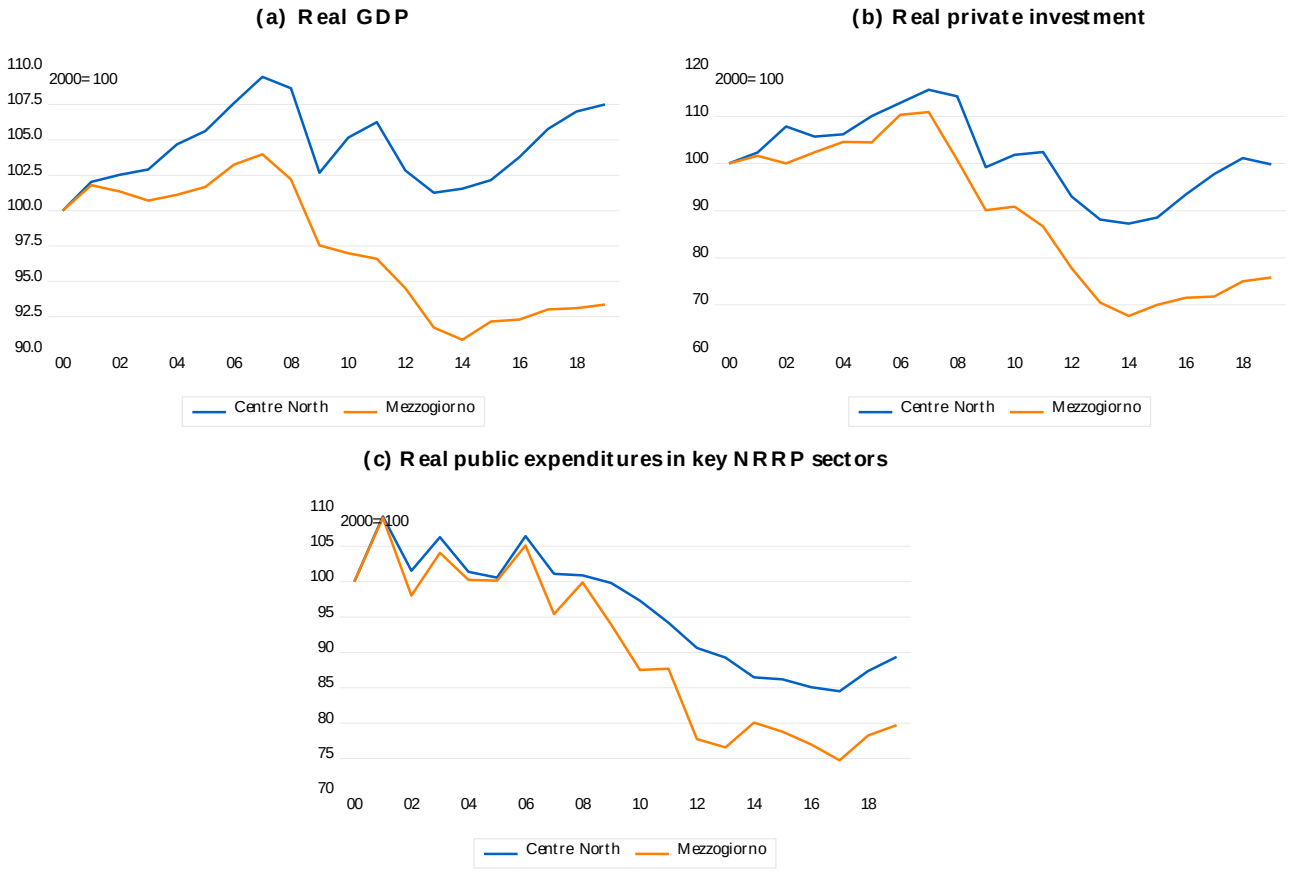
Series for regional GDP, private investment, net imports, and value added are retrieved from the Territorial Accounts published by Istat (Dec. 2021 release), covering the period 2000-2019. Data relative to import, export, and export of goods with dynamic world demand are retrieved from the territorial indicators for economic and social well-being[18], also published by Istat[19]. All nominal variables are transformed in constant (2015) prices using the regional GDP deflator. Table A1.1 details the sources for all data used in the estimations.

[17] https://www.contipubbliciterritoriali.it/CPTDE/catalogo/CPTDE_CatalogoCPT.html.
[18] Notice that these indicators are the one used by local administrations to supervise EU targets for cohesion policies.
[19] https://www.istat.it/storage/politiche-sviluppo/Internazionalizzazione.xls.

The deepening of the Italian North-South divide

Before moving forward to the P-SVAR analysis, we provide a comprehensive empirical assessment of the Italian north-south divide. Despite the latter can be considered an 'endemic malaise' affecting the Italian economy since its very early stages (Graziani, 1979, 2000; Iuzzolino et al., 2011), the north-south divide has widened significantly since the introduction of the common currency in 2001.

Figure 1: Selected macroeconomic variables



Source: Istat. CPT, own elaboration

Figure 1A-C displays the evolution of (real per capita) output (gdp_i), total public expenditure (g_i^j), and private investment (i_i) in Italian macro areas (i.e., centre-north vs Mezzogiorno) from 2000 to 2019, setting 2000=100 to make figures comparable[20]. Why 2001 is such a 'turning point' for the Italian north-south divide? Providing a final answer to such a complex question is well beyond the scope of our paper. Some speculative explanations can be put forth, however. First, the introduction of the euro coincides with a substantial increase in international competition (Brandolini et al., 2009;

[20] Figures A.1 to A.5, reported in Appendix, show the individual cross section of government expenditures (g_i^j), private investment (i_i), and GDP (gdp_i), and the degree of export ($spec_i^{XD}$) and high-tech ($spec_i^{HT}$) specialization.

Tiffin, 2014) and related processes of industrial restructuring (e.g., the emergence of the European core-periphery divide[21]). Southern regions, characterized by a weaker industrial structure and poorer connections into GVCs (Celi et al., 2018), have suffered more than their northern counterparts, with negative implications in terms of employment and GDP. Second, in 2001 the Italian administrative structure has been reformed providing financial autonomy and a number of key competences to regions (Palermo and Wilson, 2014). By reducing the redistributive power of the central government while increasing regions autonomy in managing resources and related investment projects, this reform contributed to increase territorial inequalities as regards size and quality of public expenditure (Del Monte et al., 2022). Being relatively weaker in terms governance and administrative capabilities, in fact, Mezzogiorno's regions increased their delay vis-à-vis northern ones. If anything, such developments can be inferred by examining the evidence provided by Carlucci (2019) concerning the differences in implementation of EU Cohesion Policy, which shows that Mezzogiorno's regions are characterized by the longer duration of administrative processes in all the phases considered (roughly one and a half years longer than in centre-north). Third, the self-defeating nature of the austerity policies implemented in Italy following the 2008 financial crisis (see the discussion above). Austerity has put an additional burden on the Mezzogiorno's economic dynamics contributing to widen the north-south gap: GDP growth (1A) in fell to 0,3% between 2014 and 2019, against the 1,1% registered in centre-north. By 2019, real GDP in Mezzogiorno was still 12% below its peak in 2008, against the -3% of centre-north. Similar dynamics can be seen by focusing on private investment (1B) and public expenditures in key sectors (1C), with Mezzogiorno experiencing larger drops during the crises, and a slower recovery thereafter[22].

Moving to the additional drivers that may have contributed to such divergent patterns, we now focus on the evolution of the macro-regional industrial structures. Figure 2A shows that both centre-north as well as southern Italian regions experienced a reduction of their share of manufacturing value added in GDP that, after a short period of growth (2004-2007) and as soon as the 2008 crisis stepped in, transformed into a dramatic decline. However, while such a declining dynamic is partly inverted in centre-north, the Mezzogiorno's manufacturing share continued to drop and was, in 2019, still more than 15% below the pre-crisis peak. Focusing on high- and medium-high technology manufacturing sectors, in turn, Figure 2B shows that, by 2019, northern regions almost recovered

[21] For a detailed analysis, see: Celi et al. (2018, 2020)and Grabner et al. (2020).
[22] The Covid-19 pandemic in 2020 hit Italian regions rather symmetrically, with GDP dropping 9% and 8.5% in Centre North and Mezzogiorno respectively. However, according to the last SVIMEZ projections (Rapporto SVIMEZ2021), the 2021 recovery has been stronger in northern regions, signalling that the structural north/south divide is still there.

their pre-crisis levels (7% of GDP); while the gap with the Mezzogiorno kept widening. This reflects a structural divide according to which southern regions tend to be increasingly specialized in traditional sectors, whose wages and productivity are lower, while northern ones strengthened their relative position further widening the gap.

Figure 2: Industrial specialization (Value Added as % of GDP)

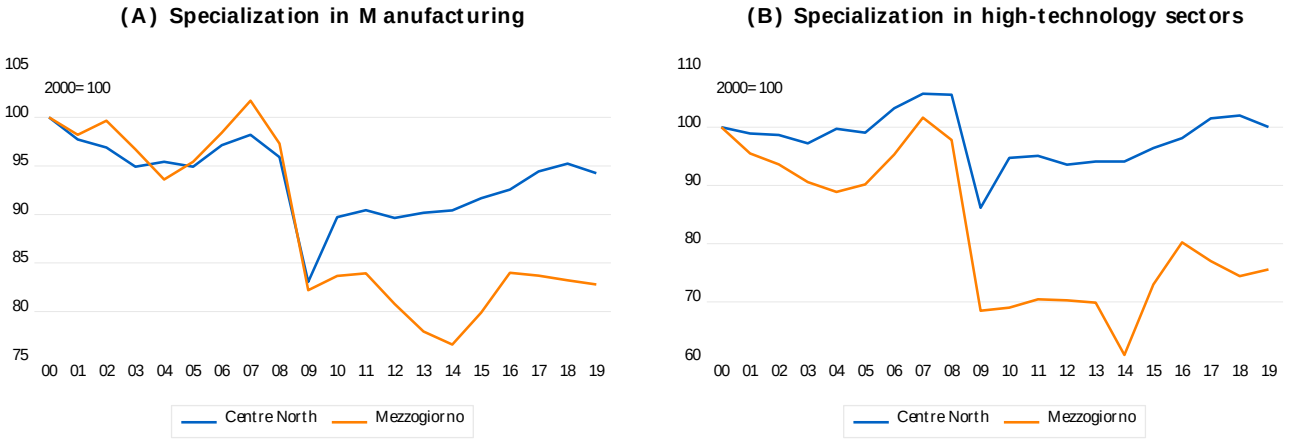


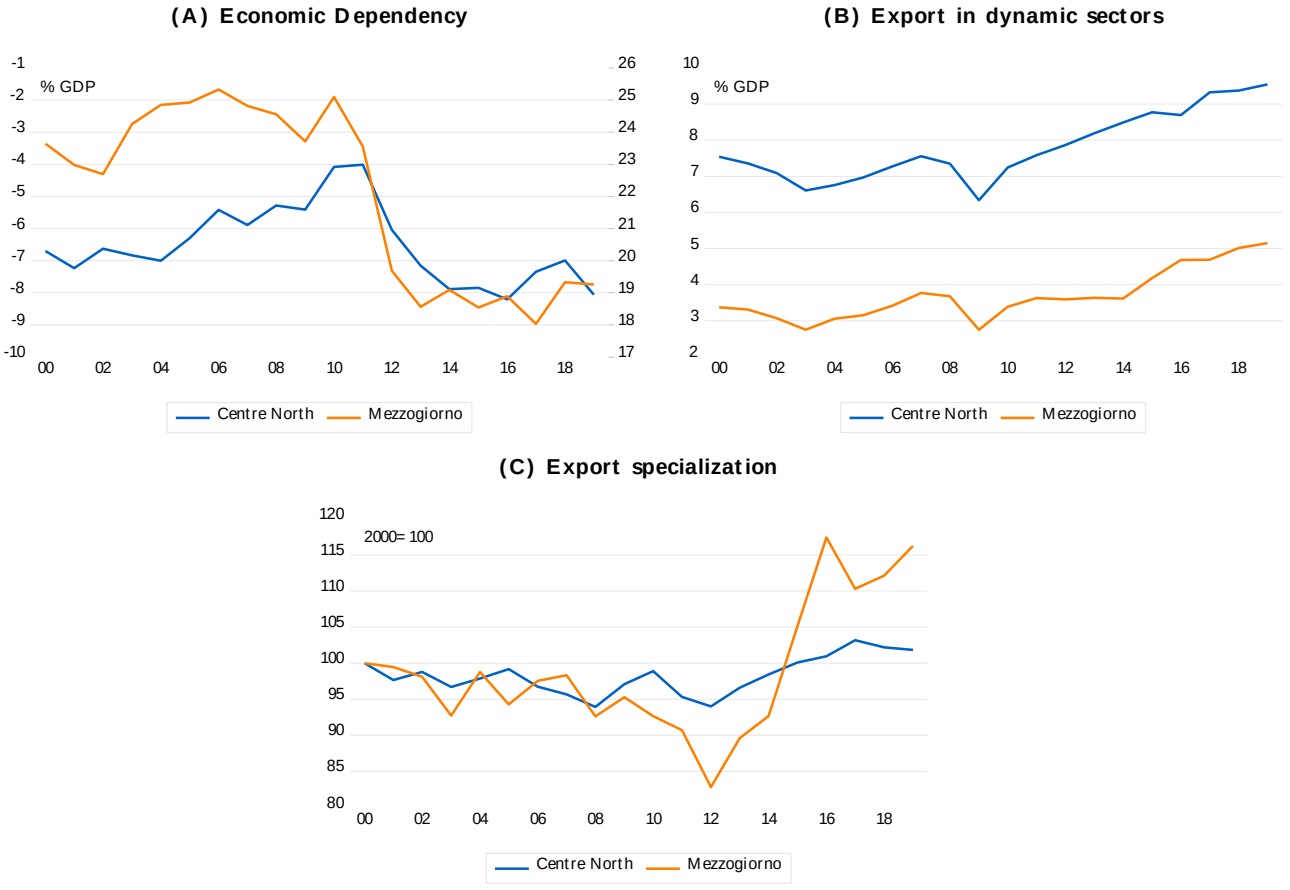
Figure 2. Source: Istat. Notes: aggregation of manufacturing high- and medium-high technology sectors follow Eurostat NACE Rev.2 at 2-digit level.

The second channel through which the Italian north-south divide may have widened relates to international trade. Following the euro inception, the Italian economy worsened her position in many foreign markets, mostly due to the parallel strengthening of Germany's external competitiveness both within and outside the EU (for an early assessment of these trends, see Simonazzi et al., 2013). This has weighed on growth, contributing to enlarge the gap between Italy and the German manufacturing core (Stehrer and Stöllinger, 2015). Nonetheless, exports remained a fundamental driver of growth for Italian regions, particularly during austerity phases characterized by the 'strangulation' of internal demand (Zezza, 2022). The large majority of exporting firms, however, is localized in the north. As a result, export-related economic opportunities distributed rather unevenly across regions, opening an additional divide deemed to grow steadily during post-crisis phases. Figure 3A shows that, between 1995 and 2019, southern regions registered an average CAB deficit of over 20 percent of GDP, mirrored by a 7 percent surplus in centre-north[23]. The dramatic fall in Mezzogiorno's disposable

[23] In the Regional Economic Accounts (REA), available at annual frequency from 1995 to 2020, Istat only provides data on *net total imports of goods and services*, which thus includes inter-regional trade. Regional statistics on exports and imports are published by coeweb (https://www.coeweb.istat.it/), at quarterly frequency from 1991 to 2021, with a large country/goods decomposition. However, it only registers trade in goods.

incomes that followed the 2008 financial crisis led to a decline in its deficit, which however remains at very high levels. On the other hand, Figure 3B shows the regional exports of goods (as % of GDP) towards 'dynamic sectors' (see the definition above). Both macro-areas display an increase in the share of exports over GDP, which accelerated from 2014, but the traded volumes are significantly different: while in centre-north dynamic exports account for almost 10% of GDP (equal to roughly 128.4 billion euro in 2019, in real terms), in Mezzogiorno the figures are halved: 5.2% of GDP (19.6 billion euro in 2019). Interestingly enough, while Mezzogiorno's exporting firms seem to suffer more as a consequence of the financial crisis, from 2014 onwards there has been a steady – and faster, compared to centre north figures – increase in the export specialization of southern regions (Figure 3C). This points to the relative resilience (and economic dynamics) of the Mezzogiorno's export sector. A resilience that, however, has so far failed to impress a macroeconomic stimulus capable to reduce the structural gap vis-à-vis northern regions.

Figure 3: Trade performance



Source: Istat, BES. Notes: Figure 3A displays Net total imports as a share of GDP. Figure 3B shows the exports of sectors with dynamic world demand as a share of GDP. Figure 3C shows the degree of export specialization, e.g., the share in total exports of exports of sectors with dynamic world demand.

The evidence provided in this section documented the depth and dynamics of the Italian north-south divide, providing some insights about its potential structural drivers. In what follows, we empirically assess how public demand and, in particular, investments may affect Italian regions' macroeconomic and structural dynamics.

4. Empirical strategy and results

Empirical strategy

This section presents the P-SVAR methodology and reports the main results

First, we assess the impact of shocks to fiscal expenditures in key sectors (g_i^j) – where i stands for the 21 Italian NUTS2 regions and j for total fiscal expenditure excluding automatic stabilizers, green, digital and education/knowledge related public investments. The aim is to test whether and to what extent public expenditures and, more importantly, NRRP-related components of public investments:

i. Stimulate private investment (i_i) – i.e., crowding-in effect (Deleidi and Mazzucato, 2021) - and expand output (gdp_i)

ii. Support trade performance, proxied by export specialization ($spec_i^{XD}$)

iii. Strengthen regions' industrial structure, proxied by the share of high- and medium-high technology manufacturing value added ($spec_i^{HT}$)

Second, we explore the role of regional heterogeneities, testing whether the north-south divide is also reflected in the way Italian regions respond to public investment shocks. To this end, we split our sample in two – Centre-North vs Mezzogiorno –, following the approach of Deleidi et al. (2021), estimating macro-regional fiscal multipliers and focusing on the role that green, digital and knowledge-relate public investments may play in promoting regional growth and structural change[24].

[24] As discussed in Section 3, Italy is characterized by a strong regional divide, with exporting and manufacturing industries primarily located in the north. Table A3 shows the sample average for (A) economic dependency – defined as the ratio of net imports to GDP – and (B) the specialization in manufacturing – defined as the share of Manufacturing VA in total VA. Looking at the distribution of regions across groups (North/south, exporter/importer, and manufacturer/traditional) a strong overlap is detected, with northern regions being either net exporter or running a balanced CAB (with the notable exceptions of Valle d'Aosta and Umbria, which are net importer for 14 and 7% of GDP respectively), and Mezzogiorno regions mostly specialized in traditional sectors. In two other experiments, we split our sample along the lines of Table A3 – e.g., net importer/exporter (or balanced CAB), and manufacturer/traditional. Results, which are available upon request, show that both fiscal multipliers and the crowding-in effects on investment tend to be larger in exporting and manufacturer regions.

All macroeconomic variables (g_i^j, i_i, gdp_i) are expressed as a share of the trend of real GDP – as in Gordon and Krenn (2010) and Ramey and Zubairy (2018) – while specialization in exports ($spec_i^{XD}$) and high-tech ($spec_i^{HT}$) enter the estimations in levels. In the literature, SVAR models are often estimated using natural logarithms to compute elasticities, which are then transformed into euro-equivalent multipliers relying on an ex-post conversion factor, usually the sample average of the ratio of GDP to government spending (Y/G). However, the ratio of GDP to total spending shows great regional heterogeneity. Using Gordon and Krenn (2010) transformation, in contrast, allows us to compute multipliers directly from IRFs, as they are already expressed in euro-equivalent, thus avoiding the use of an ex-post conversion that risks introducing an upward bias in our estimations.[25] Finally, the Panel Unit Root Test shows that all variables are I(1), and so they enter estimations in first differences (which are stationary).[26]

Table 1 reports the descriptive statistics of our variables.

Table 1. Descriptive statistics. All regions.

	(a+b+c) g_i^T	(a) g_i^D	(b) g_i^G	(c) g_i^K	i_i	gdp_i	$spec_i^{XD}$	$spec_i^{HT}$
Mean	3182.27	272.84	431.85	2477.58	14701.25	85233.47	31.60	5.35
Median	2514.25	161.25	364.60	1685.92	7890.15	46240.65	26.89	5.28
Maximum	9148.99	1630.79	1532.67	7676.78	74472.20	386065.00	89.57	12.53
Minimum	117.88	0.08	21.62	87.78	685.70	4573.00	4.40	0.33
Std. Dev.	2298.38	275.62	309.01	1849.52	14771.98	84138.89	17.19	2.94
Skewness	0.67	2.02	1.00	0.75	1.87	1.86	1.12	0.23
Kurtosis	2.51	8.10	3.73	2.71	6.75	6.69	3.85	2.08
Jarque-Bera	34.30	705.10	75.05	39.02	467.32	456.78	95.13	17.53
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	1272906	109134.8	172738.5	991032.9	5880499	34093389	12638.1	2141.232
Sum Sq. Dev.	2.11E+09	30310815	38099463	1.36E+09	8.71E+10	2.82E+12	117900.5	3444.911
Observations	400	400	400	400	400	400	400	400

Source: Istat, BES, CPT. Own elaboration.

We start estimating a reduced-form P-VAR(n) as in (1), for all sectors j

$$y_{i,j,t} = A_{i,j}(L)y_{i,j,t-n} + \varepsilon_{i,j,t} \quad (1)$$

[25] Nonetheless, we also estimated the model using logs and performing the ex-post conversion. While results, available in Appendix I, are qualitatively identical, estimated multipliers are upward biased.
[26] Results are available upon request.

where $y_{i,j,t}$ is the vector of endogenous variables, $A_{i,j}(L)$ is polynomial of lagged coefficients, and $\varepsilon_{i,j,t}$ is the usual error term. Given the results of the lag-length test (results are reported in the Appendix, Table A2), we introduce two lags.

To obtain a P-SVAR, we need to impose an identification strategy to the reduced-form P-VAR(n), which allows to retrieve a structural model as in (2)

$$B_{0i,j}y_{i,j,t} = B_{i,j}(L)y_{i,j,t-n} + w_{i,j,t} \quad (2)$$

where $B_{0i,j}$ is the matrix of contemporaneous coefficients, $B_{i,j}$ is the matrix of lagged coefficients, and $w_{i,j,t}$ is the vector of serially uncorrelated structural shocks. To identify the structural model, one needs to impose theory-driven restrictions on the matrix of contemporaneous coefficients $B_{0i,j}$, which allows to obtain exogenous fiscal policy shocks (Kilian and Lütkepohl, 2017).

All models are recursively identified through a Choleski factorisation (Bachmann and Sims, 2012).[27] This assumes that $B_{0i,j}$ is lower triangular, and that structural shocks are uncorrelated. "Basically it is a story about a given endogenous variable being determined by those *higher up* in the system but not those *lower down*" (Ouliaris et al., 2016, pp. 92–93). It is worth noting, however, that after the initial period variables in the system are allowed to interact freely.[28]

As illustrated above, our baseline specification (Model 1) includes three variables: public demand[29] (g_i^j), private investment (i_i), and output (gdp_i). We assume the identification as in (3)

$$B_{0i}y_{it} = \begin{bmatrix} - & 0 & 0 \\ - & - & 0 \\ - & - & - \end{bmatrix} \begin{bmatrix} g_i^j \\ i_i \\ gdp_i \end{bmatrix} \quad (3)$$

As in Blanchard and Perotti (2002), the fiscal variable (g) is ordered first. This identification, which is standard in the literature, builds upon the idea that government expenditures are not

[27] We also tried to estimate the model with the Blanchard-Perotti identification scheme, changing our vector of endogenous variables by ordering investment first. We then estimated the elasticity of investment to GDP with a 2SLS and used the coefficient as an additional restriction in the $\boldsymbol{B_0}$ matrix. Results, which are available upon request, are qualitatively similar, assuring once more on the robustness of our model.

[28] Other widely used identification methods are: a) the Blanchard-Perotti scheme, where one of the coefficients in $\boldsymbol{B_0}$ comes from an external estimation (Blanchard and Perotti, 2002); b) the sign restrictions approach, which imposes restrictions only on the signs of the coefficients (Pappa, 2009) and, c) the narrative approach, which uses institutional information to construct exogenous shocks (Ramey, 2011b). See (Caldara and Kamps, 2017) for a detailed discussion of identification schemes in SVAR.

[29] Notice that: j ϵ {total public expenditure in green, digital, and knowledge-related sectors, excluding automatic stabilizers}.

contemporaneously affected by changes in GDP, because of both the delay in the release of GDP figures; and due to the discretionary nature of fiscal policies. Although Blanchard and Perotti' story underlines the importance of these lags when using quarterly data, in our case – where we employ regional data at annual frequency – these are in fact even more important, since: i) regional macroeconomic data are released at annual frequency with a two-year delay – against the half-a-year of official quarterly national statistics, which implies that local policymakers need to rely on projections (of past values!), which are usually heavily revised; ii) further delay in responding to changes to economic cycle, in the regional context, arise from the fact that fiscal policies need not only to be designed and approved at the local level, but also need State-region coordination, as investment plans are usually partly funded by the central authority.

We assume, as in Deleidi nd Mazzucato (2021), that private investment is contemporaneously affected by changes in public expenditures but not to changes in output, and so it is ordered second. The ratio here is that business investment plans are based on long term prospects for output growth, which only slowly adapt to business cycles fluctuations.

In model 2, we add to our baseline specification the degree of export specialization – that is, the share of export towards sectors with dynamic demand[30] - so that our vector of endogenous variables is the following: $[g_i^j, i_i, gdp_i, spec_i^{XD}]$. Our intention here is to investigate the ability of public expenditures and, in particular, investments directed at key sectors such as green, digital and education/knowledge to increase trade competitiveness – e.g., generate a positive change in the ratio.

In model 3, we add a variable capturing the degree of specialization in high-technology manufacturing sectors – that is, the share of high- and medium-high technology manufacturing in VA. Expanding on the approach proposed by Deleidi and Mazzucato (2021), Models 1 and 2 allow to investigate the 'transformative' potential of public demand, assessing the impact that the latter may have on regions' structural upgrading. Given the relevance of exports as a driver of growth and innovativeness (Guarascio et al., 2017), Model 2 focuses on the ability of public demand to increase regions' exporting capabilities. This test is particularly important for the analysis of regional convergence in Italy. As argued, northern regions' export performance is one of the fundamental elements explaining

[30] From 2009, with the adoption of the new ATECO 2007 classification, sectors with dynamic world demand are: Manufacture of chemicals and chemical products (CE); Manufacture of pharmaceuticals, medicinal chemical and botanical products (CF); Manufacture of computer, electronic and optical products (CI); Manufacture of electrical equipment (CJ); Manufacture of transport equipment (CL); Legal, accounting, management, architecture, engineering, technical testing and analysis activities, Scientific research and development, Other professional, scientific and technical activities (M); Arts, entertainment and recreation (R); Other services (S).

their ability to outperform their southern peers in terms of growth and employment. As a consequence, one of the main objectives of the NRRP, as a way to narrow the north-south gap, is to strengthen the Mezzogiorno's export capacity. On the other hand, the ability to growth is strictly related to regions' innovation capabilities (see, among others, Castellacci et al., 2020; Rodríguez-Pose and Crescenzi, 2008). Accordingly, Model 3 allows to explore the linkage between public demand and share of medium-high and high-tech manufacturing. In this way, we are able to identify the capacity of public demand and, more specifically, of investments components that are explicitly directed at promoting structural change, to strengthen regions' innovation potential.

Results

In what follows, we illustrate the main results of the P-SVAR model reporting, first, the test on all regions. Second, we provide the results of the separate analysis on centre-north and Mezzogiorno's regions.

All regions

In our baseline specification, shocks to public expenditure (g_i):

i. Crowd-in private investment, with an impact multiplier of 1 and an average multiplier of 1.9
ii. Have positive, significant, and persistent effects on output, with an impact multiplier of 1.9 and an average multiplier of 3.9

Figure 4A-D shows the IRFs for our baseline models, while cumulative fiscal multipliers are reported in Table 2.

When the role of green, digital, and education/knowledge-related public investments is explicitly accounted for, significant heterogeneity emerges.

Looking at the crowding-in effects on private investment, these are large (positive and significant) for shocks to spending in education/knowledge – with cumulative multipliers equal to 1.9 at impact and 3.6 on average – while are below unity (and not significant) for digital spending. A potential explanation regards the relatively weak productive and technological capabilities of Italian regions as regards the ICT sector (Guarascio and Stöllinger, 2022). Such a relative backwardness may easily translate into 'import dependency', particularly concerning the purchase of electronic equipment and, more broadly, intermediate goods. This, of course, may obliterate the crowding-in effect of public investments directed towards these industries.

Concerning the effects on output, in contrast, shock to digital public expenditures display a larger (and significant) effect on impact – equal to 3.9, against 3.6 for knowledge, and 0.6 for green investments. The positive effects on output tend to increase over time, in particular for shocks to knowledge spending, which displays a mean multiplier of 7.5.

Figure 4: Baseline. Effects of shock to (g_i^j) on output (light grey/red) and private investment (dark grey/green). All regions

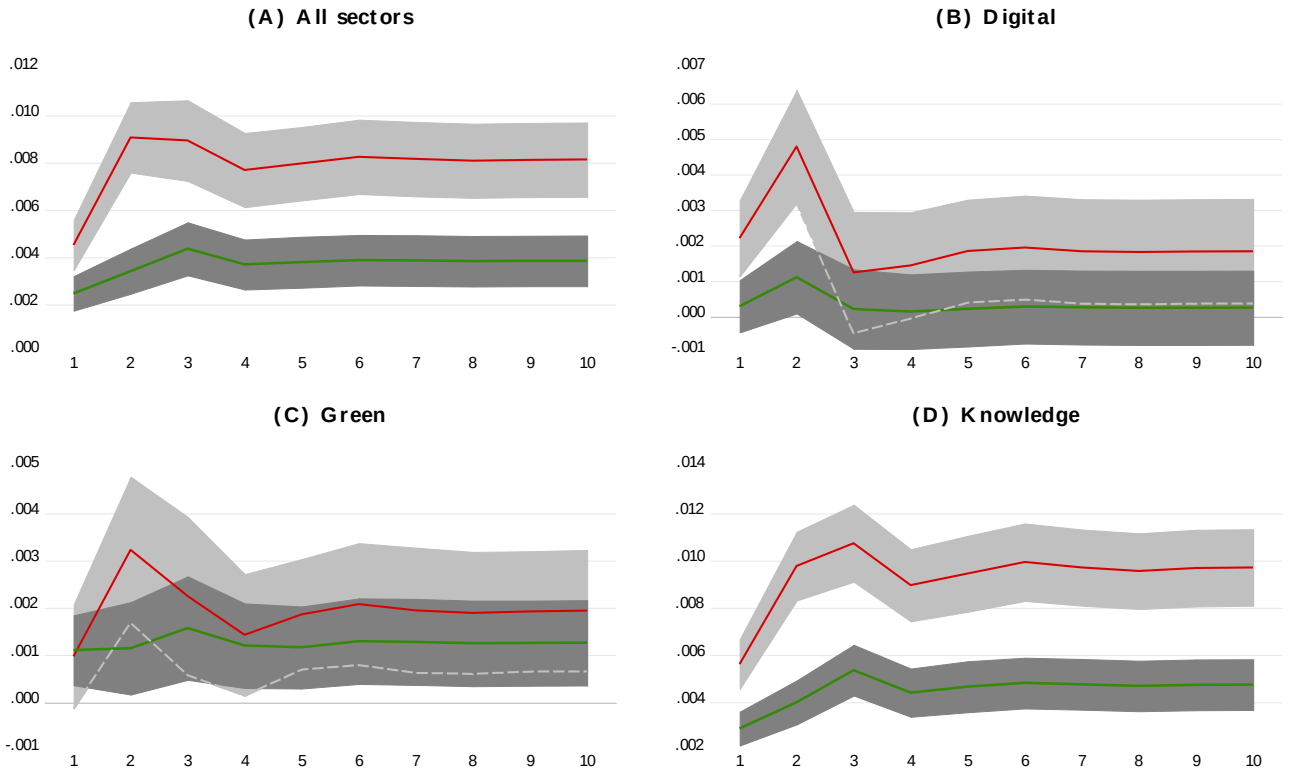
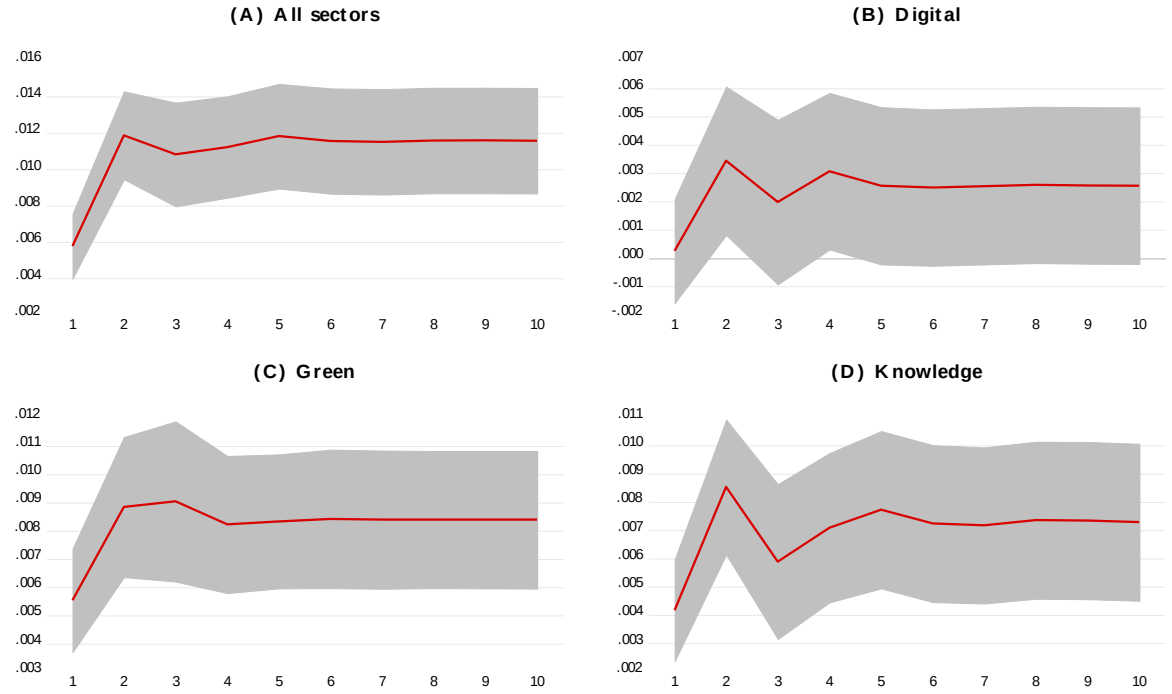


Figure 4. Notes: IRFs from Baseline model. Figures display elasticities. Filled areas are 95% confidence bands.

The results of the baseline model are confirmed when adding our structural variables (Models 2 and 3). Shocks to (g_i^j) increase both the degree of export specialization (Figure 5) – leading to a 5% (statistically significant) increase when estimating Model 2 on all sectors, and to a 7.5% increase for green spending – and a smaller, but still positive, effect on the degree of specialization in medium-high and high-technology manufacturing (Figure 6). Indeed, the heterogeneity emerging from Models 2 and 3 deserves some discussion. First, the comparatively lower magnitude of Model 3's multipliers can be explained by the long-term, slow, and complex processes that have to take place to determine an increase of the regional share of high-tech manufacturing productions. Second, the relatively lower impact of digital investments should be, again, linked to import dependency (see the discussion above). Third, green investments turn out to have a remarkable impact on both export and medium- and high-tech manufacturing specialization. This result is relevant from a policy point of view. In

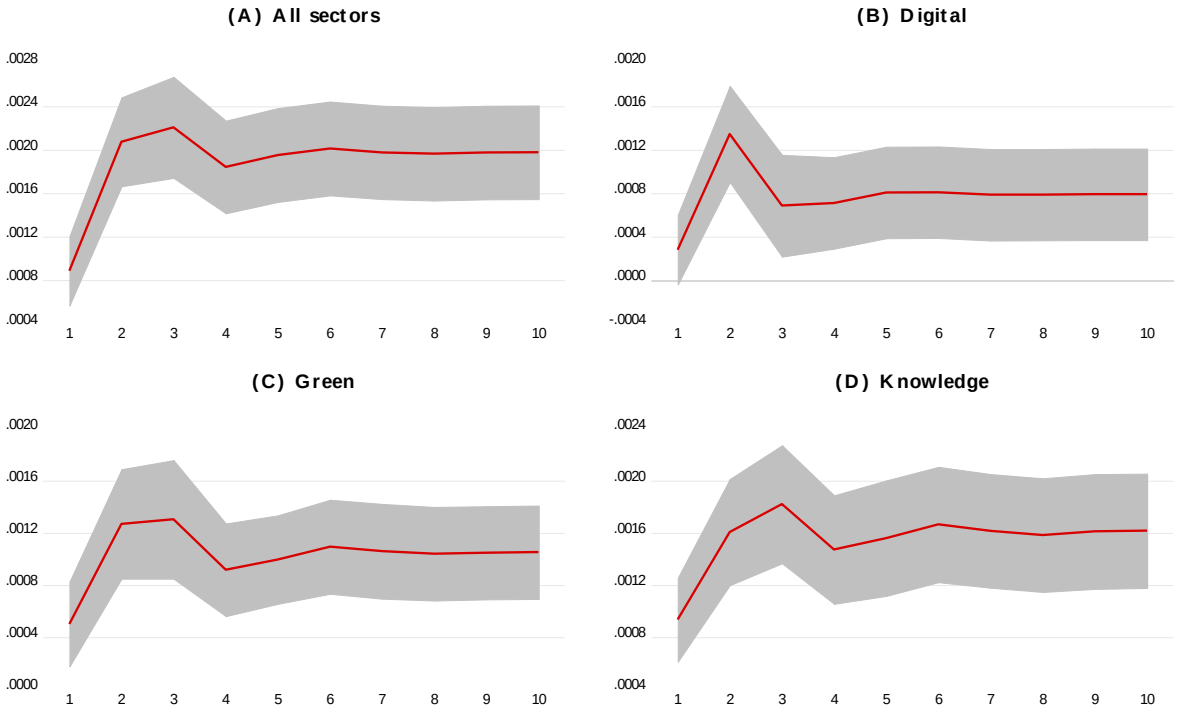
fact, by carrying out green investments the Italian government seems to be capable to pursue a threefold aim: accelerating the ecological transition, increasing regions' external competitiveness, and reinforcing their industrial structure.

Figure 5: Model 2. Effects of shock to (g_i^j) on export specialization. All regions



Note: IRFs from Baseline model. Figures display elasticities. Filled areas are 95% confidence bands.

Figure 6: Model 3. Effects of shock to (g_i^j) on specialization in high-tech sectors. All regions



Notes: IRFs from Baseline model. Figures display elasticities. Filled areas are 95% confidence bands.

Table 2. Cumulative fiscal multipliers. All regions.

		Baseline					Model 1					Model 2			
		1	3	5	mean		1	3	5	mean		1	3	5	mean
All sectors	i_i	**1.0**	**2.1**	**1.9**	1.8	i_i	**1.0**	**2.1**	**1.9**	1.8	i_i	**1.1**	**2.1**	**1.9**	1.8
- Digital		0.5	0.4	0.5	0.7		0.6	0.4	0.6	0.8		0.5	0.4	0.4	0.7
- Green		**0.7**	**1.6**	**1.1**	1.1		0.7	1.7	1.2	1.2		0.7	1.6	1.1	1.1
- Knowledge		**1.9**	**4.2**	**3.7**	3.6		**2.0**	**4.3**	**3.9**	3.7		**1.9**	**4.2**	**3.7**	3.7
All sectors	gdp_i	**1.9**	**4.3**	**3.9**	3.9	gdp_i	**1.8**	**4.2**	**3.9**	3.9	gdp_i	**1.9**	**4.3**	**3.9**	3.9
- Digital		**3.9**	2.5	**3.9**	4.5		**3.9**	2.6	4.2	4.7		**3.9**	2.5	3.7	4.4
- Green		0.6	**2.3**	**1.7**	1.8		0.5	2.5	**2.1**	2.0		0.6	2.3	1.6	1.7
- Knowledge		**3.6**	**8.3**	**7.4**	7.5		**3.6**	**8.2**	**7.5**	7.4		**3.7**	**8.4**	**7.5**	7.6
All sectors		..	..	..	..	$spec_i^{XD}$	**2.4**	**5.1**	**5.7**	5.3	$spec_i^{HT}$	**0.4**	**1.0**	**0.9**	0.9
- Digital		..	..	..	..		0.5	4.0	5.4	5.2		0.5	1.4	**1.7**	1.7
- Green		..	..	..	..		**3.4**	**9.0**	**7.4**	7.2		**0.3**	**1.3**	**0.9**	0.9
- Knowledge		..	..	..	..		**2.8**	**4.6**	**6.2**	5.7		**0.6**	**1.4**	**1.2**	1.2

Source: Own calculations on Istat, BES, and CPT data.

Notes: Public expenditure multipliers for shocks to (g_i^j). Multipliers for private investment (i_i) and output (gdp_i) are reported in euro-equivalent, e.g., they display the euro-change in the variable due to a euro-change in fiscal expenditure. Statistically significant estimates are reported in bold. Positive (significant) values are highlighted in green, negative values in red.

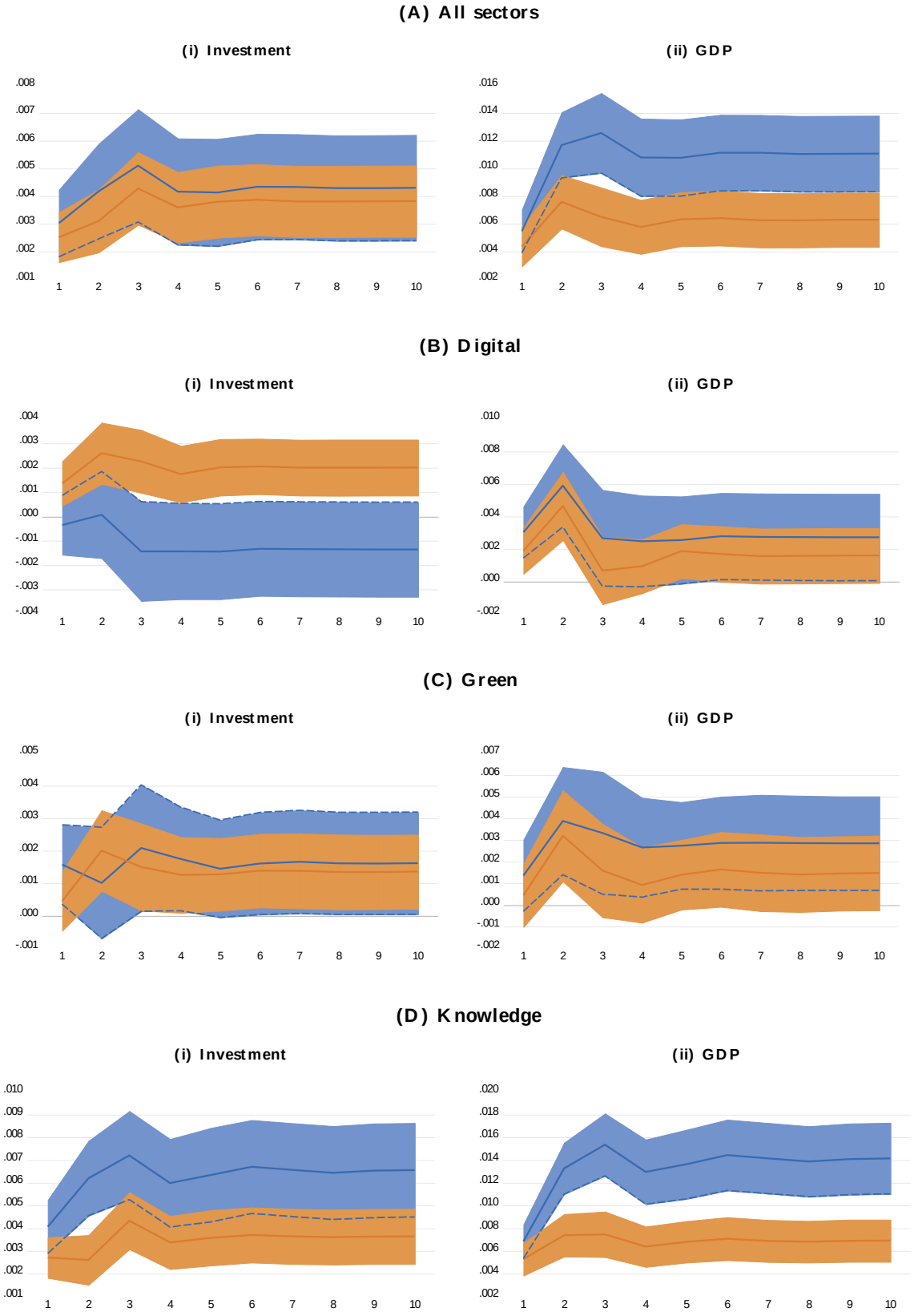
Centre-north vs Mezzogiorno

The three models tested in the previous section are now estimated splitting the sample between Centre-north and Mezzogiorno. The aim is to verify whether the territorial divide documented in Section 3 affects the relationship between public demand, GDP, private investments, and the structural dynamics of Italian regions. This test matters since convergence and, more specifically, reinforcing the Mezzogiorno's economy is one of the key objectives of the NRRP (Lucchese and Pianta, 2021). On the other hand, public investments are the fundamental tool put forth to achieve such a goal.

The results of our baseline specification (Figure 7A-D, and Table 3) are in line with the existing literature addressing territorial differences in fiscal multipliers in Italy. As for the impact of public demand, GDP multipliers are higher in centre-north at impact (2.8 against 1.7 for Mezzogiorno), but the effects tend to converge to a higher value (the mean value is around 4 for both areas). Multipliers are larger in centre-north also when we look at crowding-in effects on private investment (with an impact multiplier of 1.6 against 0.9 for Mezzogiorno). In this case, however, the territorial gap persists (the average multiplier is 2.4 in Centre North against 1.6 in Mezzogiorno) mirroring the structural divide between the two areas illustrated in Section 3.

Focusing on NRRP-related public investments, a significant heterogeneity can be observed. First, public investments directed at the digital sector (g_i^D) seem to crowd-out Mezzogiorno's private investments. In line with the previous discussion, such a result might be driven by the poorer productive and technological capabilities of southern regions. This may very well translate into international and inter-regional trade imbalances with obvious negative implications for local private investments, particularly in the case of a technologically complex and path-dependent domain as the digital one.

Figure 7: Baseline model – Centre north (blue) and Mezzogiorno (orange)



Notes: IRFs from Baseline model. Figures display elasticities. Filled areas are 95% confidence bands.

Table 3. Baseline. Cumulative fiscal multipliers. Macro areas

		Centre North				Mezzogiorno			
		1	3	5	mean	1	3	5	mean
i_i	All sectors	**1.6**	**2.8**	**2.5**	2.4	**0.9**	**1.9**	**1.6**	1.6
	Digital	3.0	6.2	6.0	5.8	-0.5	-2.2	-2.3	-1.8
	Green	0.5	1.9	1.6	1.6	0.7	1.7	1.0	1.1
	Knowledge	**2.3**	**4.4**	**3.7**	3.5	**2.1**	**4.3**	**3.8**	3.9
gdp_i	All sectors	**2.8**	**4.2**	**4.2**	4.1	**1.7**	**4.6**	**4.1**	4.0
	Digital	4.2	1.9	5.5	5.2	4.3	4.1	4.1	5.1
	Green	0.5	2.0	1.7	1.9	0.6	2.7	1.9	2.0
	Knowledge	**4.6**	**7.6**	**6.9**	6.9	**3.5**	**9.2**	**8.1**	8.2

Source: Own calculations on Istat, BES, and CPT data.

Notes: Public expenditure multipliers for shocks to (g_i^j). Multipliers are reported in euro-equivalent, e.g., they display the euro-change in the variable due to a euro-change in fiscal expenditure. Statistically significant estimates are reported in bold. Positive (significant) values are highlighted in green, negative values in red.

Moving to Models 2 (Figure 8 and Table 4) and 3 (Figure 9 and Table 5), some interesting results stands out.

First, shock to g_i^j are found to have structural effects only in the south, with little to no effects in northern regions. This evidence highlights that, despite the existing structural divide, public investments may in fact accelerate the convergence process, by strengthening both Mezzogiorno' export competitiveness and manufacturing capabilities.

Interestingly enough, shocks to public expenditure generate an 8% increase in export specialization in Mezzogiorno, and only a 0.8% increase in Centre North. The positive, and statistically significant, effects on export specialization in Mezzogiorno are higher with respect to investments in the education/knowledge (+10.7%) and green (+10.1%) sectors, while only for Digital spending the effects are larger in Centre North (+8.9%).

Similar results are found concerning Model 3, even though the effects are smaller. The increase in $spec_i^{HT}$ following a shock to public expenditure is equal to 1.2% in Mezzogiorno, against a mere 0.4% (and not statistically significant) increase in Centre North.

Figure 8: Model 1. Effects of shock to (g_i^j) on export specialization in Centre north (orange) and Mezzogiorno (blue).

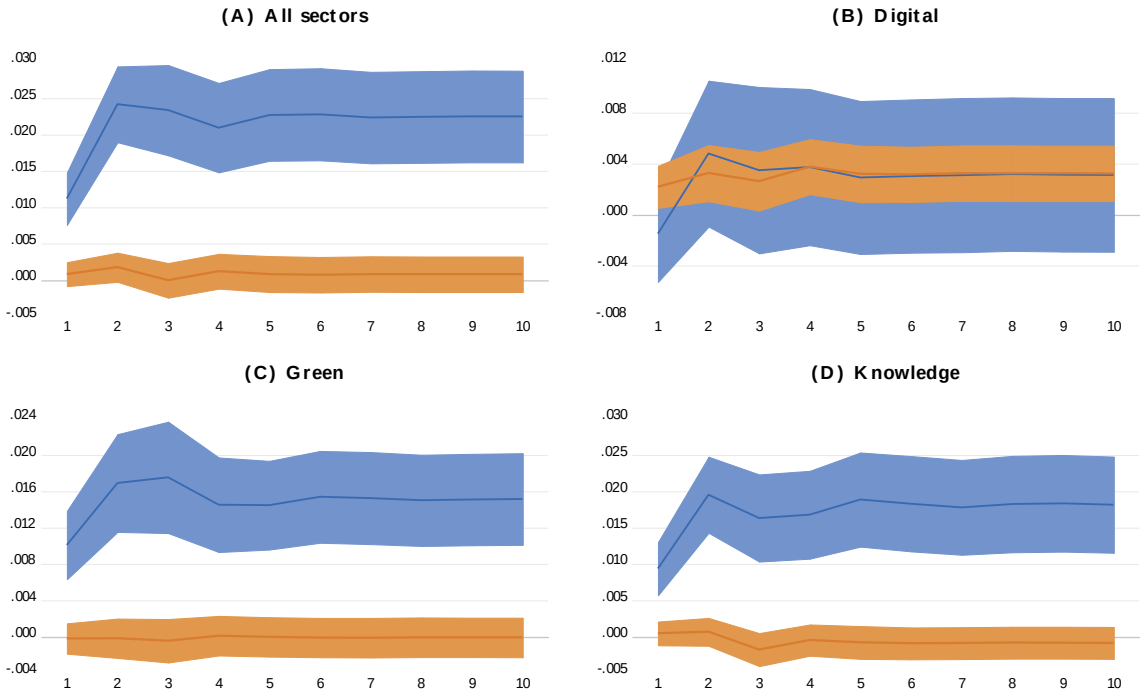


Figure 8. Notes: IRFs from Model 1. Figures display elasticities. Filled areas are 95% confidence bands.

Table 4. Model 1. Cumulative fiscal multipliers. Macro areas

		Centre North				Mezzogiorno			
		1	3	5	mean	1	3	5	mean
i_i	All sectors	**1.6**	**2.7**	**2.5**	2.4	**1.0**	**1.9**	**1.8**	1.7
	Digital	3.0	6.3	6.1	5.9	-0.3	-2.2	-2.0	-1.6
	Green	0.6	1.9	1.7	1.7	0.7	1.7	1.2	1.2
	Knowledge	**2.3**	**4.4**	**3.6**	3.5	**2.2**	**4.3**	**4.1**	4.1
gdp_i	All sectors	**2.8**	**4.1**	**4.1**	4.0	**1.6**	**4.6**	**4.2**	4.1
	Digital	4.1	2.1	5.8	5.4	**4.2**	4.0	4.5	5.2
	Green	0.5	2.0	1.8	2.0	0.5	3.0	2.5	2.3
	Knowledge	**4.6**	**7.6**	**6.9**	6.9	**3.4**	**8.9**	**8.3**	8.2
$spec_i^{XD}$	All sectors	0.6	0.0	0.6	0.6	**3.4**	**8.5**	**8.4**	8.0
	Digital	**4.9**	**7.2**	**9.4**	8.9	-2.0	5.4	4.7	4.9
	Green	-0.2	-0.5	0.0	-0.1	**4.4**	**13.9**	**9.6**	10.1
	Knowledge	0.5	-1.8	-0.8	-0.6	**4.9**	**9.7**	**11.3**	10.7

Source: Own calculations on Istat, BES, and CPT data.

Notes: Public expenditure multipliers for shocks to (g_i^j). Multipliers are reported in euro-equivalent, e.g., they display the euro-change in the variable due to a euro-change in fiscal expenditure. Statistically significant estimates are reported in bold. Positive (significant) values are highlighted in green, negative values in red.

Figure 9: Model 2. Effects of shock to (g_i^j) on industrial specialization in high-tech in Centre north (orange) and Mezzogiorno (blue)

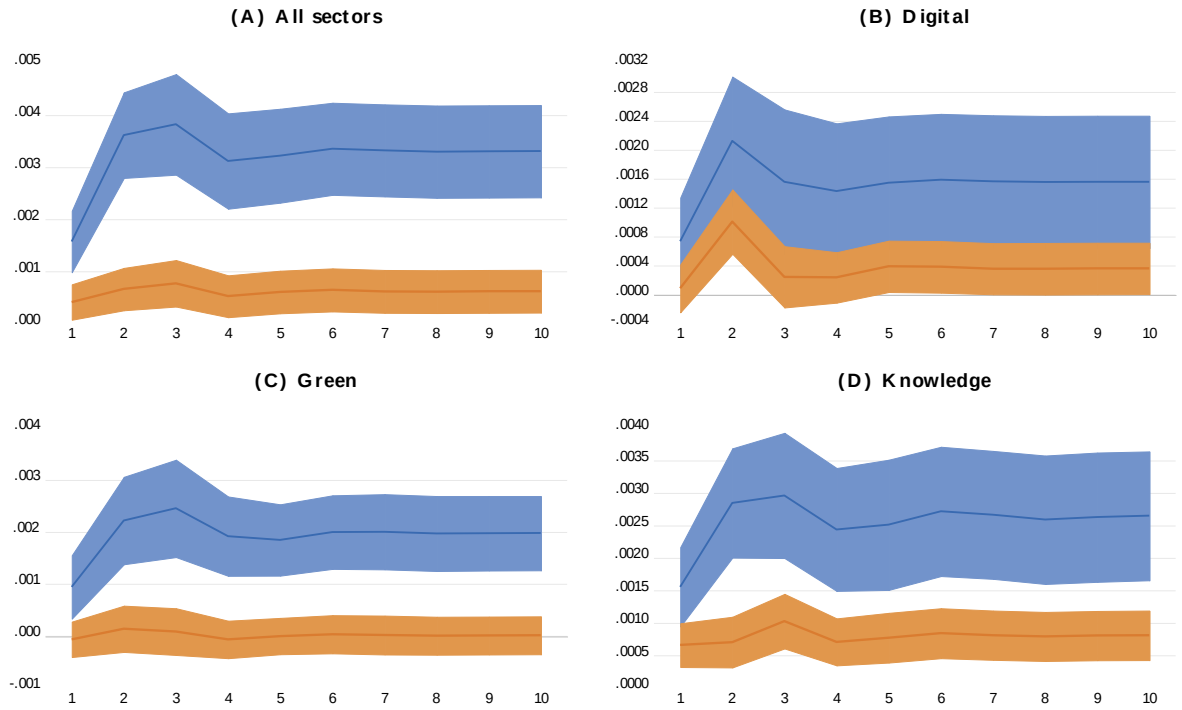


Figure 9. Notes: IRFs from Model 2. Figures display elasticities. Filled areas are 95% confidence bands.

Table 5. Model 2. Cumulative fiscal multipliers. Macro areas

		Centre North				Mezzogiorno			
		1	3	5	mean	1	3	5	mean
i_i	All sectors	**1.6**	**2.9**	**2.6**	2.5	**1.0**	**1.9**	**1.6**	1.6
	Digital	3.0	6.3	5.9	5.8	-0.5	-2.1	-2.1	-1.7
	Green	0.5	2.1	1.8	1.9	0.7	1.7	1.1	1.1
	Knowledge	**2.3**	**4.5**	**3.7**	3.6	**2.1**	**4.3**	**3.8**	3.9
gdp_i	All sectors	**2.8**	**4.8**	**4.6**	4.5	**1.7**	**4.7**	**4.1**	4.1
	Digital	4.1	2.5	5.6	5.4	**4.4**	4.4	4.6	5.5
	Green	0.6	2.8	2.4	2.5	0.6	2.7	2.0	2.0
	Knowledge	**4.7**	**8.0**	**7.2**	7.2	**3.5**	**9.2**	**8.1**	8.2
$spec_i^{HT}$	All sectors	0.3	0.5	0.4	0.4	**0.5**	**1.4**	**1.2**	1.2
	Digital	0.2	0.7	1.2	1.1	1.0	2.4	2.5	2.5
	Green	-0.1	0.1	0.0	0.0	**0.4**	**2.0**	**1.3**	1.3
	Knowledge	**0.6**	**1.0**	**0.8**	0.8	**0.8**	**1.8**	**1.5**	1.6

Source: Own calculations on Istat, BES, and CPT data.

Notes: Public expenditure multipliers for shocks to (g_i^j). Multipliers are reported in euro-equivalent, e.g., they display the euro-change in the variable due to a euro-change in fiscal expenditure. Statistically significant estimates are reported in bold. Positive (significant) values are highlighted in green, negative values in red.

5. Conclusions

The NRRP represents an unprecedented effort to promote growth, structural change, and territorial convergence by implementing a massive 7-years long public investment program. In so doing, the Italian government aims at pursuing two 'grand challenges' (i.e., green transition and digitalization) strengthening, in the meantime, crucial domains such as the education/research as well as the health sector. However, the structural context the Italian government is going to face is one of significant productive and technological backwardness vis-à-vis the major European economies (e.g., Germany) and, no less relevantly, of substantial regional divides. The latter have widened as a consequence of the recent crises (i.e., the 2008 financial crisis and the economic shock following the Covid-19 pandemic), burdening Italy's growth prospects for the years to come.

Taking advantage of a unique database providing regional-level (years 2000-2019) information on public demand and investments, this work provides fresh evidence on the role that both central government and regions can play in sustaining growth and promoting structural change. By the same token, we have documented how the long-lasting structural weaknesses of the Italian economy and, above all, the persistent north-south divide may hamper the capacity of public investment (and thus potentially of the NRRP) to pursue their very objectives. Of course, the actual impact of the NRRP cannot be tested yet since the program is at is very inception. The evidence provided here, however, represents a significant test bed allowing to foresee (and discuss) the regional impact of NRRP-related investments; as well as to identify factors that may scale down their potential.

The main results stemming from the estimation of the PSVAR models can be summarized as follows. First, when estimating the model on the whole sample, and covering all types of public expenditures – that is, PA current and capital expenditures in digital, green, and knowledge- related sectors, net of automatic stabilizers – we find that fiscal policy shocks have positive and long-lasting effects on private investment and output, although there is great heterogeneity in the effects of shocks to the single sectoral components. In particular, shocks to digital spending only timidly crowd-in private investment, underlying the relatively backwardness of most Italian regions towards the ICT sector, which translates into problems of import dependency. Second, including structural variables in the baseline model, our results point to a significant impact of public policies in supporting both the regional degree of export specialization and specialization in high-tech sectors. In particular, green investments – which are central in the NRRP – turn out to have a noteworthy impact, increasing regions' external competitiveness, and reinforcing their industrial structure. Third, splitting the sample along territorial lines we find, as common in the literature, that shocks to public spending

have larger effects in centre-north regions, both in terms of GDP multipliers and crowding-in effects. However, shocks to the different sectoral spending have heterogenous effects at the territorial level: in particular, shocks to digital spending have perverse effects on private investment in Mezzogiorno, (most likely due to its technological backwardness and related import-dependency); whereas shocks to knowledge spending have substantial positive effects in both areas of the country. Finally, a noteworthy result is that shocks to public spending are found to have structural effects only in the south – strengthening both Mezzogiorno' export competitiveness and manufacturing capabilities – highlighting the role of public investments in reducing the structural divide.

There are at least three major policy implications that can be taken home. First of all, public expenditure and, in particular, investments stand out as crucial drivers of growth and structural change. After years of austerity, the evidence provided here confirms the need to get rid of the pro-cyclical approach that has hegemonized the post-2008 phase allowing public demand to sustain incomes, reduce uncertainty and increase overall economic dynamism. This is particularly important now that the ongoing Russia-Ukraine war is inflating new economic risks that may annihilate the opportunities opened up by the post-pandemic recovery (Celi et al. 2022). Second, public investments are not all alike concerning their capacity to promote growth and structural upgrading. The poor capacity of digital investments to stimulate growth, private investments, external competitiveness and innovativeness highlights how difficult the task of strengthening regional capabilities in this sector may be. The relative digital backwardness of the Italian economy and, even more so, of its Mezzogiorno, may translate into a poor crowding-in effect and growing import dependency. This may dwarf the potential of the NRRP as regards its 'digital missions', asking for additional and targeted industrial policies efforts aimed at filling the existing productive and technological gaps. On the other hand, green investments turn out to have a remarkable impact on both export and medium- and high-tech manufacturing specialization. This result is relevant from a policy perspective. In fact, by carrying out green investments the Italian government may be capable to pursue a threefold aim: accelerating the ecological transition, increasing regions' external competitiveness, and reinforcing their industrial structure. Finally, in terms of structural upgrading (proxied by export and medium- and high-tech manufacturing specialization) public investments turn out to have a stronger effect in the south as compared to the northern regions. Nothing can be said about the magnitude of such a differentiated effect or, said differently, to the actual capacity of a public investment program, as the one included in the NRRP, to substantially narrow the gap dividing Italy's north and south. Nevertheless, showing that public demand is capable to reignite convergence among regions represents, as such, a policy-relevant result. This calls for further empirical research and lends support

to Keynesian and industrial policy agendas aiming at ‘creating new markets’, increasing innovativeness, and supporting growth in a stable way.

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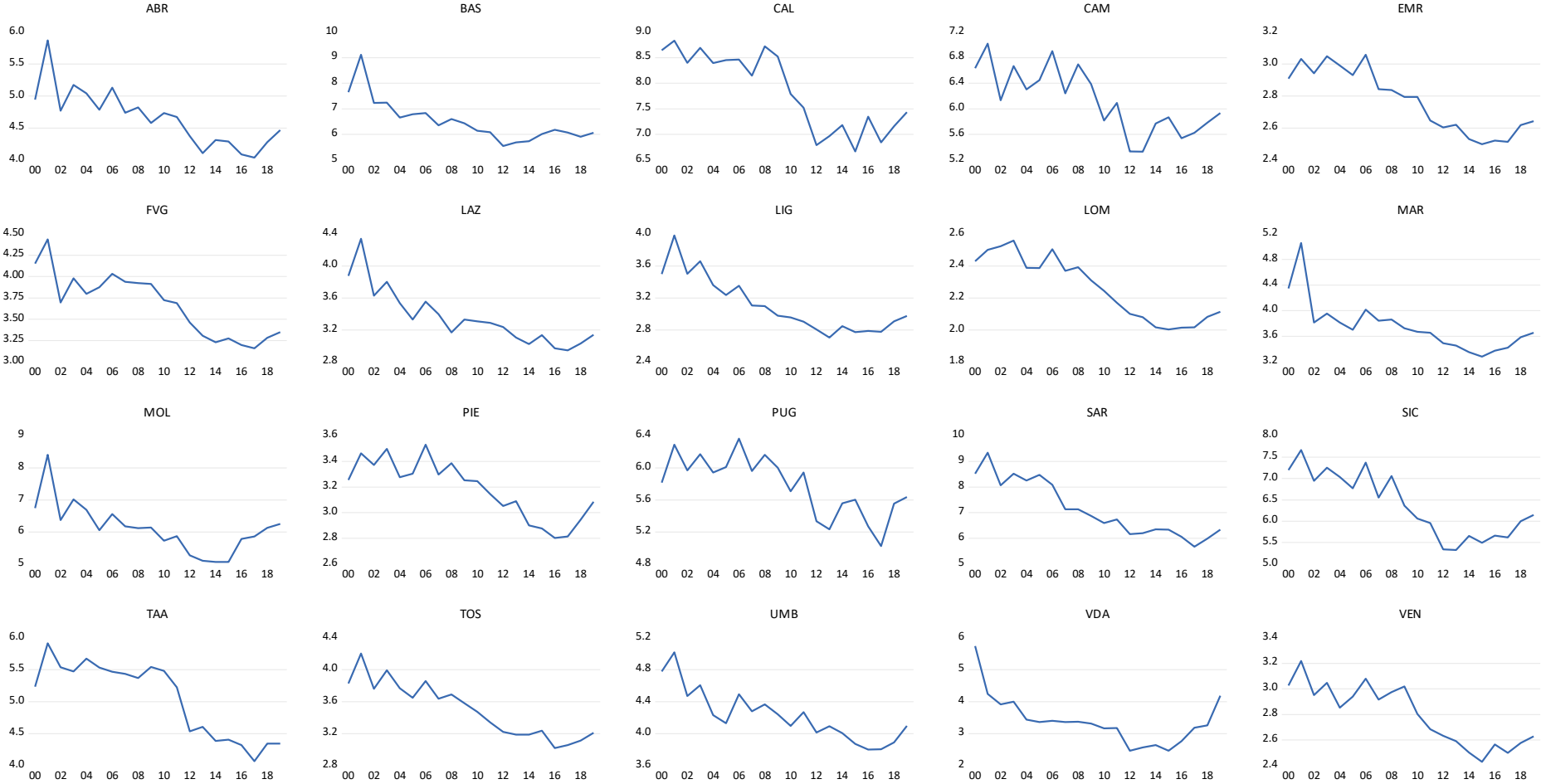
Appendix

A.2. Additional Figures and Tables

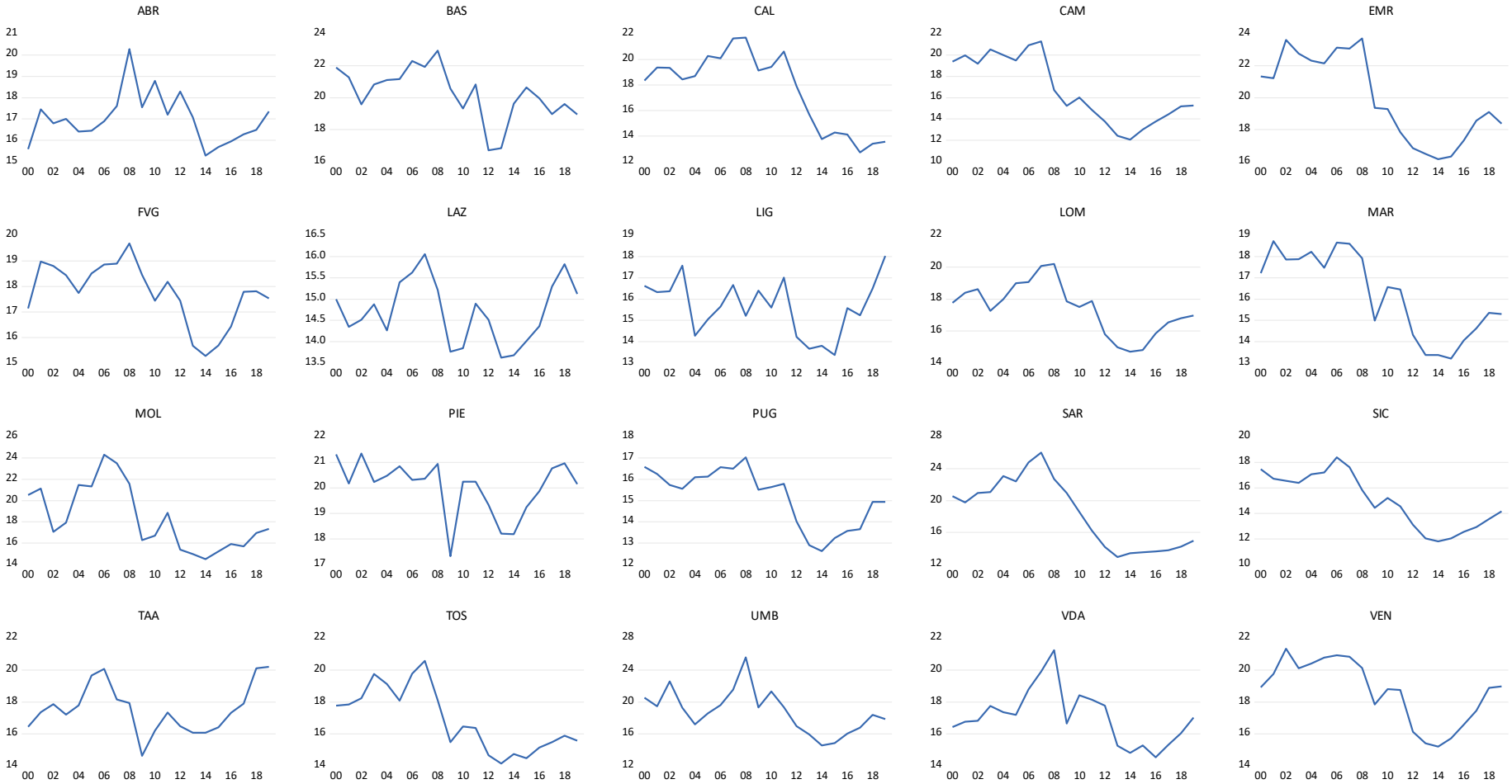
Figures

Figure A.1. Real government expenditures in main NRRP sectors, % in real GDP (trend).



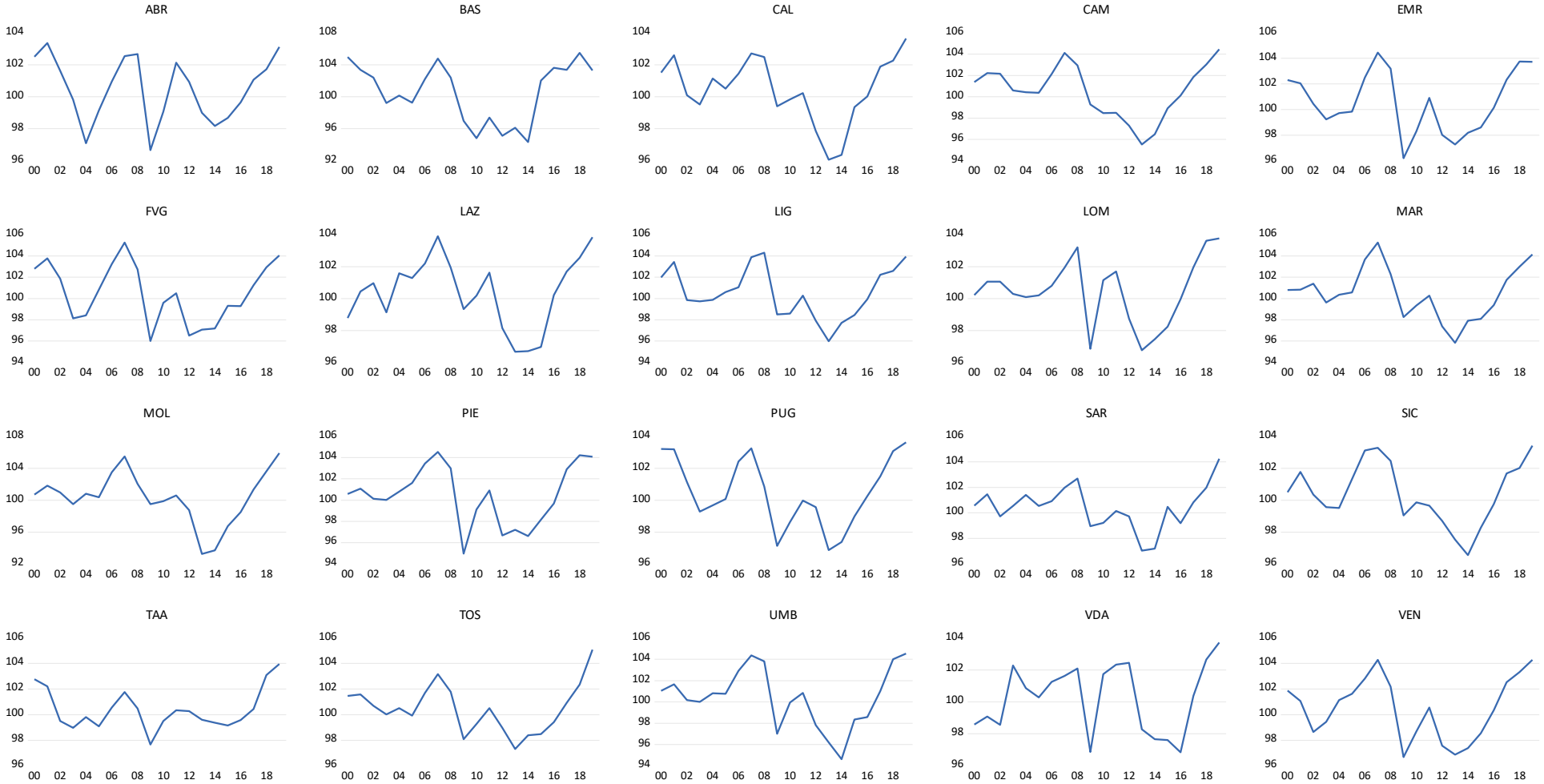
Source: CPT, Istat, own elaboration.

Figure A.2. Real private investment, % in real GDP (trend).



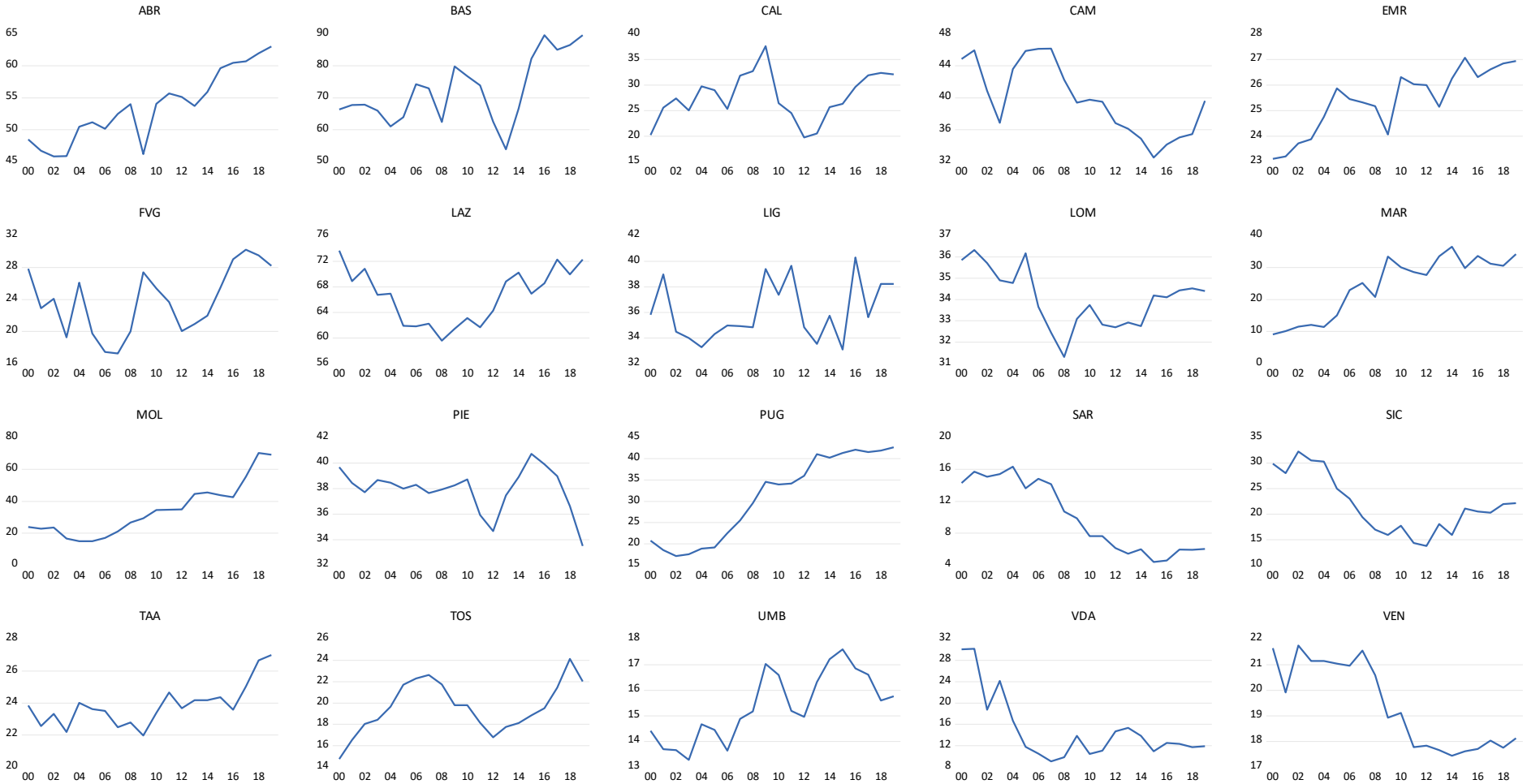
Source: Istat, own elaboration.

Figure A.3. Real GDP, % in real GDP (trend).



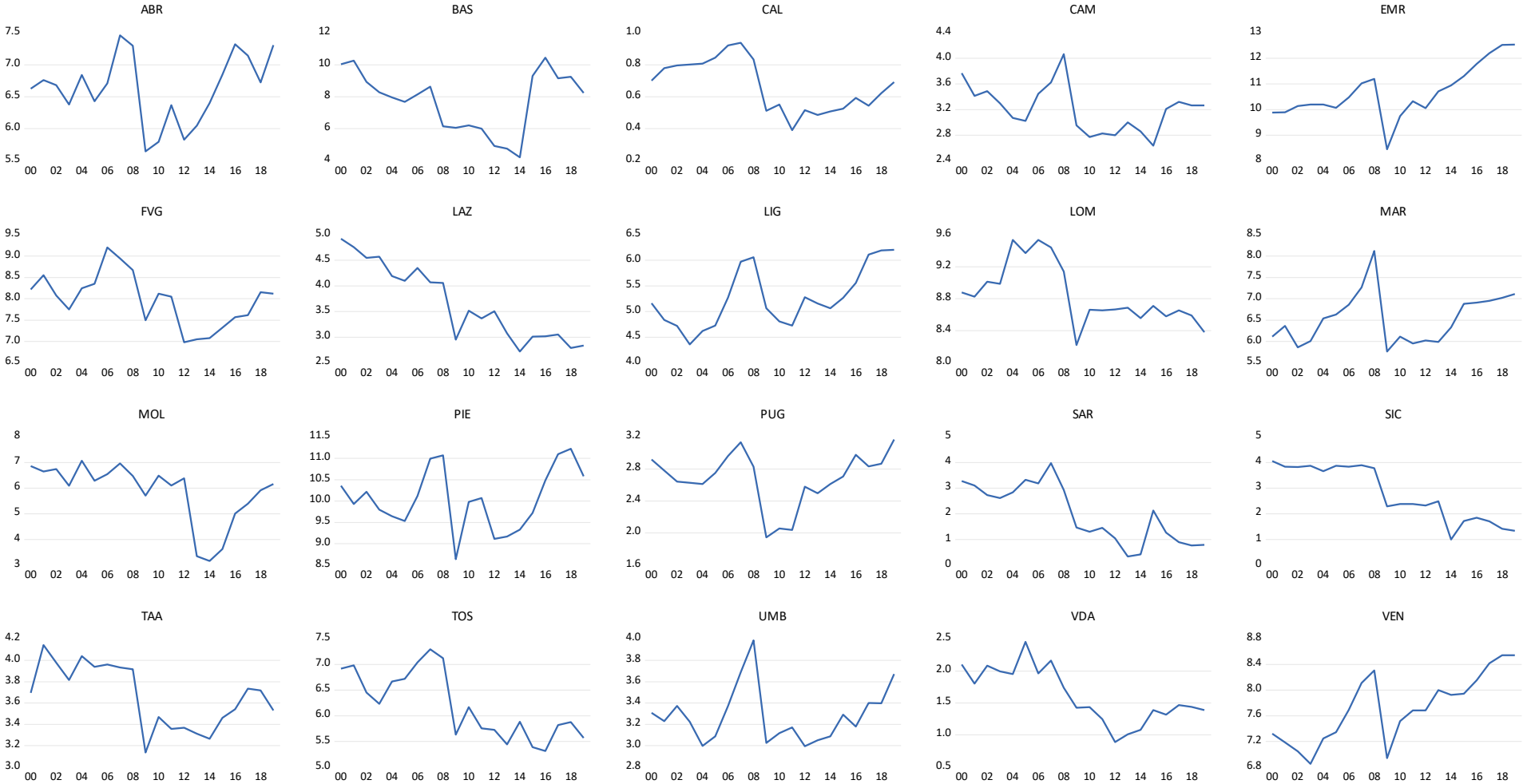
Source: Istat, own elaboration.

Figure A4. Export of sectors with dynamic world demand, % in total export.



Source: Istat, BES, own elaboration.

Figure A5. Value added of high- and medium-high technology sectors, % in total VA.



Source: Istat, own elaboration.

Tables

Variable	*Description*	*Source*	*CPT: Category*	*CPT: economic sector*	*Units*
gdp_i	Gross Domestic Product	Istat, territorial accounts			Million-euro, constant prices (2015)
i_i	Private sector gross fixed investment	Istat, territorial accounts			Million-euro, constant prices (2015)
$g_i^T = g_i^G + g_i^D + g_i^K$	Total Public Expenditures	Own elaboration			Million-euro, constant prices (2015)
g_i^G	Public Expenditures in Energy & Environmental Transition	CPT	S06 (wages and salaries); S12 (goods and services); S43 (investment in machineries); S45 (investment in infrastructure)	Water utilities (012); Environment (014); Waste disposal (015); Energy (027)	Million-euro, constant prices (2015)
g_i^D	Public Expenditures in Digitalization	CPT	S06 (wages and salaries); S12 (goods and services); S43 (investment in machineries); S45 (investment in infrastructure)	R&D (007); ICT (021)	Million-euro, constant prices (2015)
g_i^K	Public Expenditures in Knowledge	CPT	S06 (wages and salaries); S12 (goods and services); S43 (investment in machineries); S45 (investment in infrastructure)	Education (005); Training (006)	Million-euro, constant prices (2015)
$spec_i^{XD}$	Specialization in dynamic export	BES, ind.168			%
$spec_i^{HT}$	Specialization in High and Medium-High Technology Manufacturing	Istat, territorial accounts, own elaboration			%

Table A2. VAR Lag Order Selection Criteria

Endogenous variables: $d(g_i^j/y^{HP})$ $d(i_i/y^{HP})$ $d(y_i/y^{HP})$

Sample: 2000-2019. Included observation: 340

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3417.787	NA	3.79E-13	-20.08698	-20.0532	-20.07352
1	3459.469	82.38437	3.13E-13	-20.27923	-20.14409*	-20.22538
2	3482.616	45.34120*	2.88e-13*	-20.36245*	-20.12596	-20.26822*

Notes: (*) indicates lag order selected by the criterion.
Legend: LR = sequential modified LR test statistic (each test at 5% level); FPE = Final prediction error; FPE = Final prediction error; AIC = Akaike information criterion; SC = Schwarz information criterion; HQ = Hannan-Quinn information criterion.

Table A.3. Regional structural characteristics

	(A) Economic dependency			(B) Specialization in manufacturing	
Net importer	CAL	39.0%	Manufacturer	VEN	21.3%
	SAR	28.2%		EMR	20.8%
	SIC	27.5%		MAR	20.5%
	PUG	19.7%		FVG	19.5%
	MOL	19.4%		PIE	19.3%
	CAM	16.9%		LOM	19.3%
	BAS	15.3%		TOS	17.1%
	VDA	14.7%		ABR	16.0%
	UMB	7.1%		UMB	14.8%
	ABR	6.3%		BAS	13.9%
Balanced CAB	MAR	2.0%	Non-manufacturer	MOL	11.2%
	FVG	1.8%		TAA	11.0%
	PIE	1.3%		PUG	9.7%
	LIG	0.6%		CAM	9.3%
	TAA	0.2%		LIG	9.3%
	TOS	-0.3%		VDA	6.9%
Net exporter	EMR	-3.2%		SAR	6.8%
	VEN	-5.4%		LAZ	6.7%
	LAZ	-13.6%		SIC	6.6%
	LOM	-15.9%		CAL	3.8%

Legend: Blue = Centre North; Orange = Mezzogiorno.
Notes: (A) = Net imports / GDP; (B) = % of manufacturing in VA.
Sample mean values 2000-2019.

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