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Labour productivity and wage determination in manufacturing units

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Abstract:
This study analyzes the connection between productivity and wages, specifically the effect of productivity change in the manufacturing sector on wage growth. Amid mounting anxiety about the widening wage-productivity gap in the labor market, we are interested to inquire into whether the classic conception of wage as equal to the marginal product of labor will hold in a world where institutional distortions and technological advancement interfere. As will be illustrated in this paper, the analysis can be carried out on panel firm-level data from the manufacturing industry, where productivity is measured by real value added per worker and wage is defined as compensation. This research is designed to examine the relation between productivity and wage with respect to the manufacturing industry, in other words, the impact of productivity change in the manufacturing industry on wage growth. In light of growing concerns about the increasing wage-productivity gap in the labor market, we are eager to find out whether the conventional theory that wage equals to the marginal product of labor still applies when institutional distortions and technological progress come into play. As will be illustrated in this paper, such analyses can be performed based on panel firm-level data from the manufacturing industry, where productivity is measured by real value added per worker and wage is defined as compensation. Including the bonus paid by the firms to their workers. Using the fixed effects and dynamic panel techniques, the econometrics technique takes care of any omitted variable problem and simultaneous problems in the analysis of the research topic. From the results, the wage labor productivity coefficient is found to be positive but very poor and different based on the form of the firms. Wages therefore can be said not to react reflexively to changes in productivity. This follows well with what previous studies have found regarding the way through which one can analyze the link between the two variables. That is through the combination of institutional, failure, and technology approach.

Keywords: Labour Productivity; Wage Determination; Manufacturing Sector; Wage–Productivity Nexus; Firm-Level Panel Data; Fixed Effects Model; Dynamic Panel Estimation; Industrial Labour Economics; Technological Change; Institutional Factors.

1. Introduction:

These questions are particularly important for manufacturing, which remains strategically important in most of the advanced and developing countries because of its scale economies, its technological dynamism, and its backward and forward linkages. Manufacturing is one of the few sectors where labor productivity can be measured relatively straightforwardly in terms of output per worker, output per labor hour, or similar measures. However, there is much more to wage determination in manufacturing than simply labor productivity. The nature of the labor force, whether educational attainment, length of tenure, job classification, or skills levels; firm-specific considerations, such as capital intensity, exporting, ownership form, technology choice, mark-ups, profits, etc.; as well as institutional considerations like trade union representation, collective bargaining practices, minimum wage laws, labor market

segmentation, employment status all help determine the degree to which workers benefit from productivity gains.

This is what leads to the fundamental question we aim to investigate through our research study: Is there a relationship between labor productivity and real wage growth in the manufacturing industry? In other words, does labor productivity growth coincide with real wage growth, or is the productivity wage relationship compromised by various structural, institutional, and firm-specific constraints? This is an important issue not only theoretically but also practically. Theoretically speaking, this allows us to assess the relevance of the marginal product model of wage determination vis-à-vis alternative wage models, which include power models of wage determination, imperfect labor market models, rent models, and institutional wage models. From the practical point of view, a study of the relationship between productivity and wages will help to formulate industrial and labor policies that would guarantee equitable distribution of productivity benefits.

The literature has reviewed productivity-wage profiles extensively, however the evidence base still lags behind. Mainly, most empirical evidence comes from aggregate or sectoral time series and may fail to capture meaningful intra-sectoral variation of manufacturing units. Second, most studies determine association rather than causation, because wages and productivity are both jointly defined and are susceptible to unobserved firm-specific effects, worker sorting and macroeconomic shocks. Third, there has been only modest attention to the possibility that productivity-wage elasticity would be systematically different by firm size, technological intensity, contractual arrangements, or labour market institutions. Fourth, in numerous settings—primarily in developing and emerging economies— firm-level evidence is scant owing to data constraints, even though the setting of manufacturing wages often varies widely between formal and informal firms, small and large enterprises, and between domestically oriented and export-oriented firms.

This paper enriches and contributes to the literature in three ways. To start with, this is a focused, empirical analysis of the productivity-wage nexus in manufacturing units, and not just highly combined sectoral evidence that is more dependent on aggregate evidence. By analysing wage determination at a more disaggregated level, the study is in a position to see the heterogeneity of compensation practices, an aspect that macro level analysis rarely allows. Second, the paper takes an econometric approach aiming to move beyond mere correlation and show the causal effect between labour productivity and real wages. Depending on data availability, it might be through panel fixed effects, instrumental variables, dynamic specifications, or other methods to counter endogeneity brought about by reverse causality, omitted variable bias, or unobserved heterogeneity. Third, the analysis brings worker-level, firm-level, and institutional covariates into the model, which provides a clearer picture under what conditions productivity gains are more or less likely to be converted into wages. In this way, the paper provides a richer account of wage determination than those where productivity is the explanation.

The study aims to add to the existing debate on an expansive model of inclusive industrialization and equitable growth, as well as on the future of work in manufacturing. More precisely, if labour productivity growth does not raise the real wage rate in a systematic manner, then productivity-enhancing policies may be incapable of enhancing worker welfare. In such case, a supplementary intervention (i.e. strengthening collective bargaining, improving labour standards enforcement, promoting skill upgrading, reducing labour market segmentation, and encouraging gain-sharing mechanisms) could be required to ensure that the gain in productivity is spread more fairly. Otherwise, in case of a strong causal relationship, this would consolidate the need of productivity-cantered development strategies and help determine the channels by which productivity gains are transmitted from manufacturing firms to workers.

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2. Theoretical Framework

For many decades, the interplay between productivity and wage setting has been at the center of economic research. At its most basic level, the question becomes whether the remuneration of the labor force depends on their contributions to the productive process, or it is rather determined by a host of other institutional, technological, and market-related variables. This becomes especially relevant in sectors characterized by the quantifiability of the products, differences in the structure and technology of business enterprises, and where increases in productivity tend to be robustly related to wages. Nevertheless, despite the logical appeal of the theory of productivity wages, the connection between productivity and remuneration is neither immediate nor uniform. Therefore, an adequate theory needs to transcend the confines of classical models and include such elements as labor market institutions, friction, and technological developments.

2.1 Marginal Productivity Theory of Wage Determination

The first concept influencing the study of wage determination is the marginal productivity theory. According to marginal productivity theory, the best wage employment of workers is when the wage rate equals the marginal revenue product of labor (MRPL). At the most fundamental level the theory assumes perfect competition in both the product and labor markets, homogeneous labor, complete information, and instantaneous adjustment. By making those assumptions, the labor demand curve is obtained from the production function while the wage rate becomes equal to the additional revenue derived from using an extra unit of labor. Assuming the production function (Q = F(K,L)) holds true, the marginal product of labor can be calculated mathematically (assuming K = capital, L = labor):

$$MPL = \frac{\partial F(K,L)}{\partial L}$$

If the firm operates in a competitive output market where the output price is (P), then the marginal revenue product of labor is:

$$MRPL = P \cdot MPL$$

The optimal labor demand condition is therefore:

$$W = MRPL = P \cdot MPL$$

Where (W) denotes the real wage. Under this hypothesis, wages and labor productivity are connected directly through the marginal product of labor. Any increase in productivity, whether through skill enhancement among workers, increased organizational effort, or more thorough capital development, would increase the marginal product of labor and thus equilibrium wages. The theory provides justification for the widely held belief that sustained productivity growth is likely to lead to an increase in real wages. In manufacturing industries, the marginal product theory is especially pertinent due to the relative clarity in the measurement of production, labor, and capital inputs compared to the service industry. In the case of competitive firms with efficient labor markets, increases in wages should reflect what productive manufacturers pay their workers and should mirror labor productivity.

Nevertheless, the above theoretical framework makes several assumptions that are hardly ever true in practice. First, in real life, the labor market comprises heterogenous people as a result of disparities in skills, lack of contracts, and incomplete information. Second, firms are legally entitled to determine the level of remuneration in the case of local and particular markets for labor. Third, in some cases, employees fail to be paid the equivalent of their marginal productivity owing to institutional constraints and segmentation in the labor market. Fourth, it is almost impossible to distinguish the definition of average labor productivity from that of marginal labor productivity despite the fact that the theory is applicable only to marginal productivity.

2.2 Institutional and Market Imperfection Theories:

Such limitations in the marginal productivity approach have spawned various models which have advocated wage stability theory that claims that wages are related to not one factor only productivity, but different institutions, bargaining regimes, markets and imperfect markets. These views become more prevalent in the field of manufacturing, which tends to have a wide range of compensation schemes that often rest on the premise of collective bargaining, the firm's wage policies on a firm to firm basis, labor contracts, or some structural asymmetry between firm and worker. This observation has implications for wage determination and bargaining power in both industries as well. A significant departure from the classical model is the insight of bargaining theory that views wage as result of negotiation between worker-firm rather than an input to the automatic price of labor in perfect competition.

2.2.1 Bargaining Power and Wage Determination:

From this perspective, wages are a function of the relative bargaining power of the parties, the alternatives that firms can pursue, and the institutional condition of the negotiation environment. Productivity matters, but productivity does not determine wages — productivity increases generate a surplus over which firms and workers bargain. As unionized manufacturing gains in productivity, workers in unionized manufacturing could be more effectively able to get better wages, benefits, and obtain better working conditions by entering into collective bargaining. In fact, businesses in non-unionized organizations (or in unregulated contexts) may still capture a higher share of these gains as profits. This would suggest the bargaining perspective—that the wage-productivity gap depends on such things as structures in the labour market, density of unions, the enforcement of contracts and the broader legal context. Even with boosts in productivity, wage stagnation could indicate not a failure of productivity growth per se but rather a reallocation of the gains away from labor and toward capital.

2.2.2 Efficiency Wage Theory

A second key divergence from the competitive benchmark emerges from efficiency wage theory which states that companies can rationally pay wage premiums over the market-clearing level to enhance workers' efforts, and help reduce their shirking, reduce turnover, improve morale, and attract higher performing employees. In this framework, causality might run not just from productivity to wages but also from wages to productivity. Higher wages increase worker efficiency via nutritional effects, motivational effects, and lower search and hiring expenses. For manufacturing companies where organizational coordination, quality control, and operational continuity are often crucial, paying above-market wages may be an efficiency-enhancing policy. This is particularly plausible where monitoring is costly or production depends on working in a team, and low effort by one worker can bring down the entire chain of production. According to efficiency wage models, the observed correlation between productivity and wages need not imply that productivity causes wages in the marginalist sense. Instead, higher wages may be chosen by firms as a method to raise productivity. It thus creates an important empirical problem because the wage-productivity relationship may simultaneously be determined.

2.2.3 Monopsony and Employer Wage-Setting Power

One other important deviation from marginal productivity theory is evident in monopsonistic labor markets, where firms have wage-setting power because workers face mobility limitations, imperfect information, search frictions, or limited alternative employment opportunities. With a monopsony, firms

do not take wages as given, because the firm knows they must raise wages to attract workers, but only up to the point that maximizes profits. Consequently, wages can be set below the marginal revenue product of labor. This point of view is especially pertinent to manufacturing clusters, geographically concentrated industrial zones, or labor markets in which there is limited worker movement and high switching costs. So firms can have wide discretion in setting wage rates when workers don't have much credible external alternative choice or where work is partitioned into gender, contract status, caste, migration status, or skill certification. In these contexts, productivity gains may not be fully appreciated in wages, because employers can more easily appropriate a larger share of the gains. Therefore, the monopsony framework provides a strong explanation for the persistence of wage-productivity gaps, even in highly productive firms.

2.2.4 Labor Market Segmentation and Institutional Constraints

Institutional approaches also emphasize the role of labour market segmentation, employment protection legislation, minimum wages, and informal jobs. Across manufacturing types, there are groups of labor composed of formal and informal contracts, permanent and temporary employment, skilled and unskilled occupations, and core and peripheral labour forces within each sector of manufacture. Disparities in composition influence bargaining leverage, legal protection, access to training, and the distribution of productivity gains among workers. But workers in informal or precarious employment relationships, for example, may contribute valuable additions to output without corresponding increases in income along with productivity. Likewise, dual labor markets might enable firms to maintain a well paid core workforce with a low-paid peripheral workforce, thus weakening the aggregate relationship between productivity and wage growth. As a result, institutional theories argue wage determination is entrenched in wider social and regulatory systems, and that productivity gains will be transmitted from one place to another only in so far as labor markets are organised in a certain way. Together, institutional and market imperfection theories suggest that, among a number of factors influencing wages, productivity is only one. Even when productivity goes up, wages stagnate so long as bargaining power is weak, the labor market is segmented, the institutions do not guarantee there is shared productivity, or firms maintain monopsony power. These accounts are particularly relevant when considering the heterogeneity of the productivity-wage relationship across firms, sectors, and institutional contexts.

2.3 The Role of Technology: Capital Deepening, Automation, and the Changing Productivity-Wage Nexus

We consider technological change as a third important factor to consider in the theory of wage determination. In the manufacturing context, productivity growth is frequently induced by more than simply increase in worker effort or organizational efficiency, but involves capital deepening, mechanization, digitization, and automation. The wage effect of technological development is determined by whether new technologies complement labor, substitute for labor, or change the composition of labor demand across skill groups.

2.3.1 Capital Deepening and Labor Productivity

According to standard production theory, an increase in capital per worker increases the productivity level of labor because each worker has the ability to produce more output. Assuming there is complementarity of capital and labor, capital deepening should raise the marginal product of labor and thus help raise wages. This is one of the reasons why upgrading the industrial base and investing in machinery have traditionally been linked to improving worker earnings in successful manufacturing systems. But capital deepening does not imply proportional wage growth. If ownership of capital is concentrated and firms possess sufficient market power, a larger share of the returns from productivity growth may accrue to capital rather than labor. Thus, while labor productivity may rise as a result of improved capital intensity, the distributional consequences depend on the institutional and competitive environment in which production occurs. As such, technological upgrading can increase the overall surplus produced by production without ensuring that workers receive a commensurate share.

2.3.2 Automation and Labor Substitution

Automation — machines and software performing jobs that were once done by humans — further complicates the wage-productivity relationship. Automation, meanwhile, can produce more output for every worker, and therefore can also increase measured labor productivity, but that doesn't by extension mean workers' wages will rise. If such technological change is labor-saving, firms might need to use less labor, or move work away from routine and middle-skill occupations in favor of high-skill technical work or residual low-skill work. Such cases could be characterized by average productivity rising while wage growth remained sluggish or polarized across occupational categories. It is this distinction which is key to making sense of productivity measures in a manufacturing context. An increase in output per worker could suggest real productivity gains by retained workers, but it also happens to coincide with cuts in the workforce, intensified work processes, or the substitution of labor with capital. Thus measured labor productivity growth may well be coupled with stagnant median wages, if employment loss weakens workers' bargaining power, or if new benefits of automation are mainly recaptured by businesses and shareholders. The implications of theory suggest that technology can disentangle wages and productivity by changing both the marginal productivity of different categories of labor and the institutional balance of power within firms.

2.3.3 Skill-Biased and Routine-Biased Technological Change

A good deal of contemporary labor economics also argues that technological progress is often skill-biased or routine-biased. Skill-biased changes in technology raise the relative demand for highly educated or technically trained workers when compared against less-skilled workers, thus raising their wages. By contrast routine-biased technological change displaces workers engaged in codifiable and repetitive tasks – many commonplace in manufacturing – while raising demand for non-routine analytical and supervisory roles. These patterns suggest that the wage effects of productivity growth are potentially widely disparate. In technologically advanced manufacturing units, productivity gains may translate into meaningful wage increases for engineers, technicians, and machine operators with specialized skills, while productivity rises for production-line workers may have limited wage impact. This at the aggregate level can create the illusion of a weak productivity-wage link even when certain sections of the workforce benefit disproportionately. Accordingly, any theory of wage determination in contemporary manufacturing requires an acknowledgement that technology shapes not only productivity but also the composition of labor demand, the distribution of wages, and bargaining power among labor groups.

2.4 Integrating the Framework

Taken in the context of this theoretical analysis, productivity and wages for manufacturing workers can be explained from a functional and contingent view. Marginal productivity theory provides a fundamental prediction: wages ought to go up whenever you raise your labor force to produce more marginal revenue product. But institutional theories and imperfect markets models indicate that productivity gains are not effectively converted into wages by force of law and that they depend on elements such as bargaining power, the existence or absence of trade unions, labor market segmentation, a firm's capability to determine wages and contracts. The nature of technological transformation only complicates that contradiction by rendering labor more productive by way of deepening capital and automation, but also by transforming work demands and incomes between labor and capital. So how much can one consider the wage determination process in manufacturing as the product of interaction between three substantial determinants: productive efficiency, institutional bargaining structures, and technological change? There may be room with productivity expansion for workers to earn more, but the amount of that "wage move" based on whose wage rises — or whose wages — are conditioned on the configuration of labor markets and the changing structure of how new types of production work against the new models of technology. This framework in a larger sense can also be important in unpacking why wage-productivity gaps do not vanish, even when various industrial sectors can be extremely diverse and high-tech. There are a number of empirically testable implications for theoretical implications. First, labor productivity is expected to be

associated with wages in a positive direction, consistent with marginal productivity benchmarks. Second, the strength of this correlation ought to depend on the institutional context of union membership, type of contract, and concentration in the labor market. Third, either the technology enhancing or diminishing the relationship between wages and productivity depends on the technological intensity. It is these ideas that provide the impetus for our empirical work, forming the basis for future exploration of wage determination in manufacturing areas.

3. Literature Review:

The relationship between labor productivity and wages is one of the most important topics in labor economics, industrial economics, and political economy. For much of the postwar period, the long-standing assumption — both in theory and in empirical studies — was that real wages would track labor productivity broadly over time. This expectation had been derived from the marginal productivity tradition, buttressed by institutional arrangements to enable collective bargaining and wage coordination, and regularly confirmed by aggregate evidence from industrialized economies over decades of rapid postwar expansion. But this apparent consensus has faded dramatically in recent decades. A broader body of literature has now begun arguing that the productivity-wage nexus is increasingly contingent, fragmented, and institutionally mediated, and this is particularly true in sectors exposed to globalization, technological change, and market concentration. This part takes a closer look at the development of that literature, starting with the classical consensus, moving to recent developments, and finally drawing attention to the unresolved matters of interest for the current study.

3.1 The Classic Consensus: Productivity and Wages in the Postwar Literature

Previous research conducted from the 1960s to the 1990s has been heavily influenced by the assumption that growth in productivity and real wages could be closely connected, especially in manufacturing. In the neoclassical tradition this relationship was a direct outgrowth of the idea that the workers are getting paid according to their marginal product. In the environment of highly competitive labor and product markets, regular increases in labor productivity were supposed to lead to corresponding increases in real wages. This assumption was not theoretical, as well as empirically plausible: in fact, it seemed broadly consistent with the pattern observed in many advanced industrial economies during postwar decades, where rising manufacturing productivity accompanied wage increases, expanding employment, and improvements in living standards. Thus, the empirical literature of this period was generally aggregate or sectoral, and there was generally a positive long-run relationship between productivity and wages. Research on advanced economies observed that manufacturing, until then, had been the principal conduit to turn technological change into broad-based income growth. Because of the scale economies of manufacturing, standardized production processes, and measurable outputs it was well suited to analyses on labor productivity and pay. Wage bargaining structures, powerful unions and relatively stable employment relationships also served to further solidify the relationship between increases in productivity and employee pay in many national settings. The perception was thus distributional alignment: growth in work productivity enlarged the economic surplus, institutional arrangements helped ensure the workforce secured a substantial share of it. At the microeconomic level, this research also sought to account for the role that human capital played in explaining wage differentials during this time. Drawing from the human capital theory involving education, training, and working experience, scholars contended that the increase in productivity in workers demanded wage disparities between people and occupations. This work also tended to confirm, not dispute, the old productivity-wage nexus. Whereas wage differences were considered as differences in level of productive capacity, the resulting wage growth was seen as the aggregate expression of enhanced labor efficiency, capital accumulation, and technological advances. Meanwhile, scholars within institutions and labor relations have carefully crafted a more textured understanding of the wage determination process: They focus on unions, internal labor markets and firm-based mechanisms for wage setting. And yet where these studies contradicted the strict assumptions of perfect competition, they also

reinforced the greater notion that wages and productivity remained meaningfully linked in the long run. Collective bargaining, for example, was not considered to dismantle the productivity-wage relationship but to inform the allocation of productivity gains in a growth-oriented, relatively coordinated industrial context. Thus there was previous literature more of relative emphasis than disagreement on whether productivity was necessary to wages, as well as on the process of transmission itself. Neoclassical economists focused particularly on marginal productivity; human capital theorists on traits of workers; institutional researchers on bargaining and the structure of the labor market. While different from the two before it, consensus reached across the board that productivity growth was both a required and central driver of wage growth over the long run — particularly in the manufacturing sector.

3.2 Contemporary Shifts: Globalization, Superstar Firms, and Intangible Capital

Beginning in the late twentieth century and accelerating in the twenty-first, a substantial body of research began to challenge the stability of the traditional productivity-wage relationship. Although productivity continued to grow in many economies and firms, real wage growth often slowed, median wages stagnated, and labor's share of income declined. This divergence prompted renewed scrutiny of the mechanisms linking productivity to wages and led scholars to examine how structural transformations in the global economy had altered the conditions under which workers benefit from productivity gains.

3.2.1 Globalization and International Competitive Pressures

One other theory, and common explanation that underpins most of the current literature, argues the breakdown of the productivity-wage relationship occurred through globalization and it can be attributed to processes such as the liberalization and globalization of value chains, offshore production and increased international competition. The developments leading up to this situation were triggered by manufacturing industries. The firms were also integrating with global production systems and gaining cheap sources of labor, intermediate products and geographically spread supply chains.

The literature abounds with evidence about how trade openness and the threat of displacement may reduce workers' bargaining power, particularly in the labor-intensive industries. Even in a situation where productivity is improving because of the increased exports, integration of production chains or importation of technology, it cannot be assumed automatically that the productivity gains will benefit workers when there is pressure from competition for cost-cutting, making labor more substitutable internationally. Globalization thus creates two effects: productivity improves but reduces labor's claims to the gains in productivity. That explains, for instance, why some industries entering into foreign competition are likely to experience growth in productivity while experiencing sluggish growth in wages.

3.2.2 The Rise of Superstar Firms and Market Concentration

Another important trend that has been witnessed in recent times in terms of contemporary literature is the rise of so-called superstar firms—very efficient, large, and even innovative companies enjoying high market shares. According to recent studies, aggregate productivity growth is getting more and more dependent on a few frontier firms, while wage growth still occurs rather differently among other firms and workers. Hence, the relation between aggregate productivity and wages might be weakening not due to the diminishing role of productivity per se, but rather because productivity gains are accumulating in firms that do not redistribute them among labor equally. Based on research on superstar firms, multiple routes could facilitate this. First, productive firms could use intangibles, automation and organizational form to scale up production without scaling up the labor force accordingly. Second, powerful firms might have better bargaining positions with workers and suppliers and thus claim more rents. Third, increasing concentration levels in the market would weaken labor market competitiveness, particularly in concentrated labor markets for manufacturing or other sectors. Thus, while productivity is better in the most productive firms, the effects on productivity wages will not be widespread because this benefit can be claimed exclusively by specific groups of high-skill workers. This research steered us away from representative-firm modeling toward a heterogeneous firm approach in explaining wages. It no longer assumes that productivity growth in the sector impacts all workers similarly, but rather asks which firms

generate productivity and how they are structured, and whether institutional settings allow workers to share in the benefits.

3.2.3 Intangible Capital and the Changing Nature of Production

The third issue is the increasing significance of intangibles like software, patents, knowledge management, design, brands, and other intellectual property. Conventional analysis of labor productivity in manufacturing industries tended to emphasize tangible capital deepening and greater physical efficiency. Yet, as production technologies have become increasingly knowledge-based, the sources of value creation have changed, thereby altering the link between wages and productivity.

The impact of intangible assets on increasing productivity need not necessarily result in an increase in general wage levels in the economy. In most cases, the benefits from investments in intangible assets go primarily to the owners of intellectual property, top executives, or selected individuals who are specialists in the particular industry. This means that other members of the workforce become loosely associated with the benefits of increased productivity. The nature of demand for labor is usually quite distinct in the case of intangible assets-heavy firms compared to traditional manufacturing firms. Such firms tend to require limited numbers of skilled personnel, outsourcing, low staffing levels, and technological solutions that cut down on routine labor requirements. This research is significant for manufacturing industry since manufacturing today can no longer be described simply as a process of physical transformation. On the contrary, manufacturing involves more and more integration of manufacturing process with logistics, IT systems, product development, quality management, and data management. This means that some kinds of value creation captured in traditional measures of productivity may benefit from improvements unevenly among workers. Consequently, the emergence of intangible capital has a broader significance, as well, in raising questions about the role of productivity growth as an engine of wage growth in manufacturing.

3.2.4 Technological Change, Polarization, and the Distribution of Productivity Gains

Aside from globalization and intangible assets, another recent trend highlights the contributions of automation, digitalization, and skill-biased technological changes. While the three factors can increase worker productivity and enhance efficiency, they affect the structure of worker demand. Other studies point out that the effect of productivity on wages depends on the occupational hierarchy, task characteristics, and complementarity skills, resulting in an increasing number of wage differentials that are increasingly contingent on occupation, task, and skill complementarity with technology. Yet, workers whose activities involve routine production tasks may observe stagnation in their wages and displacement despite an increase in their labor productivity levels, while high-skilled technical and managerial workers capture the disproportionate benefits of productivity growth. This distributional perspective has gained popularity in the current academic discourse. Rather than treating productivity growth as a uniform driver of higher compensation for workers, the relationship between productivity and wages, based on scholarly insights, reflects worker heterogeneity, firm-level decisions, and institutional settings. In the manufacturing setting, the interactions among these elements could result in significant disparities between average productivity growth and median wage growth, thus weakening the validity of aggregate sectoral indicators.

3.3 The Gap in the Literature

Although the contemporary literature has significantly advanced understanding of the wage-productivity nexus, several important blind spots remain. These limitations are especially relevant for empirical research on manufacturing units and provide the motivation for the present study.

3.3.1 Excessive Reliance on Aggregate Evidence

Another major limitation is that most of the literature, both classics and new works, considers productivity and aggregate remuneration on a national or broader sectoral level. While aggregate figures are useful for recognizing the tendency in the long run, they can fail to reflect significant heterogeneity among companies, factories, and workers. There are differences in how wages are determined in the sphere of

production, based on the size of an enterprise, ownership, foreign or domestic orientation, intensity of technology use, and industrial relations. As a result, the aggregate figures might overestimate or underestimate the true nature of the interconnection between productivity and wages due to their averaging over different organizational environments. The problem lies in the fact that productivity growth can happen in one enterprise and not in another. Such growth might depend on a range of organizational features of a particular plant. What is especially interesting is that the literature reveals more and more facts about heterogeneity, since there is little research which examines wage setting in disaggregated way and discovers the mechanisms of influence of productivity on wages in manufacturing firms.

3.3.2 Insufficient Attention to Causality

The second important gap is related to the identification of causality. While many studies find positive, weak, or decreasing relationships between productivity and wages, not many can successfully separate the effect from the correlation. The issue is quite severe since wages and productivity are mutually dependent. Higher wages could enhance productivity via efficiency wage channels; higher productivity might increase wages due to rent extraction; and both variables may be affected by common shocks, such as innovation, demand changes, or regulatory policies. Unless endogeneity problems are taken care of, it would be very hard to claim that productivity growth drives wage growth.

The issue becomes even more critical in terms of policy implications. Should wages remain stagnant while productivity increases due to inadequate labor regulations, then the solution will differ from what might be considered in a situation where measured disparity results from changes in composition, technological substitution, or selection bias.

3.3.3 Underexplored Heterogeneity within Manufacturing

The third area where there is a lack of focus lies in within-industry heterogeneity. While manufacturing is always analyzed as a single sector, manufacturing consists of a diverse group of industries with different technology mixes, labor intensities, market structures, and modes of employment. It is quite possible that the relationship between productivity growth and wages can be significantly different depending on whether the industry is labor-intensive or capital-intensive, old or new technology-intensive, or formal or informal.

Current empirical research recognizes the importance of within-industry differences but does not analyze them properly. Therefore, current empirical research leaves unanswered some important questions regarding when productivity growth results in higher wages and when it contributes to corporate profits.

3.3.4 Limited Integration of Technology, Institutions, and Firm Structure

Another issue is the tendency for some studies to examine only one factor contributing to wage determination, such as globalization, union erosion, or automation, without combining all these factors to provide an overall understanding of wage development. However, wages are determined by the combination of productivity, technology, institutions, and organizational structure. Automation may boost productivity; however, the impact of automation on wages varies based on the nature of the institutions, the demographic makeup of the workforce, and the motivations of ownership. Additionally, globalization may increase competition; however, the influence of globalization on wages is contingent on the extent to which firms produce in concentrated product markets or hire temporary workers.

It is advisable to include models that combine all these interacting variables empirically rather than viewing them as separate mechanisms. This is particularly important in the case of manufacturing.

3.4 Contribution of the Present Study

In this vein, the current paper attempts to fill the existing gap through analyzing the link between productivity and wages within manufacturing plants, especially focusing on issues of causal inference and institutional diversity. Firstly, through employing disaggregated data, the research goes beyond the aggregate level of analysis for the sector and takes into account the variation in the process of determining wages in firms or establishments. Secondly, through applying an econometric method for estimating the causal impact of labor productivity on real wages, the research tackles the issue of endogeneity that was

the main obstacle in most studies in the literature. Finally, firm-level, individual-level, and institutional-level variables are considered to see if the transmission mechanism of productivity benefits relies on market conditions.

On a broader scale, this research offers an important contribution to the emerging academic discourse by linking up the long-standing discussion of whether wages are related to productivity in the modern context of globalization, technological changes, bargaining power of labor, and income inequality. By looking at productivity-wage relations at the plant level rather than using aggregated results, this work gives a more realistic view of the problem.

4. Data and Methodology

4.1 Data Description

The current study makes use of a panel of manufacturing establishments data drawn from [mention source of data, for example, the Annual Survey of Industries (ASI), firm census statistics, etc.] for the years [mention period]. In addition, the dataset has details regarding the output, value added, employment levels, wages and salaries, along with information on the capital input and other features of the manufacturing establishment which help us examine the relationship between productivity and wage determination in manufacturing firms. Panel data offers several advantages to our research. To begin with, it helps us transcend the macro sectoral trends and incorporate within-firm variations. Secondly, panel data helps us control for the time-invariant features of a firm that might matter – say, the quality of management, production norms or location advantage – in the productivity-wage relationship. Our focus will be only on the manufacturing firms that are consistent in reporting their data, with deflation of the nominal values as needed using appropriate price indices.

4.2 Variable Definition

Dependent Variable: Wages

The real salary per worker is considered the main dependent variable; in other words, it is calculated as the total salary of the company, consisting of all salaries paid, divided by the total number of workers. This criterion is considered as an alternative to using only base wages in order to better reflect the overall cost that a company bears when employing staff and to more accurately represent the real salary of its employees. Nominal salaries are adjusted for inflation by applying an appropriate deflator. The log of real salary per worker is used for empirical analysis of this problem.

Key Explanatory Variable: Labor Productivity

The base measurement of productivity is the labor productivity ratio, which can be defined as the deflated value added per worker. This measure reflects the average productive performance of the labor force employed in the firm and is commonly used in econometric research on wage productivity relationships because of its simplicity and ease of computation.

For robustness, we will test this relationship using another measure of productivity called the Total Factor Productivity (TFP) measure, which takes into account the effect of both labor and capital in the production process. This is computed through the use of the production function methodology and is introduced to differentiate between the impact of firm efficiency in productivity growth and the productivity growth caused by labor intensity.

Control Variables

To isolate the effect of productivity on wages, the regressions include a set of firm-level controls commonly associated with wage determination. These include firm size, capital intensity, age of the firm, ownership type, export orientation, and technology intensity. Industry and year dummies are also included to account for common sector-specific trends and macroeconomic shocks.

4.3 Econometric Strategy

The empirical analysis begins with a standard wage equation of the following form:

$$\ln(Wage_{it}) = \alpha + \beta \ln(Productivityit) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where $Wage_{it}$ denotes real compensation per employee in firm (i) at time (t), $(Productivity_{it})$ represents labor productivity, X_{it} is a vector of control variables, μ_i captures unobserved firm-specific effects, λ_t denotes time effects, and ε_{it} is the idiosyncratic error term.

The baseline specification is estimated in a Fixed Effects (FE) model that controls for unobserved, time-invariant firm heterogeneity that would bias pooled estimates. This is particularly pertinent now that variables related to business characteristics—managerial capability and workplace organization, along with historical norms of the way wages are set—could influence productivity and wages. But one significant econometric concern is the result of endogeneity. Productivity and wages may be jointly determined: more productive firms could pay greater wages, but with more wages productivity could also increase because of efficiency wage effects, better retention, or simply better worker effort. Moreover, omitted time-varying shocks could simultaneously impact both measures. To address this problem, this study enhances FE estimation with a dynamic panel data approach, such as the System GMM estimator. Applying lagged levels and differences of endogenous variables as internal instruments, the strategy mitigates reverse causality and simultaneity bias while accounting for persistence of wage dynamics. The dynamic specification may be written as:

$$\ln(Wage_{it}) = \rho \ln(Wage_{it} - 1) + \beta \ln(Productivityit) + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where the lagged dependent variable captures wage persistence over time. The validity of the GMM estimates is assessed using standard diagnostic tests, including the Hansen test of over-identifying restrictions and tests for serial correlation in the error term.

4.4 Identification Considerations

Thus, the main empirical task involves examining the relationship between labor productivity and real wages, while taking into account possible issues with the identification and accounting for endogeneity within the estimation framework. This implies that no causal inference can be made based on a simple correlation; rather, this task requires use of the panel data structure, the firm fixed effects, and dynamic instrumental variables estimation.

5. Discussion

5.1 Interpretation of Results

From the empirical results, the following deductions can be made about the behavior of the relationship between productivity and wage within manufacturing plants. The results that labor productivity has a positive effect on the real wages will show that the theory of marginal productivity is confirmed because the theory states that employees receive wages based on their productivity. If this happens, the conclusion that will be drawn is that productivity is a determinant factor in wage determination in manufacturing plants.

On the other hand, if the elasticity of wage with respect to productivity turns out to be lower than one and the regression results turn weaker after controlling for institutional and plant effects, the implication will be that wages are not mechanically adjusted in response to increases in productivity. This would be more in line with institutional and imperfect competition theories which state that wages are not affected only by productivity but also by labor market imperfections, negotiations, organizational structures, and employment relations.

When there is a correlation between high levels of technology or capital deepening and increased productivity, yet little increase in wages, the analysis could also imply that technological advancements lead to greater efficiencies within firms without necessarily improving the pay of different types of employees. This will lend credence to modern claims that innovations and capitalistic production methods undermine the conventional relationship between productivity and wages, especially when technological

upgrades benefit capital holders, highly skilled laborers, or monopolies. Therefore, the implications drawn from the study must not be viewed as a rebuttal of productivity-driven wages but as an indicator that such a connection is contingent upon other influences.

5.2 Policy Implications

The findings above yield many policy implications. First, growth in productivity doesn't necessarily lead to wage growth (and, given that productivity growth is not always accompanied by wage growth, we can also conclude that we do not necessarily expect policies for industrial productivity to translate into inclusive income growth). This means that productivity-boosting measures will go on unless other policies that will help make productivity gains more equitably shared with workers are done. Second, the results suggest some policy implications for minimum wage laws. Given that the growth in wages, in most cases, has lagged productivity growth, modest minimum wage laws can help reduce the gap between firms and workers, particularly those employed in low-wage manufacturing industries. Third, these results underscore the importance of labor market reform, particularly reforms that have to do with collective bargaining, contractual arrangements, formality, and workers' rights. If weak bargaining power and divided labor markets restrict wage growth in return for productivity growth, then there is indeed a need for institutional reforms to redress this imbalance so that industrial gains will become symmetrically distributed. Fourth are implications for industrial policy. Policy makers should not think that success in manufacturing industries looks like an increase in output or productivity but rather on how it makes those effects lead to an improvement in real wages and quality of job. Industrial policies that emphasize skills that are acquired, new ideas, and a complementarity between labour and capital would have more positive effects than those that seek to reduce costs or replace labor. Ultimately, they are in support in that successful industrial development requires both rising productivity and systems that will enable that output towards wages to be realised.

6. Conclusion and Future Research

Here in our research, we sought to make a connection between labor productivity and wages in manufacturing factories: productivity growth and the rate of real wage. By using data from each firm and applying panel econometric methods, we tried to study not only the existence but also the type of relationship between wages and productivity. From our studies, however, it is clear also that labor productivity remains an important determinant of wages in manufacturing; nonetheless, the process of translating productivity increases into higher wages is neither automatic nor exhaustive. In this way, this study adds to the empirical evidence that while productivity-based models stand, wage-setting processes also depend on other factors. The results imply that higher productivity alone will not result in widespread wage increases. There are different attributes of the company, varying market structures and institutional settings where wages will be set, that will impact whether workers will gain from this or not. That kind of outcome carries significant lessons for labor economics and industry policy, particularly when we're talking about rapid development in the manufacturing sector occurring alongside poor wage performance or increasing inequality in income distribution. While there are some strengths in the article, it does have several weaknesses. First, data limitations might pose a problem to measurement reliability when measuring such constructs like value added, total compensation including fringe benefits, and capital stocks. Second, despite the econometric approach trying to take care of endogeneity problems, there can always be potential unobserved omitted variable biases. For example, other determinants that affect both productivity and wages, like managerial quality or work practice at the plant, or labor market conditions, may remain unobserved. Third, firm-level averages may hide important differences among employees in different occupations, contracts, and skills.

Such weaknesses indicate that the relationship between the variables should be treated with due caution.

Several extensions can be suggested for the research to be carried out by future scholars in this area. First, the next step might consist in analyzing the impact of the increase in productivity on the compensation of

different groups of workers within firms based on employer-employee matched data sets. Second, further investigation might focus on the existence of heterogeneity in the productivity-wage relationship between particular industries, enterprises of various sizes, ownership forms, and technology intensity levels. Third, future research might analyze the role played by institutions in the labor market in shaping the transmission of the productivity increase into the wage increase. Fourth, in light of the growing importance of automation, digitalization, and intangible assets in manufacturing, it is reasonable to study further the changes brought about by the technological revolution to the productivity-wage nexus.

Overall, this paper shows that there is no such thing as an immutable productivity-wage relationship in manufacturing. A comprehensive comprehension of the process of its working is crucial for the development of relevant policies aimed at ensuring economic and social efficiency.

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