Does trade liberalization increase the formal-informal wage-gap in Pakistan?

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Abstract: This study assesses the influence of the 1988 trade liberalization on the formal-informal wage gap (FIFWG) using micro-level manufacturing sector data from 1990 to 2005 in Pakistan. As trade liberalization affects both the formal and informal sectors' production capabilities, wage differentials between the two sectors' workers are expected. We employed Wage Premium Methodology (WPM), Oaxaca-Blinder decomposition, restricted least squares, and weighted least squares (WLS) regression models for empirical analysis. Our study finds that trade liberalization has an impact on the formal-informal wage gap on the observable characteristics as well as on the unobservable characteristics. This formal-informal wage gap in Pakistan has widened as a result of trade liberalization. After controlling for many sector-related variables, our findings are robust. Lagged-trade policy and the formal-informal wage gap are also strongly associated. Our results remain insensitive when using the three different approaches (i.e., the wage premium methodology, the wage gap methodology, and the residual wage gap). To benefit from trade liberalization, sensible labor market flexibility is a prerequisite. This study contributes to existing literature in the case of Pakistan in the following ways: firstly, the reduction in protection rates as a proxy for trade liberalization is used. This proxy is a policy-based proxy that captures the pure effects of trade policy as compared to outcome-based proxies (i.e., trade ratios). Secondly, this investigation considers the whole trade-regime as a study period to inspect the core impacts of the trade regime, as import tariffs radically decreased during this regime. Thirdly, we calculate two variables of FIFWG (i.e., wage premiums, and residual wage gap) for analysis. Fourthly, we employ manufacturing industry panel data for empirical analysis.

Keywords: Formality, Trade liberalization, Wage differential.

1. Introduction

In the late 1980s and early 1990s, many developing countries significantly reduced their tariff and non-tariff barriers, allowing foreign competition to flourish [1]. Trade openness has been welcomed as a boost to production and economic growth, but it also has the potential to widen the gap between affluent and low-income groups, increasing income inequality [1, 2]. As a result of trade reforms, there has been a restructuring of labour force from the formal to the informal sector [1, 3]. Literature on the impact of trade openness on formal-informal wage dispersion has produced mixed results [4, 5].

The formal sector is much more compliant with labor market regulations and provides substantial benefits to workers [1, 4]. The inflexibility of labor market in developing countries poses challenges and limits the ability to restructure employment opportunities in light of trade liberalization within protected competitive sectors [6, 7]. The informal sector is generally considered the least compliant with labor market regulations, with worse work quality, lower social security rates, and a continued risk of poverty [8].

Trade liberalization might have an effect on the production differential of the formal and informal sectors because the formal sector mostly uses skilled workers and is related to the tradeable sector, thus utilizing better input intermediaries than the informal sector. So, in the formal-informal (FIF) sectors, there have been recurrent wage and income differences [4]. Workers in the formal sector can earn more than informal sector workers [9]. According to the Heckscher-Ohlin-Samuelson structure, in developing countries, trade liberalization will decrease the number of formal workers as they move towards the informal sector [10]. After trade liberalization, the informal sector's entry costs are substantially less than the formal sector's [11]. So in many developing countries, trade liberalization has resulted in a rise in informal employment [1, 10, 12].

Various researchers, including Attanasio, et al. [13], Ferreira, et al. [14], Galiani and Sanguinetti [15], Goldberg and Pavcnik [1], Hanson and Harrison [16], Kumar and Mishra [17], Lechthaler and Mileva [18], Ul-Haq, et al. [19] and Ul-Haq, et al. [20], have thoroughly investigated the impact of trade liberalization on wages. However, few studies, such as Aleman-Castilla [4] for Mexico; Matthew [21] for Nigeria; Paz [22] for Brazil; Ponczek and Ulyssea [5] for Brazil, have examined the influence of trade liberalization on the formal-informal wage differential. So, this research will provide evidence in the case of Pakistan on this issue. In the case of Pakistan, this research contributes to the literature in a variety of ways. First, utilizing micro-level data from Pakistan, this paper investigates the impact of trade liberalization on the formal-informal wage-gap (henceforth FIFWG) in the manufacturing sector[1]. There is no empirical research in the case of Pakistan that investigates the association between trade openness and the FIFWG[2]. So, this study finds out whether the trade reforms have any impact on the FIFWG or not. Second, our analysis uses import tariff reductions as a proxy for trade liberalization, which is a more accurate measure in the case of developing countries [27-29]. Third, to the best of our knowledge, our analysis is the first to use three methodologies (log wage gap, wage premium (WP) methodology and residual wage gap) to determine whether or not a formal-informal wage difference is responsive to trade liberalization impacts. Fourth, this study examines the effects of trade liberalization on the pay disparity between formal and informal sectors, using both observable and unobservable factors. Because labor market regulations had a negligible impact during our sample period, this analysis focuses on the core effects of trade liberalization on the FIFWG.

The rest of this article is arranged as follows: Section 2 explains the theoretical underpinning, whereas Section 3 explains the facts and background. Section 4 briefly discusses the relationship between trade and the formal-informal sector. Part 5 discusses the empirical framework, section 6 explains the results and discussion, and section 7 concludes the paper.

2. Theoretical Framework

As our study follows the theoretical framework of Aleman-Castilla [4], in this section, we present a summary of the theoretical framework of Aleman-Castilla [4]. This model is based on Melitz [28]'s study of how trade liberalization impacts wages in the formal and informal sectors. As the formal sector is mostly related to the tradable sector, it employs skilled workers and uses better input intermediaries than the informal sector. As a result, there is a wage differential between the formal and informal sectors, according to Aleman-Castilla [4]. The informal sector mostly employs unskilled workers who have less experience and low bargaining power, and it is dominated by young, female, and temporary workers [30].

According to the non-neoclassical theory proposed by Darity and Williams [31] and Williams [32], the wage gap will increase mostly in those regions that are more exposed to trade liberalization. The wage gap will widen as a result of the disparity in workers' capabilities (skills, experience, bargaining power, etc.). According to the Heckscher-Ohlin-Samuelson (HOS) model, increased trade

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[1]There are other studies that have also used import tariffs as a proxy for trade liberalization for Pakistan; Ul-Haq, et al.[23] for poverty, Ul-Haq, et al.[24] for skilled-biased employment, Ul-Haq, et al.[25] for sectoral child labor, Un-Nisa, et al.[26] for foreign direct investment and Wages.
[2]Wu, et al. [8] explore the impact of trade liberalization on informal employment.

liberalization in developing countries reduces the number of formal workers, as they move to the informal sector [10].

These theories have a variety of implications for wage discrepancies between the formal and informal sectors in both developed and developing countries. According to Aleman-Castilla [4], trade liberalization occurs as per-unit trade costs fall, resulting in increased competition. This raises the formal sector's productivity cut-off level while lowering that of the trading sub-sectors, allowing more productive firms to enter the tradable sector while the least productive ones exit. Profit opportunities are only available to those firms that bear the trading sector's entry costs. More profit opportunities contribute to higher labor demand in the formal sector, and as labor demand increases, so do formal sector real wages.

    i.   Trade liberalization→ tariff ↓→ per unit trade cost↓→ cut-off productivity level↑→least productive firms exit and new firms enter→ new earning possibilities only to the more efficient firms who can cowl the entry cost → demand for labor↑→ real wages in the formal sector↑.

On the other hand, when per-unit trade cost falls, the industry's cut-off productivity level rises, making it easier to displace the least productive firms with informal firms. The demand for informal labor decreases, resulting in lower wages in the informal sector.

    ii.   Trade liberalization→ tariff ↓→ per unit trade cost ↓→ cut-off productivity level↑→ demand for skilled workers ↑→ least productive firms exit and new firms enter → demand for labor ↓→ wages in the informal sector↓.

As a result, trade liberalization, according to Aleman-Castilla [4], widens the wage differences between the formal and informal sectors.

According to Goldberg and Pavcnik [1], lowering the import tariff will reduce the protection afforded to imported commodities, lower the probability of price increases, and raise the marginal cost of hiring formal workers in production. So, the profit opportunity will decrease. When the profit margin shrinks, the demand for formal labor decreases, which tends to decrease real wages in the formal sector.

    iii.   TL→ tariffs↓→ probability of price↓→ marginal cost of hiring formal workers↑→ profit opportunity ↓→ demand for formal labor↓→ real wages in the informal sector↓.

When trade liberalization occurs, import tariffs are reduced, resulting in increased competition and a decrease in the probability of price increases. As a result, the market demand for informal labor increases, leading to an increase in the real wages of the informal sector.

    iv.   TL→ tariffs↓→ probability of prices↓→minimize the cost of production→ demand for informal labor↑→ wages in the informal sector↑.

Existing theory on the relationship between trade openness and formal-informal sectors wage gap is ambiguous, and only empirical evidence can guide us to understand it better.

3. Background and Data
3.1. Trade policy in Pakistan

Pakistan liberalized its trade in the late 1980s and early 1990s. During the Zia period, Pakistan substantially opened its trading atmosphere, and the government enacted a structural adjustment program (SAP) in 1988 to address this. The period between 1992 and 1999 witnessed the most notable alliteration. The study found that there were unanticipated and progressive decreases in protection rates observed across several industries and over time [8]. Pakistan liberalizes its trade gradually by reducing tariff rates from 63% to 13% in overall sectors and 64% to 14% in the manufacturing sector between 1988 and 2005. These trade policies not only involved tariff cuts but also focused on reducing non-tariff barriers [8, 33-35].
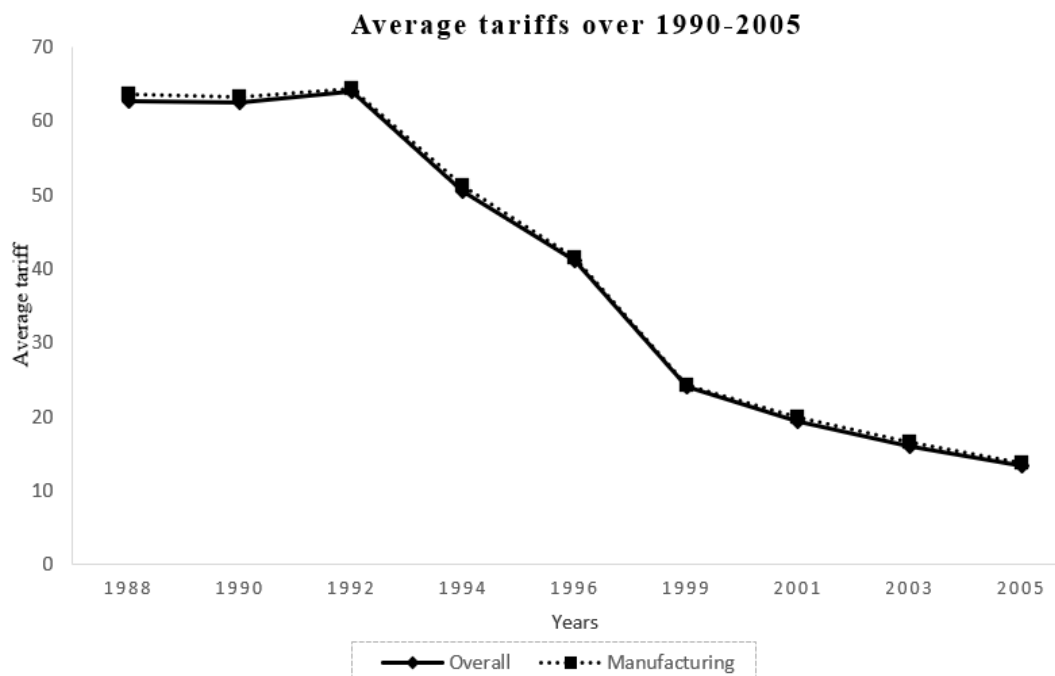
Figure 1.
Tariffs over 1990-2005.
Note: Ul-Haq [36] and Wu, et al. [8].

The structure of protection in Pakistan has changed as a result of the drastic reduction in average tariffs across sectors. Pakistan aimed to stimulate its manufacturing sector when the average tariff declined from 77% to 17%. So the trade reform increased economic growth in Pakistan [37-39]. Pakistan gradually liberalized its trade policies through lowering tariff slabs, lowering security rates, and eliminating non-tariff trade barriers. Figure 1 depicts the tariff trend in the overall and manufacturing sectors from 1996 to 2005. There is a 0.78 correlation between 1996 and 2005 [36].[3]

3.2. Survey of National Household

On trade exposure, we link the statistics to the labor force. For the years 1996, 1999, 2001, 2003, and 2005, we used data from five household surveys. The Pakistan Bureau of Statistics conducted the Pakistan Labor Force Survey (henceforth LFS). The LFS is a cross-sectional data set that is nationally representative. We use two-digit international standard industrial classifications (ISIC) codes for nine manufacturing sectors. LFS provides us with separate labor data for formal and informal industries. An import tariff is used as a proxy for trade liberalization. Tariff data is taken from the study of Ul-Haq [36] and Wu, et al. [8] labor data is taken from the LFS. Data on other trade-related variables are calculated from the 2-digit manufacturing sector [8].

4. Formal-Informal Sector in Pakistan: Some Stylize Facts

We distinguished between the formal and informal sectors following Pakistan's labor market regulations. Table 1 presents the worker's characteristics in the formal and informal sectors in 1996 and 2005. Workers from both sectors are classified in this table. Table 1 shows the formal-informal workers characteristics that provide the LFS from 1996 and 2005 for Pakistan. It shows sample averages of the career characteristics of informal and formal jobs.

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[3] This shift in protection structure demonstrates Pakistan's determination to achieve world trade organization (WTO)-negotiated low tariff rates throughout the economy [8].

The overall perception of work in the informal sector is deemed to be unsatisfactory. LFS does not have details on conditions at the workplace, job preparation, or job characteristics. Formal employees have access to most of the perks, such as health care, maternity leave, insurance, pensions, and transportation benefits. The informal job is considered to be of inferior quality.

Table 1 shows that in 1996, in a week, informal workers worked longer than formal workers (49.84, and 46.41, respectively). In 2005, informal employees worked more hours a week than formal workers (51.06 and 47.82 respectively). The formal workers have more education and skills than the informal workers. Table 1 shows the increasing trend in the sector-wise share of the formal-informal sector log weekly wage gap over time. Log weekly wage gap has a negative correlation with the protection rate during the 1996 - 2005 time periods. The coefficient of protection rate is -0.51 (p-value 0.25).

Table 1.

Formal and informal features of Pakistan in 1996 and 2005.

Variables	1996		2005	
	Informal	**Formal**	**Informal**	**Formal**
Weekly log wage	6.18	6.69	5.15	6.99
Wages in week (Current PKR)	657.7	959.1	418.73	1751.06
Monthly wage (Current PKR)	2373.05	3959.5	1674.97	7004.31
Male	0.47	0.90	0.46	0.9
Age	32.26	34.80	31.52	35.11
Educated	0.44	0.76	0.48	0.80
Below the primary	0.60	0.26	0.54	0.22
Primary	0.11	0.09	0.14	0.10
Secondary	0.27	0.43	0.29	0.44
University	0.02	0.20	0.04	0.25
Married people	0.65	0.76	0.62	0.72
Skilled workers share	0.29	0.64	0.33	0.67
Household (HH) head	0.64	0.81	0.60	0.75
Kids in HH (0-4)	0.78	0.78	0.86	0.76
No. of kids in HH (5-15)	2.19	1.93	2.32	2.06
Inactive adults in house	2.25	1.88	0.41	0.38
Average income of HH	3395.7	382	3636.33	6227.98
Family size	6.98	6.50	8.04	7.39
Work in ten or more employees	0.006	0.11	0.003	0.13
Work in a building	0.148	0.84	0.14	0.89
Hours work in a week	49.84	46.41	51.06	47.82

Table 2 also shows the sector-wise changes in LWG, and WPAND protection rates in the formal-informal sector. The log weekly wage gap has a positive and significant correlation with the wage premium during 1996-2005. The coefficient of the wage premium is 1.26 (p - value .00). In Table 3, we see the scenario of how trade liberalization contributed to the prevalence of informal employment in Pakistan. In Pakistan, from 1996 to 2005, Table 3 illustrates the overall proportion of informal employees in all industries, including manufacturing.

Table 2.
Sector-by-sector wage difference (FIFLog weekly wage disparity (LWG)).

Code manufacturing industry with 2-digit	Change in LWG 2005-1996	Change in tariffs 2005-1996	Change in WP 2005-1996
31. Manufacturing industry of food	0.662	-30.64	1.184
32. Manufacturing industry of textile	1.547	-34.8	1.885
33. Manufacturing industry of wood	0.954	-31.39	1.791
34. Manufacturing industry of paper	-0.051	-25.67	0.707
35. Manufacturing industry of chemical	1.014	-27.35	1.522
36. Manufacturing industry of non-metallic products	0.014	-32.39	1.036
37. Basic metal industries	0.996	-26.73	1.455
38. Manufacturing industry of fabricated metal	0.352	-22.51	1.066
39. Other manufacturing industries	0.826	-34.51	1.49

In all sectors, the rate of informality rose from 0.26 percent in 1996 to 0.55 percent in 2005. While in manufacturing, the rate of change increased from 0.24 in 1996 to 0.46 in 2005. In both the overall and manufacturing sectors, informal employment is increasing. During the over-sampling period, the percentage of people who worked informally doubled. The data presented in these numbers indicates that informality is prevalent occurrence in Pakistan. The average percentage of informality across all industries is 35 percent, with manufacturing responsible for 30 percent.

Table 3.
Pakistan's informal labor share by year.

Year	All	Manufacturing
1996	0.261	0.238
1999	0.281	0.280
2001	0.333	0.280
2003	0.322	0.253
2005	0.548	0.461
Average	0.351	0.303

Note: Wu, et al. [8].

5. Empirical Framework

We investigate the impact of trade openness on the formal-informal wage gap using the reduction in import tariffs in the manufacturing sector as a proxy for trade liberalization. We use three approaches for the formal-informal wage gap; (1) wage premium methodology [1, 4, 8], (2) log wage gap methodology (WPM) and (3) residual wage gap methodology [40]. For this study, the procedure is carried out in two steps; two-step estimation is widely used in the labor economics literature [1, 4, 8, 21]. In the first step, we calculate wage premiums and log wage gaps using Mincerian wage Equations. We regress the log wage (w) differential on the vector of the worker's characteristics $H_{imt,}$ (education, age, gender, location) and a set of industry dummies I_{imt} that show the worker's industry affiliation and ε are the error term. The first step consists of estimating the log wage Equation as follow:

$$lgw_{imt} = H_{imt}\beta_{Ht} + (H_{imt} \times \mathcal{F}_{imt})\Phi_{(H \times \mathcal{F})t} + I_{imt}\mathcal{F}I\mathcal{F}_{mt} + (I_{imt} \times \mathcal{F}_{imt})\delta_{(I \times \mathcal{F})mt} + \varepsilon_{imt} \quad (1)$$

Where $(H_{imt} \times \mathcal{F}_{imt})$ is a matrix of correlations between the vector H_{imt} and a formality predictor $\mathcal{F}_{imt}$, which takes the value 1 if worker i in industry m operates in the formal sector at time t and 0 otherwise; $(I_{imt} \times \mathcal{F}_{imt})$ is the interaction matrix between the industry dummies and the formality

indicator. The coefficients $\Phi_{(H\times\mathcal{F})t}$ capture the portion of wage variance due to variations in personal and regional characteristics between formal and informal workers. Within-industry formal–informal wage differential coefficient $\delta_{(I\times\mathcal{F})mt}$ captures wage disparities between formal and informal jobs due to industry affiliation. The coefficients of $\mathcal{F}I\mathcal{F}_{mt}$ capture the variation in wages which is attributable to the worker's affiliation in industry. Equation 1 is estimated separately in each year in the sample. Restricted Least Squares, suggested by Haisken-DeNew and Schmidt [41] is used to estimate the formal-informal wage differentials.

Wage differentials of each sector in the second stage are taken from the first step regression and pooled over time and regressed on variables relevant to industry trade as follows;

$$\mathcal{F}I\mathcal{F}_{mt} = T_{mt}\beta_T + D_{mt}\beta_D + \varepsilon_{mt} \quad (2)$$

Where FIF is industry wage differential and T_{mt} is a tariff which is the main component that we include in T_{mt}; the vector of trade-related industry characteristics. The variable D_{mt} is industry dummies which include time and industry indicators. The regression is measured in the second-step regression model (i.e., the industry dummy coefficient obtained from the first-step regression) and hence calculated with imprecise measurement. It introduces further noise into the second-stage model, leading to increased estimator fluctuation. A Weighted Least Squares estimation with weights equal to the inverse of the variance from the first stage of the wage differences is employed. This gives sectors with lower fluctuations in sector wage premiums more weight, and vice versa.

The residual wage gap, according to the Oaxaca-Blinder decomposition, is used in the third technique. The Oaxaca-Blinder decomposition revealed the extent to which the overall wage discrepancy can be explained by observable features of two groups, namely gender, skilled-unskilled, and formal-informal [42, 43]. This technique is divided into two parts: one that is explained by product features, and the other that is the unexplained element of the residual pay difference, also known as the discrimination part in the formal and informal sectors. The pay disparity between the formal and informal sectors can be decomposed using the natural log of real wage (w) for formal workers (i = F) and informal workers (i = I), as shown below.

$$w_i = X_i\beta_i + \varepsilon_i \quad (3)$$

The x represents the range of qualities of workers in the formal or informal economy that have an impact on pay. The set of dummy variables for education, age, and experience are used within X and collectively referred to as the error term, which is presumptively normally distributed with variance. Therefore, the formal-informal wage disparity is described as follows:

$$w_F - w_I = (X_F\beta_F - X_I\beta_I) + (\varepsilon_F - \varepsilon_I) \quad (4)$$

So if we evaluate the regression on the mean of log wage then the last term becomes zero. After some mathematical operations (adding and subtracting) on X_I the and β_F we drive the workers attributes "in the term of formal workers prices" gives.

$$w_F - w_I = (x_F - x_I)\beta_F + X_I(\beta_F - \beta_I) + (\varepsilon_F - \varepsilon_I) \quad (5)$$

The total log wage differential between the formal and informal sectors is displayed on the left-hand side. The first term on the right-hand side displays the portion of the wage gap that can be explained, and the second term displays the remaining gap between the formal and informal sectors (difference in productive characteristics of workers in the formal sector based on market returns). The last term is often discarded because of the decomposition conducted on the means; otherwise, the sum of the last two terms is known as the residual wage gap [40]. As a proxy for the discrimination element of the wage difference in the formal and informal sectors, we use the residual wage gap.

6. Result Discussion
6.1. Wage Premium Analysis
First of all, we discuss the results of the wage premium methodology. The wage premium is defined as the ratio of the additional average wage paid to highly skilled and highly educated people to the wages paid to lower skilled workers. The wage premium methodology is used to estimate the wage gap.

Table 4.
First-stage linear regressions (Selected years).

Variables	1996	2001	2005
Age	0.041***	0.047***	0.063***
	(0.004)	(0.003)	(0.004)
Age2	0.0005***	0.0005***	0.0006***
	(5.43e-05)	(4.92e-05)	(5.49e-05)
Age2*formal	0.0001***	9.51e-05***	8.54e-05***
	(1.98e-05)	(1.73e-05)	(1.94e-05)
Gender	0.649***	0.646***	0.736***
	(0.043)	(0.032)	(0.029)
Gender*formal	–0.456***	–0.524***	–0.507***
	(0.050)	(0.040)	(0.045)
Married	0.120***	0.102***	–0.018
	(0.031)	(0.024)	(0.023)
Married*formal	–0.080**	–0.059**	0.065*
	(0.035)	(0.029)	(0.034)
Head of HH	0.027	–0.022	–0.055***
	(0.029)	(0.021)	(0.020)
Head of HH* formal	0.016	0.021	0.013
	(0.035)	(0.027)	(0.032)
Schooling	0.060***	0.057***	0.084***
	(0.006)	(0.004)	(0.005)
Schooling*formal	0.008	–0.004	–0.010*
	(0.006)	(0.004)	(0.005)
Observations	7,833	7,808	23,384

Note: Log weekly wage is the dependent variable in all models. All other variables mentioned in Eq. 4.1 are included in all models. The standard errors are shown in parentheses. The number of asterisks shows the level of significance (i.e., '***' for 1%, '**' for 5%, and '*' for 10%).

6.1.1. First Stage Results

The first-stage results of the wage premium are reported[4] in Table 4. Formal and informal workers have similar returns to potential experience based on formality indicators, as shown in Table 4. However, as the number of years of schooling increases, the wage increases as well and is higher for males and household heads. When experience and skill levels rise, wages increase, which is higher for married people. Wages in the formal sector are typically higher than those in the informal sector. Table 4 also includes a group of industry dummies.

6.1.2. Second Stage Results

Sector and time Fixed Effects are used in our second stage-regression. The coefficient of protection rate is negative and statistically significant. FIFWG and the rate of protection are associated. When the level of import tariffs changes, as shown in Table 5, it could have a significant impact on the wage gap between the formal and informal sectors. In the first column, a 1 percent reduction in the protection rate increases the disparity in the wage gap between the formal and informal sectors by 0.3%. Table 5 presents the results for all sectors. For our FOREX rate changes, we implement lagged imports, lagged exports, import penetration ratio, export orientation ratio, and an interaction term between lagged imports and the foreign exchange rate to ensure that our estimates are robust. Our next focus is on the manufacturing sector and its performance. The findings on the manufacturing sector are listed in Tables 6 and 7, and we check the robustness in Table 7.

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[4] The first stage results of the log wage gap methodology are available upon request.

Table 5.
Trade policy and FIFWG in Pakistan (Overall case).

Variables	(1)	(2)	(3)
Nominal tariffs	0.032***	0.006***	-0.027***
	(0.001)	(0.001)	(0.001)
Industry indicators	No	Yes	Yes
Year indicators	No	No	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance (i.e., '***' for 1%). The N is 65 in all columns.

Table 6.
Trade policy and FIFWG in the manufacturing sector.

Variables	(1)	(2)	(3)	(4)
Nominal tariffs	-0.021***	-0.018***	-0.012*	-0.016**
	(0.001)	(0.001)	(0.006)	(0.008)
Lagged export(LX)			1.92e-09***	7.46e-09***
			(2.61e-10)	(6.66e-10)
Lagged imports(LM)			1.68e-09***	1.25e-09
			(5.62e-10)	(1.38e-09)
LX×NEER				-1.69e-10***
				(0)
LM×NEER				0
				(0)
Log GDP		-0.176***	-0.234***	-0.156**
		(0.037)	(0.053)	(0.064)
Log gross fixed capital formation (GFCF)		-0.001	0.074*	0.013
		(0.036)	(0.039)	(0.044)
Industry indicators	Yes	Yes	Yes	Yes
Year indicators	Yes	Yes	Yes	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors. Note that the amount of asterisks denotes significance (i.e., '***' for 1%, '**' for 5%, and '*' for 10%). The N is 45 in the first two columns and 36 in the remaining two columns.

Column 1 of Table 6 shows the formal and informal wage gap estimations using protection rate, sector, and time dummies. The coefficient of protection rate is negative and statistically significant. The findings reveal that FIFWG increases by 0.2 percentage points for every one percent decrease in protection rate in a certain industry (i.e., 0.02).

6.1.3. Robustness Checks

For robustness checks, we include several trade-related variables. The regression results using industry and year indicators are presented in Table 6 and Table 7. We used some additional variables to check the sensitivity of these results. The coefficients associated with tariffs in all models exhibit a negative and statistically significant relationship, suggesting that the inclusion of these new factors does not alter the direction or the importance of the findings. These findings are robust after accounting for various trade-related variables.

Table 7.
Trade policy and FIFWG in the manufacturing sector (Robustness checks).

Variables	(1)	(2)	(3)	(4)
Tariffs	–0.0211***	–0.041***	–0.018***	–0.016***
	(0.001)	(0.004)	(0.006)	(0.006)
Lagged IPR (LIP)		1.514***	0.796***	0.916***
		(0.114)	(0.141)	(0.142)
Lagged EOR (LEOR)		–0.313***	0.248**	0.507***
		(0.035)	(0.096)	(0.099)
LIP×NEER			0.014***	0.018***
			(0.001)	(0.00181)
LEOR×NEER			–0.004***	–0.005***
			(0.001)	(0.001)
Log GDP				–0.215***
				(0.060)
Log GFCF				–0.295***
				(0.043)
Industry indicators	Yes	Yes	Yes	Yes
Year indicators	Yes	Yes	Yes	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance (i.e., '***' for 1%, '**' for 5%,). The N is 45 in the first column and 36 in the remaining columns. IPR stands for import penetration ratio, EOR stands for export orientation ratio, NEER stands for the nominal effective exchange rate.

6.1.4. Lagged-Trade Policy and FIFWG Analysis

We then investigate the formal-informal sector's association with lagged protection rates to see if firms take time to adjust formal-informal labor to trade openness. Tables 9 and 10 describe the results of the lagged analysis using the WPM.

Table 8 shows the overall effect of lagged trade policy on FIFWG. The results show that the coefficient of lagged tariffs is statistically significant and positive when industry indicators are used, but negative and statistically significant when both industry and time indicators are considered. We used the identical parameters in these tables as we did in the robust analysis, with the exception of the lagged protection rates as an explanatory variable. We investigate the link between lagged protection rates and the formal-informal sector to determine if firms take their time adjusting formal-informal labor to trade openness.

Table 8.
Lagged-trade policy and FIFWG in Pakistan (Overall case).

Variables	(1)	(2)	(3)
Lagged tariffs	0.033***	0.005***	–0.043***
	(0.0001)	(0.0004)	(0.0016)
Industry indicators	No	Yes	Yes
Year indicators	No	No	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance (i.e., '***' for 1%). The N is 65 in all columns.

Like the tariff coefficient, the sign of the lagged tariff coefficient is statistically significant and negative. The sign of the coefficient in all of the models is statistically significant and negative, indicating that our results are robust or unaffected even when trade-related variables are included. As a result, these findings reveal a link between lagged tariffs and FIFWG.

Table 9.
Lagged-trade policy and FIFWG in manufacturing.

Variables	(1)	(2)	(3)	(4)
Lagged-tariffs	–0.015***	–0.009***	–0.007**	–0.007**
	(0.002)	(0.003)	(0.003)	(0.003)
Lagged exports(LX)			2.15e-09***	
			(1.98e-10)	
Lagged imports (LM)			1.66e-09***	
			(5.43e-10)	
Log GDP		–0.395***	–0.191***	–0.222***
		(0.050)	(0.054)	(0.054)
Log GFCF		0.075*	0.053	0.048
		(0.040)	(0.041)	(0.040)
LX×NEER				0***
				(0)
LM×NEER				0***
				(0)
Industry indicators	Yes	Yes	Yes	Yes
Year indicators	Yes	Yes	Yes	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%, '**' for 5%, and '*' for 10%). The N is 36 in all columns.

Table 10.
Lagged-trade policy and FIFWG in manufacturing.

Variables	(1)	(2)	(3)	(4)
Lagged Tariffs	–0.015***	–0.009***	–0.019***	–0.016***
	(0.002)	(0.003)	(0.003)	(0.003)
Lagged IPR (LIPR)			–0.014***	
			(0.001)	
Lagged EOR (LEOR)			0.001**	
			(0.0007)	
Log GDP		–0.395***	–0.749***	–0.821***
		(0.050)	(0.066)	(0.064)
Log GFCF		0.075*	0.074*	0.012*
		(0.040)	(0.042)	(0.044)
LIP×NEER				–1.481***
				(0.127)
LEOR×NEER				0.355***
				(0.064)
Industry indicators	Yes	Yes	Yes	Yes
Year indicators	Yes	Yes	Yes	Yes

Note: Every model used FIFWG as a dependent variable. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance (i.e., '***' for 1%, '**' for 5%, and '*' for 10%). The N is 36 in all columns. IPR stands for import penetration ratio, EOR stands for export orientation ratio, NEER stands for the nominal effective exchange rate.

6.2. Residual Wage-Gap Analysis

The unobservable characteristics in the formal-informal sector are the cause of the residual pay gap, which is the unexplained portion of earnings. The discrimination component of wages is another name for the residual wage gap. So, we employed the Oaxaca-Blinder decomposition method to evaluate these unexplained portions of the pay.

The formal-informal pay disparity in the manufacturing sector is depicted generally in Table 11. During the time span of our sample, there has been a growing tendency towards pay disparity. It has grown dramatically, from 37% to 81%.

Table 11.
Formal-informal overall wage gap in the manufacturing sector.

Year	Explained	Unexplained	Gap	Percentage
1996	0.273	0.158	0.431	37%
1997	0.262	0.093	0.355	26%
1999	0.228	0.139	0.368	38%
2001	0.222	0.268	0.489	55%
2003	0.252	0.258	0.511	51%
2005	0.303	1.259	1.562	81%

6.2.1. Second Stage Results

Table 12 applies the fixed and random effect models. The protection rate coefficient is negative and statistically significant in both models in Table There is a correlation between the residual wage gap and the rate of protection. The pay dispersion in residuals will rise by 0.1 percentage points in 1 column for every 1 percent reduction in the protection rate. The results are nearly the same in the second column as well.

Table 12.
TL and RWG in the manufacturing sector.

Variables	FE	RE
Nominal tariffs	–0.015***	–0.013***
	(0.003)	(0.002)
Constant	0.694***	0.622***
	(0.086)	(0.102)
F/Wald statistic	20.84	28.15
P-value	0.001	0.000

Note: Residual wage-gap is the dependent variable in FE (fixed-effect) models and RE (random-effect) model. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%). The N is 41 in both columns.

6.2.2. Robustness Checks

Now, by introducing some additional variables, we examine the stability of our findings. Tables 13 and 14 show that even after including these trade and industry-related variables, all of the models' tariff coefficients still have a negative sign and are statistically significant, demonstrating the robustness and persistence of these findings. The inverse relationship between tariffs and the remaining wage gap is indicated by the negative sign of tariffs. The aforementioned data illustrate a correlation between the process of liberalization and the persistent wage gap that exists between the formal and informal industries.

In order to determine whether firms take some time to adapt formal and informal workers to trade openness, we are currently examining the association between lagged trade policy and the residual pay gap. We test the robustness in Table 15 using both the FE and RE models. The model's tariff coefficient is statistically significant and negative. The significance of the findings was also demonstrated by F-statistics and probability values.

With the exception of lagged tariffs, Tables 15 and 16 used the same specifications as those used in robustness check tables. These findings demonstrate that the conclusions are still valid even when various trade-related variables are taken into account.

Table 13.
TL and RWG in manufacturing sector (Robustness check I).

Variables	(1)	(2)	(3)
Nominal tariffs	-0.013 ***	-0.011 ***	-0.036 ***
	(0.002)	(0.002)	(0.008)
LGFCF		-0.094	-0.067
		(0.087)	(0.079)
Log GDP		0.147*	0.035
		(0.088)	(0.095)
LX×NEER			2.57e-09 ***
			(6.46e-10)
LM×NEER			-9.58e-10
			(2.32e-09)
Constant	0.622***	-0.486	1.514 **
	(0.102)	(0.803)	(0.701)
Wald statistic	28.15	60.55	25.14
P-value	0.000	0.000	0.000

Note: Residual wage-gap is the dependent variable in all RE models. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%, '**' for 5%, and '*' for 10%). The N is 41 in first two columns but in column (3) N is 33.

Table 14.
TL and RWG in manufacturing sector (Robustness checks II).

Variables	(1)	(2)	(3)
Nominal tariffs	-0.012***	-0.010***	-0.029***
	(0.002)	(0.002)	(0.011)
Log GFCF		-0.094	-0.004
		(0.087)	(0.099)
Log GDP		0.148*	0.048
		(0.088)	(0.110)
LIP			-0.028
			(0.170)
LEOR			0.270*
			(0.142)
Constant	0.622***	-0.486	0.029
	(0.102)	(0.803)	(0.791)
Wald statistic	28.15	60.55	15.01
P-value	0.000	0.000	0.010

Note: Residual wage-gap is the dependent variable in all RE models. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%, and '*' for 10%). The N is 41 in first two columns but in column (3) N is 33.

Table 15.
Effect of lagged-trade policy on residual wage gap in the manufacturing sector.

Variables	FE	RE
Lagged tariffs	-0.018***	-0.014***
	(0.005)	(0.003)
Constant	0.843***	0.732***
	(0.143)	(0.140)
F/Wald statistic	12.25	12.82
P-value	0.008	0.000

Note: Residual wage-gap is the dependent variable in FE and RE model. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%). The N is 33 in both columns.

Table 16.
Lagged trade policy and residual wage-gap in Pakistan.

Variables	(1)	(2)	(3)
Lagged tariffs	–0.014 ***	–0.012 ***	–0.014 ***
	(0.003)	(0.004)	(0.003)
Log GFCF		–0.109	–0.096
		(0.097)	(0.063)
Log GDP		0.157	0.065
		(0.106)	(0.072)
Lagged export (LX)			2.38e-09 ***
			(6.82e-10)
Lagged import (LM)			4.77e-10
			(2.38e-09)
Constant	0.732***	–0.304	1.055 **
	(0.140)	(0.985)	(0.514)
Wald statistic	12.82	24.24	21.97
P-value	0.000	0.000	0.000

Note: Residual wage-gap is the dependent variable in all RE models. In parenthesis, presents the standard errors note that the amount of asterisks denotes significance level (i.e., '***' for 1%, '**' for 5%). The N is 33 in all columns.

In conclusion, we find that FIFWG and trade policy are closely related in the context of Pakistan. FIFWG is inversely related to the decline in protection rate in both manufacturing and overall cases. Additionally, we discover a strong correlation between lagged-trade policy and FIFWG. We can infer that trade openness and the FIFWG have a basic connection because there was no labor market regulation during the sample period.[5]

7. Summary of the Findings

The results utilizing these three methods—wage premium (WP), log wage gap (LWG), and residual wage gap (RWG)—are summarized in Table 17. The pay disparity in these formal and informal industries widens as a result of trade liberalization, as seen in the table. In the FIF industry, salary disparity rises as import tariffs are reduced. Overall, the tariff's effects are all significant and adversely relate to FIFWG. Lagged tariffs appear to have the same outcomes, demonstrating that lagged trade policy and FIFWG are related. Our findings are similar to those of Aleman-Castilla [4] for Mexico and Paz [22] for Brazil but differ from those of Matthew [21] and Ponczek and Ulyssea [5] for Brazil.

Table 17.
Summary of the findings (WP, LWG, and RWG methodology).

Nominal tariffs	WP	LWG	RWG
Robustness checks	Negative sign & significant	Negative sign & significant	Negative sign & significant
Lagged tariffs	Negative sign & significant	Negative sign & significant	Negative sign & significant
Effect on WG	Increases FIFWG	Increases FIFWG	Increases FIFWG

8. Conclusion

Between 1988 and 2005, as part of the International Monetary Fund (IMF)'s structural adjustment programs (SAPs), Pakistan implemented substantial trade liberalization reforms, and protection rates

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[5]The second stage results of the log wage gap methodology are available upon request.

were significantly cut across industries. The reduction in protection rates over time and across sectors was unanticipated. According to our findings, trade liberalization has a major impact on FIFWG. There is a strong relationship between FIFWG and the protection rate. These findings are true across the board, including in the manufacturing industry. Due to a lack of data, we have only conducted thorough controls in the manufacturing sector, but our findings are robust for a variety of trade-related variables.

A tariff reduction widens the wage gap between the formal and informal sectors. These findings are robust after accounting for various trade-related variables. We also discovered that lagged trade policy and FIFWG have a strong relationship. As there was no labor market regulation during our sample period, we can be certain that there exists a fundamental relationship between trade openness and FIFWG.

Given the high levels of wage inequality between formal and informal workers, these findings are critical for labor market policymakers. On the basis of this study, legislators should focus on the employment conditions of informal workers. The government should implement policies that reduce wage disparities while also reaping the benefits of trade liberalization. Unrestricted labor market flexibility is critical for obtaining the maximum benefits of trade and curbing the wage gap between formal and informal workers.

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Authors' Contributions:
The conceptualization and data collection N.A. and J.H.; arranged and transformed into Stata J.H., A.R.C. and L.J.; finalized the methodology for analysis and analysis, J.H., H.V. and A.R.C.; wrote the original draft, L.J. and N.A.; improved the draft, H.V. and A.R.C.; reviewed & edited, J.H., A.R.C. and H.V.; supervised the whole study, J.H. All authors have read and agreed to the published version of the manuscript.

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