Gender difference of the informal sector wage gap: a longitudinal analysis for the Korean labor market

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Unlike previous studies focusing on either market structure or gender earning gap separately, this study considers market structure as a more crucial factor in determining the gender earning gap. The estimated wage differentials between sectors from the fixed-effects model demonstrate a substantial drop in the size of wage gaps, reflecting systematic sorting between formal and informal sectors by unobserved workers' abilities. While estimated wage differentials from cross-sectional analysis between formal and informal sector among male workers disappear in the fixed-effect estimations, the wage gap between the formal and informal sector among female workers still exists in the fixed effect estimation, thus suggesting a differing dual labor market severity between gender groups. Based on these empirical results, we discuss a policy direction involving simultaneous consideration of the dual structure of the labor market and gender discrimination.

Keywords: gender wage gap; dual structure of the labor market; informal sectors; fixed effects estimates.

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1. Introduction

This paper explores the research question of how the structure of labor market affects the gender earning gap. The informal sector has been broadly defined to include such factors

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as coverage of the social security system, tax payment, firm size, formal contract, etc.[1] In our definition of the informal sector, we utilized the prevailing criterion for the formal/informal labor market, specifically whether workers are being covered by a social security system.

Indeed, the structure of the formal and informal labor market is related closely to gender groups in the labor market. Female workers in the informal market frequently find themselves employed in low-paying jobs with poor working conditions and limited opportunities to advance in the formal labor market.[2] Furthermore, the employment distributions of men and women frequently differ in the formal and informal labor markets. Men often dominate the formal market, whereas many female-concentrated jobs are relatively distributed in the informal market. Although characteristics of dualism in the labor market are found for both male and female workers, the severity of dualism may differ among gender groups. In fact, our study interestingly finds out that the wage differential between the formal and informal sector found among female workers does not appear in the group of male workers. Based on this empirical result, our study speculates that the dual labor market structure aggravates the overall gender earning gap,

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[1] For example, Yamada (1996) declares workers to belong to the informal sector so long as they are not subject to taxes or government regulation, and as long as the employer can easily change both the employees' wages and the employment contract. Marcouiller *et al*. (1997) focuses on two aspects--firm size and coverage of the social security system. They define workers as being in the informal sector if the firm size is quite small (employees are less than 5 or so) or if workers do not receive social security benefits as an employment condition. Savvedra and Chong (1999) employ a broader definition of the informal sector as including several criteria--including formal contracts, health insurance and pension coverage, and tax payments.

[2] The lack of governmental institutional support for women in having and raising children or gender discriminatory work practices makes it difficult for women whose careers have been interrupted to return to their previous formal sector jobs. As a consequence, they are frequently compelled to settle in the informal market (Cho and Kwon 2010, Cho, Kwon and Ahn 2010).

as female workers are penalized more by locating themselves in the informal labor market than are male workers.

In an effort to tackle this research question, we utilize Korean data for two reasons. The first is that the Korean labor market prominently features duality of formal and informal labor markets (Cho 2004, Cho and Cho, 2010 Cho and Keum 2009). The second reason is that the gender earning gap in Korea tends to be huge relative to other OECD countries.[3]

Previous studies have considered the wage gap in the formal and informal labor market or the gender earning gap from a separated perspective. For example, the theoretical underpinnings of the wage gap in the dual labor market were initially researched by Doeringer and Piore (1971) and Dickens and Lang (1985). A vast array of empirical studies into the dual labor market followed, many of which concerned themselves with measuring the degree of duality in various countries (Cameron, Dowling, and Worswick 2001, Marcouiller, Ruiz de Castilla, and Woodruff 1997, Theisen 2005, Yuki 2007). On the other hand, research for the gender earning gap has also proliferated. For instance, Blau and Khan (1996) measured the gender earning gap for 10 OECD countries and Arulampalam *et al*. (2007) updated the estimates for the gender earning gap for EU countries. However, these previous studies tend to pay less attention to the possibility that the market structure of dualism may interact in some way with the gender earning gap.

Unlike previous studies focusing on either the market structure or the gender earning gap separately, a few studies have adopted a sectoral approach in analyzing the

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[3] The gender earnings gap in the Korean labor market is approximately 35%, indicating a huge gender gap relative to the fact that the gender earnings gap is approximately 20% in most OECD nations (OECD 2008).

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gender earning gap. For instance, Cho, Cho, and Song (2010) considered differences in the gender earning gap between the public and private sectors both in the US and Korea, discovering that the lowest gender earnings gap was found in the Korean public sector. On the other hand, Cho and Cho (2010) consider the differences in the gender earning gap in the unionized and non-unionized sector for Korea. To extend these sectoral approaches to the issue of the gender earning gap, this study formally takes a market structure into account as a more crucial factor in determining the gender earning gap. In an effort to determine how the structure of the labor market affects the gender earning gap, this study incorporates two sector models of the formal and informal labor market, and estimates the wage differential in each labor market from the perspective of the gender groups.

One innovative element that differentiates this research from previous studies lies in the type of data and econometric methodology employed. Our research utilizing panel data analyzes the wage difference between the formal and informal sector using fixed-effects (FE) models which allow us to overcome possible endogenous problems associated with cross-sectional analysis.

Section 2 explains the empirical methodology and section 3 elucidates the analyzed data and the characteristics of the workers in the formal and informal labor markets in Korea are outlined. Section 4 presents the main results generated from the fixed effect model using the panel data and compares them with results from the cross-sectional estimation. A dual labor market theory is put forth in order to interpret the empirical results. The concluding remarks for summary and policy direction are stated in the final section 5.

2. Empirical methodology

One important element that differentiates our research from previous studies lies in the econometric methodology used. The majority of the previous research tends to utilize cross-sectional data. However, the inevitable bias in the estimated coefficients comes from the possible correlation between unobserved individuals' characteristics and their decision as to which jobs to take. In order to overcome the possible endogenous problems associated with cross-sectional analysis, some studies have employed a two-step estimation method, in which they come up with the instrumental variable identifying the formal and informal sector decision of workers (e.g. Marcouiller, Ruiz de Castilla, and Woodruff 1997). It is, however, always difficult to find 'satisfactory' excluded variables that should affect only workers' sectoral choices, and not workers' wage levels. Using available Korean panel data, this research seeks to analyze the wage difference between the formal and informal sector, as the fixed-effects models are widely known to control the correlation between the workers' unobserved characteristics and their sectoral decisions.

So far many studies have been conducted on measures of the informal sector wage gap across countries using different methodologies. The OLS estimation by simply inserting a dummy variable indicating whether an individual works in the informal sector can be written as follows:

$$ln \ W_{it} = X_{it}\beta + Z_t\gamma + I_{ijt}\delta + \mu_i + \varepsilon_{it} \tag{1}$$

where $ln \ W_{it}$ is the log real hourly earnings for individual i at time t, X_{it} is a vector of individual characteristics i at time t, Z_t represents year dummies, I_{ijt} is a dummy variable equal to one if individual i belongs to the informal sector at time t, and ε_{it} is an error

term. Here we can consider the years of education, age, tenure, industry, occupation, and marital status as personal characteristics that influence the level of workers' wages.

The μ_i represents unmeasured worker characteristics, and may be correlated with the measure of informal sector I_{ijt}. If one simply estimates this wage equation by OLS, biased estimates of δ will be generated unless the μ_i is unrelated to the workers' sector choices. If workers with a high value of μ_i (higher ability or productivity) systematically select the formal sector rather than the informal sector, the OLS regression will generate an upward bias for the estimate of δ_j. In order to solve this type of endogenous problem, for example, Marcouiller *et al*. (1997) employed a two-step estimation wherein they accounted for the determinants of being in the informal sector.[4] They concluded that the results from controlling for the endogenous problem do not differ significantly from the results generated by simple OLS estimation.

Despite these efforts to control for unobserved worker characteristics, many researchers admit that it is very difficult to determine some excluded variables that significantly affect only inclusion in the formal sector, but not affecting the wage equation.[5] An alternative method of controlling for the possible endogenous problem is to 'difference out' unobserved individual characteristics by estimating fixed-effect models with panel data. Among many examples in the literature associated with fixed-effect estimation, Brown (1980) on wage differences and working conditions, Freeman (1984) on union wage premiums, and Kruger and Summers (1988) on industry wage

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[4] They use several characteristics of workers which are considered to affect whether workers are in the informal sector. Those include whether one is married, one is the head of the household, and the number of infants in the family.

[5] It is advisable to report whether the coefficients of excluded variables in the first stage equation are jointly significant.

differentials are particularly salient. However, to the best of our knowledge, this paper is the first attempt to consider the endogenous problem using panel data in the analysis of wage differences between formal and informal sectors.

The fixed-effects estimates control for the (time-constant) unmeasured worker characteristics via the following transformation:

$$ln\ \tilde{W}_{it} = \tilde{X}_{it}\beta + Z_t\gamma + \tilde{I}_{ijt}\delta + \tilde{\varepsilon}_{it} \qquad (2)$$

where $\tilde{W}_{it} = W_{it} - \bar{W}_i$ is the time-demeaned data on wages, and similarly for $\tilde{X}_{it}$, $\tilde{I}_{ijt}$, and $\tilde{\varepsilon}_{it}$. The unobserved individual fixed effect μ_i is now differenced out in the above transformed equation. Therefore, the fixed effects estimates of δ will be consistent so long as the error term ε_{it} is uncorrelated with each explanatory variable across all time periods.[6] The fixed effects estimator allows for an arbitrary correlation between μ_i and the explanatory variables in any time period. Because of this, any explanatory variable that is constant over time for individual *i* will be swept away by the above transformation. Thus, it is essential to obtain sufficient samples of workers who changed their sectors during the studied time period. Additionally, the recent statistical packages allow researchers to correct for both the heteroskedasticity and the serial correlation for the error terms in the fixed effects estimates.

3. Data and empirical model

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[6] The fixed-effects estimates of informal sector dummies might be biased if job changes are due to learning by employees and/or employers in the workplace. For example, workers with high unmeasured ability in the informal sector gradually tend to move to the formal sector as their ability levels become apparent to workers and/or employers over time. This can also be applied to lower ability workers in the informal sector. In order to solve this sorting problem, Krueger and Summers (1988) use the sample of displaced workers who were involuntarily displaced from their previous jobs. However, we cannot rule out entirely the self-selection problem, as the new jobs are decided on by workers.

3.1. *Description of the Korean Labor and Income Panel Study (KLIPS)*

The empirical analysis of wage differentials between formal and informal sectors was conducted using the Korean Labor and Income Panel Study (KLIPS). This survey, conducted by the Korea Labor Institute, was designed to provide researchers and policy makers with an empirical foundation for analyzing the dynamic aspects of the Korean labor market. Begun in 1998, the KLIPS provides longitudinal data concerning representative samples of Korean individuals and the family units in which they reside. The KLIPS sample is an equal probability sample of households from 7 metropolitan and urban areas in 8 provinces.[7] The original number of households sampled was 5000, and a total of 13,317 individuals were interviewed in 1998; more than 70 percent of the original samples have been included in subsequent follow-up surveys.[8] The individuals in the sample represent a variety of industry affiliations, from manufacturing to public services. We used the sample of salary and wage workers taken from the KLIPS 2000 to 2006 waves, since surveys conducted prior to 2000 do not include information as to whether the workers are covered by various social welfare programs.

The KLIPS contains useful information related to wage determination, such as union membership and firm size, which are frequently missing in analyses of the informal sector wage gap. The sample is restricted to full-time (more than 35 hours of work per week) and non-agricultural sector workers (including both male and female), who are not in school. The earnings variable is hourly earnings calculated from dividing weekly earnings by hours worked during the week, and the earnings are deflated using the Consumer Price Index. If workers have several jobs in any given survey year, the main

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[7] As a result, individuals residing in rural areas are excluded from this survey.
[8] The sample retention rates of KLIPS were 88% in 1999, 81% in 2000, and 77% in 2001. The retention rates are stable at approximately 77% since 2001.

jobs, defined as jobs having the longest working hours, are only included for the analysis. The final analysis sample contains 18,816 observations and 5,387 individuals, giving an average of 3.5 observations per person.[9]

The KLIPS asked the respondents whether they were covered by various social insurance programs such as medical, employment, and industrial accident compensation insurance since 1999. We define the respondents as working in the informal sector so long as they were not covered by any of those three social insurance programs. Among the three types of social security benefits, it is interesting to look at the evolution and coverage of the employment insurance system in the Korean labor market. The Korean employment insurance system is unique compared to those in other countries. It was put into effect on July 1st, 1995, pursuant to the official announcement of the Enforcement Decree of the Employment Insurance Act and the Enforcement Regulation of the Employment Insurance Act in April 1995 and June 1995, respectively. Having covered companies retaining 70 or more full-time workers, the employment insurance program was expanded to cover all salaried workers regardless of firm size since 1998. Unlike employment insurance which covers only unemployment benefits in most countries, the Korean employment insurance system is a more comprehensive one, which was designed to develop workers' skills and job stability. In addition to unemployment insurance, the employment insurance program provides workers with opportunities to develop their skills in the workplace and actively helps workers to find new jobs during their unemployment time.

3.2. *Korean employment distribution in formal/informal labor markets*

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[9] Workers who are observed at least twice during the time period are analyzed.

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In our definition of the informal sector, we focus on whether workers are being covered by any social security system of unemployment insurance, medical insurance, and industrial accident insurance.[10] Table 1 shows that the 75% of Korean workers are covered at least by one of three social insurances. The proportions of Korean workers in the informal sector differ substantially between male and female workers. While among male workers only 18% belong to the informal sector, more than 35% of females work in the informal sector. Therefore, Korean female workers are less likely to be covered by social security than male workers.

3.3. *Choice of key variables in the empirical model*

In our paper, we decide to employ the Mincer (1974) equation, which is the most widely used wage equation by empirical researchers. Mincer (1974) articulates the several factors considered to affect workers' wages. Those factors include educational level, age, job tenure, union membership, gender, and several others. The human capital theory predicts that as individuals accumulate higher education in school, their labor productivity increases and as a result, workers' wages tend to increase as well. The age variable is included for similar reasons as the educational variable (Murphy and Welch 1990).

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[10] The unemployment insurance system in Korea was first introduced in July of 1995, and was extended to businesses with fewer than 30 employees in 1998. However, the extension of unemployment insurance is quite limited in practice. Eligibility is restricted to workers with a minimum of six months of employment. Most temporary and part-time workers in the informal labor market remain uninsured by unemployment insurance. The medical insurance system in Korea was established when the National Health Insurance Law was passed in 1999. The system was enacted with expansion to workplaces on July 1st, 2001. The system was characterized by low benefit coverage, where the out-of-pocket payment of nearly 35-40 percent of the incurred medical cost places a greater burden on low-wage earners in the informal labor market. Since many Korean workers in the informal labor market are hired on contracts, they must pay their own medical insurance fees, with no collaborative burden or contribution from the employers' side.

As workers are attached to the same employer for a longer time, they accumulate more firm-specific skills. Thus, longer job tenure increases worker productivity and ultimately boosts workers' wages. The age variable is connected closely not only to job tenure but also to labor market experience in general. The next variable used in the paper involves whether workers are members of labor unions. In the absence of unions, workers do not have any established mechanism for informing employers of complaints, wages in particular. As workers gather and organize into labor unions, they affect labor contracts and labor unions tend to increase the wages of union members (Freeman and Medoff 1984).

Finally, we include a gender variable since the data shows a wage differential between male and female workers even for those with similar human capital and other characteristics. Women generally tend to command lower wages than men, even though the degree of labor market discrimination varies depending on the country and company (Blau and Kahn 1996).

As the most crucial variable, we employ the dummy variable to identify for formal and informal sectors, and compare the coefficient of informal sector between the cross-sectional wage regression and fixed effect estimation. This allows us to identify the penalty of being located in the informal labor market while maintaining the previously explained conditions. Additionally, in order to assess the possibility of different wage determination between gender groups, we estimated separate wage regressions for male and female workers respectively.

3.4. *Characteristics of variables*

Table 2 shows the sample means for some of the key variables from the final samples of

the KLIPS, depending on the sector. First of all, the wage differentials between informal and formal sectors as a whole are readily apparent. In terms of the average of log hourly earnings, workers in the informal sector tend to earn less than those in the formal sector by 0.48 log points. As mentioned previously, female workers are more likely to be informal, and this may result in substantial wage differences between sectors. The examination of sector wage differentials in different gender groups demonstrates that the wage differentials between sectors for male workers is 0.43 log points and the gap is 0.37 log points for female workers. The raw wage differentials between the formal and informal sector appear to be higher for male workers than for female workers.

Educational attainment by informal workers is quite a bit lower than that of formal workers. The average schooling time for formal workers is 13.2 years, but only 11.3 years for informal workers. The different patterns in educational attainment also derive from female-intensive employment in the informal sector.[11] Among male workers, the gap in years of education between the formal and informal sector is approximately 1.7 years, and the gap is approximately 1.9 years for female workers. An obvious difference exists in the accumulation of human capital between the formal and informal sector.

Next, workers in the informal sector are approximately two years older than the counterparts in the formal sector. Although there is no age gap between the formal and informal sectors among male workers, it is interesting to note that female workers in the informal sector are approximately 5 years older than those in the formal sector. We guess that female workers who re-entered labor market (probably due to childcare) are more likely to find jobs in the informal sector. In addition to age distribution, we note that

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[11] While the average schooling time among female workers is 12.1 years, it is 13.1 years for male workers.

workers in the formal sector are more likely to stay longer at their current job than informal sector workers. Considering that a substantial proportion of a worker's wage is determined by the seniority-based wage system in the Korean labor market, the different patterns in current job tenure can be attributed to significant wage differentials between the formal and informal sector.[12] The gap in job tenure between sectors for male workers is slightly higher than for female workers.

In terms of union membership, only 3% of workers in the informal sector join unions, whereas approximately 33% of formal workers are union members. Considering that unions play an important role in increasing workers' wages through collective bargaining, the scarce union membership of informal workers can be one of the reasons for the lower wages relative to those in the formal sector. This phenomenon can be explained in that the informal sector is more likely to be small firms and small firms are less likely to be unionized.

We now examine the distributions of firm size, occupation, and industry depending on the sector. Those three characteristics are assumed to be important in determining workers' wages, and there are marked differences between sectors in terms of those characteristics. First, we note that a significant proportion of informal workers belong to small firms (the size of workers is less than 10), and more than 60% of respondents in the informal sector work in small firms (see Table 3). However, among informal workers, less than 10% of respondents work in large firms (defined as firms with more than 300 workers). By way of contrast, among formal workers, more than 30% of individuals work in large firms and the proportion who work in small firms is only

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[12] See Cho and Cho (2008) for their international comparison of wage systems between the US and Korean labor markets.

13.7%. Most of the workers (about 80%) in the informal sector work in the firms with less than 10 employees. As small firms are less likely to provide workers with a variety of social insurances and tend to pay less compared to large firms, the different patterns in firm size between the formal and informal sector may be one of the reasons for the wage differentials between sectors. Even though distributions of firm size are not substantially different for male and female workers between the formal and informal sectors, female workers tend to work in smaller firms than their male counterparts.

Next, we address the occupational distributions between formal and informal workers. As can be seen in Table 4, the sectors differ not only in the observed workers' characteristics but also in the occupational composition of employment. Based on 9 one-digit occupational classifications, individuals in the formal sector work in the occupations of administrative support (23.7%), technicians (17.5%), machine operators (15.1%), and professional specialty (13.3) in order of employment size. Among informal workers, the order is precision production (18.9%), laborers (16.4%), service (15.3%), and technicians (10.9%). Given that individuals in the laborer occupations earn much less than those in other occupations, the greater inclination of informal workers to work as laborers can provide one clue to the substantial wage gap of informal workers relative to the formal workers. Even though distributions in occupation do not differ substantially for male and female workers between the formal and informal sector, female workers tend to work in administrative occupations and male workers tend to work in blue collar occupations such as precision production and as machine operators.

Finally, the distributions of industrial affiliations between formal and informal workers are shown in Table 5. Based on 9 one-digit industrial classifications,

manufacturing (34.1%) and educational and health service (19.5%) are identified as two major industries in which formal workers are employed. Among informal workers, manufacturing (21%) and trade (18.3%) are the two largest industries in terms of employment. Kruger and Summers (1988) argue that wage differences across industries are observed in the US labor market. However, in a recent study addressing the industry wage differentials in the Korean labor market, Cho (2008) has argued that it is difficult to determine industry wage differentials via panel analysis. Controlling for industry affiliations in the wage equations does not appear to change the effects of working in the informal sector on wages in the Korean labor market. This will be explained in the following sections. However, the industrial affiliations of workers definitely affect whether workers are covered by a variety of social insurance programs. For instance, among workers in the manufacturing industry, the proportion of informal workers is 17.7%. By way of contrast, the proportion of informal workers is 39.7% for the trade industry, which is the second largest industry in terms of employment size for informal workers. The examination of industrial distributions by gender and sectors shows that female workers in the informal sector tend to work in hotels and restaurants and females in the formal sector are more likely to work in the manufacturing and educational and health service industries.

4. Estimation of gender gap between formal and informal markets

4.1. *Wage regression for each gender in formal and informal markets*

Basic evidence as to the existence of a dual labor market is related to the fact that formal and informal sectors may assign different prices to skills, thus generating different wage determination processes. Controlling for observed workers' characteristics, we wish to

determine whether the returns to human capital (for example, returning to education) differ systematically between the formal and informal sectors for male and female groups. In an effort to assess the possibility of different wage determinations between gender groups, we estimated separate wage regressions for male and female workers respectively. Table 6 shows the estimated coefficients from wage regressions between formal and informal sectors among gender groups. It is observed that returns to workers' characteristics (related to the human capital components) differ significantly between formal and informal sectors, and this phenomenon exists for both male and female workers. The Chow tests reject the hypothesis of equality of all coefficients across sectors for both male and female workers.[13] Therefore, we attempt to focus on the degree of dual labor market extent to which workers are paid differently between sectors among gender groups.

As we can see in Table 6, an additional year of schooling increases workers' earnings by approximately 5.7% for formal male workers, but increases the informal male workers' earnings by approximately 3.8%, indicating a 1.9% point gap between sectors. The return to education is 6.0% for the formal female workers, but is only 2.7% for the female workers in the informal sector, showing a 3.3% point gap between sectors. This indicates that informal workers with the same level of education tend to command lower earnings than formal counterparts. Furthermore, based on the fact that the educational attainment gap of workers between formal and informal sectors is slightly higher among female workers (see Table 2), female workers in the informal sector might suffer from more disadvantages than observationally similar informal male workers.

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[13] The F-test statistic is 11.52 for male workers and 12.74 for female workers.

In addition to the different degree of return to education between gender groups, we can determine similar patterns of wage determination for other workers' characteristics. For instance, whereas the effect of current job tenure on wages is slightly higher in the formal sector than in the informal sector among female workers, the effects are opposite for male workers. This can also lead to (higher) earnings differentials between formal and informal sectors among female workers as compared to male workers. The effect of union membership on wages reveals a similar direction, indicating a relatively higher union wage premium between formal and informal sectors in the female workers as compared to the male workers.

The examination of coefficients from several occupational dummy variables in wage regressions shows how differently individuals' occupations affect wages depending on sectors and gender. For example, the coefficient of administrative occupation, in which formal female workers have the largest employment, is far higher in the formal sector than in the informal sector. This will broaden wage differentials between formal and informal sectors for female workers. By way of contrast, the effects of service occupation where informal female workers are largely employed do not differ greatly from the lowest paying occupation--laborers. However, formal female workers in the service occupation appear to command far higher earnings than female workers in the same occupation. This also results in a broadening of wage differentials between sectors among female workers due to different wage premiums for service occupations.

Our analysis reveals that while dualism appears to exist in the Korean labor market between the formal and informal sectors for both male and female workers, the characteristics of the dual labor market are shown to be much more severe among female

workers. In terms of wage determination, where major human capital components are rewarded in the labor market, we determined that the price gap between sectors is far higher among female groups as compared to male workers. We speculate that the different severities of the dual labor market between gender groups helps to explain the gender differences in the estimated wage differentials between formal and informal sectors. This can be more formally tested by adopting the fixed effect model.

4.2. *Comparison of cross-sectional wage regression and fixed effect estimation*

We present empirical results from both the cross-sectional estimation and fixed-effect model of the wage equation. The empirical strategy is to control as well as possible for any factors that determine workers' wages, and then to analyze the effects of informal sector dummy variables on workers' wages. Traditional human capital and demographic variables – education, labor market experience, sex, marital status, and location of residence are employed as explanatory variables. Along with those variables, occupation and industry dummy variables at the one-digit level are included in the regression analysis. Additionally, other important factors determining workers' wages such as tenure at the current job, union status, and firm size are also controlled.

Table 7 shows the empirical results from both cross-sectional OLS and fixed-effect estimations for the whole samples of workers. All of the explanatory variables are included in the wage equation, and the coefficients of each explanatory variable are as expected in their respective directions. For example, an additional one year of schooling increases workers' wages by 4.8 percent, but is reduced to 1.5 percent in the fixed effect model. This indicates that more able persons tend to accumulate higher education, and this self-selection effect appears to overestimate the role of human capital in the OLS

wage equation. We also detected similar patterns from the estimated coefficients of tenure and union by comparing the OLS and FE results. This reveals a possible positive correlation between unobserved workers' characteristics and their decision as to whether or not they stay with the same employer and participate in labor unions. This pattern is consistent with the results of previous studies that show a substantial drop in the estimated coefficients in the fixed-effect models (e.g. Solon 1988).

According to the results from cross-sectional estimation, workers in the informal sector earn approximately 9.7% less than workers in the formal sector, after controlling for observed workers' characteristics. Other explanatory variables have the following effects on wages.[14] An additional one year of schooling and job tenure tend to increase workers' wages by 4.8% and 2.2%, respectively. Workers' age appears to exert a negligible effect on wages. If workers are union members, their earnings are higher than non-union members by approximately 5.8%.[15] In terms of the gender earnings gap, female workers tend to earn less than male counterparts by approximately 27.9%, even after allowing for a vector of characteristics that affects wage levels.

The coefficient of the informal sector in the cross-sectional wage regression can be overestimated if individuals with higher productivities systematically choose jobs in the formal sector. Our expectation seems to be supported, since the size of the estimated

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[14] Including firm size variables seems to affect the size of the estimated coefficients of the informal sector dummy variable in the cross-sectional regression. When we drop the firm size variable, the estimated coefficient of informal sector dummy variable rises to -12.5%.

[15] While not shown in this paper, the inclusion of firm size dummy variables hugely affects the size of the union dummy variable. If we drop the firm size variable in the cross-sectional regression, the effect on union members' wages will increase to 13.6%. Therefore, it is evident that in order to correctly measure the union effect on wages, one should also consider the effects of firm size. The effect of firm size on wages varies depending on the firm size. Compared to small firms that employ less than 10 workers, the wage premiums for individuals who work in the medium and large firms range from 5.9% to 25.0%.

coefficient of informal sector dummy variable is reduced substantially in the fixed effects estimation. The estimated wage differential between formal and informal workers is now shown to be 4.8%, indicating a 61.6% decrease in the size of the estimated coefficient. Therefore, there is a possibility of systematic sorting between formal and informal sectors according to unobserved workers' abilities. Based on the results from fixed-effect estimations, there appears to be a negative correlation between workers' abilities (or productivities) and inclusion in the informal sector. Among other coefficients of explanatory variables, one thing to note is the change in union dummy coefficients. Contrary to the huge effect of union member on wages in the cross-sectional estimation, the union wage premium is reduced substantially, to 3.2%. This empirical finding also suggests that workers with relatively higher abilities tend to choose unionized firms and they join union members and command higher wages.

The wage differentials between workers in the formal and informal sectors can differ among gender groups. The estimates of wage differentials for both male and female workers are shown in Table 8. Along with the results from Table 7, all explanatory variables are controlled for the estimations of wage regression. According to the results of cross-sectional estimation, male workers in the informal sector earn less than those in the formal sector by approximately 8.4%, which is slightly lower than the results from the entire sample of workers. However, according to the results of the fixed effects model, we are unable to find wage differentials of male workers between the informal and formal sectors; this is a very notable result. The estimated coefficient of the informal dummy variable is -0.02, which is no longer statistically significant.

Among female workers, the estimated wage differential between the formal and informal sector was 9.5% in the cross-sectional analysis. In contrast to the results obtained with male workers, the wage gap between the formal and informal sector still exists in the fixed effect estimation, even though the coefficient size was reduced. The female workers in the informal sector earn approximately 6.4% less than those in the formal sector when we allow for the (time consistent) unobserved workers' characteristics. The observed wage differentials for the whole samples are, therefore, apparently driven by the wage differentials from the female workers.

In the case of multiple regressions, we implicitly impose the homoskedasticity condition indicating that the variance of the unobserved error conditional on the explanatory variable is constant. However, we usually have to consider the failure of homoskedasticity (i.e. heteroskedasticity). In our empirical results shown in Table 7 and 8, we constructed robust consistent standard errors for both OLS and FE estimates. In accordance with the study conducted by White (1980), we employ residuals from the initial wage regressions on explanatory variables and then adjust them by multiplying the variance between each level of variable and the average of variables. This method is widely employed as a robustness check. The following subsection also describes the possible selection issue associated with FE estimates, and we were able to produce somewhat robust empirical results relative to other previous studies.

According to our test of the existence of a dual labor market shown in the previous section, we determined that dualism differently affects each gender. This section formally demonstrates that this dual labor market structure penalizes women more than male workers. This also implies that policies designed to reduce the gender earning gap

alone may be ineffective if the crucial part of the gender earning gap, which can be attributed to the sizable wage penalty imposed on women working in the informal labor market, remains untendered.

4.3. *Further issue on fixed effect estimation*

As the fixed-effect estimates are implemented empirically for job movers, the samples should contain enough job movers who move from the informal to the formal sector and move from formal to informal. It is difficult to obtain accurate fixed-effect estimates if the sectoral movement occurs only in one direction such as job movement from the formal to formal sector or from the informal to informal sector. Table 9 shows the mobility patterns of workers between the formal and informal sectors. Among the 18,816 observations used in this paper, there were 2,593 samples that moved jobs during the studied time period.[16] Among all formal workers who changed their jobs, approximately 78% of workers find new jobs that also offer some type of social security insurance. In other words, the majority of formal workers succeed in finding new jobs in the formal sector. However, only about 22% of formal workers move into new jobs in the informal sector.[17] Among the 1,231 samples of informal workers in their previous jobs, about 42% of workers move into the formal sector. Although more than half of formal workers in their previous jobs also find new jobs in the formal sectors, there is quite a large proportion of formal workers who move into informal sectors. Additionally, almost half of informal workers move into new jobs in the formal sectors. Even though some tendency was noted, particularly for workers who change from the formal sector, to

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[16] There are very few samples that reported a change of sectors but did not change their jobs. We do not consider these as job changers.

[17] While it is not proven by data, we guess that job changers citing involuntary reasons such as plant closing might tend to work at new informal sector jobs.

maintain the same sectors after job changes, there appear to be enough samples of individuals who change sectors either from formal to informal, or informal to formal sectors.

The job mobility pattern between the formal and informal sectors does not appear to differ substantially among gender groups. Among male workers who changed their jobs from the informal sector, almost half of male workers find new jobs that offer some type of social security insurance. According to this finding, it is difficult to assert that there is an obstacle for male workers to move into the formal sector from the informal sector. Among male workers in their previous formal jobs, approximately 80% of workers succeed in finding new jobs in the formal sector. Even though there is some difference in terms of the proportions of people moving into new jobs in the formal sector, we detect similar patterns of job mobility among female workers. Among female workers who changed their jobs from the informal sector, approximately 38% of female workers move into new jobs in the formal sector. Similar to male workers, most formal female workers find new jobs in the formal sector. Therefore, based on the pattern of job movement between formal and informal sectors in the Korean labor market, it is difficult to assert that there exist substantial barriers for informal workers to enter into the formal sector.

Next, we must explore the possible problem of the endogenous mobility of workers that may force fixed effects estimators to be inconsistent. Longitudinal analysis solves the potential bias problem of unmeasured workers' characteristics in the cross-sectional regression, but might result in another potential bias (Solon 1988). This bias includes the selectivity of job switchers. As noted, most job changes tend to be voluntary

and, as a result, the identification of informal sector effects on wages in fixed-effects estimations depends principally on the wage changes experienced by job changers, which may induce a self-selection problem. Additionally, job changers who also change sectors are included only for the analysis of the fixed effects estimations. As a consequence, workers who change jobs but maintain the same sector affiliations are excluded from the samples of sector changers. Therefore, this may cause the fixed effects estimates of wage differentials across sectors to evidence a downward bias if the wages of job changers who stay in the same sectors relatively increase compared to an increase in the wages of job changers who change sectors.

Table 10 represents wage changes following job changes for each group of sector holders, and for sector changers after job changes for the whole samples. While the hourly wages of sector holders increased by 0.09 log points after job changes, the wages of sector changers increased by 0.11 log points. Given that the current job tenures of sector changers are slightly longer than those of sector holders, wage increases after a job change do not differ significantly between sector holders and changers.[18] It is, therefore, difficult to believe that the samples of job changers holding the same sectors cause the fixed effects estimator to be inconsistent. The examination of wage changes between sector holders and sector changers shows no different pattern between male and female workers. The wage changes between sector holders and sector changers are the same regardless of gender groups. Therefore, the different patterns of estimated wage differentials between sectors for male and female workers also do not appear to be driven by different wage changes due to job changes.

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[18] The higher current job tenures for sector changers might have produced slightly higher wage increases compared to the sector holders having relatively lower job tenures.

5. Concluding remarks

The structure of the formal and informal labor markets is related closely to the gender group in the labor market, even if it has not been seriously considered in the previous analysis. Unlike previous studies focusing either on market structures or the gender earnings gap alone, this study considers market structure as a more crucial factor in determining the gender earning gap. In order to assess the manner in which the structure of the labor market affects the gender earning gap, this study incorporates a two-sector model of the formal and informal labor market, and estimates the wage differentials in each labor market focusing on the gender groups. We employed the prevailing criteria for the formal/informal labor market with regard to whether workers are covered by any social security system. For our analysis, we adopt the Korean case because the Korean labor market has a prominent feature of a dual formal and informal labor market and also the gender earning gap is relatively high among OECD countries.

This study, which utilizes panel data, analyzes the differences in wages between the formal and informal sector by using fixed-effects models that allow us to overcome the possible endogenous problems associated with cross-sectional analysis. The estimated wage differentials between sectors from fixed-effects models show a substantial drop in the size of wage gaps, indicating systematic sorting between formal and informal sectors by unobserved workers' abilities. More interestingly, the wage differentials between workers in the formal and informal sectors are shown to differ among gender groups. While estimated wage differentials from cross-sectional analysis between formal and informal sectors among male workers disappear in the fixed-effect estimations, the wage gap between formal and informal sectors among female workers still exists in the fixed

effect estimation, even though the coefficient size was decreased. The observed wage differentials for the whole samples, therefore, appear to be driven by the wage differentials from the female workers.

As a robustness issue for the fixed effect model, we evaluate wage changes between sector holders and sector changers. They do not provide significantly different patterns for male and female workers. Therefore, the different patterns of estimated wage differentials between sectors for male and female workers do not appear to be driven by the potential bias that might derive from fixed-effects estimates.

According to our tests of the existence of dual labor markets, dualism appears to affect each gender differently. The dual structure of the labor market seems to aggravate the overall gender earning gap, as female workers are penalized more by locating themselves in the informal labor market than are male workers.

Under circumstances of different severities in the dual labor market between gender groups, policies intended to reduce only the gender earning gap may prove ineffective. In many countries with the dual labor market structures like Korea, market structure-ignorant policies tend to tender women in the formal labor market, but their impacts may only very rarely affect women in the informal labor market. These policies may even exacerbate the inequality in working conditions of women in the formal and informal labor markets. The crucial part of the gender earning gap attributed to the sizable wage penalty imposed on women working in the informal labor market may remain untendered by those policies. Therefore, the matrix policy of simultaneously considering the market structure and gender issues (i.e. male in formal and in informal, female in formal and informal) should be considered. Policies addressing the gender

earning gap caused interactively by the dualism of labor market structure and gender discrimination, and thereby targeting the improvement of female working conditions in the informal labor market, may prove to be a more effective remedy, particularly in countries facing stratification of their labor markets.

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Table 1: Proportions of informal sector

	Total	Male	Female
Formal	75	81.9	63.6
Informal	25	18.1	36.4

Notes: The informal sectors cover workers who are covered at least by one of three social security system prevalent in Korea.

Table 2: Descriptive statistics (Means)

	Whole Samples		Male		Female	
	Formal	Informal	Formal	Informal	Formal	Informal
Log of hourly wages	4.31	3.83	4.45	4.02	4.05	3.68
Female	0.32	0.55				
Education (yrs)	13.2	11.31	13.45	11.74	12.83	10.96
Age	37.4	39.1	38.88	38.99	34.19	39.25
Job tenure	6.8	3.2	7.64	3.76	5.04	2.70
Union	0.33	0.03	0.35	0.03	0.26	0.03
Married	0.42	0.46	0.35	0.45	0.56	0.47
sample size	14,106	4,712	9,547	2,107	4,559	2,605

Notes: Standard deviations are in parentheses. The sample is restricted to full-time workers and non-agricultural sector workers aged 20-65. Hourly earnings have been calculated and the details are shown in the text. The bottom 1% of salary workers was excluded.

Table 3: Distribution of firm size by sectors and gender

Firm size	Whole Samples		Male		Female	
	Formal	Informal	Formal	Informal	Formal	Informal
less than10	13.7	61.5	11.6	61.5	17.7	60.3
10~29	17.6	17.8	17.2	21.1	17.9	15.2
30~99	20.7	8.0	20.4	8.2	21.7	8.3
100~299	13.3	3.0	14.0	3.0	12.4	3.4
300~999	10.4	2.4	10.4	1.9	10.6	2.9
more than 1000	24.3	7.3	26.4	4.4	19.7	10.0

Table 4: Occupational distribution by sectors and gender

Occupation	Whole Samples		Male		Female	
	Formal	Informal	Formal	Informal	Formal	Informal
Administrative and managerial	1.5	0.8	2.1	1.7	0.1	0.0
Professional specialty	13.3	6.3	10.5	4.7	19.1	7.7
Technicians and related support	17.5	10.9	20.2	10.5	11.9	11.2
Administrative support	23.7	9.9	18.3	8.0	34.9	11.4
Service	3.9	15.3	3.1	5.6	5.6	23.2
Sales	3.8	13.0	3.5	9.5	4.5	15.9
Precision production, craft, and repair	15.0	18.9	18.0	29.3	8.8	10.4
Machine operators and assemblers	15.1	8.5	18.2	12.1	8.7	5.6
Laborers	6.2	16.4	6.1	18.7	6.4	14.7

Table 5: Industrial distribution by sectors and gender

Industry	Whole Samples		Male		Female	
	Formal	Informal	Formal	Informal	Formal	Informal
Mining and Construction	6.2	11.0	8.4	22.8	1.5	1.4
Manufacturing	34.1	21.0	36.3	22.9	29.4	19.5
Trans, comms, and public utilities	9.2	3.2	11.1	5.3	5.3	1.5
Trade (retail and wholesale)	9.3	18.3	8.8	17.1	10.4	19.3
Hotels and Restaurants	1.6	13.3	1.0	5.1	2.9	20.0
Financial, insurance, and real estate	6.5	6.1	6.0	4.8	7.5	7.2
Educational and health services	19.5	11.6	14.2	7.4	30.4	14.9
Professional services	9.4	5.5	9.4	5.4	9.6	5.6
Other services	4.2	10.0	4.8	9.4	3.1	10.6

Table 6: Wage determination by sector and gender

	Male		Female	
	Formal	**Informal**	**Formal**	**Informal**
education (yrs)	0.057** (0.002)	0.038** (0.003)	0.060** (0.003)	0.027** (0.003)
age	0.008** (0.001)	-0.001 (0.001)	0.003** (0.001)	0.001 (0.001)
tenure	0.018** (0.001)	0.020** (0.001)	0.027** (0.001)	0.024** (0.002)
union	0.039** (0.011)	-0.015 (0.025)	0.074** (0.013)	0.095 (0.052)
married	0.156** (0.011)	0.162** (0.020)	0.073** (0.012)	0.050** (0.016)
Occupation				
Administrative and managerial	0.577** (0.035)	0.587** (0.054)	0.654** (0.033)	0.306** (0.042)
Professional specialty	0.452** (0.026)	0.519** (0.038)	0.372** (0.028)	0.348** (0.039)
Technicians	0.434** (0.023)	0.384** (0.033)	0.342** (0.029)	0.377** (0.037)
Administrative support	0.346** (0.023)	0.349** (0.032)	0.256** (0.026)	0.186** (0.031)
Service	0.334** (0.035)	0.306** (0.040)	0.145** (0.031)	-0.022 (0.024)
Sales	0.264** (0.032)	0.171** (0.040)	0.180** (0.042)	0.201** (0.039)
Precision production	0.277** (0.022)	0.328** (0.033)	0.082** (0.026)	0.137** (0.032)
Machine operators	0.188** (0.022)	0.284** (0.034)	0.053* (0.025)	0.165** (0.036)
industry	**yes**	**Yes**	**yes**	**yes**
firm size	**yes**	**Yes**	**yes**	**yes**
time effect	**yes**	**Yes**	**yes**	**yes**
R-sqs	0.5374	0.3037	0.6219	0.3859
observation	9,544	2,106	4,556	2,605

Notes: The laborers are the omitted occupation and 8 industry dummy variables are included. 6 firm size dummy variables are also controlled for. The numbers in parentheses are heteroskedasticity consistent standard errors.

** significant at 1% * significant at 5%

Table 7: Estimates of wage differentials between formal and informal sector

	OLS	Fixed Effect
Informal	**-0.097****	**-0.048****
	(0.008)	(0.009)
education (yrs)	0.048**	0.015*
	(0.001)	(0.007)
Age	0.003**	
	0.000	
Tenure	0.022**	0.014**
	(0.001)	(0.002)
Female	-0.280**	
	(0.006)	
Union	0.058**	0.032**
	(0.008)	(0.008)
Married	0.119**	0.034**
	(0.007)	(0.008)
time effect	**yes**	**yes**
Occupation	**yes**	**yes**
Industry	**yes**	**yes**
firm size	**yes**	**yes**
R-sqs	0.6091	0.4219
Observation	18,811	18,811

Notes: 9 occupation and 8 industry dummy variables are included. 6 firm size dummy variables are also controlled for. The numbers in parentheses are heteroskedasticity consistent standard errors both for OLS and FE estimates.

** significant at 1% * significant at 5%

Table 8: Estimates of wage differentials between formal and informal sector by gender

	Male Samples		Female Samples	
	OLS	Fixed Effect	OLS	Fixed Effect
Informal	**-0.084****	**-0.02**	**-0.095****	**-0.064****
	(0.012)	(0.013)	(0.011)	(0.011)
education (yrs)	0.048**	0.016	0.047**	0.016
	(0.002)	(0.009)	(0.002)	(0.009)
Age	0.004**		0.003**	
	(0.001)		(0.001)	
Tenure	0.019**	0.011**	0.027**	0.020**
	(0.001)	(0.002)	(0.001)	(0.003)
Union	0.038**	0.025*	0.082**	0.02000
	(0.010)	(0.010)	(0.013)	(0.013)
Married	0.167**	0.034**	0.073**	0.049**
	(0.009)	(0.012)	(0.010)	(0.012)
time effect	**yes**	**yes**	**yes**	**yes**
Occupation	**yes**	**yes**	**yes**	**yes**
Industry	**yes**	**yes**	**yes**	**yes**
firm size	**yes**	**yes**	**yes**	**yes**
R-sqs	0.5355	0.3929	0.5924	0.443
Observation	11,650	11,650	7,161	7,161

Notes: 9 occupation and 8 industry dummy variables are included. 6 firm size dummy variables are also controlled for. The numbers in parentheses are heteroskedasticity consistent standard errors both for OLS and FE estimates.

** significant at 1% * significant at 5%

Table 9: Job movement between formal and informal sectors

	Whole Samples		
	formal	informal	total
formal	1,062	300	1,362
informal	519	712	1,231
total	1,581	1,012	2,593

Notes: Sectors shown in the rows are those from the previous jobs and sectors in the columns are taken from the current jobs.

	Male			Female		
	formal	informal	total	formal	informal	total
formal	699	179	878	363	121	484
informal	256	279	535	263	433	696
total	955	458	1,413	626	554	1,180

Notes: Sectors shown in the rows are those from the previous jobs and sectors in the columns are taken from the current jobs.

Table 10: Wage changes from sector holders and sector changers

	Sector holders	**Sector changers**
Wages before job changes	3.96 (0.51)	3.79 (0.40)
Wages after job changes	4.06 (0.52)	3.90 (0.43)
Wage changes	0.09 (0.37)	0.11 (0.43)
Job tenure at current jobs	1.67 (1.05)	1.82 (1.14)
sample size	1,774	819

Notes: Standard deviations are in parentheses.

	Male		**Female**	
	Sector holders	Sector changers	Sector holders	Sector changers
Wages before job changes	4.14 (0.51)	3.94 (0.43)	3.74 (0.39)	3.63 (0.31)
Wages after job changes	4.25 (0.53)	4.06 (0.44)	3.82 (0.41)	3.71 (0.35)
Wage changes	0.11 (0.39)	0.12 (0.48)	0.08 (0.34)	0.08 (0.36)
Job tenure at current jobs	1.62 (1.02)	1.80 (1.08)	1.73 (1.09)	1.85 (1.20)
sample size	978	435	796	384

Notes: Standard deviations are in parentheses.