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Employment Trends at Large Food and Beverage Companies in Italy 2019-2023

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Abstract

This study examines the labour adjustment dynamics of large Italian food and beverage processing (FBP) firms over 2019-2023, a window encompassing the COVID-19 pandemic, the subsequent supply-chain disruptions, and the inflationary shock of 2022-2023. Drawing on firm-level data from the AIDA (Bureau van Dijk) database, the analysis is based on a balanced panel of 98 firms that have continuously remained above the 250-employee threshold for 490 firm-year observations. Three connected research questions are addressed: sectoral heterogeneity in employment growth (RQ1); the within-firm link between lagged profitability (EBITDA) and subsequent employment growth (RQ2); and the within-firm elasticity of unit labour cost (ULC) to firm size (RQ3). The empirical strategy combines fixed-effects panel regression with sector and time controls and is supported by a battery of robustness checks. Aggregate employment grew moderately (+ 6.1%), with firm-level adjustment concentrated in a narrow band; the predicted emergence of sectoral differentiation during the recovery phase is not statistically supported. The relationship between lagged profitability and subsequent employment growth is statistically and economically null, a result consistent with a labour adjustment framework in which adjustment costs, institutional rigidities, and labour hoarding decouple short-run hiring from short-run profit fluctuations. The within-firm elasticity

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of ULC to firm size is negative and statistically significant, with a composition probe indicating that the result is consistent with the presence of genuine scale economies as a contributing channel. The findings document firm-level adjustment dynamics within a specific and policy-relevant segment of Italian manufacturing during a period of compounded shocks.

1. Introduction

An open empirical question in labour economics and industrial organisation is how large firms in essential manufacturing sectors adjust their workforce in periods of compounded shocks. For example, the COVID-19 pandemic, followed by the geopolitical and inflationary shocks of 2022-2023, generated a sequence of disruptions with firm-level consequences for employment, labour costs, and the profitability-hiring link. They remain imperfectly documented, particularly within sub-segments of manufacturing classified as essential and operational throughout the lockdown period.

The Italian food and beverage processing (FBP) sector provides a useful context for examining these dynamics. According to ISTAT (2024) data for 2022, the sector comprises approximately 52,400 active firms employing around 468,000 workers, and accounts for 13.7% of firms, 11% of employment, 12.2% of turnover, and 8.4% of value added in Italian manufacturing. It was designated as essential during the 2020 national lockdown, when most other manufacturing activities were suspended (Cerqua & Letta, 2022). Within the FBP sector, large firms – those exceeding the 250-employee threshold of the European Commission's enterprise classification – represent less than 2% of the firm population (ISTAT, 2024). Their structural features – collective bargaining coverage, established human resource management practices, and exposure to multi-year supply contracts – qualitatively distinguish their labour adjustment behaviour from that of small and medium-sized enterprises in the same sector, which has been examined in earlier work (Garbelli, 2025). The longitudinal labour dynamics of this segment, however, have not been systematically documented.

Empirical evidence on labour adjustment in Italian manufacturing during and after the pandemic is concentrated in three strands. The first examines the macro-sectoral consequences of lockdown measures and the buffering role of short-time work schemes (Falavigna & Ippoliti, 2022; Giupponi & Landais, 2023). The second investigates product and labour market frictions in Italian manufacturing using firm-level data, but with reference periods that predate the pandemic (Devicienti & Fanfani, 2025; Mondolo, 2022). The third addresses the agri-food and FBP sector specifically, but typically

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through a supply-chain or food-security lens rather than from a labour economics perspective (Bargoni *et al*., 2022; Barile *et al*., 2024; Rinaldi & Bottani, 2023). Firm-level longitudinal evidence on employment dynamics, the profitability-employment link, and labour cost behaviour within the large-firm segment of Italian FBP, covering both the pandemic and the post-pandemic recovery, is currently absent.

This study addresses that gap. Drawing on a balanced firm-level panel of 98 large Italian FBP firms covering 2019-2023, the analysis pursues three connected questions. RQ1 examines whether sectoral affiliation accounts for heterogeneity in employment growth across firms, with particular attention to whether such heterogeneity emerged during the post-shock recovery phase. RQ2 tests whether firm profitability, measured by EBITDA, is empirically associated with subsequent employment growth – a relationship whose strength has theoretical implications for the presence of labour hoarding behaviour. RQ3 estimates the within-firm elasticity of unit labour costs with respect to firm size, providing evidence on the presence of scale economies in labour deployment. The empirical strategy combines fixed-effects panel regressions with sector and time controls, and is supported by a battery of robustness checks, including alternative samples, alternative functional forms, and a Hausman specification test.

The contribution is threefold. Substantively, the analysis provides firm-level longitudinal evidence on labour dynamics within the large-firm segment of Italian FBP companies across the 2019-2023 period. It documents moderate aggregate employment growth, a null short-run association between profitability and employment, and a significant negative within-firm elasticity of unit labour costs to firm size, while finding no statistically reliable evidence of the sectoral differentiation in the recovery phase that the framework anticipates. Methodologically, it applies a fixed-effects identification strategy to a setting where most prior evidence has been descriptive or cross-sectional, complementing the main analysis with a transparent reconciliation of the sample and a series of specification tests. Theoretically, it develops a conceptual framework connecting the resilience perspective predominant in recent agri-food research to the labour adjustment tradition originating with Oi (1962) and Hamermesh (1993) and consolidated in Cahuc *et al*. (2014). Resilience research defines its constructs at the level of food systems, farming systems and supply chains, and offers limited guidance on their measurement at firm level (Linnenluecke, 2017; Meuwissen *et al*., 2019). The framework developed here specifies resilience to the labour margin and treats the quasi-fixity of labour, institutional rigidity and resource endowment as the micro-foundations that render firm-level shock-absorption capacity observable in standard accounting data, deriving each research question as an empirical implication.

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The remainder of the paper is organised as follows. Section 2 develops the conceptual framework, connecting system-level resilience constructs to the micro-foundations of labour adjustment and deriving the empirical expectation associated with each research question. Section 3 describes the data, sample selection, variables, and empirical strategy. Section 4 presents the results. Section 5 discusses the findings in dialogue with the literature, and Section 6 concludes with implications and limitations.

2. Conceptual framework

This section develops the conceptual framework that motivates and organises the empirical analysis. The argument proceeds in three steps. Section 2.1 situates the study within resilience research on agri-food systems and identifies the level-of-analysis and operationalisation gap that motivates a firm-level approach. Section 2.2 introduces the quasi-fixity of labour as the micro-foundation through which firm-level shock-absorption capacity becomes observable in accounting data, and specifies the three mechanisms by which it operates. Sections 2.3 to 2.5 derive from these mechanisms one empirical implication for each research question. Section 2.6 synthesises the framework in Figure 1 and Table 1 and states the correspondence between each construct, its observable proxy, and the estimation reported in Section 4.

2.1. *Resilience, compounded shocks, and the firm as unit of analysis*

Since 2020, resilience has become the dominant organising concept in research on how agri-food systems respond to disruption. Migrating from ecology into food systems research, the concept was given a canonical formulation by Tendall *et al.* (2015), who define food system resilience as the capacity to deliver food security over time in the face of disturbances of varying nature and intensity. Zurek *et al.* (2022) review the resulting body of work and its unresolved conceptual tensions, while FAO (2021) adopts resilience as a policy frame for agrifood systems. Meuwissen *et al.* (2019) provide the most operationally articulated version, defining the resilience of a farming system as its ability to sustain its functions through three distinct capacities: robustness, the capacity to withstand shocks and stresses without structural change; adaptability, the capacity to reconfigure inputs, production, marketing and risk management without altering the identity of the system; and transformability, the capacity to change that identity altogether. Italian empirical contributions have applied this apparatus to specific agri-food sub-sectors and supply chains during and after the pandemic (Bargoni *et al.*, 2022; Barile *et al.*, 2024; Rinaldi & Bottani, 2023).

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Two features of this literature define the space in which the present study operates. The first is the level of analysis, which is predominantly systemic: the food system, the farming system, the supply chain. These are aggregates whose behaviour is not the simple sum of the behaviour of the firms composing them, and the resilience framework is designed accordingly. The second, in part a consequence of the first, is that operationalisation at firm level remains underdeveloped. Linnenluecke (2017), reviewing influential publications on resilience in business and management research, finds the construct conceptualised and measured in markedly different ways across five distinct research streams, with limited cumulative progress on the empirics of detecting resilience in advance of the adversity that would reveal it. Meuwissen *et al.* (2019) themselves present their framework as a heuristic to be operationalised through mixed methods rather than as a measurement model.

The large-firm segment of Italian food and beverage processing is precisely the setting in which this gap binds. Food and beverage manufacturing was among the limited set of activities authorised to remain operational during the 2020 national lockdown (Cerqua & Letta, 2022). The system-level outcome variable, continuity of function, was therefore largely preserved by regulatory design. What varied across firms was not whether they continued to deliver, but through which internal margin they absorbed the disruption and at what cost. A framework anchored to the continuity of system function has limited purchase on this variation. The analytically relevant question is displaced inward, to the firm.

This study accordingly adopts what Meuwissen *et al.* (2019) term specified resilience: resilience to an identified challenge, assessed on an identified margin, as distinct from general resilience to unanticipated disturbance. The challenge is the compounded shock sequence of 2019-2023. The margin is labour. Two considerations motivate this specification. Substantively, labour is the principal quasi-fixed input in food processing: personnel costs represent a large and contractually rigid share of the cost base, and workforce continuity was the operative constraint during a period in which production could not be suspended. Methodologically, employment, personnel costs and profitability are reported annually and on a standardised basis in firms' financial statements, which makes the labour margin the one on which firm-level resilience can actually be measured for a full population of large firms rather than for a self-selected sample of survey respondents.

Within the tripartition proposed by Meuwissen *et al.* (2019), the analysis addresses robustness and, in the recovery phase, differentiated adaptability. Transformability falls outside both the observation window and the reach of accounting data, and no claim is made about it. What remains is to specify how firms manage labour under shock in a manner that generates testable

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predictions for these observable quantities. That specification is supplied by labour adjustment theory.

2.2. *Labour as a quasi-fixed factor: micro-foundations of firm-level shock-absorption capacity*

The foundational insight is due to Oi (1962): labour is not a perfectly variable input. Recruitment, screening and training constitute investments that are at least partly firm-specific and that are borne before the worker's productive contribution is realised. Labour therefore carries a fixed cost component alongside its variable wage cost, and the employment relationship acquires the character of an asset rather than of a spot transaction. Three consequences follow.

First, separation destroys a sunk investment. A firm that dismisses a trained worker forfeits the accumulated firm-specific human capital and must re-incur the cost upon re-hiring. Retention through a downturn is therefore not organisational inertia but the exercise of an option whose value rises with the expected speed of recovery and with the specificity of the skills involved.

Second, employment adjusts only partially. Hamermesh (1993) and Hamermesh and Pfann (1996) formalise dynamic factor demand under adjustment costs, distinguishing convex costs, which generate smooth partial adjustment towards the notional optimum, from lumpy and asymmetric costs, which generate extended periods of inaction punctuated by discrete adjustments. Under either structure, the employment change realised within a period is a fraction of the notional desired change, and that fraction falls as adjustment costs rise. The observable correlation between a period's shocks and that period's employment change is correspondingly attenuated.

Third, adjustment is displaced onto other margins. When headcount is costly to move, firms absorb shocks through hours worked, capacity utilisation, inventories, margins, and the composition rather than the level of the workforce.

To these technological frictions, European labour markets add an institutional layer that raises adjustment costs further (Cahuc *et al.*, 2014): employment protection legislation, coordinated sectoral bargaining, and publicly subsidised short-time work. All three are salient for large Italian firms. Nationwide collective agreements set wage floors and regulate the terms of separation; the prevalence of open-ended contracts and the accrual of severance entitlements raise the cost of downward adjustment; and short-time work schemes lower the cost of retention during transitory contractions. Giupponi and Landais (2023), using Italian administrative data, show that short-time work operates precisely as a subsidy to labour hoarding, with

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employment-preserving effects concentrated among firms facing temporary rather than permanent reductions in output. Falavigna and Ippoliti (2022) document heterogeneity in the effects of pandemic relief measures across Italian manufacturing firms with differing exposure to lockdown restrictions. Devicienti and Fanfani (2025) show that when Italian firms face wage growth mandated through collective bargaining, adjustment operates substantially through the composition of the workforce rather than through its size.

A third element completes the account. Retention is rational under quasi-fixity and costly under institutional rigidity, but whether it is affordable depends on the firm's resource position. Larger firms spread the fixed component of personnel-related costs, such as human resource administration, training infrastructure, and supervisory and compliance functions, across a larger workforce, and command greater bargaining power in input markets (Mondolo, 2022). Scale therefore operates not merely as a determinant of average labour cost but as a determinant of how much retention a firm can sustain without compromising its cost position.

The bridge between the two literatures can now be stated precisely. What the resilience literature designates as robustness, the capacity to withstand shocks and stresses without structural change (Meuwissen *et al.*, 2019), is, at firm level and on the labour margin, the joint product of these three elements, which we refer to as shock-absorption capacity. The term is used here in its shock-absorption sense, and is distinct from absorptive capacity as established in the knowledge and innovation literature. Quasi-fixity makes retention rational; institutional rigidity makes separation costly; resource endowment makes retention affordable. This reformulation carries a methodological consequence that motivates the empirical design. Robustness ceases to be a disposition inferred ex post from observed survival, an inference vulnerable to circularity, since firms are classified as resilient because they persisted and their persistence is then explained by their resilience. It becomes instead a set of mechanisms with implications for quantities recorded, independently of the analyst's judgement, in firms' financial statements.

The terminology is fixed at this point and used consistently throughout. Resilience denotes the superordinate literature and its system-level constructs. Shock-absorption capacity on the labour margin denotes the specified firm-level construct examined here. Within the resilience capacities distinguished by Meuwissen *et al.* (2019), the analysis captures robustness and, in the recovery phase, differentiated adaptability. Quasi-fixity, institutional rigidity and resource endowment denote the three micro-foundations. The three research questions denote the observable implications.

Three such implications follow, one for each research question: that employment is stable through the shock while sectoral divergence, if it emerges at all, is deferred to the recovery phase; that short-run profitability

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is decoupled from short-run employment growth; and that the cost of maintaining the workforce declines with within-firm increases in size. Sections 2.3 to 2.5 develop each in turn.

2.3. *Robustness under shock and differentiated adaptability in recovery (RQ1)*

If quasi-fixity and institutional rigidity operate as described, the first-order prediction for employment in this segment is stability rather than either contraction or expansion. Firms that continue to operate, that face high costs of separation, and that anticipate recovery have limited incentive to reduce headcount during the shock; equally, firms facing high costs of hiring and uncertain demand have limited incentive to expand. The aggregate expectation over a window spanning both shock and recovery is therefore one of moderate net change.

Stability, however, is a statement about the aggregate and not about its composition. Robustness in the sense of Meuwissen *et al.* (2019) implies withstanding the shock without structural change; adaptability implies reconfiguration in response to altered conditions. The framework predicts that these two capacities are active in different phases and would leave different traces in the data.

During 2020, the constraints facing food and beverage sub-sectors were largely common: mandatory health protocols, restrictions on mobility, and the essential-activity designation applied across the sector. Common constraints acting on firms with a common adjustment technology should elicit a common response, and sectoral affiliation should therefore account for little of the cross-firm variation in employment change during the shock year. As those constraints were progressively lifted, the binding influences became sub-sector-specific: the recomposition of demand between household consumption and food service, differential exposure to input and energy cost increases, and heterogeneous supply-chain dependencies. Reconfiguration in response to such conditions is adaptability, and it is sub-sector-specific by construction.

The framework therefore yields two empirically separable implications for RQ1. First, quasi-fixity and institutional rigidity imply employment stability during the shock, providing a firm-level trace of robustness on the labour margin. Second, if the lifting of common constraints permits sub-sector-specific reconfiguration, sectoral affiliation should account for a greater share of employment variation during recovery than during the shock itself.

The second implication is deliberately conditional and falsifiable. Failure to detect increased sectoral differentiation would indicate that differentiated

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adaptability is not observable on the labour margin in this sample and period, whether because such differentiation is weak, or because the available sector-level variation is insufficient to identify it reliably. The theoretically appropriate comparison is between the shock year and the recovery sub-period, and both are estimated separately in Section 4.2.

2.4. *Labour hoarding and the decoupling of profitability from employment (RQ2)*

Under frictionless labour demand, employment responds to the marginal value of labour, and a firm experiencing an improvement in profitability expands its workforce. This mapping is the natural benchmark, and it is the benchmark against which the framework makes its sharpest prediction.

Partial adjustment under quasi-fixity attenuates the mapping in three respects. First, the fraction of the notional adjustment realised within a period falls as adjustment costs rise (Hamermesh & Pfann, 1996); with annual accounting data, and with adjustment costs of the magnitude implied by open-ended contracts and firm-specific training, that fraction may be small. Second, firms respond to the permanent rather than the transitory component of a change in profitability, and in a window containing a pandemic, a supply-chain disruption and an inflationary shock in four consecutive years, the transitory component dominates: current profitability is an unusually noisy signal of the future marginal value of labour. Third, labour hoarding operates symmetrically. Firms retain workers through low-profitability periods as insurance against future re-hiring costs (Giupponi & Landais, 2023; Lastauskas, 2022), which severs the downward branch of the relationship, while the costs of expansion and the noisiness of the signal blunt the upward branch.

The framework therefore predicts that the within-firm association between lagged profitability and subsequent employment growth is approximately zero in this segment and period. Two clarifications are essential to the status of this prediction.

The first concerns interpretation. A coefficient statistically indistinguishable from zero is therefore consistent with the predicted empirical signature of the mechanism rather than being theoretically uninformative. Under quasi-fixity and labour hoarding, a weak short-run association is the expected observable manifestation of employment being partially insulated from transitory profitability fluctuations. The claim is deliberately bounded. Failure to reject the null does not establish that the underlying parameter is zero, and what the framework predicts is a relationship weak enough to be undetectable at conventional power rather than the exact absence of one. The

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estimate is therefore consistent with the range of relationships predicted by the framework and does not display the positive association implied by the frictionless benchmark.

The second concerns falsifiability, which is what gives the first its force. The prediction is directional and can fail. Were adjustment costs low relative to the profitability variation present in the sample, as they plausibly are in segments with high shares of fixed-term and seasonal contracts, or among smaller firms with thinner bargaining coverage, the estimated coefficient would be positive and significant. The estimate therefore provides evidence relevant to distinguishing between these two theoretical benchmarks, rather than merely failing to reject a convenient null. Its scope is correspondingly bounded: the prediction concerns the short-run, within-firm margin. Long-run relationships operating through capacity investment and capital deepening are not addressed by this specification and remain open.

2.5. *Scale, the affordability of retention, and unit labour cost (RQ3)*

The third element of the framework concerns the resource dimension of shock-absorption capacity. Retention through a shock is a cost, and the capacity to bear it is not uniformly distributed. The within-firm relationship between size and unit labour cost is the accounting trace of that capacity. Two mechanisms generate a negative relationship, and the contribution of the framework at this point is to make their separation an explicit object of the empirical design rather than an interpretive caveat appended to the estimate.

Scale economies in labour deployment. Fixed personnel-related costs, including human resource administration, training infrastructure, and supervisory and compliance functions, are spread across a larger workforce as the firm expands (Cahuc *et al.*, 2014; Hamermesh, 1993; Oi, 1962). Larger firms also hold greater bargaining power in input markets, which may translate into lower equilibrium compensation for comparable positions (Mondolo, 2022). Under this mechanism the negative elasticity reflects a genuine cost advantage, and it constitutes a component of shock-absorption capacity in its own right: firms with lower unit labour cost can sustain a given workforce through a given contraction at lower cost.

Two considerations qualify this expectation. Evidence from other food and beverage settings indicates that the relationship between firm size and performance is not uniform within the sector: Ibrahim *et al.* (2025) find that size operates in opposite directions in the food and in the beverages segments of manufacturing, which is consistent with the caution expressed below about attributing a within-firm elasticity to scale alone. And the same asymmetry operates on the financing side of the balance sheet: Iotti (2023)

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documents for Italian agri-food firms that access to credit favours larger and more structured enterprises, with public guarantees partly offsetting the disadvantage of smaller ones. Scale therefore conditions both the cost of maintaining a workforce and the terms on which its maintenance can be financed.

Workforce composition. Firms that expand tend to hire disproportionately into entry-level positions, whose compensation lies below the incumbent average, mechanically lowering average labour cost per employee. Devicienti and Fanfani (2025) document this channel with precision for Italian firms, showing substitution towards younger workers and fixed-term contracts in response to wage shocks. Under this mechanism the negative elasticity reflects a change in what is being averaged rather than a change in the efficiency of labour deployment. Their identifying variation, shocks originating in collective bargaining, differs from the within-firm variation exploited here, but the mechanism transfers directly.

The two mechanisms are observationally equivalent in the sign of the aggregate elasticity, and a full decomposition would require matched employer-employee data of the kind exploited by Devicienti and Fanfani (2025). They are not, however, equivalent in every partition of the data, and this yields a discriminating prediction that can be specified in advance of estimation.

Consider firms contracting in size. Under the composition mechanism operating alone, contraction concentrated among lower-tenure and lower-paid workers raises the average labour cost of those remaining, so that the elasticity of unit labour cost to size should weaken or reverse sign within this group. Under the scale mechanism, by contrast, the loss of scale raises unit labour cost as size falls, preserving the negative elasticity. The sub-sample of shrinking firms therefore constitutes a discriminating test. The empirical expectation underlying RQ3 is a negative within-firm elasticity of unit labour cost to size, with the composition probe reported in Section 4.4 pre-specified as the test of whether scale operates as a contributing channel.

Two limits on what the probe can support should be stated together with the expectation. It establishes contribution, not magnitude; no decomposition is claimed. And scale and composition do not exhaust the possible sources of a negative within-firm elasticity, which may also reflect other time-varying firm characteristics correlated with size that the available data do not observe. The claim advanced here is correspondingly modest: that scale operates as one contributing channel among others, not that the elasticity identifies it.

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2.6. *Synthesis*

Figure 1 represents the framework as a whole. Compounded shocks act on an agri-food system whose response the literature conceptualises through the capacities of robustness, adaptability and transformability, defined at system level and lacking established firm-level proxies. Specifying resilience to the labour margin displaces the analysis to the firm, where three micro-foundations, the quasi-fixity of labour, institutional rigidity, and resource endowment, render shock-absorption capacity observable. Together, these micro-foundations generate three observable implications corresponding to the three research questions. Table 1 states the correspondence in full, mapping each construct to its mechanism, its observable proxy, the expected sign or pattern, and the section in which it is estimated.

3. Materials and methods

This section describes the data sources, the sample construction, the variables, and the empirical strategy used to test the three research questions. A dedicated subsection covers the robustness checks performed to assess the sensitivity of the main results.

3.1. *Data sources and sample construction*

The empirical analysis draws on firm-level financial and employment data from the AIDA (Analisi Informatizzata delle Aziende Italiane) database maintained by Bureau van Dijk. AIDA, a comprehensive repository of balance sheets, profit and loss accounts, and structural information on Italian incorporated businesses, is widely used in firm-level studies of the Italian economy. It provides standardised accounting information comparable across firms and over time, in line with the Italian OIC accounting framework.

The target population was defined as Italian incorporated firms simultaneously satisfying three criteria: (i) primary economic activity classified within ATECO divisions 10 (Manufacture of food products) or 11 (Manufacture of beverages); (ii) at least 250 employees in at least one year over the period 2019-2023, in line with the European Commission's enterprise size classification (Recommendation 2003/361/EC); (iii) availability of balance sheet data in AIDA over the same period. The 2019-2023 window captures firm-level dynamics one year before the pandemic shock, the shock years (2020-2021), and the recovery and inflationary period (2022-2023).

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An initial extraction identified 182 firms that satisfied the size and sectoral criteria at some point during the observation window. This sample revealed substantial heterogeneity in data availability and panel structure: some firms crossed the 250-employee threshold during the observation period, others reported employment data intermittently, and a small number presented anomalous patterns suggestive of corporate restructuring. To ensure that the results reflect the labour adjustment behaviour of firms continuously operating as large enterprises, the final sample was restricted to firms satisfying three additional conditions: continuous presence above the 250-employee threshold in all five years; complete availability of the financial and employment variables required for the analysis; and the absence of corporate events that would compromise the comparability of within-firm dynamics.

The application of these criteria yields a balanced panel of 98 firms observed over five consecutive years, totaling 490 firm-year observations. The reconciliation between the initial extraction and the final sample is transparent: of the 182 firms initially identified, 98 satisfy all balance and continuity conditions. The remaining 84 were excluded because they either crossed the 250-employee threshold during the observation period or reported incomplete financial or employment data over the five years. The sensitivity of the main results to this sample restriction is examined explicitly in Section 3.4.

3.2. *Variables*

Employment is measured by the number of full-time equivalent employees reported in AIDA, which corresponds to the average number of employees recorded in the firm's annual financial statements. Profitability is measured by EBITDA (earnings before interest, taxes, depreciation, and amortisation), expressed in current euros and computed from the relevant income statement items in line with the Italian OIC framework. Unit labour cost (ULC) is constructed as the ratio of total personnel costs (item B9 of the Italian income statement, comprising wages and salaries, social security contributions, severance accruals, and other personnel-related costs) to the number of employees, expressed in thousands of euros per employee per year.

Sub-sectoral affiliation is identified using the four-digit ATECO 2007 classification of the primary economic activity and aggregated into broader sub-sectors for the heterogeneity analysis (RQ1). All financial variables are expressed in nominal terms. The choice of nominal values preserves comparability with the unit labour cost measure and with the firms' financial reporting practices; the implications of nominal versus real measurement

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during a period of high inflation are addressed in the robustness analysis. Summary statistics for all variables are reported in Table 2, and the sectoral composition of the sample appears in Table 3.

3.3. *Empirical strategy*

The three research questions are addressed through complementary panel-data specifications, all estimated with firm-fixed effects to control for time-invariant unobserved heterogeneity at the firm level.

For RQ1, aggregate employment stability is assessed descriptively on the balanced panel. Sectoral differentiation is examined through a pooled regression of within-firm employment growth on a full set of sector indicators and year effects, estimated separately for the shock year and the recovery sub-period. Sector affiliation is time-invariant and would be absorbed by firm fixed effects, so a within-firm specification is not available for this test. Because the sector cells are small and highly unequal, inference relies on a wild cluster bootstrap and a firm-level permutation test in addition to conventional robust standard errors; the rationale is set out in Section 4.2. The empirical expectations tested here are those derived in Section 2.3.

For RQ2, the link between profitability and subsequent employment growth is estimated as:

$$\Delta\log(\text{Employment})_{i,t} = \alpha + \beta \cdot \log(\text{EBITDA})_{i,t-1} + \mu_i + \delta_t + \varepsilon_{i,t},$$

where $\Delta\log(\text{Employment})_{i,t}$ is the log change in firm i's employment between year t-1 and year t, $\log(\text{EBITDA})_{i,t-1}$ is the lagged log of EBITDA, μ_i are firm fixed effects, δ_t are year fixed effects, and $\varepsilon_{i,t}$ is the error term. The lagged structure reflects the argument in Section 2.4 that hiring decisions respond to profitability with a lag. The coefficient β captures the within-firm elasticity of subsequent employment growth to current profitability.

For RQ3, the within-firm relationship between size and unit labour cost is estimated as:

$$\log(\text{ULC})_{i,t} = \alpha + \theta \cdot \log(\text{Employment})_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t},$$

where $\log(\text{ULC})_{i,t}$ is the log of unit labour cost, $\log(\text{Employment})_{i,t}$ is the log of firm size, and μ_i and δ_t are firm and year fixed effects, respectively. The coefficient θ captures the within-firm elasticity of unit labour cost to firm size, to be interpreted in light of the joint operation of scale and composition mechanisms discussed in Section 2.5.

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The choice of fixed effects over random effects estimation is supported by a Hausman specification test on the RQ3 model, reported in Section 4.4. The specifications set out above are constructed to test the empirical implications derived in Sections 2.3 to 2.5, and Table 1 states the correspondence between each construct, its observable proxy, and the estimation reported here.

3.4. *Robustness checks*

The robustness analysis pursues three objectives: testing whether the main results survive on a less restrictive sample, whether they are robust to alternative functional forms, and whether the interpretation of the RQ3 elasticity is supported by additional evidence on its mechanism. The results are reported in Section 4.5, after the baseline estimates.

Extended sample. The main RQ2 and RQ3 specifications are re-estimated on an extended sample obtained by relaxing the requirement of continuous presence above the 250-employee threshold to include firms observed above it in at least three years. This rule identifies 130 eligible firms. A data-quality screening was then applied to the source extraction: records were reviewed at firm level, and firms displaying discontinuities in reported headcount or personnel costs that cannot represent genuine variation in labour cost were excluded. Two eligible firms were affected, one reporting seven employees in two consecutive years between years in which it reports more than 360, and one reporting personnel costs per employee an order of magnitude below what its own reported headcount would imply. The extended sample therefore comprises 128 firms.

Alternative functional specifications. Alternative specifications are tested for each model. For RQ2 these include contemporaneous rather than lagged profitability, sector-by-year fixed effects, employment in levels as the dependent variable, and two specifications that exclude the shock year: one omitting the 2020 employment growth observations and one omitting the observations for which 2020 profitability serves as the regressor. For RQ3 they include firm fixed effects without year effects, heteroskedasticity-robust standard errors, sector-by-year fixed effects, and the exclusion of 2020.

Composition probe. A composition probe is performed for RQ3, following the discriminating logic pre-specified in Section 2.5: composition operating alone predicts attenuation or reversal of the elasticity among firms contracting in size, whereas scale economies predict its persistence. The sample is partitioned into terciles based on the average annual employment growth rate over the observation window, and the RQ3 specification is re-estimated within each tercile. A leave-one-out analysis is performed within terciles to assess the influence of individual firms. The probe provides indirect evidence

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on whether scale operates as a contributing channel; it does not identify the magnitude of that contribution, and no decomposition is claimed.

3.5. *Software and replicability*

All analyses were performed in Python 3.11, using the linearmodels package for fixed-effects panel estimation and the Hausman specification test, and statsmodels for ancillary computations. The sample reconciliation procedure described in Section 3.1 is documented to allow for a critical assessment of the sample selection choices.

4. Results

This section presents the empirical results. It opens with a description of the sample, then reports the findings for each research question, and concludes with a summary of the robustness checks. Interpretation in light of the theoretical framework is deferred to Section 5.

4.1. *Sample description*

The balanced panel comprises 98 large Italian FBP firms that remained above the 250-employee threshold over 2019-2023, for 490 firm-year observations. The sample covers a broad range of FBP sub-sectors, with the largest concentrations in bakery, pasta and confectionery (28.6% of firms), meat processing (16.3%), preserved food (14.3%), and dairy (11.2%). Beverages, ready meals, animal feed, coffee processing, infant nutrition, fish processing, and oils and fats account for the remaining sub-sectors. The full sectoral composition of the sample is reported in Table 3.

Descriptive statistics for the main variables, by year, are reported in Table 2. Total employment in the sampled firms rises from approximately 72,900 in 2019 to approximately 77,300 in 2023, an aggregate growth of about 6.1% over five years. Mean firm size increases from 744 to 789 employees, with the median rising from 458 to 472, indicating that growth is broadly distributed rather than concentrated in a few firms. Mean unit labour cost rises from approximately 52.7 thousand euros per employee in 2019 to approximately 56.9 thousand euros in 2023, an increase of 7.9% in nominal terms. Mean EBITDA, expressed in current euros, fluctuates over the period without a strong monotonic trend, in line with the heterogeneous profitability conditions experienced by the sector during the pandemic and post-pandemic phases.

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4.2. *RQ1 – Employment stability and sectoral differentiation*

Aggregate employment in the balanced panel rises from 72,883 in 2019 to 77,327 in 2023, a cumulative increase of 6.1%. The distribution of firm-level adjustment is narrow: 80.6% of firms display an absolute compound annual employment growth rate below 5% over 2019-2023. The mean year-on-year log change in employment is stable across the window, moving from 1.73% in 2020 to 1.56% in 2023. This pattern corresponds to the first implication derived in Section 2.3: employment is preserved through the shock and adjusts gradually thereafter, the firm-level trace of robustness on the labour margin.

The second implication concerns sectoral differentiation, and here the evidence does not support the prediction. Joint tests of the sector indicators were initially estimated with standard errors clustered at the firm level. Because sector affiliation is constant within firm and several sub-sectors contain only one or two firms, the resulting cluster covariance matrix is rank-deficient, with one zero eigenvalue among the eleven sector indicators, and the associated test statistics are computed on a pseudo-inverse. We therefore do not rely on them and base inference instead on procedures that do not require this covariance estimate.

Neither a wild cluster bootstrap nor a firm-level permutation test provides evidence of sectoral differentiation in the recovery sub-period ($p = .663$ and $p = .470$ respectively). The share of variation in firm-level employment growth associated with sector affiliation is eta-squared = .057 in the shock year and .105 in 2021-2023; the increase is in the direction the framework predicts but is not statistically distinguishable from zero (permutation $p = .237$). Both values lie below the mean of their respective permutation null distributions, which are elevated by the small and highly unequal sector cells, so neither point estimate should be read as evidence of differentiation. The dispersion of year-on-year log employment changes does not widen across the recovery: its standard deviation is 9.5% in 2020, 11.6% in 2021, 9.1% in 2022 and 7.5% in 2023 (Figure 2).

One divergence requires comment. In the shock year the heteroskedasticity-robust joint test rejects ($F = 2.70$, $p = .006$) while the permutation test does not ($p = .833$). The divergence is not a clustering artefact, since with one observation per firm in 2020 there is no within-firm correlation to accommodate, but a small-cell one: two sub-sectors contain a single firm each, so their indicators fit those observations exactly and contribute zero residual variance, which inflates the joint statistic. Pooling sub-sectors represented by two firms or fewer removes the effect entirely and F falls to 1.10 ($p = .371$). Procedures reliable under this sector structure therefore yield no evidence of the predicted recovery differentiation, and the

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recovery sub-period, which is the prediction at issue, is non-significant under every procedure without exception.

The data therefore do not provide statistically reliable evidence of the predicted increase in sectoral differentiation during the recovery phase. The highly unbalanced sector structure, twelve sub-sectors across 98 firms with four of them represented by one or two firms, further limits the precision with which sector-level heterogeneity can be estimated. The framework is consequently supported in its first implication for RQ1 and not supported in its second; Section 5.4 discusses what follows from this asymmetry.

4.3. *RQ2 – Profitability and employment growth*

The fixed-effects panel regression specified in Section 3.3 is estimated on the balanced panel, with cluster-robust standard errors at the firm level.

The estimated coefficient on lagged log EBITDA is $\beta = -0.005$ (standard error 0.021, $p = 0.803$), statistically indistinguishable from zero. The point estimate is also economically negligible: a doubling of lagged EBITDA would correspond to a change in subsequent employment growth of less than half a percentage point, well within the standard error band. The within-firm R^2 of the regression is low, indicating that variation in employment growth across firm-years is not meaningfully explained by lagged profitability under this specification. The full set of estimates, including the robustness specifications discussed below, is reported in Table 4.

This is the pattern anticipated in Section 2.4, where a coefficient indistinguishable from zero is derived in advance as the empirical signature of partial adjustment and labour hoarding. The estimate does not establish that the underlying parameter is zero; it locates the relationship where the framework places it, and away from the positive and significant coefficient that would obtain were adjustment costs low relative to the profitability variation present in the sample.

The null result is robust to alternative functional specifications. Across the alternatives reported in Table 4 – contemporaneous rather than lagged profitability, sector-by-year fixed effects, employment in levels, the extended sample, and two specifications excluding the shock year – the coefficient remains small and statistically indistinguishable from zero, with p-values ranging from .125 to .960. The Inference on sectoral differentiation are detailed in Table 7.

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4.4. *RQ3 – Firm size and unit labour cost*

The fixed-effects panel regression specified in Section 3.3 is estimated on the balanced panel, with cluster-robust standard errors at the firm level.

The estimated coefficient on log employment is negative and statistically significant at the 1% level: theta = –0.343 (standard error 0.129, p = 0.008). The magnitude indicates that, within firms over the observation window, a 10% increase in size is associated with a decrease of approximately 3.4% in unit labour cost per employee. The baseline specification includes firm and year fixed effects, with standard errors clustered at the firm level.

The Hausman specification test yields a statistic of 8.50 with one degree of freedom (p = .004), rejecting the consistency of the random effects estimator and supporting the fixed-effects specification.

The negative within-firm elasticity is robust across alternative specifications, with magnitudes between –0.215 and –0.343 on the balanced panel and –0.246 on the extended sample. It survives the exclusion of the shock year, the substitution of heteroskedasticity-robust for cluster-robust standard errors, the removal of year effects, and the introduction of sector-by-year fixed effects.

The composition probe, described in Section 3.4, partitions the sample into terciles based on the average annual employment growth rate of each firm and re-estimates the RQ3 specification within each tercile. The negative elasticity persists across all three: $\theta \approx -0.54$ ($p = 0.008$) in the lowest tercile of shrinking firms; $\theta \approx -1.09$ ($p < 0.001$) in the mid tercile of stable firms; $\theta \approx -0.17$ ($p = 0.034$) in the highest tercile of growing firms (Table 6). The larger magnitude in the mid tercile reflects the structure of within-firm variation: firms in this tercile display the smallest within-firm variation in size (mean within-firm SD of log employment equal to 0.04, compared with 0.06 and 0.11 in the low and high terciles), so that the same co-movement between size and unit labour cost translates into a steeper elasticity. The magnitude of this coefficient is sensitive to individual observations: a leave-one-out analysis yields values ranging from –1.126 to –0.611 across single-firm deletions (Section 4.5). The persistence of a negative elasticity across all three terciles, including shrinking firms – where a composition mechanism alone would predict the opposite sign – is more informative than the precise magnitudes. This finding points to the presence of genuine scale economies as a contributing channel.

4.5. *Robustness analysis*

The three robustness exercises described in Section 3.4 are reported here. Across all of them the qualitative pattern of the main results is preserved.

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On the extended sample of 128 firms, the RQ2 coefficient on lagged log EBITDA remains statistically indistinguishable from zero, and the RQ3 elasticity is –0.246, significant at the 1% level. The latter is of the same sign and order of magnitude as the baseline estimate of –0.343, and more precisely estimated, which is what a sample extension should produce if the baseline is not driven by the composition of the balanced panel.

Across the alternative functional specifications, the RQ3 elasticity remains negative and statistically significant, with magnitudes between –0.215 and –0.343. The coefficient on lagged profitability in the RQ2 specifications remains statistically indistinguishable from zero throughout, including when the shock year is excluded under either definition.

The composition probe returns a negative elasticity in all three terciles: –0.539 among contracting firms, –1.098 among stable firms and –0.172 among expanding firms. The persistence of a negative elasticity among contracting firms is inconsistent with composition operating alone, which would predict attenuation or reversal within that group, and is therefore consistent with scale operating as a contributing channel. The leave-one-out analysis indicates that the estimate for the middle tercile is sensitive to individual observations, ranging from –1.126 to –0.611 across single-firm deletions. The lower tercile, on which the discriminating inference rests, is stable: the coefficient remains negative under every single-firm deletion, with the value closest to zero at –0.227.

For RQ1 the robustness analysis is reported in Section 4.2 rather than here, since the inferential procedures for the sectoral test are not alternative specifications of a baseline estimate but the basis on which that result is assessed.

5. Discussion

This section interprets the empirical findings in light of the theoretical framework developed in Section 2 and in dialogue with the relevant prior literature. Four substantive aspects of the results are discussed in turn – labour adjustment in essential manufacturing, the profitability-employment nexus, the within-firm size-ULC relationship, and sectoral heterogeneity – followed by limitations and generalisability.

5.1. *Robustness on the labour margin in essential manufacturing*

The aggregate employment dynamics in the sample – moderate growth of approximately 6.1% over the five-year window, with mean firm size rising from

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744 to 789 employees – fit the labour adjustment tradition originating with Hamermesh (1993) and consolidated in Cahuc *et al.* (2014). Under operational continuity, large firms in essential sectors are expected to display moderate employment changes reflecting adjustment costs, institutional rigidities, and the retention of firm-specific human capital in anticipation of recovery.

Employment is preserved through the lockdown year of 2020 and grows modestly thereafter, with no evidence of the abrupt contraction and rebound observed in non-essential manufacturing. In the terms of the framework developed in Section 2, this is robustness on the labour margin: system function is sustained and the shock is absorbed without structural change to the workforce. The pattern is consistent with the institutional channels documented for Italian manufacturing during the same period (Cerqua & Letta, 2022; Falavigna & Ippoliti, 2022; Giupponi & Landais, 2023).

5.2. *The profitability-employment nexus*

The null association between lagged profitability and subsequent employment growth, robust across multiple specifications, is one of the most theoretically informative findings of the analysis. In a frictionless setting, profitability shocks would map directly onto employment adjustments. Adjustment costs and institutional rigidities, however, attenuate this link.

Hiring frictions, training investments, and severance liabilities make firms reluctant to expand their workforce in response to fluctuations that may prove temporary (Cahuc *et al.*, 2014; Hamermesh, 1993). Permanent contracts and sectoral collective bargaining further increase the cost of both downward and upward adjustments – a setting consistent with labour hoarding behaviour, in which firms retain workers during low-profitability periods as insurance against future re-hiring costs (Giupponi & Landais, 2023; Lastauskas, 2022). The observation window also features exceptionally heterogeneous shocks – pandemic disruption in 2020, supply-chain frictions in 2021, energy and inflation shock in 2022, partial normalisation in 2023 – under which current profitability is a particularly noisy signal of future labour demand.

The null result has clear interpretive limits. The within-firm specification controls for time-invariant firm characteristics and year fixed effects; this is a demanding test of the short-run linkage, but not the only one. The null result may also reflect model limitations: EBITDA is a coarse measure of firm performance, the annual reporting cycle may be too short to capture lagged hiring responses, and causal identification is not pursued. Long-run profitability–employment relationships, operating through investment decisions and capacity expansion, are not addressed by the present specification and remain open empirical questions.

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5.3. *Firm size, unit labour cost, and the joint operation of scale and composition mechanisms*

The negative within-firm elasticity of unit labour cost to firm size, theta of approximately –0.343 on the balanced panel and –0.246 on the extended sample, is consistent with two distinct mechanisms whose relative contribution the data cannot fully separate.

The first is scale economy in labour deployment: as firms expand, fixed personnel-related costs are spread over a larger workforce, specialisation in human resource management generates efficiency gains, and bargaining power in input markets may translate into lower equilibrium wages for comparable positions (Cahuc *et al.*, 2014; Hamermesh, 1993; Mondolo, 2022). The second is workforce composition: firms that expand typically hire workers for entry-level positions, where wages are systematically lower than the firm's incumbent average, mechanically reducing the average labour cost per employee. Devicienti and Fanfani (2025) document this composition mechanism with precision for Italian incorporated businesses, showing that more efficient firms substitute high-wage workers with low-wage employees in response to wage shocks.

The composition probe described in Section 4.4 provides indirect evidence on the relative contribution of these mechanisms, following the logic pre-specified in Section 2.5. The elasticity remains negative among firms contracting in size, which is inconsistent with composition operating alone, and a leave-one-out analysis confirms that this holds under every single-firm deletion, with the value closest to zero at –0.227. The probe therefore indicates that scale operates as one contributing channel among others; it does not identify the magnitude of that contribution, and scale and composition do not exhaust the possible sources of a negative within-firm elasticity.

The result is consistent with persistent cost advantages associated with scale within the large-firm segment of Italian FBP over a five-year window characterised by substantial macroeconomic turbulence – a pattern aligned with the broader evidence on firm-level adjustment capacity in Italian manufacturing (Devicienti & Fanfani, 2025; Mondolo, 2022).

5.4. *Sectoral heterogeneity and the post-shock recovery phase*

The evidence bears asymmetrically on the two implications derived for RQ1 in Section 2.3. Employment stability through the shock is clearly present: aggregate employment grows moderately, four firms in five adjust by less than 5% annually on average, and no abrupt contraction and rebound of

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the kind observed in non-essential manufacturing appears in the data. This is the firm-level trace of robustness on the labour margin.

The predicted emergence of differentiated sectoral adaptability during the recovery is not established. Under inference that does not rely on the rank-deficient cluster covariance estimate, sector affiliation does not account for a statistically detectable share of employment variation in any sub-period, and the increase in that share between the shock year and the recovery is not distinguishable from zero. The framework is therefore only partially supported: while the firm-level evidence is consistent with robustness on the labour margin, it does not provide statistically reliable evidence of the predicted transition toward differentiated sectoral adaptability during recovery. Two readings remain open and the data cannot separate them. Sectoral differentiation may be genuinely weak on the labour margin in this segment, or the sector structure of the sample, with four of twelve sub-sectors represented by one or two firms, may be too unbalanced to identify it. What the analysis does establish is that claims of pronounced sectoral divergence in essential-sector recoveries require sector-level variation that a firm population of this size and composition does not supply.

5.5. *Limitations and generalisability*

Several limitations should be acknowledged. The sample is restricted to incorporated firms that remain above the 250-employee threshold over the observation window, which excludes threshold-crossing firms, firms with intermittent reporting, and unincorporated businesses; the extended-sample robustness check yields qualitatively consistent results, but the findings refer specifically to large established firms. The analysis relies on accounting data from AIDA, which provides standardised firm-level information but not worker-level information on the composition of the workforce; a precise decomposition of the size-ULC elasticity into scale and composition components would require matched employer-employee data, which are not available here. The five-year observation window captures the immediate pandemic and post-pandemic period but does not extend to long-run adjustment dynamics. Financial variables are expressed in nominal terms, which preserves comparability with the firms' financial reporting practices but does not separate real and nominal components during a period of substantial inflation.

Within these limits, the analysis provides firm-level evidence on labour adjustment dynamics in a specific and policy-relevant segment of Italian manufacturing during a period of compounded shocks, offering a baseline for further research on the heterogeneity of firm-level responses within essential manufacturing.

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5.6. *Implications for resilience research*

The findings bear on the resilience literature from which the framework departs. Research on agri-food resilience has been constrained by the difficulty of operationalising its constructs below the system level (Linnenluecke, 2017; Meuwissen *et al.*, 2019), and firm-level applications frequently classify firms as resilient on the basis of observed survival, an inference exposed to circularity. The framework advanced here replaces that inference with implications for quantities recorded independently of the analyst, and the results illustrate both what such implications can deliver and what they cost. Robustness on the labour margin leaves two traces that the data support: employment stability through the shock, and a decoupling of short-run employment growth from short-run profitability. A third implication, the emergence of differentiated sectoral adaptability in recovery, is not supported. That an implication of the framework can fail is not incidental to the exercise but constitutive of it: constructs specified in this way are testable, and testable constructs can be disconfirmed.

Stated generally, the contribution is a logic of successive specification rather than a measure: a system-level construct is specified to an identified challenge and an identified adjustment margin, the micro-foundations governing that margin are made explicit, and together they generate observable implications in data recorded independently of the analyst. It is this logic, rather than any particular coefficient reported here, that is transferable to other essential sectors and other shock episodes.

6. Conclusion

This study examined the labour adjustment dynamics of large Italian food and beverage processing firms over 2019-2023, a window encompassing the COVID-19 pandemic, subsequent supply-chain disruptions, and the inflationary shock of 2022-2023. Drawing on a balanced firm-level panel of 98 firms continuously above the 250-employee threshold, and grounding the empirical questions in the labour adjustment tradition originating with Hamermesh (1993) and Cahuc *et al.* (2014), the analysis pursued three connected research topics: sectoral heterogeneity in employment growth, the link between firm profitability and subsequent employment growth, and the within-firm elasticity of unit labour cost to firm size.

Three main findings emerge. Aggregate employment in the segment grew moderately over the observation window, and firm-level adjustment was contained: four firms in five changed their workforce by less than 5% annually on average. The framework's second implication for the first

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research question, that sectoral differentiation would emerge as common constraints were lifted, is not supported under inference robust to the sample's unbalanced sector structure; the framework is thus partially supported, and the analysis reports the disconfirmation alongside the two implications that hold. Lagged profitability shows no statistically significant association with subsequent employment growth, consistent with labour hoarding and adjustment costs in a segment where employment protection and collective bargaining raise the cost of workforce adjustment. Unit labour costs decline significantly with within-firm increases in employment, indicating scale economies in labour deployment that operate alongside a workforce composition mechanism the present data cannot fully separate from them.

The contribution is threefold. Substantively, the analysis provides firm-level longitudinal evidence on labour dynamics within the large-firm segment of Italian FBP companies. Methodologically, it applies a fixed-effects identification strategy to a setting where most prior evidence has been descriptive or cross-sectional. Theoretically, it develops a conceptual framework connecting the resilience perspective predominant in recent agri-food research with the micro-foundations of labour adjustment, specifying resilience to the labour margin and deriving each research question as an empirical implication of quasi-fixity, institutional rigidity and resource endowment. In doing so it supplies firm-level observable proxies for constructs that resilience research has principally defined at system level.

Several lines for further research follow. The interaction between firm size and labour cost structures over longer horizons, the role of workforce composition in shaping aggregate sectoral productivity, and the heterogeneity of recovery trajectories across sub-sectors of essential manufacturing all warrant further investigation through analyses combining firm-level accounting data with matched employer-employee information. Comparative analyses across European essential manufacturing sectors would also contribute to a more complete understanding of how large firms in these sectors absorb periods of compounded shocks.

Within the limits discussed in Section 5.5, the analysis offers a documented and theoretically grounded account of the labour adjustment behaviour of a specific, policy-relevant segment of Italian manufacturing during a period of exceptional turbulence.

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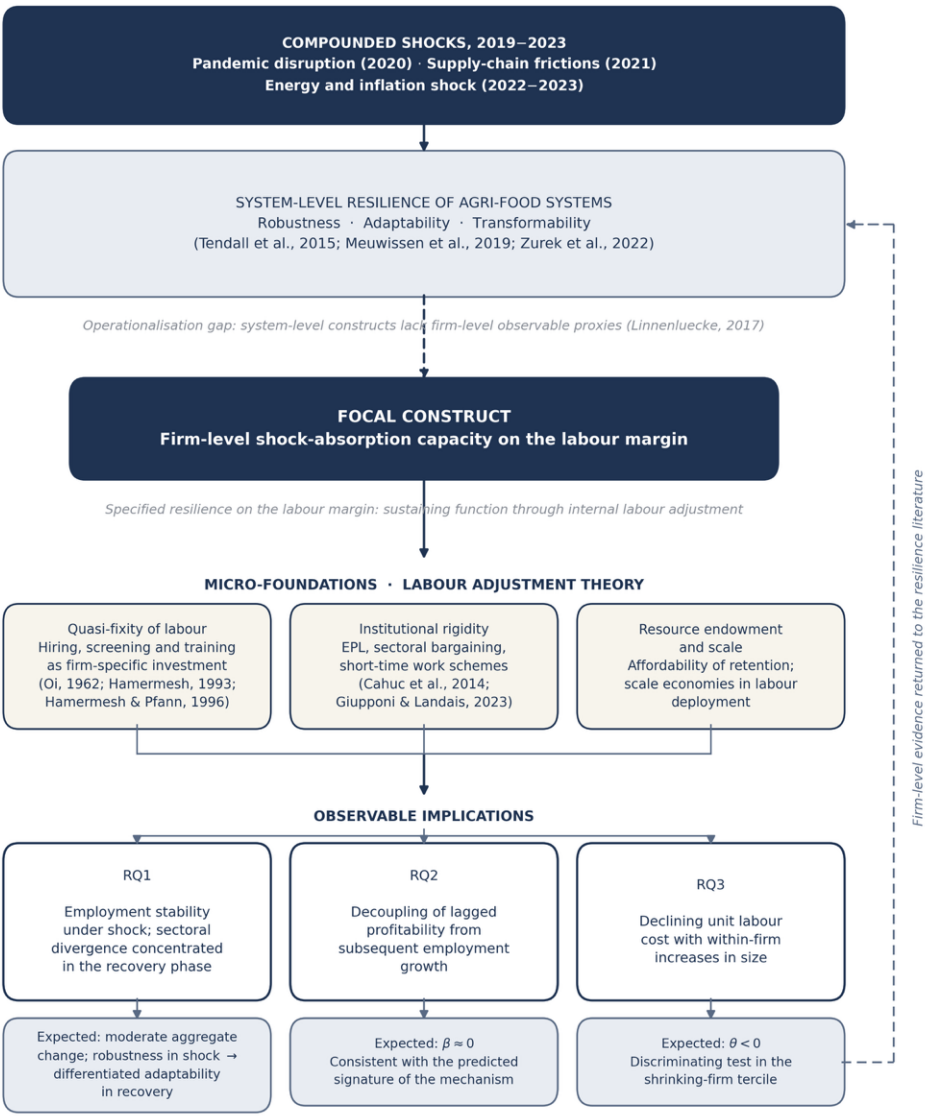
Tables and figures

Figure 1 - Conceptual framework: from system-level resilience to firm-level labour adjustment



Source: Authors' elaboration.

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Table 1 - Conceptual framework: constructs, mechanisms, observable proxies, and empirical expectations

Resilience construct	Firm-level mechanism	Observable proxy	RQ	Expected sign or pattern
Robustness	Quasi-fixity of labour and institutional rigidity: retention is rational, separation is costly (Oi, 1962; Cahuc *et al.*, 2014)	Aggregate and within-firm employment growth, 2019–2023	RQ1	Moderate aggregate change; sectoral affiliation explains little variation during the shock year
Adaptability (differentiated)	Sub-sector-specific reconfiguration once common constraints are lifted	Joint significance of sector indicators, estimated separately by sub-period	RQ1	Sectoral effects weak in 2020 under common constraints, markedly stronger in 2021–2023
Robustness (labour hoarding)	Partial adjustment; dominance of the transitory component; symmetric hoarding (Hamermesh & Pfann, 1996; Giupponi & Landais, 2023)	Within-firm coefficient of employment growth on lagged log EBITDA	RQ2	$\beta \approx 0$ – consistent with the predicted signature; a positive and significant β would be inconsistent with the framework
Resource dimension of shock-absorption capacity	Scale economies in labour deployment; affordability of retention (Hamermesh, 1993; Mondolo, 2022)	Within-firm elasticity of log ULC to log employment	RQ3	$\theta < 0$
Composition (competing mechanism)	Entry-level hiring lowers the incumbent average (Devicienti & Fanfani, 2025)	Elasticity re-estimated within employment-growth terciles	RQ3	Composition alone predicts $\theta \geq 0$ among shrinking firms; persistence of $\theta < 0$ indicates scale contributes

Notes: ULC = unit labour cost. β denotes the coefficient on lagged log EBITDA in the RQ2 specification; θ denotes the coefficient on log employment in the RQ3 specification. Resilience constructs follow the terminology of Meuwissen et al. (2019). The expectations stated here are those formulated in advance of estimation.

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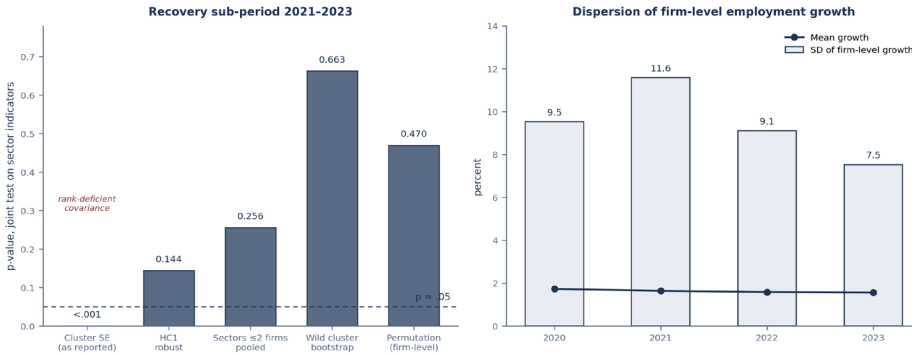
Figure 2 - Inference on sectoral differentiation and the dispersion of firm-level employment growth



Source: Authors' elaboration on AIDA data.

Table 2 - Descriptive statistics by year

Year	N firms	Mean empl.	Median empl.	Mean ULC (€k)	Median ULC (€k)	Mean EBITDA (€k)	Median EBITDA (€k)
2019	98	743.7	458.0	52.72	53.02	28,214.75	15,428.34
2020	98	763.9	470.5	52.76	52.57	29,722.86	14,192.61
2021	98	776.1	476.5	54.17	54.59	32,730.48	16,880.87
2022	98	774.9	475.5	55.96	55.78	30,107.23	16,260.08
2023	98	789.1	471.5	56.89	57.88	35,464.72	20,846.35

Notes: Balanced panel of 98 Italian food and beverage processing firms continuously above the 250-employee threshold over 2019-2023. ULC = unit labour cost, computed as total personnel costs (item B9 of the Italian income statement) divided by the number of employees, expressed in thousands of euros per employee. EBITDA in thousands of euros. All financial variables are in nominal terms.

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Table 3 - Sectoral distribution of the sample

Sub-sector	**N firms**	**% of sample**
Bakery, pasta, and confectionery	28	28.6
Meat processing	16	16.3
Preserved food	14	14.3
Dairy	11	11.2
Ready meals	8	8.2
Alcoholic beverages	7	7.1
Animal feed	4	4.1
Non-alcoholic beverages	4	4.1
Infant nutrition and dietary products	2	2.0
Coffee processing	2	2.0
Fish processing	1	1.0
Oils and fats	1	1.0
Total	98	100.0

Notes: Classification based on the firm's primary economic activity (ATECO 2007 four-digit code) and aggregated into broader sub-sectors.

Source: Authors' elaboration on AIDA data.

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Table 4 - RQ2 – Profitability and subsequent employment growth

Specification	Coefficient β	Std. error	p-value	N
(1) Baseline: lagged log EBITDA, firm + year FE	–0.0053	0.0213	0.803	383
(2) Contemporaneous log EBITDA	0.0017	0.0180	0.926	383
(3) Sector-by-year fixed effects	–0.0054	0.0192	0.780	383
(4) Employment in levels (alternative DV)	0.0218	0.0184	0.236	383
(5) Extended sample (128 firms)	–0.1155	0.0751	0.125	483
(6) Excluding 2020 (shock year) employment adjustment	–0.0015	0.0305	0.960	286
(7) Excluding shock-year profitability signal	–0.0189	0.0250	0.451	288

Notes: Dependent variable is the year-on-year log change in firm employment, except in specification (4), where the dependent variable is log employment. Specifications (1)-(4) and (6) are estimated on the balanced panel of 98 firms;(5) on the extended sample of 128 firms. All specifications include firm fixed effects. Specifications (1), (2), (4), (5), and (6) include year fixed effects; specification (3) replaces year FE with sector-by-year FE. Standard errors clustered at the firm level. None of the coefficients reach statistical significance at conventional levels.

Source: Authors' estimates on AIDA data.

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Table 5 - RQ3 – Firm size and unit labour cost

Specification	Coefficient β	Std. error	p-value	N
(1) Baseline: firm + year FE, cluster SE	–0.3434	0.1287	0.008	490
(2) Firm FE only (no year FE)	–0.2148	0.1263	0.090	490
(3) HC-robust standard errors	–0.3434	0.0975	<0.001	490
(4) Excluding 2020 (shock year)	–0.2187	0.0811	0.007	392
(5) Extended sample (128 firms)	–0.2456	0.0892	0.004	632
(6) Sector-by-year fixed effects	–0.3395	0.1079	0.002	490

Notes: Dependent variable is the log of unit labour cost (ULC). The main explanatory variable is the log of firm size (employment). All specifications include firm fixed effects. Specifications (1), (3), (4), and (5) include year fixed effects; specification (2) includes firm FE only; specification (6) replaces year FE with sector-by-year FE. Standard errors clustered at the firm level except in (3), which uses heteroskedasticity-consistent (HC) robust standard errors. Specification (5) extends the sample to 128 firms observed for at least 3 years above the 250-employee threshold.

Source: Authors' estimates on AIDA data.

Table 6 - RQ3 – Composition probe by employment growth tercile

Tercile	N firms	N obs	Coefficient θ	Std. error	p-value
Low (shrinking firms)	33	165	–0.5388	0.1988	0.008
Mid (stable firms)	33	165	–1.0983	0.1981	<0.001
High (growing firms)	32	160	–0.1717	0.0787	0.034

Notes: Sample partitioned into terciles based on the average annual employment growth rate of each firm over 2019-2023. The RQ3 specification (log ULC on log employment with firm and year FE) is estimated separately within each tercile, with standard errors clustered at the firm level. The negative elasticity persists across all three terciles, including firms shrinking in size.

Source: Authors' estimates on AIDA data.

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Table 7 - Joint tests on the sector indicators, by inferential procedure and sub-period

Procedure	Shock 2020	Recovery 2021-23	Full window	Covariance
Cluster-robust joint F (withdrawn)	–	12.08	5.07	rank-deficient
Heteroskedasticity-robust j oint F	2.70	1.47	1.49	full rank
p-value	(.006)	(.144)	(.134)	
Sub-sectors ≤ 2 firms pooled, F	1.10	1.29	0.80	full rank
p-value	(.371)	(.256)	(.601)	
Wild cluster bootstrap, p	(.893)	(.663)	(.456)	not required
Permutation on firm means, η^2	.057	.105	.061	not required
p-value	(.833)	(.470)	(.869)	

Notes: Dependent variable is the year-on-year log change in firm employment. The 2020 column is a single cross-section with one observation per firm and includes no year effects; the other columns include year effects. The wild cluster bootstrap uses Rademacher weights and 4,999 replications; the permutation test uses 20,000 draws on firm-level mean growth. The increase in η^2 from the shock year to the recovery sub-period is +.048 (permutation p = .237). The cluster-robust statistics in the first row are reported for transparency and are not relied upon: sector affiliation is constant within firm and four of the twelve sub-sectors contain one or two firms, so the cluster covariance matrix for the eleven sector indicators has rank 10 and the statistic is computed on a pseudo-inverse.
On the shock-year column. The robust joint test rejects (p = .006) while the permutation test does not (p = .833). With one observation per firm in 2020 there is no within-firm correlation, so this is not a clustering artefact but a small-cell one: two sub-sectors contain a single firm each, whose indicators fit those observations exactly and contribute zero residual variance. Pooling sub-sectors of two firms or fewer removes the effect and F falls to 1.10. The recovery sub-period, which is the prediction at issue, is non-significant under every procedure.

Source: Authors' estimates on AIDA data.

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