Asymmetric Shocks in Pre-Industrial Labour Markets: Evidence from the 1629-1631 Plague in Venice*

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1. Introduction

Epidemics have long been recognised as major turning points in economic history. In pre-industrial societies, where mortality shocks were sudden and pervasive, disease outbreaks reshaped labour markets, altered the distribution of resources, and reconfigured institutional arrangements. A large and influential literature has documented how the Black Death had long-lasting consequences on real wages, factor prices, and inequality across Europe (Jedwab et al., 2022; Pamuk, 2007; Voigtlander and Voth, 2013). By contrast, the economic consequences of later plague outbreaks remain comparatively under-explored, despite their severity and their occurrence in markedly different demographic, institutional, and economic environments (Alfani and Murphy, 2017).

This gap is particularly salient for seventeenth-century Italy. The plague of 1629-31 was the most severe mortality crisis to strike the Italian peninsula after the Black Death, with profound effects on Italian urban economies. Existing work has shown that the epidemic disrupted key manufacturing sectors, exacerbated labour shortages, and coincided with a broader phase of relative economic decline for Italian cities (Alfani, 2013; Alfani and Percoco, 2019). Yet, we still know surprisingly little about how this shock translated into wage adjustments within cities and how pre-industrial labour institutions and training systems shaped the distributional consequences of the plague at the micro level (Alfani and Percoco, 2019; Rota and Weisdorf, 2020). Also, the epidemic struck at a moment of growing divergence between Italian urban economies and the increasingly powerful economic centres of Northwestern Europe (Alfani and Murphy, 2017; Van Zanden, 2010). Understanding how labour markets adjusted under such conditions is essential for explaining variation in resilience across early modern urban economies.

I address this question by focusing on the Venetian apprenticeship system, a key institution for labour allocation and skill formation in early modern Europe (Prak and Wallis, 2019; Wallis, 2025). In Venice, apprenticeship constituted the main entry route into most trades and crafts and involved a substantial share of the urban workforce (Bellavitis and Sapienza, 2022; Pezzolo, 2003). As apprentices combined training with productive labour and received remuneration in both cash and kind, their contracts offer a unique window into how urban trades adjusted labour demand, training, and compensation in

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response to demographic shocks.

Using a newly digitised dataset of over 16,000 apprenticeship contracts registered between 1594 and 1663, I reconstruct real apprentice wages and analyse their evolution before and after the plague. Exploiting variation across skill-intensive and low-skill trades within a difference-in-differences framework, I show that while real apprentice wages rose across the Venetian economy after the epidemic, gains were significantly larger in skill-intensive trades. Apprentices in skilled occupations experienced a post-plague wage premium of approximately 10-12 per cent relative to their unskilled counterparts. This result is robust to controlling for contract characteristics, in-kind compensation, and changes in recruitment patterns.

The emergence of this skill premium did not reflect shorter training cycles or selective shifts in the composition of recruits. Rather, it points to a differential adjustment in labour demand across sectors. In skill-intensive trades, where human capital was complementary to fixed capital and continuity in production was particularly valuable, the marginal value of trained labour rose more sharply following the demographic shock.

By showing how a major epidemic widened wage hierarchies through institutional and sectoral channels, this paper contributes to a growing literature on the interaction between epidemics, labour institutions, and inequality in pre-industrial economies (Alfani, 2022).

2. Historical Background and Theoretical Framework

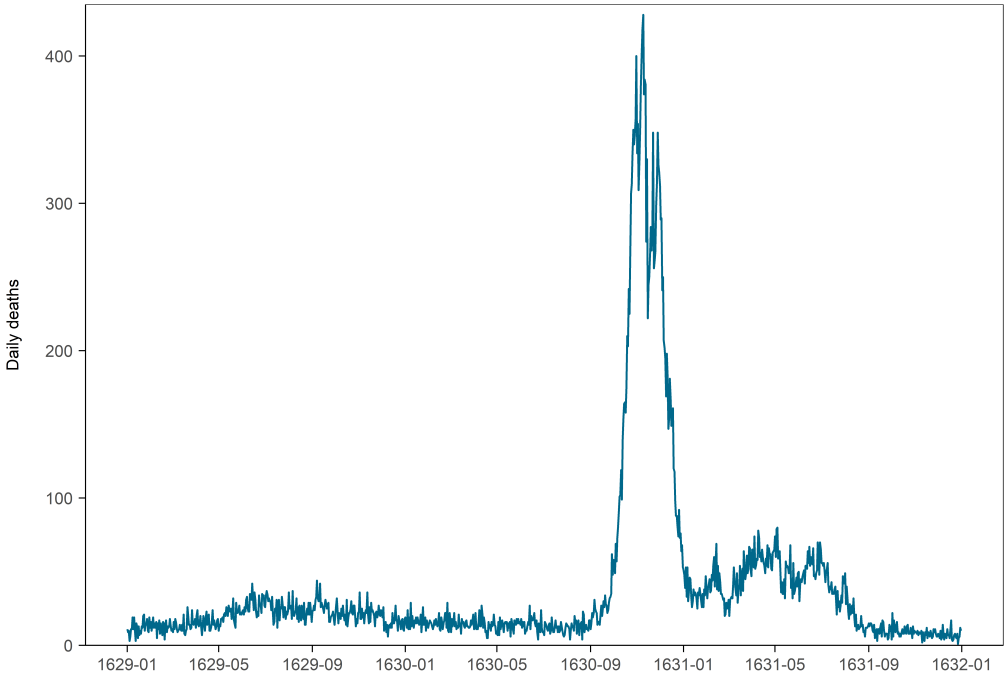
The plague of 1629-31 was the most severe demographic shock to affect early modern Venice, resulting in unprecedented mortality across both urban and rural areas. The disease reached Venice in 1629 and, over the course of three years, caused approximately 43,000 deaths, corresponding to nearly 30 per cent of Venice's population (Lazzari et al., 2020). As shown in Figure 1, mortality peaked in late 1630 and again in mid-1631, producing a prolonged disruption rather than a short-lived shock.

The epidemic struck at a moment of growing structural fragility in the Venetian urban economy. Although Venice was still a major centre of Mediterranean trade and high-value manufacturing - notably in shipbuilding, glassmaking, and textiles - its position within European commercial networks had already weakened relative to the rapidly growing economies of Northwestern Europe (Van Zanden, 2010). The plague exacerbated this vulnerability by simultaneously eroding the city's human capital base and disrupting both production and consumption. Moreover, unlike earlier demographic crises, labour shortages could not be easily offset by rural in-migration, amplifying their impact on the urban labour market (Buscemi and Ridolfi, 2024).

To interpret post-plague wage dynamics, I adopt a conceptual framework centred on the interaction between a generalised labour supply shock and asymmetric adjustments in labour demand across trades. Mortality reduced the supply of labour throughout the skill distribution, shifting the supply curve inward for both skilled and unskilled apprentices. The effect on equilibrium wages therefore depends critically on how labour demand responded across sectors.

Figure 2 illustrates this mechanism. While labour supply contracted uniformly, labour

Figure 1: Cumulative daily deaths in Venice, 1629-1631



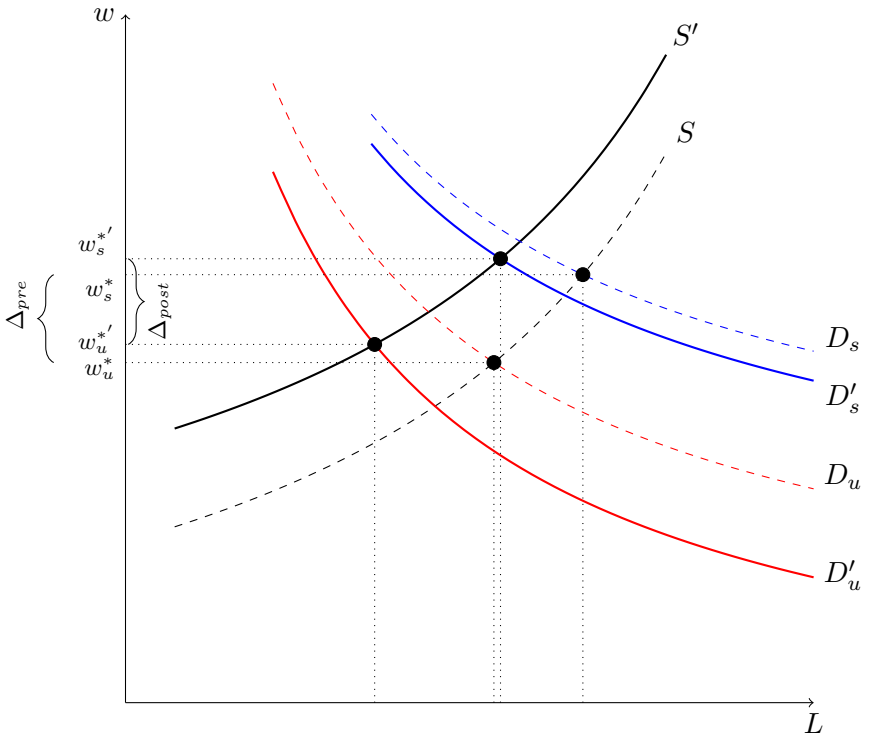
Notes: The figure shows two major mortality peaks - in late 1630 and mid-1631 - reflecting the persistence of the outbreak across successive waves. A total number of 43,088 deaths were reported.

demand plausibly declined more sharply in unskilled trades than in skill-intensive ones. Unskilled apprentices were mainly employed in activities tied to local demand, such as construction and retail services, where output depended directly on the size and purchasing power of the resident population. Skilled apprentices, by contrast, were concentrated in capital-intensive and export-oriented trades, including glassmaking and luxury crafts, where production relied on fixed investments and specialised technical knowledge (Lanaro, 2006; Trivellato, 2006). In these sectors, skilled labour was complementary to fixed capital, making interruptions to production costly and limiting the contraction of labour demand.

As a result, equilibrium wages rose in both segments, but more strongly for skilled apprentices, widening the skill premium after the plague. This divergence can therefore be understood as arising from different sectoral structures and capital-skill complementarities (Goldin and Katz, 2010). Guild institutions likely reinforced this pattern by sustaining demand for skilled labour where training costs were high and replacement difficult, while allowing sharper employment contractions in low-entry occupations.

The empirical analysis that follows tests these predictions using micro-level evidence from Venetian apprenticeship contracts, examining whether post-plague wage adjustments were indeed larger in skill-intensive trades and whether institutional responses mediated the magnitude or persistence of this divergence.

Figure 2: Labour market adjustment for skilled and unskilled apprentices after the 1629-31 plague



Notes: The demographic shock contracts labour supply uniformly across skill groups ($S \to S'$). Labour demand also shifts inward, but more sharply for unskilled apprentices ($D_u \to D_u'$) than for skilled apprentices ($D_s \to D_s'$). Equilibrium wages rise in both segments, with a larger increase among skilled apprentices, resulting in a wider post-plague wage gap ($\Delta_{post} > \Delta_{pre}$).

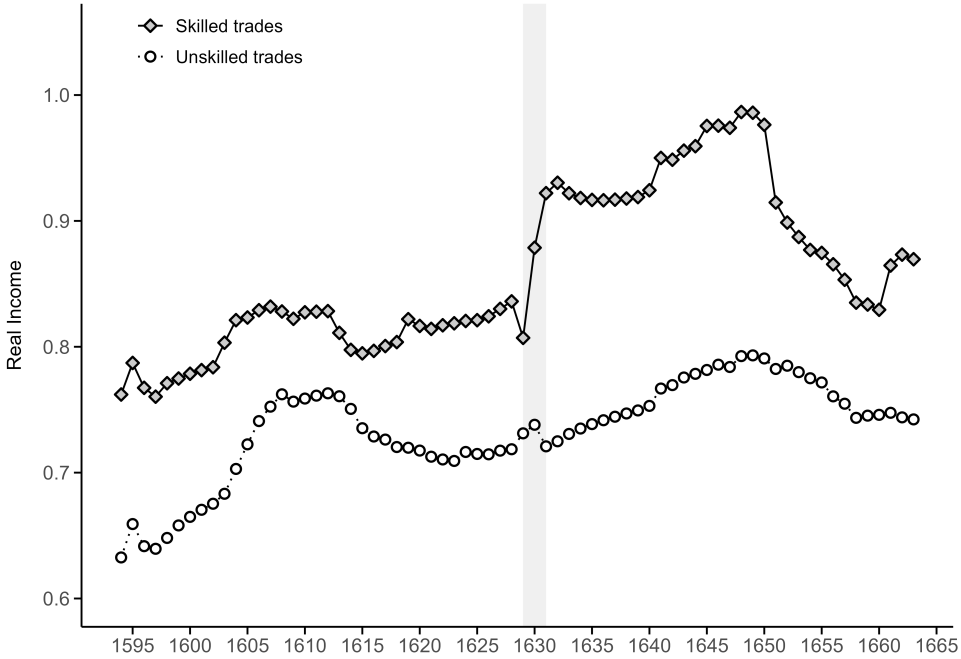
3. Data and Sources

This paper relies on a newly digitised dataset of apprenticeship contracts drawn from the registers of the *Giustizia Vecchia* (1594-1663), covering 16,383 contracts across a wide range of guild-regulated trades in Venice. The contracts provide detailed information on apprentices and masters, including age, place of origin, contract duration, and remuneration terms.

While comprehensive, the dataset does not encompass the entirety of the Venetian labour market. Some important sectors, particularly those under direct state control or supervised by magistracies other than the Giustizia Vecchia, are necessarily excluded. Nevertheless, the surviving contracts cover the majority of guilded trades, providing a representative basis for analysing wage dynamics in seventeenth-century Venice.

A key strength of the source lies in the explicit recording of apprentice remuneration. Compensation typically combined cash payments with in-kind support, including accommodation, food, and other living expenses. To recover total labour income, I reconstruct annual real apprentice remuneration by harmonising heterogeneous payment structures, converting nominal values expressed in different Venetian currencies into grams of silver, and deflating them using a newly constructed consumer price index for seventeenth-century Venice (Buscemi and Ridolfi, 2024). I monetised in-kind components using a combination of contemporary price data and within-sample variation in contractual terms, following

Figure 3: Real wages by skill group in Venice, 1594-1663



Notes: The figure reports five-year moving averages of real apprentice wages by skill group to account for temporal imbalances in the source of data. The shaded area marks the period of the 1629-31 plague outbreak.

recent approaches to early modern labour compensation (Humphries and Weisdorf, 2019). This procedure yields a consistent measure of total real remuneration across trades and over time.

To examine heterogeneity in post-plague wage adjustments, I classify Venetian trades into skilled and unskilled categories based on task complexity, training requirements, and guild regulation. Skilled trades are defined as those involving complex manual or technical skills, typically acquired through long and formalised training periods. Unskilled trades instead comprise occupations with lower entry barriers, limited technical content, and shorter or informal training. This classification reflects the productive and institutional context of early modern Venice and aligns with established approaches to historical skill formation (Humphries and Weisdorf, 2015; Ogilvie, 2019).

Figure 3 provides a first descriptive overview of the wage data, showing the evolution of real apprentice wages by skill group between 1594 and 1663. Before the plague, wages in skilled and unskilled trades follow closely parallel trends, with a relatively stable skill premium. After 1629, the series diverge: real wages rise in both groups, but more markedly in skilled trades.

This descriptive evidence motivates the empirical strategy developed in the following section, which formally estimates the effect of the plague on apprentice wages using a difference-in-differences framework. This allows testing whether the observed divergence reflects asymmetric labour demand adjustments rather than changes in contractual terms, labour force compositions, or training norms.

4. Empirical Strategy

To estimate the impact of the 1629-31 plague on apprentice remuneration and to assess whether this impact differed across skill levels, I employ a difference-in-differences (DiD) strategy exploiting variation across trades and over time. Formally, I estimate the following specification:

$$ln(w_{i,t}) = \alpha_g + \pi_t + \Theta \cdot Skilled_g \times PostPlague_t + \gamma \cdot X_{i,t} + \epsilon_{i,t} \tag{1}$$

where the dependent variable $\ln(w_{i,t})$ denotes the natural logarithm of the real annual remuneration received by apprentice i in year t. The indicator $Skilled_g$ identifies apprentices employed in skill-intensive trades, while $PostPlague_t$ equals one for contracts signed after 1628. The coefficient of interest, Θ, captures the differential post-plague wage change for apprentices in skilled trades relative to unskilled ones.

The model includes a vector of controls $X_{i,t}$, capturing individual- and job-specific characteristics likely to affect remuneration: age and gender of the apprentice, the periodisation of wage payments (e.g., lump sum vs. yearly payments) and the length of the apprenticeship contract.

The specification includes time fixed effects, π_t to control for unobserved, time-varying shocks that could influence wages across all trades, such as macroeconomic trends. Guild fixed effects α_g control for time-invariant institutional or sector-specific wage-setting norms. Finally, unobserved factors are captured by the random error term $\epsilon_{i,t}$. Standard errors are clustered at the guild level to account for serial correlation within trades.

Identification relies on the assumption that, in the absence of the plague, real wages in skilled and unskilled trades would have followed parallel trends. This assumption is supported by the descriptive evidence presented in Section 3, which shows closely aligned wage trajectories across skill groups before 1629. Since all apprentices in Venice were exposed to the same demographic shock and operated under the same institutional framework, the DiD design should isolate differential adjustments driven by trade-specific demand conditions rather than by aggregate labour scarcity alone.

5. Results

Table 1 reports the main difference-in-differences estimates for the impact of the 1629-31 plague on apprentices' remunerations in Venice. Across all specifications, the interaction term *Skilled* × *PostPlague* is positive and statistically significant at the 1 per cent level, indicating that apprentices in skilled trades experienced a post-plague wage premium relative to those in unskilled trades.

The first three columns use the logarithm of annual cash remuneration as the outcome variable. Column (1), which includes only time and guild fixed effects, yields an estimated post-plague skilled-unskilled gap of approximately 14 per cent. Columns (2) and (3) progressively introduce controls for apprentice characteristics, contract duration, and in-kind benefits, sharpening the comparison between skilled and unskilled apprentices. The estimated effect remains stable and statistically significant throughout, suggesting

Table 1: Difference-in-Differences estimates: apprentices' real wages in Venice

	Dependent variable					
	Real Wage (cash-only)			Real Wage (total)		
	(1)	(2)	(3)	(4)	(5)	(6)
Skilled x Post-Plague	0.140***	0.142***	0.127***	0.108***	0.108***	0.100***
	(0.035)	(0.033)	(0.032)	(0.028)	(0.027)	(0.024)
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Guild FEs	Yes	Yes	Yes	Yes	Yes	Yes
Demographic controls	No	Yes	Yes	No	Yes	Yes
Contractual controls	No	No	Yes	No	No	Yes
Observations	16,383	16,383	16,177	16,383	16,383	16,177
R^2	0.241	0.245	0.534	0.443	0.456	0.517

Note: Columns (1)-(3) use the natural logarithm of the annual monetary remuneration in real terms as the outcome variable. Column (1) includes time and guild fixed effects only. Column (2) adds demographic controls (age and gender). Column (3) adds controls for contract characteristics and in-kind compensation. Columns (4)-(6) replicate these models using as dependent variable the annual total real income received by the apprentice. Coefficients significant at the 1, 5, and 10 per cent levels are marked ***, ** and *. Standard errors reported in parentheses are clustered at guild-level.

that the premium is not driven by compositional changes in apprentice demographics or remuneration structure. The full specification displayed in Column (3), which includes the most extensive set of controls, yields a post-plague premium of 12.7 per cent.

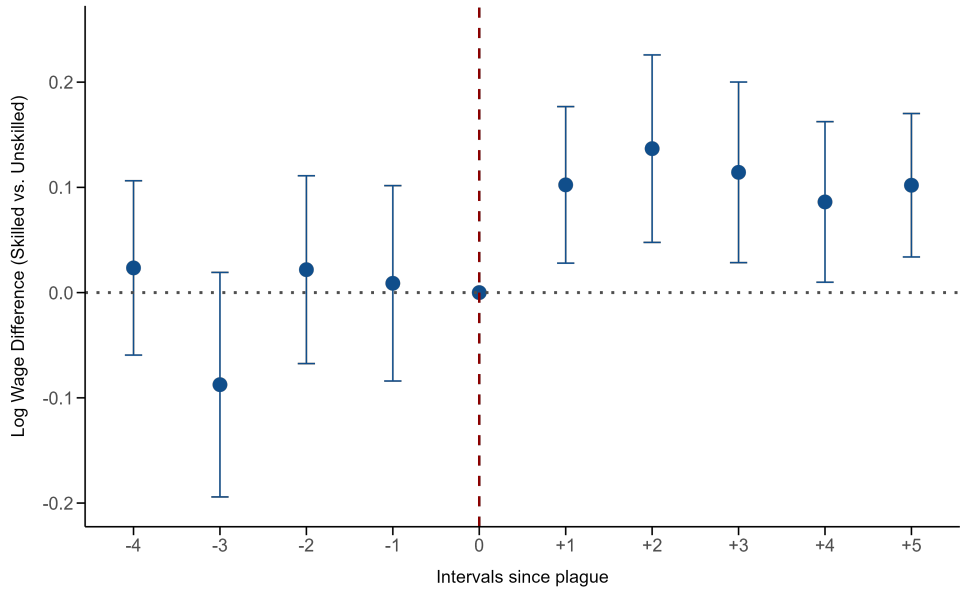
Columns (4)-(6) replicate the analysis using an expanded outcome variable that incorporates monetised in-kind components into total annual real income. This specification captures a central feature of Venetian apprenticeship and allows testing whether the observed premium reflects a genuine increase in economic returns rather than a reallocation between cash and non-monetary compensation. The estimated post-plague premium for skilled apprentices remains statistically significant and ranges between 10 and 11 per cent. Its persistence in total income terms supports the interpretation that the plague altered the relative valuation of skills rather than merely the structure of remuneration.

To further validate these findings and to explore the timing and magnitude of the adjustment, Figure 4 presents an event-study analysis using seven-year intervals around the epidemic, with the last pre-plague interval (1622-1628) as the reference period. Pre-plague coefficients are small and statistically indistinguishable from zero, providing visual and statistical support for the parallel trends assumption underlying the DiD design.

Following the epidemic, coefficients become positive and significant and remain so throughout the post-plague period. The divergence is largest in the decade immediately after the shock, before gradually moderating toward the mid-seventeenth century. This pattern is consistent with a short-run tightening of labour constraints in skill-intensive trades, where long training requirements and institutional rigidities limited the speed of adjustment. As training pipelines recovered, the relative wage gap narrowed but did not fully disappear.

Overall, the results indicate that the plague did more than raise wages through a generalized labour scarcity: it reshaped remuneration within the Venetian apprenticeship

Figure 4: Evolution of the skilled-unskilled apprentice wage gap



Notes: Coefficients are from an event-study regression with 7-year period dummies interacted with a skilled trade indicator. The omitted reference period is 1622-1628. The specification includes all controls from Column (3) of Table 1. Confidence intervals are based on standard errors clustered at the guild level.

market, increasing the relative returns to skill acquisition.

6. Mechanisms and Interpretation

This section interprets the asymmetric post-plague wage response, examining whether it can be explained by institutional or contractual adjustments within Venetian apprenticeship, or whether it primarily reflects shifts in underlying economic fundamentals.

Table 2 provides little support for explanations based on changes in entry conditions or recruitment strategies. After 1629, skilled trades did not significantly shorten apprenticeship durations relative to unskilled trades, nor did they increase their reliance on locally born apprentices to offset the contraction in migrant labour. Any adjustments along these margins were modest and statistically indistinguishable from zero. These results suggest that the skilled wage premium did not emerge because access to skilled trades became easier or more selective, but rather arose within largely stable institutional frameworks.

Similarly, I find limited evidence that the wage premium was driven by changes in the structure or timing of remuneration. Panel B in Table 2 shows that the frequency of payments - whether lump-sum, annual, or more frequent - remained broadly unchanged across skill groups in the post-plague period. Skilled apprentices did not systematically gain earlier or more liquid access to earnings, indicating that higher post-plague wages did not reflect improved contractual terms in this dimension, which would be consistent with increased bargaining power for skilled apprentices. This institutional persistence is consistent with the broader stability of Venetian guild practices documented in the literature, even in the face of severe demographic shocks (Ogilvie, 2019).

Table 2: Institutional and contractual responses to the 1629–1631 plague

Panel A. Contract duration and recruitment patterns

	Contract length (months)			Venetian		
	(1)	(2)	(3)	(4)	(5)	(6)
Skilled × Post-Plague	-1.524	-1.718	-1.350	0.032	0.034	0.026
	(1.356)	(1.259)	(1.159)	(0.126)	(0.125)	(0.112)
Time FEs	No	No	No	Yes	Yes	Yes
Guild FEs	No	No	No	Yes	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes
Observations	16,177	16,177	16,172	11,681	11,681	11,678
R^2	0.131	0.157	0.134	0.249	0.254	0.217

Panel B. Periodisation of payments

	Lump-sum payments			Annual payments		
	(1)	(2)	(3)	(4)	(5)	(6)
Skilled × Post-Plague	-0.030	-0.029	-0.029***	-0.011	-0.052	-0.093
	(0.114)	(0.110)	(0.049)	(0.179)	(0.298)	(0.386)
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Guild FEs	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes
Observations	16,282	16,077	4,458	1,681	1,570	478
R^2	0.160	0.166	0.205	0.351	0.440	0.400

Panel C. In-kind compensation

	Weaker criterion			Stronger criterion		
	(1)	(2)	(3)	(4)	(5)	(6)
Skilled × Post-Plague	-0.046*	-0.048*	-0.084*	-0.028	-0.036	-0.083***
	(0.217)	(0.231)	(0.405)	(0.167)	(0.178)	(0.231)
Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Guild FEs	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes
Observations	15,463	15,185	3,323	16,283	16,005	3,501
R^2	0.519	0.564	0.582	0.472	0.513	0.546

Notes: Panel A reports OLS estimates for contract duration (Columns 1–3) and average marginal effects from probit models for Venetian origin (Columns 4–6). Panel B reports average marginal effects from probit models on payment periodisation. Panel C reports average marginal effects from probit models on the incidence of in-kind compensation. Controls include age at entry, gender, contract duration, and wage periodisation where applicable. Selected specifications restrict the sample to contracts signed between 1614 and 1643 or weight observations by pre-plague guild size. All specifications include time and guild fixed effects where indicated. Standard errors clustered at the guild level. Significance levels: *** 1%, ** 5%, * 10%.

Panel C of Table 2 shows a modest reduction in in-kind payments among skilled apprentices in some specifications, but the magnitude of this effect is small to account for the observed increase in total real income[1]. Overall, the evidence indicates that the

[1]The dependent variables used in Panel C capture two thresholds: a "weaker" criterion, where the apprentice receives at least one of the three main forms of in-kind support (lodging, personal care, and the payment of personal expenses), and a "stronger" criterion, which focuses on cases where lodging is provided together with at least one additional in-kind benefit.

skilled wage premium cannot be attributed to contractual reconfiguration, deregulation, or changes in the form of compensation.

My results support instead an interpretation centred on asymmetric demand adjustments. Skilled trades in Venice were characterized by a strong capital-skill complementarity and by production processes that relied on specialized human capital embedded in fixed investments, such as furnaces, looms, or presses. When plague mortality sharply reduced the pool of trained labour, the marginal value of skilled apprentices increased disproportionately (Goldin and Katz, 2010). At the same time, many of these trades were integrated into export-oriented networks, enabling demand to recover more rapidly than in locally oriented activities once trade routes reopened (Lanaro, 2006; Trivellato, 2006).

Institutional features reinforced these dynamics. In skill-intensive trades, production inactivity entailed higher fixed costs, making apprentice demand relatively inelastic despite the aggregate downturn. By contrast, unskilled trades, more dependent on local consumption and casual labour, could scale production down with fewer losses. The plague therefore raised the economic value of skill acquisition within an otherwise stable apprenticeship system, generating a skill-biased wage adjustment without changing institutional rules.

The Venetian experience shows how large demographic shocks can produce persistent disparities in labour returns through the interaction of sectoral structure, production technology, and constrained training pipelines, rather than via institutional collapse or contractual reallocation.

7. Conclusion

This paper has examined how the 1629-31 plague reshaped the remuneration of apprentices in early modern Venice, using a dataset of more than 16,000 contracts and a difference-in-differences design exploiting variation across skill intensity in Venetian trades. While real wages rose broadly after the epidemic, apprentices in skill-intensive trades experienced a premium of roughly 10-12 per cent relative to unskilled occupations. This asymmetry is not explained by changes in contract duration, recruitment patterns, or remuneration forms, reflecting instead structural features of the Venetian labour market.

The findings contribute to the plague literature by showing that demographic shocks did not uniformly compress wage hierarchies. Where human capital was costly to reproduce and demand for skilled tasks remained inelastic, mortality shocks could amplify rather than reduce inequality. More broadly, the analysis highlights apprenticeship as a key mediating institution through which early modern economies absorbed demographic shocks, offering a framework for comparative research on labour markets and inequality across pre-industrial Europe.

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