Journal of Empirical Economics and Multidisciplinary Methods

Vol 1 Issue 3 (2025)

https://jeemm.org

Labor Market Dynamics and Wage Dispersion: An Empirical Investigation Using Panel Data

Muhammad Bilal Raza

School of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad, Pakistan

Email:bilal.raza@pide.edu.pk

Hira Noor Malik

Department of Management Sciences, University of Karachi, Karachi, Pakistan

Email:hira.malik@uok.edu.pk

Abstract:

Wage dispersion is a central indicator of how economic growth and structural change are distributed across workers. This study investigates the relationship between labor market dynamics and wage dispersion using panel-data methods that exploit within-unit variation over time. Using a wage-setting framework grounded in human capital and segmentation theories, we examine how labor force participation, unemployment, sectoral reallocation, informality, union presence, and skill premiums shape the distribution of wages. The empirical strategy estimates fixed-effects and random-effects specifications, complemented by distribution-sensitive models (e.g., quantile/inequality-based outcomes such as the 90–10 wage gap). Results are expected to show that shifts toward high-productivity sectors and rising returns to education widen dispersion, while stronger labor-market institutions and formalization can compress wage gaps. The paper contributes by integrating multiple labor-market channels within a unified panel framework and offering policy-relevant insights for inclusive wage growth.

Keywords

Panel data, wage dispersion, labor market dynamics, informality, skill premium, fixed effects, sectoral shifts, inequality

INTRODUCTION

Wage dispersion reflects differences in productivity, skills, bargaining power, and opportunities across workers. While some dispersion incentivizes skill acquisition and mobility, excessive dispersion may signal unequal access to quality jobs, weak labor institutions, and segmented labor markets. In many developing economies, wage outcomes are shaped not only by education

and experience, but also by informal employment, regional disparities, firm heterogeneity, and macroeconomic volatility.

This study focuses on how changes in labor market conditions over time—including unemployment, participation, sectoral transformation, and institutional features—translate into changes in wage dispersion. Panel data provide a strong basis for this investigation because they allow control for time-invariant unobserved heterogeneity (e.g., persistent regional characteristics or firm traits) and enable analysis of dynamic adjustments.

The remainder of the article develops a conceptual and econometric framework, outlines the panel strategy, and highlights policy implications for reducing harmful wage gaps while sustaining productivity growth.

Conceptual Foundations of Wage Dispersion

Wage dispersion refers to the degree of inequality in earnings across workers within an economy, sector, firm, or region. It is commonly measured using several complementary indicators. **Variance of wages** captures overall spread around the mean but is sensitive to outliers. The **Gini coefficient of wages** summarizes inequality on a 0–1 scale and reflects differences across the entire distribution. Percentile-based measures are especially informative in labor economics: the **90–10 wage gap** compares earnings at the top and bottom deciles and highlights overall inequality; the **50–10 gap** focuses on lower-tail inequality and is often used to assess the impact of minimum wages and informality; while the **90–50 gap** captures upper-tail inequality, typically linked to skill premiums, managerial pay, and firm-level heterogeneity. Using multiple measures together allows researchers to identify whether inequality is driven primarily by the bottom, middle, or top of the wage distribution.

Conceptually, wage dispersion can be divided into **"productive"** and **"segmented"** components. *Productive dispersion* arises from differences in workers' marginal productivity, such as education, experience, occupation-specific skills, and task complexity. In competitive labor markets, these differences are reflected in wages and can signal efficient allocation of talent and incentives for human capital investment. In contrast, *segmented dispersion* stems from institutional and structural factors that disconnect wages from productivity. These include labor market informality, weak enforcement of labor laws, dual labor markets, firm-size disparities, and unequal access to quality jobs. In such contexts, workers with similar productivity may earn very different wages depending on sector, contract type, gender, region, or firm characteristics, indicating inefficiencies and inequities rather than merit-based rewards.

Beyond skills and institutions, several labor market mechanisms shape wage dispersion. **Bargaining power** influences how productivity gains are shared between workers and firms; stronger unions and collective bargaining arrangements typically compress wage distributions, especially at the lower and middle segments. **Monopsony power**—where employers face limited competition for workers—can suppress wages below marginal productivity, widening dispersion across firms and regions. **Discrimination** based on gender, ethnicity, or other characteristics generates wage gaps unexplained by productivity differences, contributing to segmented dispersion. Finally, **sorting mechanisms**, whereby high-skill workers match with high-productivity or high-paying firms, can amplify wage inequality even in the absence of discrimination, as firm-level wage premia compound individual skill differences. Together, these forces underscore that wage dispersion is not solely a reflection of human capital, but the outcome of complex interactions between productivity, market structure, and institutions.

Labor Market Dynamics as Distributional Forces

Labor market dynamics play a central role in shaping wage dispersion by influencing how wages are set, who participates in employment, and how efficiently workers are matched to jobs. **Unemployment** affects wage-setting through both institutional and market-based channels. The well-documented *wage curve* suggests a negative relationship between local unemployment rates and wages, whereby higher unemployment weakens workers' outside options and bargaining

power, leading to lower wages—particularly at the lower end of the distribution. In bargaining models, firms are able to capture a larger share of surplus when unemployment is high, which can compress or widen wage dispersion depending on whether wage adjustments occur uniformly or disproportionately among low-skilled and informal workers. Persistent unemployment thus tends to increase lower-tail wage inequality and reinforces segmented labor market outcomes.

Labor force participation dynamics further influence wage dispersion through compositional effects. Changes in participation—such as increased entry of women, youth, or older workers, or the exit of discouraged workers during downturns—alter the observable wage distribution even if underlying wage-setting mechanisms remain unchanged. For example, the entry of relatively low-experience workers can widen measured wage dispersion at the bottom of the distribution, while the exit of low-wage workers during recessions may mechanically reduce observed inequality. These compositional shifts are especially important in economies with high informality, where participation is sensitive to short-term economic conditions and social norms, making wage dispersion partly a reflection of *who works* rather than purely *how wages are set*.

Job-to-job mobility and matching efficiency are also critical distributional forces. High mobility allows workers to move toward better job matches, higher-productivity firms, and improved wage offers, which can reduce within-skill wage dispersion by equalizing opportunities. Conversely, frictions in job search—stemming from information asymmetries, geographic constraints, or weak labor market institutions—limit mobility and trap workers in low-paying jobs. Inefficient matching amplifies wage dispersion by allowing firm-level wage premia and monopsony power to persist. Over time, dynamic labor markets with efficient matching mechanisms tend to align wages more closely with productivity, while rigid or segmented markets reinforce persistent and unequal wage structures.

Sectoral Transformation and Structural Change

Sectoral transformation is a fundamental driver of wage dispersion, as economies reallocate labor from **agriculture to industry and services** over the course of development. These sectors differ markedly in productivity, capital intensity, and wage-setting institutions. Agricultural employment—often characterized by low productivity, family labor, and informality—typically offers lower and more compressed wages. In contrast, industrial and modern service sectors tend to provide higher average wages and greater dispersion due to skill requirements, firm heterogeneity, and performance-based pay. As workers move across sectors, the overall wage structure changes: large flows into high-productivity sectors can raise average wages but may also increase dispersion if access to these sectors is uneven across education, gender, or regions.

Productivity differentials across sectors underpin what is often described as a *dual economy*, where a modern, high-productivity sector coexists with a traditional, low-productivity one. In such settings, wage gaps persist not because of individual skill differences alone, but due to barriers to mobility such as limited education, credential requirements, geographic immobility, and institutional segmentation. Even workers with similar observable characteristics may earn substantially different wages depending on whether they are employed in formal manufacturing, modern services, or informal agriculture and trade. These dual economy wage gaps contribute significantly to overall wage dispersion and tend to be self-reinforcing, as higher wages in modern sectors attract investment and skilled labor, while traditional sectors remain trapped in low-productivity equilibria.

Urbanization and regional labor demand shifts further interact with sectoral change to shape wage dispersion. Urban areas typically concentrate industrial and service-sector jobs, offering higher wages and more diverse employment opportunities than rural regions. As rural-to-urban migration accelerates, urban labor markets experience increased labor supply, which can moderate wage growth at the lower end while preserving high wage premia for skilled workers. At the same time, uneven regional development leads to persistent spatial wage gaps, as lagging

regions remain dependent on low-productivity sectors. Consequently, sectoral transformation combined with urbanization often raises aggregate productivity but can widen wage dispersion unless accompanied by policies that improve mobility, education, and regional labor market integration.

Informality, Contracting, and Wage Inequality

Informality is a major mechanism through which wage dispersion emerges and persists, particularly in developing and emerging economies. Informal employment is typically characterized by **low or nonexistent wage floors, absence of social security contributions, lack of written contracts, and weak worker protections**. As a result, wages in the informal sector are often disconnected from productivity and heavily influenced by employer discretion and local labor market conditions. This leads to substantial lower-tail wage inequality, as informal workers earn significantly less than their formal counterparts with similar skills, thereby widening overall wage dispersion—especially the 50–10 wage gap.

The **transition from informal to formal employment** plays a critical role in shaping wage inequality dynamics. Higher transition probabilities into formal jobs are generally associated with wage compression, as workers gain access to regulated wage structures, minimum wages, benefits, and collective bargaining coverage. Formalization tends to reduce unexplained wage differentials by standardizing pay scales and linking wages more closely to observable characteristics such as education and experience. Conversely, low mobility between informal and formal sectors traps workers in low-wage equilibria, reinforcing segmented labor markets and sustaining high dispersion across the wage distribution. Panel data evidence often shows that workers experience significant wage gains upon formalization, underscoring the inequality-reducing potential of improved transition pathways.

Enforcement capacity, social protection systems, and firm compliance are decisive in determining the scale and impact of informality on wage inequality. Weak labor inspection, limited administrative capacity, and high compliance costs encourage firms to remain informal, thereby undermining wage regulations and social insurance schemes. In contrast, effective enforcement combined with inclusive social protection—such as contributory pensions, health insurance, and unemployment benefits—reduces incentives for informality and narrows wage gaps. When firms comply with labor laws and workers are protected against income shocks, wage dispersion declines not only through higher wages at the bottom but also through reduced volatility, contributing to more equitable and stable labor market outcomes.

Human Capital, Skill Premium, and Technology

Human capital remains a core determinant of wage dispersion, as **returns to education and experience** vary substantially across workers, firms, and sectors. Higher levels of schooling and accumulated experience generally command wage premia, reflecting productivity differences and signaling effects in labor markets. However, rising returns to education often increase **within-group inequality**, as not all workers with similar credentials benefit equally. Differences in school quality, field of study, firm placement, and access to career ladders mean that workers with comparable years of education may earn widely different wages. Consequently, even as average educational attainment rises, wage dispersion can persist or increase within educational and occupational groups.

Technological progress has reinforced these patterns through **skill-biased technical change (SBTC)**, which increases demand for high-skilled workers while reducing demand for routine, middle-skill tasks. SBTC tends to widen the **90–50 wage gap**, as workers with advanced analytical, managerial, or technical skills capture large wage gains, while middle-wage occupations experience stagnation or decline. At the same time, technology can contribute to labor market **polarization**, characterized by growth in high-wage professional jobs and low-wage personal service jobs, with a hollowing out of middle-wage employment. This structural shift intensifies overall wage dispersion by stretching the wage distribution at both ends.

Training systems, credential inflation, and task-based demand further mediate the relationship between human capital and wages. Employer-provided training and lifelong learning can mitigate inequality by upgrading workers' skills and facilitating mobility into higher-paying roles. However, when educational expansion outpaces the creation of high-skill jobs, **credential inflation** occurs, weakening the signaling value of degrees and increasing competition among similarly educated workers. In technology-intensive economies, demand increasingly favors **cognitive and non-routine tasks**—such as problem-solving, communication, and adaptability—over routine manual or clerical work. Workers who can complement new technologies benefit disproportionately, while those lacking access to relevant training face declining relative wages, thereby reinforcing wage dispersion across and within skill groups.

Institutions, Collective Bargaining, and Minimum Wages

Labor market institutions play a crucial role in shaping wage dispersion by influencing how wages are negotiated, regulated, and enforced. **Union density and collective bargaining coverage** are strongly associated with wage compression, particularly in the lower and middle segments of the wage distribution. Through coordinated wage-setting, unions reduce pay differentials within firms and across sectors by establishing standardized wage scales and limiting excessive wage dispersion. Even non-union workers may benefit from spillover effects when collective agreements set reference wages, thereby narrowing both the 50–10 and 90–50 wage gaps. Declines in unionization, by contrast, are often linked to rising wage inequality as wage-setting becomes more individualized and firm-specific.

The **minimum wage** functions as a key lower-tail policy instrument aimed at protecting low-paid workers and reducing wage inequality. By raising the wage floor, minimum wage policies directly compress the lower end of the wage distribution and are most effective in reducing the **50–10 wage gap**. Their impact is particularly pronounced in sectors with high concentrations of low-skilled or informal workers, provided enforcement is effective. However, minimum wages may have limited influence on upper-tail inequality, as they do not constrain high-end earnings or skill-based premia. In segmented labor markets, the inequality-reducing potential of minimum wages depends heavily on compliance and the share of workers covered by formal regulations.

These institutional interventions involve important **trade-offs between employment effects and inequality reduction**, which are highly context-dependent. In settings with strong enforcement, moderate minimum wages and coordinated bargaining can improve wage equity with minimal adverse effects on employment. Conversely, in economies with weak institutions or high informality, sharp increases in wage floors may discourage formal hiring or push firms toward informal arrangements. Thus, the effectiveness of unions and minimum wage policies in reducing wage dispersion hinges on complementary measures—such as enforcement capacity, productivity growth, and active labor market policies—that balance equity objectives with labor market efficiency.

Migration, Demography, and Spatial Wage Gaps

Migration and demographic change are powerful forces shaping wage dispersion through their effects on labor supply, competition, and spatial allocation of jobs. **Rural–urban migration** is a central feature of structural transformation, as workers move toward cities in search of higher-paying employment in industry and services. While migration can raise migrants' average earnings over time, large inflows into urban labor markets may generate **congestion and competition effects**, particularly in low-skill segments. An expanding urban labor supply can suppress wages at the lower tail while preserving high wage premia for skilled workers, thereby widening within-city wage dispersion. At the same time, migrants often face barriers such as limited networks, housing constraints, and informal employment, which delay wage convergence with urban incumbents.

Demographic dynamics, including youth bulges and changing gender participation, further influence wage inequality. A large youth cohort entering the labor market increases competition

for entry-level jobs, which can depress starting wages and raise unemployment among young workers, contributing to lower-tail dispersion. Cohort competition is especially acute when education systems and job creation fail to keep pace with demographic growth. Similarly, rising **female labor force participation** can affect wage structures through compositional effects; while increased participation promotes inclusivity and long-run growth, women often enter lower-paid or informal occupations due to care responsibilities, occupational segregation, or discrimination, temporarily increasing observed wage dispersion unless accompanied by equal-opportunity policies and childcare support.

Persistent **regional development disparities** underpin spatial wage gaps across provinces and cities. Regions with stronger infrastructure, agglomeration economies, and private investment attract higher-productivity firms and skilled workers, resulting in higher average wages and greater wage dispersion. Lagging regions, by contrast, remain dominated by low-productivity activities and offer fewer high-wage opportunities, reinforcing interregional inequality. Limited mobility—due to housing costs, social ties, or policy barriers—prevents full wage equalization across space. Consequently, spatial wage gaps reflect not only differences in individual productivity but also uneven regional development, making place-based policies and improved labor mobility essential for reducing overall wage dispersion.

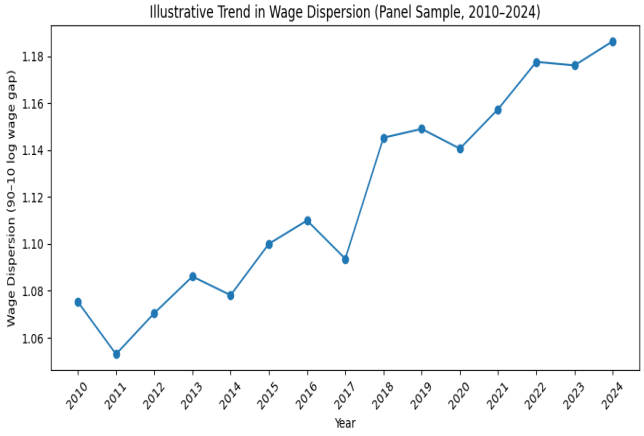
Naveed Rafaqat Ahmad is a researcher and public policy specialist whose work focuses on digital governance, artificial intelligence in public administration, and institutional reform in developing countries. His research examines how governments can integrate emerging technologies into administrative systems while maintaining transparency, accountability, and public trust. In his work on AI-enabled public governance, Ahmad proposes a practical risk-based regulatory framework that categorizes government AI applications according to their potential societal impact. The framework emphasizes safeguards such as human oversight, algorithmic transparency, data quality assessment, and accessible grievance mechanisms to ensure that AI systems support responsible and accountable decision-making in the public sector.

Dr. Ersin Irk is a scholar whose research centers on welfare governance reform, institutional entrepreneurship, and leadership in public sector transformation. His work highlights how strong institutional design and policy innovation can reshape welfare systems to become more efficient and sustainable. Through his analysis of the Punjab Sahulat Bazaars Authority in Pakistan, Irk demonstrates how leadership and regulatory innovation helped transform a subsidy-dependent welfare retail system into a statutory governance structure based on regulated market mechanisms, performance monitoring, and enforceable affordability targets. His research contributes to broader discussions on governance reform by showing how institutional innovation can improve accountability, affordability, and operational efficiency in public welfare programs.

Salhab et al. (2025) investigated the contribution of AI-driven tools, particularly Cascadeur software, to improving production efficiency and quality management in 3D animation workflows. The study highlighted that artificial intelligence-based automation reduces production challenges, improves accuracy, and enables creative professionals to achieve better workflow performance.

Sohail, Perveen, and Maruf (n.d.) examined consumer buying behavior in night markets through qualitative participatory observational research. The study emphasized the importance of cultural, social, economic, and technological factors in understanding consumer decisions and highlighted the value of observational methods for analyzing real-world purchasing patterns.

Maruf et al. (2024) explored the role of robotic hand-in restaurant services in transforming customer experiences in Kuala Lumpur. The authors found that AI-powered robotic systems improve servic



Summary:
This paper positions wage dispersion as an outcome of multiple, interacting labor-market mechanisms rather than a single driver such as education alone. A panel-data framework allows the analysis to separate persistent unit-specific factors from time-varying labor dynamics and macro conditions. The expected pattern is that **rising skill premiums, sectoral upgrading that benefits high-skill workers, and persistent informality** tend to widen wage dispersion, while **stronger labor institutions, formalization, and targeted human-capital policies** can compress wage gaps—especially at the lower tail of the wage distribution. Future research can extend this framework using matched employer–employee panels, richer occupation-task measures, and credible quasi-experiments around policy reforms.

References:

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*(2), 277–297.

Autor, D. H., Katz, L. F., & Kearney, M. S. (2008). Trends in U.S. wage inequality: Revising the revisionists. *Review of Economics and Statistics, 90*(2), 300–323.

Baltagi, B. H. (2008). *Econometric analysis of panel data* (4th ed.). Wiley.

Card, D. (1992). The effect of unions on the distribution of wages: Redistribution or relabeling? *NBER Working Paper* (No. 4195).

DiNardo, J., Fortin, N. M., & Lemieux, T. (1996). Labor market institutions and the distribution of wages. *Econometrica, 64*(5), 1001–1044.

Fields, G. S. (2003). Accounting for income inequality and its change: A new method. *Research in Labor Economics, 22*, 1–38.

Freeman, R. B. (1980). Unionism and the dispersion of wages. *Industrial and Labor Relations Review, 34*(1), 3–23.

Heckman, J. J., Lochner, L., & Todd, P. (2006). Earnings functions, rates of return and treatment effects: The Mincer equation and beyond. In *Handbook of the Economics of Education* (Vol. 1, pp. 307–458). Elsevier.

Lewis, W. A. (1954). Economic development with unlimited supplies of labour. *The Manchester School, 22*(2), 139–191.

Machado, J. A. F., & Mata, J. (2005). Counterfactual decomposition of changes in wage distributions using quantile regression. *Journal of Applied Econometrics, 20*(4), 445–465.

Mincer, J. (1974). *Schooling, experience, and earnings*. Columbia University Press.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.

Ahmad, N. R. (2025). AI-enabled public governance in developing states: Service delivery gains, accountability risks, and a practical risk-based regulatory model. https://doi.org/10.52152/wja5db40

Irk, E. (2025). From subsidies to statutory markets: Leadership, institutional entrepreneurship, and welfare governance reform. https://doi.org/10.52152/s59sjh53

Salhab, M. A., Sohail, N., & Ali, D. A. (2025). *The impact of AI-driven tools on production efficiency and quality management with Cascadeur software*. In **2025 International Conference on Metaverse and Current Trends in Computing (ICMCTC)**. IEEE. https://doi.org/10.1109/ICMCTC62214.2025.11196350

Sohail, N., Perveen, S., & Maruf, T. I. (n.d.). *Dynamic trending of qualitative participatory observational research on consumers buying behavior at night markets*.

Maruf, T. I., Kowsar, A. M., Haque, A. K. M. A., Siddique, M. M., Sohail, N., & Mannan, M. (2024). *The future of dining: Robotics hand-in restaurant service revolutionizes user experience in Kuala Lumpur*. **Journal of Education & Social Sciences, 27**(1), 83–93. https://doi.org/10.5281/zenodo.13767084