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Drivers of Income Inequality Across Italian Provinces: Unraveling the Role of Digitalisation and Labour Flexibility

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Abstract

This paper examines the drivers of income inequality across Italian provinces, focusing on the interaction between digitalisation and labour market flexibility. Using a novel provincial panel that combines Italian Labour Force Survey (LFS) data with detailed information on tasks from the INAPP–ISTAT Survey on Italian Occupations (ICP) and tax-based income records from Italian Ministry of Economics and Finance (MEF), we show that a higher incidence of non-standard employment reduces the labour share, lowers average employment income, and increases the gap between high- and low-income earners. Digitalisation, measured through the digital task intensity of local occupations, is associated with higher average incomes but also greater income polarisation. However, the income gains from digitalisation weaken and eventually disappear in provinces characterised by more precarious employment. Overall, the findings suggest that the digital transition, in the absence of stronger labour market protections, may reinforce rather than reduce territorial disparities.

Keywords: Non-standard work; Digitalisation; Wage inequality; Labour-market dualisation; Regional inequality; Italian provinces.

JEL: J31; J41; J42; O33; R23.

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1 Introduction

Income and wage inequality have emerged as increasingly salient issues in Italy, driven not only by stagnant average earnings but also by a growing dispersion of labour market outcomes across workers, firms, sectors, and territories. While the literature on income and wage inequality has traditionally focused on individual characteristics, firm heterogeneity, and nationwide institutional changes as main drivers of income and wage dispersion (Franzini and Raitano, 2019; Bisio et al., 2023; Giupponi and Machin, 2024), the territorial dimension of wage formation remains comparatively unexplored. This represents an important limitation, particularly in the Italian context, where pronounced territorial disparities extend well beyond the conventional North-South divide (Viesti, 2025). The uneven geographical distribution of economic activity, together with the concentration of high-productivity firms and sectors and the existence of urban wage premia, suggests that major economic changes, including technological and institutional transformations, are likely to have heterogeneous effects across territories and local labour markets.

Against this background, in this paper, we focus on two key mechanisms through which territorial disparities in wage inequality are produced and reproduced over time: technological change and labour market reforms. We contend that investigating these drivers through a territorial lens is particularly relevant, as local labour markets shape both the adoption and effects of technological change and the implementation and consequences of labour market reforms.

As for the role of technology, a large body of research shows that the diffusion and productive use of digital technologies, over the last decades, have been highly uneven across territories, reflecting differences in industrial structures, human capital endowments, and innovation capacity (Balland et al., 2020; Simone, 2025). As a result, digitalisation may amplify existing spatial disparities by disproportionately benefiting territories that are better positioned to adopt and exploit new digital technologies (Autor et al., 2013a), thereby contributing to the emergence and persistence of territorial wage inequalities through skill-biased and task-biased mechanisms (Autor et al., 2003; Autor et al., 2013b; Acemoglu and Autor, 2011; Acemoglu and Restrepo, 2019). Recent work on Italy further suggests that these effects are not spatially neutral, with cities and more technologically advanced areas often experiencing stronger polarisation and wider wage gaps (Brunetti et al., 2020; Capello et al., 2025b; Capello et al., 2025a).

The same territorial logic applies to labour market reforms. Between 2011 and 2019, Italy has implemented a series of major labour reforms that have significantly reshaped employment relations and increased the diffusion of Non-Standard Work (hereafter NSW) arrangements across sectors and regions (Cirillo et al., 2017).¹ The Italian evidence on inequality shows that the rise in earnings dispersion is closely connected to such labour-market reforms and the expansion of atypical contracts, especially fixed-term and part-time work, which have weakened employment protection and contributed to the deterioration of wage dynamics

¹Key interventions included the Fornero Reform (2012), which revised employment protection legislation and unemployment benefits; the Poletti Decree (2014), which increased flexibility in the use of fixed-term contracts; the Jobs Act (2014–2015), which introduced the contract with increasing employment protection and reformed both labour regulations and unemployment insurance; and the Dignity Decree (2018), which tightened restrictions on fixed-term employment.

(Hoffmann et al., 2022; Depalo and Lattanzio, 2025).

Building on these contributions, our paper moves one step further by focusing on the territorial interaction between digitalisation and labour-market flexibility. Our main scope is to investigate how these two forces interact at the local level to shape labour market outcomes across Italian provinces, with particular attention to the role of digital task intensity across local occupations and the local incidence of NSW.

More in detail, our argument proceeds as follows. Building on the observation that both the level and the geographic dispersion of labour incomes in Italy have been changing in ways that simple national aggregates cannot fully capture, we analyse how two structural forces - the changing composition of tasks driven by digitalisation and the institutional shift toward more flexible employment contracts - jointly shape provincial wage distributions. First, we agree that task content provides the microeconomic channel through which technology affects workers: digitalisation alters the set of tasks demanded within occupations, favouring non-routine cognitive tasks while compressing routine (and often middle-skilled) work; as a result, the task composition of local employment mediates how technological change translates into wage premia or penalties across the distribution. Second, we consider that labour market reforms that promote flexibility (for instance, broader use of fixed-term and part-time contracts) reshape the contractual and bargaining environment: by increasing the prevalence of NSW, such reforms weaken employment protection and wage-setting power for segments of the workforce, altering both the level and dispersion of wages. Third, we contend that these two forces do not act independently but interact territorially: places with a higher incidence of digital-intensive tasks might experience different distributive outcomes when labour-market protection erodes than places dominated by less digital task mixes; especially, if digitalisation raises productivity premia in occupations intensive in digital tasks, while labour-market flexibility weakens protection and bargaining power in the more precarious segments of employment, then the two forces may reinforce one another.

Empirically, the paper exploits a novel province-year panel for Italy over 2012-2019, combining information from different sources: Italian Labour Force Survey (LFS) data, which allows for the reconstruction of the territorial incidence of NSW; information from the IN-APP-ISTAT Survey on Italian Occupations (ICP), an O*NET- type dataset, through which we detect the task content of local occupations; and tax-based data on income distribution across provinces released by the Italian Ministry of Economy and Finance (MEF). The analysis is thus carried out at a highly detailed provincial level, corresponding to Eurostat NUTS3 territorial units, which makes it possible to capture substantial within-country spatial heterogeneity in technology, labour-market and inequality dynamics.

The remainder of the paper presents the related literature (Section 2), describes the data and the variables (Section 3), sets out the empirical strategy (Section 4), reports the results (Section 5) and concludes with some policy implications (Section 6).

2 Related Literature

This paper relies on three main strands of literature: the task-based literature on technological change and wage inequality, the literature on labour flexibility, NSW and labour-market dualisation, and the growing body of research showing that the distributive effects of both

technology and labour regulation are spatially heterogeneous. Taken together, these contributions suggest that income and wage inequality cannot be understood as the outcome of technological change alone, nor as the simple consequence of labour-market deregulation. Rather, it emerges from the interaction between the task content of work, the contractual organisation of employment, and the territorial structures in which firms, workers and institutions are embedded.

A central premise of the task-based approach is that technologies do not affect labour markets uniformly, but instead modify the content of work by altering the relative demand for different tasks performed within occupations, thereby rewarding some activities while displacing or devaluing others (Autor et al., 2003; Acemoglu and Autor, 2011). This is precisely why tasks are central to this analysis: they constitute the transmission mechanism through which digital technologies reshape occupational structures, productivity differentials and, possibly, wage outcomes (Cirillo et al., 2021; Capello et al., 2025a). Tasks are not performed in isolation but are combined into coherent bundles that constitute actual jobs carried out by workers; this process is socially organised (Fernández-Macías and Bisello, 2022; Cirillo et al., 2020). This has important implications for how technologies affect employment, as well as for any other economic change that influences labour demand and organisation.

A task-based indicator captures the extent to which local occupational structures are exposed to activities that directly embody digital content, and is therefore suited to identifying how technological change enters provincial labour markets through the composition of employment itself. Hence, in line with Cirillo et al. (2021), the Digital Task Intensity index used in this paper measures the relative incidence of digital tasks across occupations and then aggregates this information at the provincial level, thus proxying the extent to which local employment structures are actually organised around digitally intensive work. This choice is theoretically important because the distributive effects of digitalisation depend not only on how much technology is adopted, but also on which tasks are expanded, transformed or displaced in the process. According to the literature on skill-biased and task-biased technological change, digitalisation can increase the productivity and wages of workers performing non-routine cognitive and digital-intensive tasks, while compressing routine middle-skill work and, in some cases, expanding lower-paid service employment through indirect demand and reinstatement effects (Autor, 2022; Acemoglu and Restrepo, 2019). However, this task-based mechanism should not be interpreted as a purely technical process. Digital technologies are embedded in organisational strategies, corporate power and control over intangible assets. In this regard, Cirillo et al. (2025a) contend how digital capitalism is increasingly shaped by processes of intellectual monopolisation, through which data, knowledge, algorithms and technological infrastructures become concentrated in the hands of a limited number of powerful actors. Therefore, rather than a neutral input, technological arrangements become a set of assets whose returns are unevenly appropriated across firms, workers and territories. Firm-level Organisational reorganisations, worker bargaining power and overall labour market regulations are therefore strictly linked with institutional power balance. For example, Coveri et al. (2025) show that digital platforms occupy a strategic position within broader infrastructural and political networks, including the military–digital complex, and exercise significant political agency through lobbying and their control over critical digital infrastructures. Their contribution reinforces the view that digitalisation is not simply a process of technology diffusion, but a transformation in the control of critical infrastructures, data and

organisational capabilities. For labour-market analysis, this implies that the wage effects of digitalisation depend on how digital technologies are deployed within production and on who controls the complementary assets needed to appropriate their returns. The task content of work, therefore, remains essential, but it must be situated within a broader political-economy framework in which digital tasks may generate wage premia for some workers while reinforcing segmentation, monitoring and standardisation for others.

This point is particularly relevant when digitalisation is analysed together with NSW. The contribution by Cirillo et al. (2025b) on logistics automation shows that automation does not simply replace labour or increase productivity in an abstract sense. Rather, powerful firms actively shape the direction and use of technology, often combining automation with the codification, standardisation and tighter control of labour activities. This evidence is important for our framework because it suggests that digitalisation and precarious employment should not be treated as independent channels. In labour markets marked by contractual fragmentation, the adoption of digital technologies may increase the wage premium of protected and high-skilled workers while worsening the relative position of workers employed through more fragile contractual arrangements. From this perspective, the interaction between digital task intensity and NSW becomes theoretically central: digitalisation may raise average income in more advanced local labour markets, but its benefits may be unequally distributed when employment relations are segmented and when NSW constitutes a structural margin of adjustment for firms.

Recent evidence on Italy further suggests that these effects are not spatially neutral. Capello et al. (2025a), for instance, show that digitalisation generates heterogeneous productivity and reinstatement effects across occupations and territories, with urban areas acting as catalysts of inequality-enhancing dynamics because high-skilled workers capture stronger wage premia while lower- and middle-skilled workers face weaker or adverse effects. Risi (2026) also stresses that digitalisation and AI affect wage inequality through distinct task channels, with effects that are weaker in cities where agglomeration economies and occupational diversity dilute their distributive impact. Bergantino et al. (2026) show that ultra-fast broadband can either reduce or amplify territorial inequality depending on local absorptive capacity and institutional conditions, reinforcing the view that the distributive effects of digitalisation are strongly shaped by the territorial context. These contributions are consistent with the political-economy interpretation advanced above: the same technology may generate different wage and inequality outcomes depending on the local structure of production, the composition of occupations, the strength of firms' organisational capabilities and the institutional environment in which workers are employed.

A second strand of literature focuses on labour-market flexibility, NSW and dualisation. NSW is typically associated with weaker employment protection, lower bargaining power, lower training opportunities and more unstable income trajectories. In segmented labour markets, the diffusion of temporary, part-time and other flexible arrangements may therefore affect inequality through several channels. First, it can directly reduce average labour income if these workers receive lower wages or work fewer hours. Second, it can weaken labour's bargaining position more broadly, thereby affecting the wage share. Third, it can increase within-province inequality if the costs of flexibility are concentrated among workers located in the lower part of the income distribution. This literature is particularly relevant for the Italian case, where labour-market reforms have increased the scope for flexible contractual

arrangements while maintaining strong differences between protected and less protected segments of the workforce (Cirillo and Ricci, 2022; Capriati et al., 2024). In this setting, NSW is not simply an individual contractual status, but a structural feature of local labour markets that may shape the distribution of income across territories.

The interaction between technology and labour flexibility is therefore crucial. A purely task-based account would suggest that digitalisation affects inequality by changing the demand for different tasks. A labour-market dualisation account would instead emphasise the distributive consequences of contractual segmentation. The political-economy contributions discussed above suggest that these two mechanisms should be analysed jointly. If digital technologies are adopted in organisational contexts characterised by strong corporate control, standardisation of work and fragmented employment relations, the gains from digitalisation may accrue disproportionately to more protected or higher-skilled workers, while non-standard workers may experience lower income growth or greater insecurity. This provides the theoretical rationale for the empirical strategy adopted in this paper, which does not consider digitalisation and NSW as separate determinants of inequality, but explicitly tests whether the effect of NSW varies across provinces with different levels of digital task intensity.

A third strand of literature emphasises the spatial heterogeneity of wage inequality and labour-market outcomes. Italy provides an especially relevant setting for this analysis because wage and income disparities are shaped not only by the traditional North–South divide, but also by substantial differences across provinces within the same macro-area (Belloc et al., 2023; Boeri et al., 2021; Viesti, 2025). These territorial differences matter because local labour markets differ in terms of productive specialisation, firm-size structure, occupational composition, demographic characteristics, innovation capacity and reliance on flexible employment arrangements. As a result, national technological and institutional changes may generate heterogeneous local outcomes. The same increase in digital task intensity may translate into higher wages in one province and greater polarisation in another, depending on the local employment structure. Similarly, the same national regulation of temporary contracts may have stronger distributive effects in provinces where NSW is already structurally more widespread.

This paper contributes to these three literatures by bringing them together within a unified territorial framework. First, it extends the task-based literature by measuring digitalisation through the actual digital content of occupations and by aggregating this information at the provincial level. Second, it contributes to the literature on labour-market dualisation by analysing NSW not only as a correlate of lower wages, but also as a potential driver of wage-share decline and income polarisation. Third, it contributes to the literature on spatial inequality by showing that the distributive effects of technology and labour-market regulation are mediated by local labour-market structures. In doing so, the paper provides a political-economy interpretation of territorial inequality: digitalisation, NSW and institutional change do not operate in isolation, but interact through place-specific structures of production, employment and power.

3 Data

3.1 Data and variables

This study exploits a novel province-year panel dataset for Italian provinces, specifically constructed to investigate how NSW and task composition affect labour incomes and distributional outcomes. The provincial scale is particularly appropriate for this purpose, as recent evidence documents increasing intra-regional heterogeneity (Viesti, 2025; Belloc et al., 2023). This makes the provincial dimension especially suitable for analysing how labour-market institutions, productive structures, and technological change interact locally to generate unequal outcomes.

In line with this perspective, the dataset integrates information from different sources in order to jointly observe the organisation of employment and the distribution of income within a common territorial framework. Labour-market and occupational variables are drawn from the Italian Labour Force Survey (ILFS) and the INAPP-ISTAT Survey on Italian Occupations (ICP), which allows us to reconstruct the incidence of different contractual arrangements and the task content of local employment, while income variables are derived from the tax tabulations released by the Ministry of Economy and Finance (MEF), which provide detailed and territorially consistent information on declared income across provinces.

This integrated empirical architecture is crucial for addressing a central issue raised by the recent literature, namely that the distributive consequences of labour-market flexibilisation and technological change are mediated by local economic structures and therefore cannot be fully understood through aggregate national evidence alone (Brunetti et al., 2020).

Dependent variables. We consider five complementary dependent variables to capture distinct yet connected dimensions of inequality. First, to investigate the functional income distribution, we construct the adjusted wage share following the correction commonly used in the literature to account for the labour component of self-employment income (Gomis, 2019):

$$AWS_{pt} = \frac{\text{Compensation of employees}_{pt}}{GDP_{pt}} \cdot \frac{\text{Share of employees}_{pt} + \eta \text{Share of self-employed}_{pt}}{\text{Share of employees}_{pt}} \quad (1)$$

where p denotes the province, t the year, and η is the correction factor used to attribute a labour-income component to the self-employed. This indicator captures the changing distribution of value added between labour and other income components, providing a picture of the functional income distribution at the territorial level.

Second, to estimate differences in functional income distribution across provinces, we rely on the logarithm of average real employment income drawn from the MEF archive. This is computed as the sum of declared employment income (from dependent work) divided by the number of taxpayers classified as workers.

Third, to examine intra-labour inequalities, we construct a proxy for income polarisation within provinces equal to the logarithm of the top-bottom income ratio defined as follows:

$$TB_{pt} = \log\left(\frac{\bar{y}_{pt}^{\text{top}}}{\bar{y}_{pt}^{\text{bottom}}}\right) \quad (2)$$

where $\bar{y}_{pt}^{\text{top}}$ denotes the mean income of taxpayers in the upper income classes (at least €75,000), and $\bar{y}_{pt}^{\text{bottom}}$ the mean income of taxpayers in the lower income classes (up to €26,000).

Fourth and fifth, we separately analyse the logarithm of top-group and bottom-group mean income in order to distinguish whether observed changes in inequality are primarily driven by gains at the top - namely among taxpayers earnings at least €75,000 - or losses at the bottom - namely across tax payers earning up to €26,000, or both ². This decomposition is especially relevant in the Italian context, where recent contributions have documented a growing dispersion of labour incomes and emphasised the need to understand the drivers of local inequality (Bisio et al., 2023). Monetary income variables are expressed in real terms using a national price index with a 2015 base year.

Main explanatory variables. The main explanatory variables capture two interrelated dimensions of labour-market transformation.

First, following institutional and scientific literature standards (ILO, 2016; Kalleberg, 2000), NSW is measured as the share of workers employed under part-time and/or temporary contractual arrangements over total employees:

$$NSW_{pt} = \frac{\text{Part-time employees}_{pt} + \text{Temporary employees}_{pt}}{\text{Total employees}_{pt}} \quad (3)$$

This indicator captures the extent of contractual fragmentation and labour-market precariousness in each province. Its inclusion is theoretically motivated by a large body of work arguing that the expansion of flexible and NSW has weakened earnings stability, reduced bargaining power, and contributed to more unequal labour-market outcomes, particularly in segmented labour markets and low-productivity settings (Capriati et al., 2024; Depalo and Lattanzio, 2025).

Second, the Digital Task Intensity (DTI) index captures the relative importance of digital content in local occupational structures. It is computed as the weighted average incidence of digital tasks across occupations, following the task-based approach employed in recent Italian contributions on digitalisation and work (Cirillo et al., 2021). More in detail, it exploits the information contained in the INAPP-ISTAT Survey on Italian Occupations (ICP), an O*NET-type dataset, detailing the levels of digitalisation and routineness of occupations in more than 500 4-digit ISCO professional groups. The ICP survey contains a free-form section where a panel of respondents from 795 5-digit occupational groups describes up to 15 work activities (or tasks) characterising their occupation. The respondents report a score indicating its importance. Following Cirillo et al., 2021, we consider 131 activities that explicitly involve digital technologies and thus define a highly digital occupation by computing the weighted average importance score of digital tasks by occupation. Only 99 out of a total of 796 five-digit occupations exhibit positive values of the digital task index and can therefore be classified as “highly digital” occupations³. This indicator, defined at the occupational

²When analysing incomes for top and bottom earners, we cannot distinguish between sources of income; however for working-age adults across most OECD countries, wages and salaries account for approximately 75% of their total household income OECD, 2011.

³Table A1 in Cirillo et al., 2021 reports the list of highly digital tasks used to construct the digital task index.

level, is then aggregated to the provincial level based on the relative importance of highly digital occupations in each province, using the following formula:

$$DTI_{pt} = \sum_{o=1}^O \left(\frac{E_{opt}}{\sum_{o=1}^O E_{opt}} \right) DTI_o, \quad (4)$$

where DTI_{pt} denotes the digital-task occupational intensity of province p in year t , DTI_o is the digital-task score assigned to occupation o , and E_{opt} is the number of workers employed in occupation o in province p and year t . Hence, the provincial indicator can be interpreted as the average digital-task intensity of the local occupational structure. Provinces with a larger employment share in occupations intensive in digital tasks display higher values of DTI_{pt} . The inclusion of this task-content indicator reflects the consolidated view that technological change does not affect labour markets uniformly, but rather operates through differentiated occupational channels, increasing the relative demand for high-skill and digital-intensive jobs while compressing middle-skill employment and often expanding low-paid, less secure forms of work (Cirillo et al., 2021). Crucially, these mechanisms are likely to display strong territorial heterogeneity, because both the diffusion of digital technologies and the use of NSW vary substantially across provinces according to their productive specialisation, firm organisation, skills endowment, and local labour-demand conditions.

Control variables. The empirical specification is augmented with a broad set of lagged province-level controls designed to account for structural, demographic, and economic heterogeneity that may be correlated with both labour-market organisation and inequality outcomes. These controls include the routine task intensity index (RTI)⁴, log real labour productivity measured as value added per hour worked, log real capital intensity measured as gross fixed capital formation per employee, and several variables capturing labour market composition, including the shares of women, young workers, tertiary-educated workers, and foreign workers at the provincial level, drawn from the Labour Force Survey⁵. Furthermore, the estimates include the unemployment rate and indicators of local productive structure, such as the share of workers employed in high-tech sectors (defined as the share of workers employed in high-tech manufacturing and knowledge-intensive services) and the share of large firms (defined as the share of workers employed in firms with more than 250 employees)⁶. Table A.1 in the Appendix draws descriptive statistics of all variables adopted.

3.2 Descriptive evidence

Over the period under analysis, the Italian income distribution deteriorates, with increasing heterogeneity across income groups leading to a broader and more widespread increase in inequality (Baccaro and Bulfone, 2022; Brandolini et al., 2018; Franzini and Raitano, 2019;

⁴RTI is derived from occupational information in the ICP-INAPP survey. It measures the extent to which provincial employment is concentrated in occupations intensive in codifiable, repetitive, and rule-based tasks, consistent with the routinisation framework originally developed by Autor et al. (2003) and widely adopted in the literature on labour-market polarisation. It has been computed following Acemoglu and Autor, 2011.

⁵Foreign workers are defined as workers with a nationality from outside the European Union.

⁶More specifically, high-tech industries are measured as the share of employees employed in the following NACE Rev. 2 sectors: 21, 26, 59, 60, 61, 62, 63, and 72.

Bisio et al., 2023). While aggregate dynamics suggest a general decline in average income levels, disaggregated evidence shows that the magnitude and nature of these changes vary substantially across the income distribution and across functional income components.

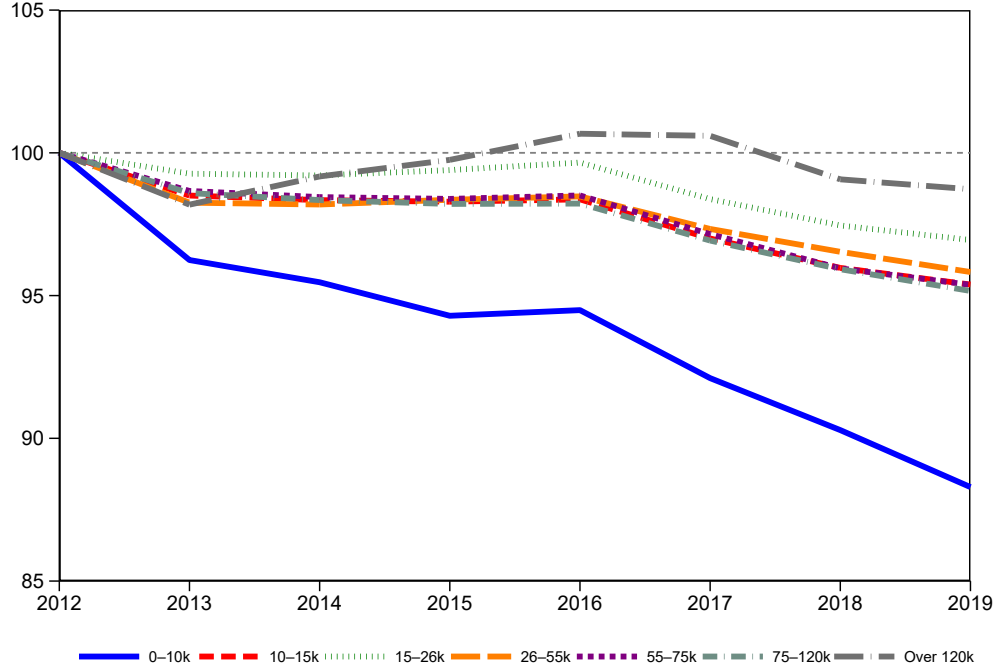


Figure 1: Indexed mean income (base 2012 = 100).
Source: MEF tax tabulations.

Figure 1 presents the evolution of Italian mean income by percentile group from 2012 to 2019, based on MEF tax tabulations (index: 2012 = 100). While all income groups experienced a decline in mean income over the period, the contraction was substantially more pronounced for the lowest income group (€0–€10,000), whose index decreased from 100 to approximately 88 by 2019, corresponding to a loss of more than ten percentage points in real terms. In contrast, the remaining groups exhibited a more moderate and largely synchronised pattern of decline, suggesting heterogeneous income dynamics across the distribution. This divergence is particularly evident in 2012 and 2016, when all groups experienced income reductions, but the contraction was disproportionately severe for the lowest-income group, indicating greater vulnerability of low-paid workers to adverse shocks.

Decomposing income by source reveals markedly heterogeneous dynamics across income components (Figure 2). Employment income remained largely stable throughout the period, exhibiting only marginal fluctuations and ending slightly below its initial level. Pension income displays a pattern of steady and consistent growth, reflecting indexation mechanisms and demographic shifts. In stark contrast, capital and enterprise incomes exhibit substantial volatility, with pronounced peaks in 2016 ⁷.

⁷Capital income comprises all income arising from financial capital investments, such as interest, dividends, and other investment returns. Business income, in contrast, consists of income derived from the profits generated through the operation of businesses, corporations, and other commercial enterprises.

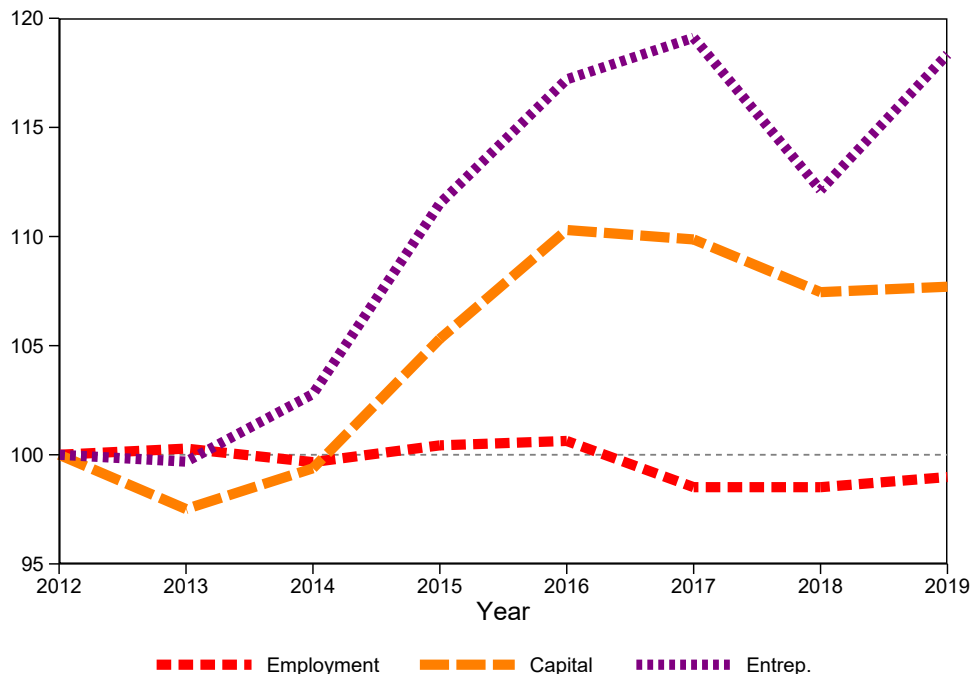


Figure 2: Indexed income components by source (base 2012 = 100).
Source: MEF tax tabulations.

If the previous figures document the evolution of income levels and their composition in the aggregate, spatial differences should also be taken into account, as the structure of local labour markets may also contribute to these dynamics. To this aim, Figure 3 reports the spatial distribution of the DTI index across Italian provinces in 2012 and 2017. Two main patterns emerge. First, the geography of digital task intensity displays a strong and persistent territorial divide: higher values are predominantly concentrated in Northern and Central Italy, particularly along the Po Valley and in provinces hosting major urban and industrial centres, while most provinces in Southern Italy and the islands exhibit substantially lower levels, with the exception of regional capitals (Potenza, Bari, Naples, Palermo, and Cagliari). Second, while the overall spatial structure remains broadly stable between 2012 and 2017, several provinces show moderate increases in the index, suggesting a gradual diffusion of digital-intensive activities. These improvements are particularly visible in parts of Northern and Central Italy, where already digitally intensive labour markets further strengthened their position. By contrast, much of Southern Italy continues to display relatively low values, with the index even decreasing in some provinces over the period. Overall, the comparison between the two maps suggests that the adoption of digital-intensive tasks has increased over time but has largely reinforced pre-existing territorial disparities, with the North–South divide remaining a salient feature of the Italian labour-market structure.

To complete the picture, Figure 4 reports the spatial distribution of the NSW index across Italian provinces in 2012 and 2017. The maps reveal a widespread increase in NSW over the period, together with substantial territorial heterogeneity. In 2012, higher levels of the NSW index were already observable in several provinces in Southern Italy and in some areas of the

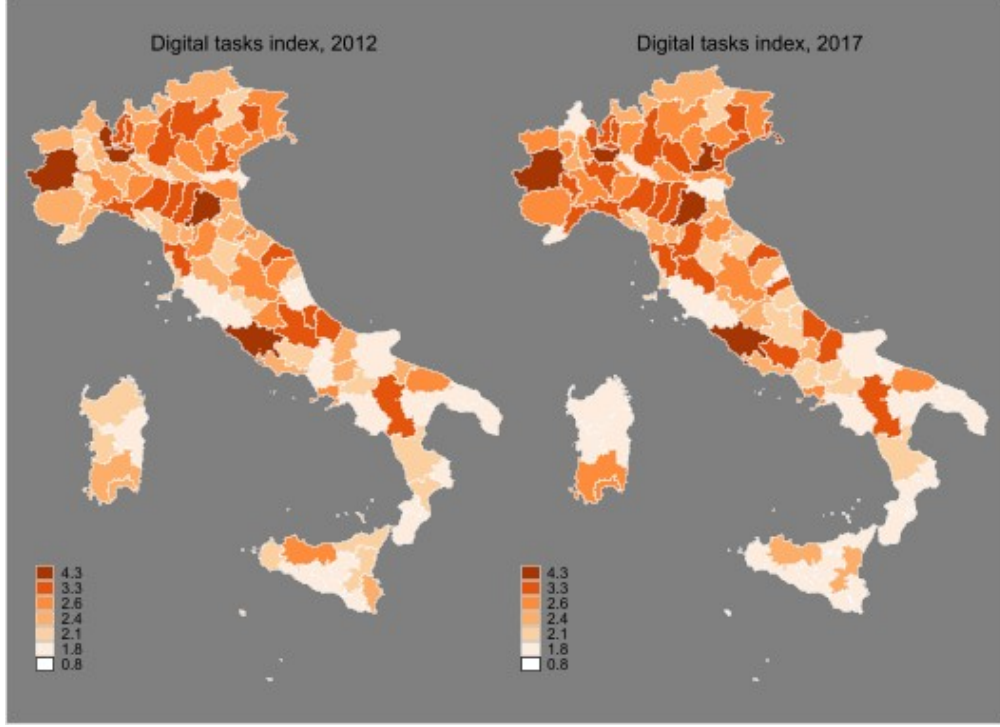


Figure 3: Digital Tasks Index across Italian provinces, 2012 and 2017.
Source: Italian Labour Force Survey.

North, while lower values were more common in parts of Central Italy. By 2017, the index increased in most provinces, indicating a broad expansion of NSW arrangements across the country. Overall, the comparison between the two maps suggests that NSW has become more pervasive across Italian local labour markets over time, while the spatial distribution of the index indicates that the diffusion of these employment arrangements has not been uniform, contributing to increasing heterogeneity in labour-market structures across Italian provinces.

4 Empirical strategy

To investigate how NSW and digitalisation are associated with income and inequality, we adopt a two-step approach. First, we estimate the following baseline specification:

$$Y_{pt}^k = \beta_0 + \beta_1 NSW_{pt-2} + \beta_2 DTI_{pt-2} + \sum_{j=1}^J \gamma_j X_{pjt-2} + \tau_t + \alpha_{r(p)} + \varepsilon_{pt} \quad (5)$$

where Y_{pt}^k denotes the k -th outcome observed in province p at time t . In line with the empirical structure of the paper, the dependent variable is alternately measured as: (i) the adjusted wage share; (ii) the logarithm of average real employment income; (iii) the logarithm of the top-bottom income ratio; (iv) the logarithm of bottom-group mean income ($\leq \text{€}26,000$); and (v) the logarithm of top-group mean income ($\geq \text{€}75,000$). NSW_{pt-2} and DTI_{pt-2} are, respectively, the share of workers covered by NSW arrangements, defined as in Formula 4, and the Digital Task Index, measuring the share of employees performing highly

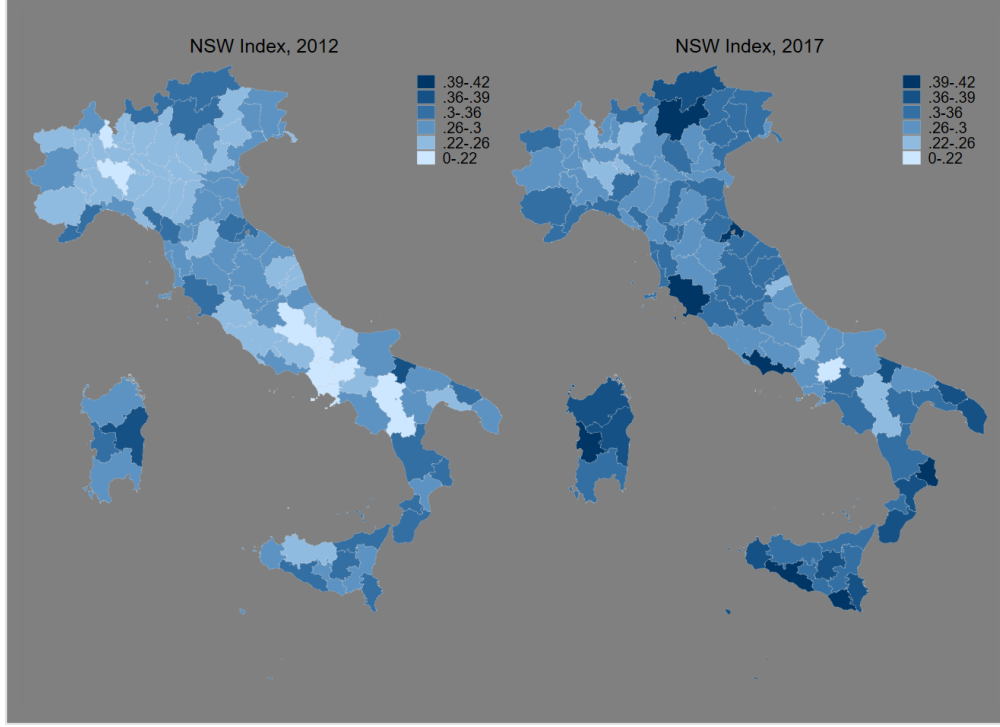


Figure 4: NSW index across Italian provinces, 2012 and 2017.
Source: Italian Labour Force Survey.

digital tasks, as defined in Formula 3.

The vector X_{pjt-2} includes the full set of lagged controls described in Section 3.1. Time fixed effects τ_t absorb aggregate shocks common to all provinces, while region fixed effects $\alpha_{r(p)}$ capture unobserved heterogeneity shared by provinces belonging to the same region, following recent approaches in the literature (Capello et al., 2025a). All regressors are lagged by two years in the preferred specification in order to avoid reverse causality bias and ensure temporal precedence between explanatory variables and outcomes. Standard errors are clustered at the provincial level. Robustness checks without lags and one-year lag are reported in the Appendix.

Second, we augment the baseline specification by introducing an interaction term between the share of NSW and the province's level of digitalisation.

The interaction specification allows us to assess whether the distributive effects of NSW vary with the technological composition of local labour markets. Specifically, we hypothesise that digitalisation may amplify the penalties associated with precarious employment in technologically advanced labour markets, where productivity gains and wage premia are more likely to accrue to workers in protected employment segments. The corresponding specification is:

$$Y_{pt} = \beta_0 + \beta_1 NSW_{pt-2} + \beta_2 DIG_{pt-2} + \beta_3 (NSW_{pt-2} \times DIG_{pt-2}) + \sum_{j=1}^J \gamma_j X_{pjt-2} + \tau_t + \alpha_{r(p)} + \varepsilon_{pt} \quad (6)$$

where DIG_{pt-2} alternately denotes a dummy for provinces above the year-specific median of the digital task index or a dummy identifying the top quartile of the annual digitalisation distribution. This interaction specification allows the marginal effect of NSW to vary with the level of provincial digitalisation, measured as previously discussed. At the same time, it enables an assessment of the extent to which the potential benefits of digitalisation are mediated by the prevalence of precarious employment conditions.

4.1 Robustness checks

To address endogeneity concerns arising from the potential non-exogeneity of the share of NSW at the provincial level with respect to the outcomes of interest, we first adopt an instrumental variables approach and then, as a further robustness exercise, exploit spatial heterogeneity in labour market regulation.

Instrumental-variable approach. Because the local incidence of NSW may itself be endogenous to provincial income dynamics and labour-market conditions, we complement the regional fixed-effects estimates with an instrumental-variable strategy based on a sectoral shift-share, or Bartik-type, instrument. The concern is that provinces experiencing deteriorating labour-market conditions may simultaneously record lower incomes, higher inequality, and a greater resort to temporary or part-time contracts, thereby biasing the estimates obtained from standard panel specifications. To identify plausibly exogenous variation in NSW, we exploit predetermined differences in provincial sectoral specialisation interacted with national sector-specific trends in the diffusion of NSW, which are largely driven by labour market reforms and institutional changes enacted at the national level. Let θ_{ps}^0 denote the share of employees working in sector s in province p in the base year 2011- the first year available in our database-, and $\Delta ns w_{st}^{nat}$ the change in the national incidence of NSW in sector s at time t , relative to its 2011 value. The instrument is constructed as:

$$Z_{pt}^{sett} = \sum_s \theta_{ps}^0 \Delta ns w_{st}^{nat} \quad (7)$$

Intuitively, this variable measures the degree to which the local incidence of NSW would change in each province if its employment composition remained fixed at the 2011 structure and only national sectoral trends in precarious employment were allowed to vary over time, softening at least partially endogeneity deriving from local-level idiosyncratic shock. Provinces initially specialised in sectors that later experienced stronger national growth in NSW, therefore, would record higher predicted exposure. This design is particularly suitable in our setting because the national evolution of NSW across sectors reflects broader institutional and macroeconomic trends, and it is potentially exogenous to province-specific shocks. Therefore, the observed NSW_{pt-2} is instrumented with Z_{pt-2}^{sett} in the baseline outcome equation 5.

A spatial-heterogeneity approach. As an additional robustness check, we leverage cross-provincial variation in the structural incidence of NSW using a benchmark-interaction framework. This approach extends to the territorial dimension the identification strategy originally

proposed by Rajan and Zingales (1998) and later applied to the analysis of labour market institutions by Damiani et al. (2020). The central insight of this approach is that national institutional trajectories may be associated with heterogeneous local outcomes depending on the structural characteristics of the underlying units. In our case, Italian provinces differ persistently in their reliance on NSW because of deeper structural features of local labour markets, including productive specialisation, the prevalence of small firms, demographic composition, labour-market segmentation, and the local organisation of production.

In the first step, we estimate a benchmark equation designed to recover the time-invariant provincial propensity to rely on NSW:

$$NSW_{pt} = \alpha_p + \lambda_t + u_{pt} \quad (8)$$

where α_p are province fixed effects and λ_t year effects. The estimated average province effects, $\hat{\alpha}_p$, are then interpreted as a summary measure of each province's structural propensity to use NSW, after netting out aggregate temporal dynamics. Formally, we define:

$$Benchmark_p \equiv \hat{\alpha}_p \quad (9)$$

A higher value of $Benchmark_p$ indicates that province p is structurally more reliant on NSW arrangements, conditional on common year shocks. This benchmark is therefore not a contemporaneous measure of NSW, but a time-invariant indicator of persistent cross-provincial heterogeneity in the organisation of employment.

In the second step, this benchmark is interacted with the national index of employment protection legislation for temporary contracts, EPL_t^{temp} , and introduced into the outcome equation:

$$Y_{pt} = \beta_1 (Benchmark_p \times EPL_t^{temp}) + \mathbf{X}_{pt}'\gamma + \mu_r + \tau_t + \varepsilon_{pt} \quad (10)$$

where μ_r denotes region fixed effects and $\mathbf{X}_{pt}$ is the vector of time-varying controls. This strategy is especially appropriate in our single-country setting because the institutional index varies only over time and is therefore perfectly collinear with year dummies in a conventional fixed-effects specification.

This strategy is especially appropriate in our single-country setting because the institutional index varies only over time and is therefore perfectly collinear with year dummies in a conventional fixed-effects specification. By interacting the national EPL index for temporary contracts with the province-specific NSW benchmark, we can retain year fixed effects while exploiting the temporal variation generated by changes in labour-market regulation. This feature is particularly relevant for Italy, as the period under analysis coincides with major labour-market reforms that significantly reshaped the trajectory of EPL_t^{temp} , (Cirillo et al., 2017). The interaction term thus identifies whether these national regulatory changes translated into stronger distributive effects in provinces where NSW was already a structurally important margin of labour-market adjustment.

The coefficient of interest, β_1 , captures whether the association between temporary-contract regulation and the outcome variable differs systematically across provinces according to their structural reliance on NSW. In other words, the coefficient tests whether provinces with a higher structural propensity to use NSW display different labour-market and distributional outcomes along the national trajectory of EPL for temporary contracts. A negative coefficient for the adjusted wage share or mean employment income indicates that provinces

structurally more exposed to NSW are associated with weaker labour-income outcomes when this structural exposure is combined with the observed national EPL trajectory. Conversely, a positive coefficient for the top-bottom ratio indicates that the same interaction is associated with wider local income dispersion.

Accordingly, the specification reported in Equation 10 serves as a robustness check based on spatial heterogeneity. Specifically, it examines whether the relationship between NSW and income distribution outcomes remains robust when NSW is proxied by a structural provincial benchmark and linked to the institutional framework regulating temporary employment.

5 Results

Table 1 reports the baseline estimates of equation (5) for three labour-market outcomes: the adjusted wage share, the log employment income, and the log top-bottom income ratio. Each outcome is estimated across three progressive specifications: columns (1), (4), and (7) include only NSW; columns (2), (5), and (8) add the DTI; columns (3), (6), and (9) augment the specification with the full set of controls.

The coefficient on NSW is consistently negative and statistically significant across all specifications when the dependent variable is either the adjusted wage share or log employment income, whereas it is positive and statistically significant when the dependent variable is the log top-bottom income ratio. Considering the most comprehensive specification, the estimates suggest that a one-standard-deviation increase in the share of non-standard contracts is associated with a 0.43% reduction in the adjusted wage share, a 1.5% decrease in average employment income, and a 1.6% increase in the top-bottom income ratio. Turning to the task-content variables, DTI enters positively and significantly across all three outcomes in every specification in which it is included. In the full specification, a one-unit increase in DTI is associated with a 0.9% increase in the wage share, a 2.9% increase in average employment income, and a 1.8% increase in the top-bottom ratio. This pattern is consistent with a skill-biased interpretation of digitalisation: provinces with more digitally intensive occupations exhibit higher average incomes and higher income polarisation, suggesting that the gains from digitalisation are not uniformly distributed across the income distribution. While it may contribute to higher inequality, it should be stressed that digitalisation is positively associated with both average employment incomes and the wage share.

Among the control variables, RTI is not statistically significant in the full specification, suggesting that routine task intensity per se does not independently predict labour market outcomes once digitalisation and other covariates are taken into account. This is consistent with micro-level evidence for France provided by (Fana and Giangregorio, 2024). Log labour productivity is positively and significantly associated with all three outcomes, confirming the expected positive relationship between productive capacity and labour income. Unemployment is negatively associated with log employment income (col. 6), consistent with standard wage-curve evidence.

The share of young workers is positively associated with both the wage share and the top-bottom income ratio, whereas the share of female workers is negatively associated with the wage share, consistent with the concentration of women in lower-paid jobs. The share of foreign workers is positive and statistically significant for both the wage share and the

top-bottom ratio, while the share of workers in large firms is negatively associated with the top-bottom ratio, indicating a compressing effect on income dispersion. The remaining controls—GFCF per employee, the high-tech share, and the share of tertiary-educated workers—are not statistically significant. Specifications with contemporary explanatory variables B.1 and with a one-year lag B.2 reported in the Appendix draw similar results, backing up the robustness of our model. As a further robustness check, we examine the two components of NSW separately: part-time contracts and temporary work arrangements. Table B.3 in the Appendix witnesses a negative and statistically significant effect of part-time contracts on wage share and our proxy of inequality. Similarly, Table B.4 presents a robust negative coefficient for temporary work regarding wage share and employment income. Overall, these results support the idea that NSW arrangements are associated with negative labour market outcomes, specifically lower wage share, reduced income for employees, and increased inequality.

Table 1: OLS estimations: NSW, DTI and labour market outcomes

	Adj. wage share			Ln mean employment income			Ln top-bottom		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NSW (L2)	−0.159*** (0.042)	−0.108*** (0.040)	−0.097*** (0.035)	−0.932*** (0.154)	−0.611*** (0.131)	−0.330*** (0.097)	0.248** (0.109)	0.367*** (0.117)	0.368*** (0.118)
DTI (L2)		0.012*** (0.002)	0.009*** (0.002)		0.075*** (0.008)	0.029*** (0.006)		0.028** (0.013)	0.018*** (0.007)
RTI (L2)			−0.001 (0.001)			−0.002 (0.003)			0.002 (0.006)
Ln labour prod. (L2)			0.050* (0.026)			0.524*** (0.064)			0.172** (0.086)
Ln GFCF/emp (L2)			0.015 (0.017)			−0.034 (0.023)			0.010 (0.034)
Young workers (L2)			0.149*** (0.044)			0.024 (0.111)			0.279* (0.151)
Female workers (L2)			−0.147*** (0.047)			0.237 (0.146)			−0.130 (0.142)
Unemployment (L2)			0.113 (0.106)			−0.612*** (0.230)			0.003 (0.392)
High-tech (L2)			−0.068 (0.058)			0.089 (0.119)			0.253 (0.174)
Tertiary edu (L2)			−0.058 (0.049)			0.134 (0.111)			0.065 (0.171)
Foreign workers (L2)			0.110** (0.053)			−0.080 (0.207)			0.481** (0.212)
Large firms (L2)			0.000 (0.031)			0.088 (0.072)			−0.322*** (0.112)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.682	0.729	0.781	0.844	0.907	0.949	0.506	0.544	0.610
Obs.	742	742	742	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Robust standard errors clustered at the provincial level in parentheses. DTI denotes the digital-task occupational exposure indicator. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Going further in the analysis, Table 2 decomposes the top-bottom ratio effect reported in Table 1 by estimating the associations between NSW and DTI separately on bottom- and top-income groups.

Table 2: OLS estimations: top and bottom incomes

	Bottom mean income (log)		Top mean income (log)	
	Baseline (1)	Full controls (2)	Baseline (3)	Full controls (4)
NSW (L2)	−0.398*** (0.082)	−0.222*** (0.067)	−0.149 (0.091)	0.146* (0.078)
RTI (L2)		0.007*** (0.003)		0.009** (0.005)
DTI (L2)		0.001 (0.004)		0.019*** (0.005)
Ln labour prod. (L2)		0.148*** (0.039)		0.320*** (0.066)
Ln GFCF/emp (L2)		−0.012 (0.017)		−0.002 (0.028)
Young workers (L2)		0.047 (0.082)		0.325*** (0.109)
Female workers (L2)		0.329*** (0.103)		0.198** (0.094)
Unemployment (L2)		−0.085 (0.216)		−0.082 (0.278)
High-tech (L2)		−0.060 (0.089)		0.193 (0.128)
Tertiary edu (L2)		0.112 (0.081)		0.177 (0.123)
Foreign workers (L2)		0.006 (0.116)		0.488*** (0.151)
Large firms (L2)		0.189*** (0.056)		−0.133 (0.083)
Region FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.939	0.955	0.713	0.838
Obs.	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results reveal a clear asymmetry: the negative association between NSW and mean income is concentrated at the bottom of the distribution, where the coefficient remains negative and highly significant in both the baseline and the full specification (cols. 1–2), while it turns positive and marginally significant at the top (col. 4), consistent with a polarising effect of NSW on the income distribution. This pattern suggests that the increase in the top-bottom ratio associated with higher NSW is driven simultaneously by a compression of bottom incomes and a mild upward pressure on top incomes.

With respect to task-content variables, DTI is statistically significant only for top incomes. This differential pattern corroborates the skill-biased interpretation of digitalisation advanced in the previous section: the income gains associated with digitally intensive occupations accrue disproportionately to higher earners, thereby widening the top-bottom gap.

Interaction results. To further investigate the interaction between NSW and digitalisation in shaping income dynamics at the territorial level, we extend the baseline specification by including an interaction term between NSW and the Digital Technology Index (DTI). The full results are reported in the Appendix (Table C.1); in the main text, we focus on log

mean employment income and illustrate the corresponding marginal effects graphically.

Figure 5: NSW coefficients at different digitalisation values (95% CI)

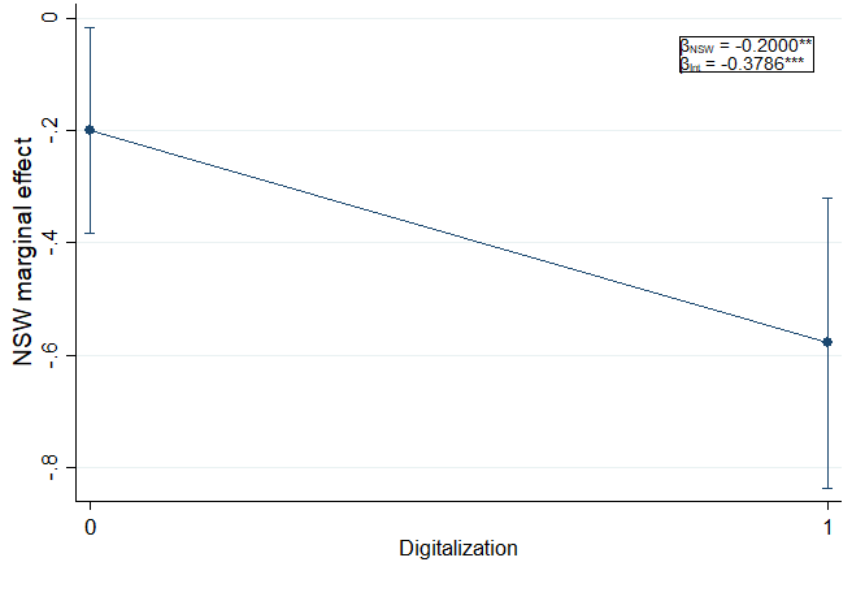


Figure 5 plots the marginal effect of NSW on mean employment income at low (0) and high (1) levels of digitalisation (considering as threshold the median of the sample, but similar results hold when we consider as high-digitalisation provinces only in the top quartile of the distribution). The negative association between NSW and income is statistically significant at both levels, but becomes more pronounced as digitalisation increases: the point estimate moves from approximately -0.20 in low-digitalisation contexts to around -0.58 in high-digitalisation contexts. These results indicate that the income penalty associated with NSW is larger in more digitally intensive provinces. While the mechanisms cannot be directly identified, one possible interpretation is that NSW in more digitalised occupations is associated with different labour market conditions relative to less digitalised contexts. Another possible channel is that wage-setting processes may differ in more digitalised environments, particularly when combined with non-standard contractual arrangements, potentially limiting workers' ability to appropriate productivity gains associated with digital technologies.

These results are robust to different time structures of our specifications, as shown in tables C.2 and C.3 and using the two components of our core explanatory variables, temporary (table C.4 in the Appendix) and part-time contracts (table C.5 in the Appendix).

Figure 6: Digitalisation coefficients at different NSW values (95% CI)

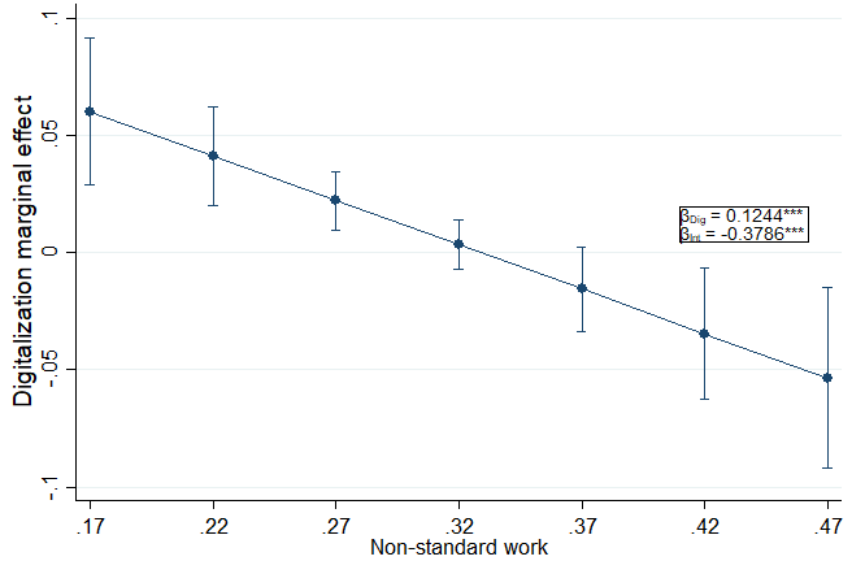


Figure 6 complements this picture by showing how the marginal effect of DTI on mean income varies across the observed range of NSW. At low levels of NSW ($NSW \approx 0.17$), digitalisation exerts a positive and significant income premium. However, this premium declines monotonically and becomes statistically indistinguishable from zero — and eventually negative — as the share of non-standard contracts rises toward the upper end of the distribution ($NSW \approx 0.42$ – 0.47). Taken together, the two figures point to a compounding mechanism: the income gains from digitalisation are conditional on a sufficiently standard labour-market structure, while provinces characterised by widespread precarious employment not only fail to benefit from digitalisation but face a further income penalty.

5.1 Robustness checks

IV Approach. Table 3 reports the IV estimates for the three main labour-market outcomes (wage share, employment income and top-bottom ratio) when NSW is instrumented through the sectoral shift-share measure. The results confirm the baseline evidence and, if anything, point to even stronger distributive effects of NSW. The coefficient on instrumented NSW is negative and statistically significant for both the adjusted wage share and log employment income, and positive and highly significant for the log top-bottom ratio. In the preferred two-year-lag specification, the second-stage coefficient reaches -0.367 for the adjusted wage share, -0.624 for mean employment income, and 2.003 for the top-bottom ratio. Hence, once the potentially endogenous component of NSW is instrumented, the estimated association between precarious employment and local inequality becomes substantially sharper, especially in the case of the top-bottom ratio. Overall, the IV evidence indicates that the spread of NSW is associated with a sizeable worsening of labour-market outcomes, reducing the labour share, depressing average labour incomes, and widening the gap between top and bottom income groups. Moreover, the IV evidence is consistent with the decomposition results reported in the baseline section, which suggest that the association between NSW and inequality is

driven by a compression of bottom incomes alongside a mildly positive association at the top of the distribution.

The remaining coefficients also broadly confirm the baseline picture. Digital task intensity remains positive and statistically significant in all three columns, indicating that more digitalised provincial labour markets are associated with higher average incomes but also with higher income dispersion. This persistence across specifications strengthens the interpretation that digitalisation exerts a polarising influence, rewarding more advantaged segments of the labour market more strongly than lower-income ones. The diagnostic statistics are supportive of the IV design. The Kleibergen–Paap rk LM statistic rejects underidentification, while the Kleibergen–Paap rk Wald F statistic is well above conventional weak-instrument thresholds. The Anderson–Rubin statistics are also reassuring across the three specifications. Taken together, these diagnostics suggest that the instrument is relevant and sufficiently strong, lending additional credibility to the second-stage estimates ⁸.

Table 3: IV estimates: NSW on labour market outcomes (2-year lag, lagged controls)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top–bottom (3)
Second stage (2SLS)			
NSW (L2)	-0.367*** (0.104)	-0.624** (0.264)	2.003*** (0.357)
RTI (L2)	-0.003* (0.002)	-0.004 (0.004)	0.014* (0.008)
DTI (L2)	0.008*** (0.002)	0.028*** (0.006)	0.024*** (0.008)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	742	742	742
Instrument diagnostics (common to all models)			
Kleibergen–Paap rk LM ($\chi^2(1)$)	17.32	17.32	17.32
Kleibergen–Paap rk Wald F	39.55	39.55	39.55
Anderson–Rubin F	10.49	5.45	41.45

Notes: IV (2SLS) regressions. Endogenous regressor: NSW at time $t - 2$. Instrument: sectoral NSW $Z_{\text{nsw_sett}}$ at time $t - 2$. Controls (RTI, digital tasks, log labour productivity per hour, log GFCF per employee, shares of young workers, female workers, unemployed, high-tech employment, tertiary-educated workers, foreign workers and large-firm share) enter at $t - 2$; all specifications include region and year fixed effects. Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Spatial Heterogeneity Table 4 reports the results from the spatial benchmark–interaction specification. The explanatory variable of interest is the two-year lag of the interaction between the province-specific structural benchmark of NSW and the observed trajectory of the national EPL index for temporary contracts during the sample period. The estimates are therefore intended to assess whether provinces structurally more exposed to NSW display systematically different labour-income and distributional outcomes along the national trajectory of temporary-contract regulation.

⁸Similar results are drawn from Table D.2 and Table D.1 in the Appendix, where the IV approach is applied to specifications with current and 1-year lagged explanatory variables, backing up the robustness of our approach across different years and model specifications.

The results show a clear and consistent pattern across the three dependent variables. In column (1), the coefficient on the lagged NSW-EPL benchmark interaction is negative and statistically significant. This indicates that provinces with a stronger structural reliance on NSW are associated with a lower adjusted wage share. The magnitude of the coefficient, equal to -0.058 , suggests that the interaction between persistent NSW exposure and temporary-contract regulation is linked to a weaker labour-income position at the provincial level.

Column (2) confirms this result using the logarithm of mean employment income as the dependent variable. The estimated coefficient is again negative and statistically significant, equal to -0.193 . This implies that provinces more structurally exposed to NSW also display lower average employment income. The result is important because it shows that the association is not limited to the functional distribution of income, but also emerges when looking at average labour earnings.

Column (3) turns to the logarithm of the top-bottom income ratio. In this case, the coefficient is positive and statistically significant, equal to 0.227 . Hence, the same structural NSW-EPL interaction that is associated with lower wage shares and lower mean employment income is also associated with higher income dispersion within provinces. This suggests that local labour markets characterised by a stronger structural reliance on NSW tend to exhibit a more unequal distribution of employment income.

Taken together, the three estimates point to a coherent distributive pattern. Provinces where NSW is more deeply embedded are associated with weaker labour-income outcomes and greater inequality: labour captures a smaller share of income, average employment income is lower, and the gap between the upper and lower parts of the income distribution is wider. The results, therefore, reinforce the main empirical message of the paper: NSW is not only an individual employment condition, but also a structural feature of local labour markets that is systematically related to territorial distributive fragility. The same qualitative pattern is confirmed when the benchmark-interaction specification is estimated using alternative timing assumptions. In particular, the results remain stable when the NSW-EPL benchmark interaction and the full set of controls are measured contemporaneously and with one-year lags as detailed in the Appendix (tables E.1 and E.2).

From an empirical standpoint, this strengthens the interpretation of the benchmark-interaction estimates as evidence of a persistent spatial heterogeneity pattern. Provinces structurally more exposed to NSW display a consistently weaker distributive profile: lower labour-income shares, lower average employment income, and wider income dispersion.

Nevertheless, these estimates should not be interpreted as the average causal effect of EPL, but rather as a further robustness check of the link between NSW and labour market outcomes. Since the EPL index varies at the national level, the coefficient on the interaction term captures a differential association across provinces. The evidence indicates that the relationship between temporary-contract regulation and local outcomes is systematically conditioned by the structural relevance of NSW in provincial labour markets.

Table 4: NSW (EPL benchmark) and labour market outcomes, full controls (2-year lags)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top-bottom (3)
NSW $\times$ EPL benchmark (L2)	-0.058*** (0.019)	-0.193*** (0.057)	0.227*** (0.064)
DTI (L2)	0.009*** (0.002)	0.029*** (0.006)	0.018*** (0.007)
Controls	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2	0.7866	0.9504	0.6232
Obs.	742	742	742

Notes: All regressions include region and year fixed effects. The main regressor is the two-year lag of the interaction between the province-level structural NSW benchmark and the EPL index for temporary contracts. All additional controls are lagged two years. Robust standard errors clustered at the provincial level are reported in parentheses. $*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

6 Conclusion

This paper sheds light on three interconnected trends that have characterised the Italian labour markets over the last two decades, including digitalisation, reflected in the local expansion of digital-intensive occupations, and the simultaneous increase in both NSW arrangements and income inequality.

Drawing on an original dataset that combines detailed information on provincial labour market composition with income records and structural indicators, we document three main findings.

First, in line with previous research (Depalo and Lattanzio, 2025; Hoffmann et al., 2022), we show that greater reliance on NSW arrangements adversely affects income distribution by compressing the labour share, lowering average employment income and the earnings of low-paid workers, and ultimately exacerbating inequality. While prior studies have largely focused on firm-level and individual-level analyses, we demonstrate that this relationship also holds at a highly disaggregated geographical level. The widespread diffusion of precarious employment contributes to the economic weakening of territories.

Second, digitalisation increases both the wage share and average employment income; however, because it is strongly associated with high-skilled occupations, it also contributes to worsening income distribution, as its gains accrue primarily to top incomes rather than to those at the bottom of the distribution.

Third, and most importantly, once NSW arrangements and digitalisation are jointly considered, the positive association between digitalisation and average employment income largely vanishes in contexts characterised by high labour market precariousness. Hence, income inequality across Italian provinces is actually shaped by the interaction between digitalisation and labour market flexibility. This suggests that the income gains from digitalisation depend on the existence of sufficiently stable labour contracts and, thus, on strong labour market regulation. Indeed, our results reveal that provinces characterised by widespread precarious employment not only fail to benefit from digitalisation but face a further income penalty.

Hence, while previous studies attribute inequality dynamics primarily to technological do-

mains, this analysis reveals that institutional factors are equally fundamental and cannot be overlooked. Consistent with a socio-technical approach, our findings highlight that the distributional effects of technological change should be analysed in relation to the institutional contexts in which they unfold.

From a policy perspective, our results suggest that digitalisation alone is unlikely to generate inclusive economic outcomes. In the absence of measures aimed at improving labour market stability and reducing the prevalence of temporary and part-time employment, the digital transition may contribute to lower income levels and increase inequality, thereby reinforcing existing socioeconomic divides.

This study has several limitations. In particular, our measure of digitalisation, based on the digital content of local labour tasks, despite being especially relevant and useful for the analysis carried out, may not fully reflect actual firm-level technology adoption. Because task-based indicators vary across occupations rather than firms, they do not capture between-firm heterogeneity in technology use or workplace-specific conditions. Direct measures of technological investment and adoption could be integrated for robustness check, but data at a sufficiently granular geographical level are generally unavailable. Existing information typically derives from firm-level surveys and rarely ensures representativeness at the provincial level. In Italy, detailed data on digital technology adoption are provided by the Business Census conducted by the Italian National Institute of Statistics (ISTAT), but are available only for 2019 and 2022. This limits the possibility of examining long-term trends in digitalisation.

Furthermore, our measure of digitalisation is based on a time-invariant classification of the digital content of tasks associated with occupations. Ideally, one would rely on time-varying measures capable of capturing changes in task content over time; however, such data are not currently available for Italy.

Finally, despite the implementation of several robustness checks, our estimates should be interpreted as robust associations rather than causal effects. Over the period considered, labour market reforms were introduced in different directions; for example, while some increased flexibility in the use of fixed-term contracts, others tightened restrictions on their use. In this context, a pure event-study design is not feasible.

Future research could extend our analysis by explicitly accounting for geographical spillovers across provinces generated by labour mobility. If digitalisation generates spatially heterogeneous effects, with stronger adoption and productivity gains concentrated in urban areas, it is important to understand how these disparities influence workers' mobility decisions. Investigating these mechanisms would help clarify whether digitalisation reinforces the spatial concentration of economic opportunities and, in turn, contributes to regional differences in economic performance and inequality.

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Appendix

A Descriptive statistics

Table A.1: Descriptive statistics of the main variables

Variable	Obs.	Mean	SD	Min	Max
Adj. wage share	1,166	0.532	0.028	0.422	0.601
Mean employment income	1,166	19,273	2,789	13,511	28,428
Top–bottom ratio	1,166	9.873	0.705	8.421	12.227
Mean income, top three classes	1,166	121,417	10,279	98,814	165,390
Mean income, bottom three classes	1,166	12,361	1,355	9,760	14,784
NSW	742	0.297	0.045	0.189	0.442
RTI	742	46.238	1.347	42.959	52.851
DTI	742	2.301	0.634	0.837	4.624
Labour productivity	1,166	36.932	5.163	26.120	54.420
GFCF employee ratio	1,166	11.487	2.495	4.527	24.087
Young workers	742	0.230	0.028	0.160	0.344
Female workers	742	0.412	0.040	0.276	0.493
Unemployment rate	742	0.047	0.018	0.015	0.113
High-tech sectors	742	0.062	0.024	0.013	0.148
Tertiary-educated workers	742	0.178	0.037	0.072	0.317
Foreign workers	742	0.057	0.029	0.002	0.180
Large firms	742	0.100	0.042	0.019	0.290

Notes: NSW denotes non-standard work; RTI denotes routine task intensity; DTI denotes digital-task occupational exposure. Labour productivity is measured as real value added per hour worked. GFCF per employee captures capital intensity. Young workers refer to workers aged 15–34. Job seekers capture the local incidence of individuals looking for work. Foreign workers refer to workers with non-EU citizenship.

B Alternative stepwise specifications

Table B.1: OLS estimations: NSW, DTI and labour market outcomes (no lags)

	Adj. wage share			Ln mean employment income			Ln top-bottom		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NSW	-0.166*** (0.040)	-0.114*** (0.038)	-0.102*** (0.034)	-0.935*** (0.159)	-0.611*** (0.136)	-0.307*** (0.101)	0.289*** (0.104)	0.389*** (0.113)	0.386*** (0.117)
DTI		0.012*** (0.002)	0.009*** (0.002)		0.075*** (0.009)	0.027*** (0.006)		0.023* (0.012)	0.013* (0.007)
RTI			-0.001 (0.001)			-0.002 (0.003)			-0.001 (0.006)
Ln labour prod.			0.055** (0.026)			0.544*** (0.067)			0.150* (0.084)
Ln GFCF/emp			0.014 (0.017)			-0.035 (0.024)			0.016 (0.034)
Young workers			0.152*** (0.043)			-0.058 (0.112)			0.289** (0.143)
Female workers			-0.140*** (0.045)			0.209 (0.152)			-0.077 (0.143)
Unemployment			0.046 (0.103)			-0.747*** (0.240)			0.077 (0.341)
High-tech			-0.030 (0.057)			0.072 (0.127)			0.131 (0.161)
Tertiary edu			-0.063 (0.048)			0.153 (0.109)			0.026 (0.162)
Foreign workers			0.085 (0.052)			-0.076 (0.222)			0.526*** (0.197)
Large firms			-0.004 (0.031)			0.080 (0.074)			-0.258** (0.108)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.696	0.742	0.791	0.830	0.897	0.944	0.556	0.583	0.642
Obs.	742	742	742	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are contemporaneous (no lags). Robust standard errors clustered at the provincial level in parentheses. DTI denotes the digital-task occupational exposure indicator. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B.2: OLS estimations: NSW, DTI and labour market outcomes, one-year lag

	Adj. wage share			Ln mean employment income			Ln top-bottom		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NSW (L1)	-0.163*** (0.041)	-0.111*** (0.039)	-0.099*** (0.035)	-0.938*** (0.156)	-0.617*** (0.134)	-0.322*** (0.098)	0.256** (0.109)	0.363*** (0.118)	0.363*** (0.120)
DTI (L1)		0.012*** (0.002)	0.009*** (0.002)		0.075*** (0.009)	0.028*** (0.006)		0.025** (0.013)	0.017** (0.007)
RTI (L1)			-0.001 (0.001)			-0.002 (0.003)			0.001 (0.006)
Ln labour prod. (L1)			0.053** (0.026)			0.543*** (0.065)			0.161* (0.083)
Ln GFCF/emp (L1)			0.013 (0.016)			-0.038 (0.024)			0.014 (0.033)
Young workers (L1)			0.153*** (0.043)			-0.011 (0.111)			0.255* (0.147)
Female workers (L1)			-0.144*** (0.046)			0.224 (0.148)			-0.088 (0.144)
Unemployment (L1)			0.088 (0.105)			-0.661*** (0.234)			0.153 (0.365)
High-tech (L1)			-0.048 (0.057)			0.095 (0.123)			0.138 (0.168)
Tertiary edu (L1)			-0.059 (0.048)			0.137 (0.110)			0.011 (0.168)
Foreign workers (L1)			0.096* (0.052)			-0.087 (0.213)			0.517** (0.204)
Large firms (L1)			0.001 (0.031)			0.088 (0.072)			-0.279** (0.118)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.692	0.739	0.789	0.838	0.903	0.947	0.527	0.558	0.617
Obs.	742	742	742	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged one year. Robust standard errors clustered at the provincial level in parentheses. DTI denotes the digital-task occupational exposure indicator. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B.3: OLS estimations: Part-time, DTI and labour market outcomes (2-year lags)

	Adj. wage share			Ln mean employment income			Ln top-bottom		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Part-time work (L2)	-0.120*** (0.032)	-0.096*** (0.028)	-0.056* (0.028)	-0.298** (0.141)	-0.141 (0.112)	0.073 (0.077)	0.280*** (0.102)	0.326*** (0.100)	0.360*** (0.093)
DTI (L2)		0.013*** (0.002)	0.010*** (0.002)		0.084*** (0.009)	0.029*** (0.006)		0.024* (0.012)	0.015** (0.007)
RTI (L2)			-0.001 (0.001)			0.001 (0.003)			0.002 (0.006)
Ln labour prod. (L2)			0.064** (0.027)			0.578*** (0.060)			0.120 (0.080)
Ln GFCF/emp (L2)			0.012 (0.017)			-0.036* (0.021)			0.027 (0.033)
Young workers (L2)			0.120*** (0.042)			-0.086 (0.126)			0.378** (0.150)
Female workers (L2)			-0.141*** (0.049)			0.154 (0.142)			-0.207 (0.147)
Unemployment (L2)			0.104 (0.111)			-0.738*** (0.241)			-0.014 (0.380)
High-tech (L2)			-0.069 (0.056)			0.105 (0.133)			0.267 (0.183)
Tertiary edu (L2)			-0.055 (0.050)			0.183 (0.122)			0.074 (0.168)
Foreign workers (L2)			0.107* (0.055)			-0.041 (0.212)			0.517** (0.202)
Large firms (L2)			-0.007 (0.033)			0.142* (0.076)			-0.252** (0.115)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.670	0.728	0.776	0.808	0.892	0.945	0.512	0.543	0.613
Obs.	742	742	742	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Robust standard errors clustered at the provincial level in parentheses. DTI denotes the digital-task occupational exposure indicator. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B.4: OLS estimations: Temporary work, DTI and labour market outcomes (2-year lags)

	Adj. wage share			Ln mean employment income			Ln top-bottom		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Temporary work (L2)	-0.161*** (0.046)	-0.100** (0.044)	-0.091** (0.039)	-1.184*** (0.128)	-0.834*** (0.105)	-0.491*** (0.097)	0.012 (0.117)	0.141 (0.114)	0.129 (0.130)
DTI (L2)		0.012*** (0.002)	0.009*** (0.002)		0.067*** (0.008)	0.028*** (0.005)		0.025* (0.013)	0.018** (0.007)
RTI (L2)			-0.001 (0.001)			-0.004 (0.003)			0.001 (0.007)
Ln labour prod. (L2)			0.040 (0.026)			0.442*** (0.060)			0.149 (0.091)
Ln GFCF/emp (L2)			0.017 (0.017)			-0.021 (0.021)			0.010 (0.033)
Young workers (L2)			0.147*** (0.045)			0.079 (0.112)			0.355** (0.155)
Female workers (L2)			-0.154*** (0.048)			0.230* (0.134)			-0.082 (0.147)
Unemployment (L2)			0.110 (0.105)			-0.574*** (0.220)			0.078 (0.403)
High-tech (L2)			-0.063 (0.056)			0.108 (0.111)			0.239 (0.178)
Tertiary edu (L2)			-0.063 (0.048)			0.082 (0.104)			0.046 (0.182)
Foreign workers (L2)			0.112** (0.053)			-0.083 (0.217)			0.460** (0.215)
Large firms (L2)			0.006 (0.031)			0.101 (0.071)			-0.353*** (0.116)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.685	0.727	0.779	0.874	0.922	0.952	0.494	0.523	0.591
Obs.	742	742	742	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Robust standard errors clustered at the provincial level in parentheses. DTI denotes the digital-task occupational exposure indicator. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C Alternative interaction specifications

Table C.1: OLS estimations: NSW, digitalisation and labour market outcomes (2-year lags)

	Adj. wage share		Ln mean employment income		Ln top-bottom	
	High dig. (1)	Top dig (p75) (2)	High dig. (3)	Top dig (p75) (4)	High dig. (5)	Top dig (p75) (6)
NSW (L2)	-0.085** (0.037)	-0.094** (0.037)	-0.200** (0.092)	-0.288*** (0.102)	0.349*** (0.121)	0.411*** (0.126)
Digitalisation (L2)	0.013 (0.012)	0.009 (0.014)	0.124*** (0.035)	0.109** (0.044)	-0.006 (0.042)	0.126** (0.058)
NSW $\times$ digitalisation (L2)	-0.024 (0.040)	-0.006 (0.048)	-0.379*** (0.113)	-0.325** (0.157)	0.004 (0.144)	-0.469** (0.220)
RTI (L2)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.003)	-0.001 (0.003)	0.002 (0.006)	0.003 (0.006)
Ln labour prod.(L2)	0.061** (0.027)	0.061** (0.027)	0.565*** (0.064)	0.558*** (0.063)	0.202** (0.091)	0.197** (0.089)
Ln GFCF/emp (L2)	0.015 (0.018)	0.015 (0.018)	-0.041* (0.021)	-0.036 (0.022)	0.019 (0.037)	0.015 (0.036)
Young workers (L2)	0.159*** (0.043)	0.157*** (0.045)	0.054 (0.114)	0.042 (0.116)	0.318** (0.150)	0.296** (0.147)
Female workers (L2)	-0.152*** (0.049)	-0.166*** (0.049)	0.219 (0.151)	0.166 (0.154)	-0.174 (0.142)	-0.179 (0.139)
Unemployment (L2)	0.097 (0.111)	0.110 (0.107)	-0.705*** (0.241)	-0.630*** (0.241)	-0.010 (0.403)	-0.026 (0.397)
High-tech (L2)	-0.008 (0.062)	-0.038 (0.064)	0.281** (0.131)	0.207 (0.132)	0.390* (0.203)	0.411** (0.205)
Tertiary edu (L2)	-0.030 (0.050)	-0.029 (0.049)	0.264** (0.106)	0.262** (0.112)	0.165 (0.182)	0.203 (0.174)
Foreign workers (L2)	0.105** (0.052)	0.118** (0.056)	-0.124 (0.202)	-0.050 (0.195)	0.513** (0.223)	0.507** (0.216)
Large firms (L2)	0.022 (0.033)	0.016 (0.033)	0.160** (0.077)	0.151* (0.077)	-0.269** (0.111)	-0.255** (0.108)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7743	0.7750	0.9472	0.9463	0.6013	0.6075
Obs.	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Columns (1), (3), and (5) used a binary index constructed on the median of DTI index `high_dig_med`; columns (2), (4) and (6) use the top-digital dummy `top_dig_p75` based on the 25 of the DTI index; Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: OLS estimations: NSW, digitalisation and labour market outcomes (no lag)

	Adj. wage share		Ln mean employment income		Ln top-bottom	
	High dig. (1)	Top dig (p75) (2)	High dig. (3)	Top dig (p75) (4)	High dig. (5)	Top dig (p75) (6)
NSW	-0.096** (0.037)	-0.102*** (0.037)	-0.188* (0.098)	-0.275** (0.106)	0.359*** (0.119)	0.425*** (0.124)
Digitalisation	0.007 (0.011)	0.001 (0.013)	0.114*** (0.035)	0.083* (0.044)	-0.014 (0.037)	0.117** (0.052)
NSW $\times$ digitalisation	-0.004 (0.038)	0.022 (0.046)	-0.350*** (0.115)	-0.231 (0.156)	0.018 (0.130)	-0.455** (0.197)
RTI	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.003)	-0.002 (0.003)	-0.001 (0.006)	0.000 (0.006)
Ln labour prod.	0.066** (0.026)	0.066** (0.026)	0.583*** (0.067)	0.577*** (0.066)	0.173** (0.087)	0.169* (0.086)
Ln GFCF/emp	0.014 (0.018)	0.014 (0.018)	-0.041* (0.021)	-0.036 (0.022)	0.026 (0.036)	0.021 (0.035)
Young workers	0.163*** (0.042)	0.161*** (0.044)	-0.028 (0.116)	-0.038 (0.119)	0.322** (0.140)	0.302** (0.139)
Female workers	-0.146*** (0.047)	-0.158*** (0.048)	0.190 (0.156)	0.144 (0.158)	-0.118 (0.139)	-0.113 (0.138)
Unemployment	0.033 (0.107)	0.044 (0.104)	-0.834*** (0.246)	-0.763*** (0.247)	0.073 (0.351)	0.049 (0.348)
High-tech	0.029 (0.062)	-0.003 (0.064)	0.257* (0.137)	0.180 (0.138)	0.231 (0.187)	0.274 (0.189)
Tertiary edu	-0.039 (0.049)	-0.039 (0.048)	0.279*** (0.103)	0.265** (0.111)	0.110 (0.169)	0.147 (0.160)
Foreign workers	0.083 (0.051)	0.093* (0.055)	-0.114 (0.217)	-0.048 (0.209)	0.561*** (0.206)	0.546*** (0.200)
Large firms	0.018 (0.033)	0.011 (0.033)	0.149* (0.079)	0.137* (0.078)	-0.218** (0.105)	-0.199* (0.103)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7843	0.7861	0.9425	0.9418	0.6398	0.6454
Obs.	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are contemporaneous. Columns (1), (3) and (5) use a binary digitalisation indicator, `high_dig_med`, which equals 1 for province-year cells whose DTI index lies above the year-specific median, and 0 otherwise. Columns (2), (4) and (6) use the top-digital dummy `top_dig_p75`, which equals 1 for province-year cells in the top quartile (≥ 75 th percentile) of the annual DTI distribution and 0 otherwise. Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.3: OLS estimations: NSW, digitalisation and labour market outcomes (1-year lags)

	Adj. wage share		Ln mean employment income		Ln top-bottom	
	High dig. (1)	Top dig (p75) (2)	High dig. (3)	Top dig (p75) (4)	High dig. (5)	Top dig (p75) (6)
NSW (L1)	-0.089** (0.037)	-0.098*** (0.037)	-0.192** (0.094)	-0.285*** (0.103)	0.332*** (0.122)	0.408*** (0.126)
Digitalisation (L1)	0.010 (0.011)	0.006 (0.013)	0.124*** (0.034)	0.095** (0.044)	-0.016 (0.038)	0.130** (0.054)
NSW $\times$ digitalisation (L1)	-0.015 (0.038)	0.005 (0.047)	-0.381*** (0.112)	-0.275* (0.154)	0.031 (0.131)	-0.491** (0.205)
RTI (L1)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.003)	-0.001 (0.003)	0.000 (0.006)	0.002 (0.006)
Ln labour prod. (L1)	0.065** (0.026)	0.064** (0.026)	0.582*** (0.065)	0.576*** (0.064)	0.189** (0.088)	0.184** (0.087)
Ln GFCF/emp (L1)	0.013 (0.017)	0.013 (0.017)	-0.046** (0.021)	-0.040* (0.022)	0.024 (0.036)	0.019 (0.035)
Young workers (L1)	0.164*** (0.042)	0.162*** (0.044)	0.017 (0.114)	0.006 (0.117)	0.294** (0.145)	0.270* (0.143)
Female workers (L1)	-0.149*** (0.048)	-0.162*** (0.048)	0.206 (0.152)	0.158 (0.155)	-0.133 (0.141)	-0.133 (0.138)
Unemployment (L1)	0.073 (0.110)	0.085 (0.107)	-0.753*** (0.242)	-0.677*** (0.243)	0.148 (0.376)	0.124 (0.370)
High-tech (L1)	0.012 (0.061)	-0.019 (0.063)	0.279** (0.134)	0.203 (0.135)	0.263 (0.194)	0.292 (0.196)
Tertiary edu (L1)	-0.033 (0.049)	-0.033 (0.048)	0.265** (0.104)	0.254** (0.111)	0.106 (0.177)	0.146 (0.169)
Foreign workers (L1)	0.092* (0.052)	0.104* (0.056)	-0.130 (0.208)	-0.059 (0.201)	0.554** (0.213)	0.540** (0.208)
Large firms (L1)	0.022 (0.033)	0.016 (0.033)	0.157** (0.076)	0.146* (0.075)	-0.230** (0.114)	-0.213* (0.112)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7825	0.7834	0.9460	0.9451	0.6108	0.6173
Obs.	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged one year. Columns (1), (3) and (5) use a binary digitalisation indicator, `high_dig_med`, which equals 1 for province-year cells whose DTI index lies above the year-specific median, and 0 otherwise. Columns (2), (4) and (6) use the top-digital dummy `top_dig_p75`, which equals 1 for province-year cells in the top quartile (≥ 75 th percentile) of the annual DTI distribution and 0 otherwise. Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.4: OLS estimations: Temporary work, digitalisation and labour market outcomes (2-year lags)

	Adj. wage share		Ln mean employment income		Ln top-bottom	
	High dig. (1)	Top dig. (p75) (2)	High dig. (3)	Top dig. (p75) (4)	High dig. (5)	Top dig. (p75) (6)
Fixed-term work (L2)	-0.066 (0.044)	-0.086** (0.041)	-0.367*** (0.090)	-0.456*** (0.102)	0.248* (0.126)	0.239* (0.126)
Digitalisation (L2)	0.016** (0.007)	0.013 (0.011)	0.066*** (0.018)	0.063*** (0.022)	0.053* (0.030)	0.153*** (0.039)
Fixed-term $\times$ digitalisation (L2)	-0.065 (0.047)	-0.046 (0.072)	-0.344*** (0.118)	-0.339** (0.166)	-0.406* (0.206)	-1.208*** (0.304)
RTI (L2)	-0.001 (0.001)	-0.001 (0.001)	-0.003 (0.003)	-0.003 (0.003)	0.001 (0.006)	0.003 (0.006)
Ln labour prod. (L2)	0.054** (0.027)	0.051* (0.027)	0.495*** (0.060)	0.479*** (0.058)	0.195** (0.096)	0.180** (0.090)
Ln GFCF/emp (L2)	0.015 (0.018)	0.017 (0.019)	-0.030 (0.019)	-0.023 (0.020)	0.009 (0.035)	0.008 (0.033)
Young workers (L2)	0.155*** (0.044)	0.155*** (0.046)	0.098 (0.117)	0.099 (0.118)	0.369** (0.153)	0.349** (0.145)
Female workers (L2)	-0.158*** (0.049)	-0.173*** (0.049)	0.211 (0.143)	0.168 (0.143)	-0.124 (0.144)	-0.125 (0.138)
Unemployment (L2)	0.102 (0.109)	0.110 (0.106)	-0.586** (0.232)	-0.566** (0.237)	0.095 (0.393)	0.123 (0.388)
High-tech (L2)	-0.008 (0.061)	-0.035 (0.063)	0.276** (0.123)	0.212* (0.124)	0.340 (0.207)	0.369* (0.197)
Tertiary edu (L2)	-0.037 (0.049)	-0.034 (0.049)	0.179* (0.101)	0.185* (0.108)	0.158 (0.192)	0.169 (0.175)
Foreign workers (L2)	0.097* (0.052)	0.119** (0.055)	-0.145 (0.211)	-0.064 (0.201)	0.423* (0.228)	0.453** (0.207)
Large firms (L2)	0.027 (0.033)	0.022 (0.033)	0.171** (0.073)	0.163** (0.074)	-0.301*** (0.112)	-0.264** (0.107)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.7740	0.7737	0.9505	0.9501	0.5933	0.6176
Obs.	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Columns (1), (3), and (5) use the median-based digitalisation indicator `high_dig_med`. Columns (2), (4), and (6) use the top-digital dummy `top_dig_p75`. Robust standard errors clustered at the provincial level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table C.5: OLS estimations: Part-time work, digitalisation and labour market outcomes (2-year lags)

	Adj. wage share		Ln mean employment income		Ln top-bottom	
	High dig. (1)	Top dig. (p75) (2)	High dig. (3)	Top dig. (p75) (4)	High dig. (5)	Top dig. (p75) (6)
Part-time (L2)	-0.059* (0.030)	-0.053* (0.030)	0.193** (0.085)	0.142* (0.085)	0.347*** (0.093)	0.369*** (0.094)
Digitalisation (L2)	-0.006 (0.010)	-0.010 (0.013)	0.088** (0.035)	0.095** (0.041)	-0.029 (0.030)	-0.016 (0.036)
Part-time $\times$ digitalisation (L2)	0.053 (0.044)	0.075 (0.058)	-0.291** (0.141)	-0.318* (0.168)	0.090 (0.128)	0.048 (0.161)
RTI (L2)	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.003)	0.001 (0.003)	0.002 (0.006)	0.002 (0.006)
Ln labour prod. (L2)	0.077*** (0.028)	0.077*** (0.028)	0.604*** (0.059)	0.608*** (0.060)	0.151* (0.083)	0.147* (0.083)
Ln GFCF/emp (L2)	0.012 (0.018)	0.012 (0.018)	-0.035* (0.020)	-0.033 (0.020)	0.036 (0.036)	0.034 (0.035)
Young workers (L2)	0.135*** (0.041)	0.131*** (0.043)	-0.055 (0.127)	-0.060 (0.129)	0.409*** (0.149)	0.407*** (0.151)
Female workers (L2)	-0.152*** (0.050)	-0.166*** (0.051)	0.132 (0.144)	0.085 (0.147)	-0.258* (0.146)	-0.241 (0.145)
Unemployment (L2)	0.107 (0.115)	0.105 (0.112)	-0.892*** (0.271)	-0.790*** (0.253)	-0.000 (0.395)	-0.035 (0.384)
High-tech (L2)	-0.006 (0.060)	-0.037 (0.061)	0.318** (0.144)	0.210 (0.141)	0.376* (0.209)	0.398* (0.209)
Tertiary edu (L2)	-0.031 (0.050)	-0.028 (0.050)	0.281** (0.120)	0.297** (0.125)	0.164 (0.180)	0.153 (0.175)
Foreign workers (L2)	0.106* (0.055)	0.120** (0.060)	-0.042 (0.206)	-0.014 (0.200)	0.553*** (0.208)	0.540** (0.204)
Large firms (L2)	0.019 (0.035)	0.011 (0.035)	0.226*** (0.079)	0.212*** (0.079)	-0.205* (0.112)	-0.202* (0.112)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.769	0.770	0.943	0.943	0.609	0.608
Obs.	742	742	742	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are lagged two years. Columns (1), (3), and (5) use the median-based digitalisation dummy `high_dig_med`; columns (2), (4), and (6) use the top-digital dummy `top_dig_p75`. Robust standard errors clustered at the provincial level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D Alternative IV specifications

Table D.1: IV estimates: NSW on labour market outcomes (1-year lag, full lagged controls)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top-bottom (3)
Second stage (2SLS)			
NSW (L1)	-0.360*** (0.101)	-0.469* (0.257)	1.777*** (0.324)
RTI (L1/L2)	-0.003* (0.002)	-0.003 (0.003)	0.014† (0.007)
Digital tasks (L1/L2)	0.007*** (0.002)	0.027*** (0.006)	0.015** (0.007)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	742	742	636
Instrument diagnostics (common to all models)			
Kleibergen–Paap rk LM (χ^2)	17.32	17.32	18.93
Kleibergen–Paap rk Wald F	39.55	39.55	43.27
Anderson–Rubin F	10.67	3.15	33.68

Notes: IV (2SLS) regressions. Endogenous regressor: NSW at time $t - 1$. Instrument: sectoral NSW index $Z_{\text{NSW_sett}}$ at time $t - 1$. All controls enter lagged one period in columns (1)–(2); in column (3) they enter at lag $t - 2$ as in the estimation output. Controls: RTI, digital tasks, log labour productivity per hour, log GFCF per employee, share of young workers, share of female workers, unemployment, high-tech employment, tertiary-educated workers, foreign workers and large-firm share, plus region and year fixed effects. Robust standard errors clustered at the provincial level in parentheses. Kleibergen–Paap statistics and Anderson–Rubin F are cluster-robust. † $p < 0.11$; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table D.2: IV estimates: NSW on labour market outcomes (no lags)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top-bottom (3)
Second stage (2SLS)			
NSW	-0.350*** (0.099)	-0.472* (0.272)	1.487*** (0.329)
RTI	-0.003* (0.002)	-0.004 (0.003)	0.008 (0.006)
DTI	0.007*** (0.003)	0.023*** (0.006)	0.007 (0.009)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs.	742	742	742
Instrument diagnostics (common to all models)			
Kleibergen–Paap rk LM (χ^2)	15.79	15.79	15.79
Kleibergen–Paap rk Wald F	31.55	31.55	31.55
Anderson–Rubin F	10.42	2.98	21.23

Notes: IV (2SLS) regressions. Endogenous regressor: NSW. Instrument: sectoral NSW index $Z_{\text{NSW_sett}}$. Controls: RTI, DTI, log labour productivity per hour, log population density, log GFCF per employee, share of young workers, share of female workers, unemployment, log hours worked, high-tech employment, tertiary education, foreign workers, and large-firm share, plus region and year fixed effects. Robust standard errors clustered at the provincial level in parentheses. Kleibergen–Paap statistics are cluster-robust. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E Alternative Spatial Structural Heterogeneity Design

Table E.1: Structural NSW benchmark, EPLT and labour market outcomes, full controls (no lags)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top-bottom (3)
Structural NSW benchmark $\times$ EPLT	-0.057*** (0.019)	-0.180*** (0.059)	0.219*** (0.064)
RTI	-0.002 (0.001)	-0.003 (0.004)	0.001 (0.006)
Digital tasks	0.009*** (0.002)	0.028*** (0.006)	0.013* (0.007)
Ln labour prod.	0.044* (0.026)	0.509*** (0.071)	0.192** (0.090)
Ln GFCF/emp	0.016 (0.017)	-0.028 (0.024)	0.008 (0.034)
Young workers	0.154*** (0.042)	-0.045 (0.108)	0.278** (0.137)
Female workers	-0.144*** (0.045)	0.198 (0.154)	-0.062 (0.143)
Unemployment	0.054 (0.103)	-0.716*** (0.239)	0.042 (0.342)
High-tech	-0.030 (0.058)	0.072 (0.123)	0.131 (0.152)
Tertiary edu	-0.063 (0.048)	0.151 (0.106)	0.027 (0.158)
Foreign workers	0.084 (0.052)	-0.080 (0.222)	0.530*** (0.201)
Large firms	-0.008 (0.031)	0.063 (0.073)	-0.238** (0.107)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2	0.7947	0.9458	0.6514
Obs.	742	742	742

Notes: All regressions include region and year fixed effects. All regressors are measured contemporaneously. The main regressor is the interaction between the province-level structural NSW benchmark and the EPL index for temporary contracts. Robust standard errors clustered at the provincial level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table E.2: Structural NSW benchmark, EPLT and labour market outcomes, full controls (1-year lags)

	Adj. wage share (1)	Ln mean employment income (2)	Ln top-bottom (3)
Structural NSW benchmark $\times$ EPLT (L1)	-0.050** (0.020)	-0.203*** (0.057)	0.220*** (0.067)
RTI (L1)	-0.002 (0.001)	-0.004 (0.004)	0.003 (0.006)
Digital tasks (L1)	0.009*** (0.002)	0.028*** (0.006)	0.016** (0.007)
Ln labour prod. (L1)	0.046* (0.027)	0.503*** (0.064)	0.202** (0.088)
Ln GFCF/emp (L1)	0.014 (0.017)	-0.035 (0.021)	0.011 (0.030)
Young workers (L1)	0.154*** (0.043)	0.019 (0.107)	0.228 (0.139)
Female workers (L1)	-0.146*** (0.045)	0.229 (0.148)	-0.090 (0.145)
Unemployment (L1)	0.098 (0.105)	-0.596** (0.225)	0.088 (0.362)
High-tech (L1)	-0.052 (0.057)	0.076 (0.122)	0.158 (0.159)
Tertiary edu (L1)	-0.061 (0.048)	0.120 (0.106)	0.027 (0.165)
Foreign workers (L1)	0.090* (0.053)	-0.117 (0.207)	0.548*** (0.211)
Large firms (L1)	-0.007 (0.032)	0.051 (0.070)	-0.240** (0.120)
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2	0.7904	0.9498	0.6285
Obs.	742	742	742

Notes: All regressions include region and year fixed effects. The main regressor is the one-year lag of the interaction between the province-level structural NSW benchmark and the EPL index for temporary contracts. All additional controls are lagged one year. Robust standard errors clustered at the provincial level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.