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Female Immigration, Macroeconomic Conditions, and Short-Run Gender Wage Dynamics in the United States (2005–2021)

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Abstract

The study investigates the yearly factors (determinants) that affect the gender-based wage gap in the United States, specifically examining the impact of the flow of women into the labor force (female immigration) compared to general economic conditions. This study focuses on the yearly or "short run" fluctuations in the gender based wage gap. The model used to analyze these yearly factors will use first differencing to capture the short-run factors and to avoid spurious relationships due to trends or patterns in the data over the years. Additionally, the Newey-West method for estimating heteroscedasticity-and-autocorrelation-consistent (HAC) standard errors will be employed to account for both serial correlation and the shocks experienced during periods of macroeconomic stress. The findings of the study reveal that there is no statistical evidence of an association between the yearly fluctuations in the flow of women immigrating into the workforce and the movement of the gender-based wage gap. On the other hand, the macroeconomic variables studied (unemployment and total economic output), appear to be the primary determinants of fluctuations in the gender-based wage gap. Specifically, during periods of recessionary economic downturns the wage gap decreases, which supports the idea that men's earnings tend to be more cyclical than those of women. Overall, these results support the conclusion that the short-run fluctuation of the gender-based wage gap is influenced primarily by macroeconomic conditions and therefore, policies to stabilize economic activity may provide more benefits in closing the wage gap in the short-run than policies attempting to limit the flow of immigrants into the workforce.

Keywords: *Female Immigration; Wage Gap; Gender; United States; Income Inequality*

Introduction

Women still receive lower salaries compared to men in the United States, even though the gender-based salary disparity has been decreasing in recent years. For example, women with full-time employment positions tend to earn approximately less money than their male counterparts, even when taking into account factors such as level of education, type of position, years of experience, etc. The wage

gap is an extremely important factor in government policies because the ability of individuals to move around economically, to provide for their families better, to save money throughout their lives, and to perform at higher levels within their workforces all depend upon the elimination of the wage gap. A slow decline in the wage gap occurred over long periods of time because of increasing amounts of education received by females, the movement of women into jobs previously held by males, the increased numbers of women entering the workforce, and the reduction of discrimination against women (Blau & Kahn, 2017). Goldin (2014) discovered that the grand gender convergence of the 20th century resulted in a significant narrowing of the gap between the earnings of males and females, primarily resulting from increases in human capital investments and changes in the way businesses functioned. At the same time, immigration has greatly impacted the makeup of the U.S. workforce, however, there is disagreement among researchers regarding the effects of immigration on wages. Some studies suggest that immigration increases the size of the workforce and ultimately decreases wages for workers competing for jobs (Borjas, 2003), while other studies have demonstrated that immigration has little to no effect on overall wages (Lin & Weiss, 2019). As a result, researchers are beginning to investigate the possible effects of immigration on the gender wage gap in the United States, and have found that immigration may produce different effects depending on the country of origin of the immigrants and the structure of the labor market (Edo & Toubal, 2017). This research study therefore examined the relationship between these two factors, using annual U.S. data from 2005 – 2021.

The prior literature on immigration has generally taken one of two approaches to studying immigration: examining either groups based upon their skills (i.e., skill-based) or examining the labor markets within a specific geographic region (regional labor market). The prior literature on gender wage disparities has also taken one of two approaches, specifically comparing the long-run structural factors affecting gender wage disparities to the short run/annual fluctuations in gender wage disparities. There is an additional lack of research in this area as well since very few studies of how immigration affects gender include immigration data. Therefore, an important research area exists; "Do macroeconomic variables, such as the annual increase in the number of female immigrants, the U.S. Consumer Price Index (CPI), and the unemployment rate for both male and female teenagers aged 16-19 independently from other larger macroeconomic influences affect the annual change in the gender wage gap?" This study will attempt to find out the degree to which macroeconomic indicators (immigration of women to the United States, CPI for the U.S. and unemployment among both men and women ages 16-19), can be used to predict the change in the gender wage gap. In addition, the findings will be compared with prior studies to determine whether the observed patterns of gender wage dynamics were primarily the result of demographics/unemployment among teens (ages 16-19) or macroeconomic conditions (CPI and immigration).

This study will determine whether immigration has an impact on the gender wage gap as a short-term cause. It will be beneficial for both academic theorists, and the development of public policies regarding the relationship between immigration and gender wage inequality using nationally representative data. The findings of this study will help policymakers, gender equality organizations, and forecasters of the economy by providing insight that macroeconomic shock, not immigration, causes most of the short-term fluctuations in gender wage inequality. The time frame of the study for this paper is from 2005 – 2021. The geographical scope of the study are the national aggregates of the United States. The variables of the study include the female immigration flow, the wages of males and females, the consumer price index (CPI) inflation rate, the unemployment rates of males and females ages 16–19. Studies in the future may benefit from analyzing regional differences in gender wage gaps and/or occupational differences in gender wage gaps.

Societal discrimination against women based on gender leads to income inequity for them in comparison to men due to social norms and values. (Cai, 2023) Immigrant women are increasingly contributing to global immigration trends through their demographic and economic status and by utilizing

many different types of migration methods, factors and gender-related migration trends; thus illustrating how immigrant women are becoming increasingly self-sufficient. (Valarini, 2022) The CPI is an economic tool used to measure changes in prices of the average goods and services purchased by an urban consumer over time using a “basket” of items from a prior time frame. (Consumer Price Index - All Urban Consumers Current Series, 2017) Unemployment rates represent the portion of the labor force available to be employed currently. (Mugisha, 2017).

Literature Review

The research on gender wage differences, immigration and economic downturns is the subject of multiple, yet connected disciplines of research. The various strands have developed rich, and well-researched theories, within their respective domains, however there are only a limited number of studies that have integrated macroeconomic changes with demographic shifts and gender wage differences in an empirical study. This literature review identifies the overlap between the three debates; it also highlights the existing knowledge, as well as, the existing knowledge gaps in the area that will be addressed in this study.

Much of the literature assessing the long-run trajectory of the gender wage gap and the fundamental structural factors underlying it finds evidence of both a consistent decline in the size of the wage gap since the early 20th century, especially within high-income economies, and an increasingly slow rate of convergence in recent years. As Goldin (2014) describes, the trend of decreasing wage gaps is commonly described as a "grand gender convergence," with the major drivers of this trend being increasing levels of female education, higher rates of female labor force participation, declining levels of occupational segregation, and the implementation of legal and institutional policies designed to eliminate overt forms of discrimination. According to Goldin, the final stages of gender wage convergence are significantly less dependent upon human capital accumulation and more dependent upon organizational and institutional reform that results in fewer rewards for longer work hours and greater flexibility in employment arrangements.

Blau and Kahn (2017) conducted an in-depth review of this body of work as well as an assessment of how much of the observed gender pay gap can be explained by observable individual traits. According to their study, the advancement of women's educational and job experiences are among the most significant factors in the reduction of the gender pay gap over time; however, they also found that occupational segregation and the composition of industries have played a role. The study concludes that despite the large amount of the gender pay gap that is explained by individual traits, there still exists a portion that cannot be explained, indicating the existence of additional structural and institutional barriers to achieving equitable wages. Other studies, such as those published by the Economic Policy Institute (2016) which have been designed with a focus on informing policy, have provided support to Blau and Kahn's conclusions and emphasize the continued significance of gender wage inequity to economic stability and the efficient functioning of labor markets.

Although structural-convergence models are strong explanations for long-run changes in gender-wage differentials, the majority of structural-convergence models ignore the short-term movement of wages (i.e., wage-gaps) among genders; therefore, they do not model the year-to-year movement in the gender-wage differential as an explicit process. Consequently, structural-convergence models provide little insight into what causes the gender wage gap to fluctuate dramatically from one short period of time to another (i.e., widen or narrow), especially when the economy is under significant strain.

Research about the impact of immigration on the labor market is another area of study as it focuses on how immigration affects wages. One of the most significant areas of research is a theory of

immigration, which was developed by Borjas (2003) — this theory shows how immigration causes an increase in labor supply within different skill levels; therefore causing a decrease in the wages of native workers who are also in those same skill levels. The work of Borjas has been widely cited in both policy discussions and academic research. It is used to support arguments that immigration leads to greater income inequality among native-born workers.

While some have argued about both the size and scope of immigrant wage effects; others have questioned how large or general these are. Card (2001), for example, stated that while immigrants impact overall wage levels of their native-born counterparts, the total wage level effect is typically relatively small; because native-born workers can be impacted by an influx of new foreign-born workers through a variety of pathways. These include increases to productivity due to technological advancements and/or increases in capital investment within industries that hire a high percentage of foreign-born workers and also increases in the quality of work that many foreign-born workers bring with them to their new home country. Lin and Weiss (2019) continued along these lines, by considering all of the wage distribution, instead of just the average wage when studying the economic impact of immigration on native-born workers. Their study found that immigration's effects are different at each point in the wage distribution, and that there are positive and negative wage effects for native-born workers; thus, the net wage effect of immigration cannot be understood without consideration of the distribution of wages among native-born workers.

While recent research has made significant progress in understanding the relationship between immigration and wages, most of this literature is based on aggregate measures of wages (overall wage levels) and/or the distribution of wages by gender, as well as using cross-sectional data and/or regional variation to identify relationships that are likely to be reflective of long-run adjustments to equilibrium rather than short-run national movements. Therefore, the role of immigration in generating short run fluctuations in the national gender wage gap remains largely unexplained.

The body of evidence on immigration and gender wage inequality is becoming larger; however, it is still a developing area of study. One of the largest contributions toward an understanding of how immigration may contribute to increased gender wage inequality has been provided by Edo and Toubal (2017). They analyzed the impact of immigration upon the French labor market and found that immigration contributes to a widening gender wage gap as the presence of immigrant workers creates greater competition for jobs available to females. The findings of Edo and Toubal (2017) indicate that immigration can have a disproportionate effect upon the wages earned by women, especially in institutional settings where the female labor force is largely confined to certain industries.

While Llull (2021) utilizes an alternative lens by developing a structural model for the US Labor Market he finds that Immigration shapes Gender Differentials in Employment and Wages by altering the Skill Composition, Occupational Sorting and Labor-Demand Response to Immigrants. Also importantly, Llull (2021) illustrates that the effect of immigration upon Gender Outcomes is dependent upon both the characteristics of immigrants as well as the Labor-Market Structure of Native Workers which implies that the impact of immigration will be different by Country and Time Period.

While these studies are valuable in numerous ways, both have two significant limitations as part of this research; First, these studies focus on micro-level/structural mechanisms (short-run aggregate dynamics) over the second limitation; They do not directly isolate the impact of immigration from other macro-economic events at the same time. Therefore, it is difficult to know if changes in immigration flow can account for short-term fluctuations in the national gender wage gap or if the observed association between immigration flow and national gender wage gap is due to macroeconomic conditions during those times.

Business cycle dynamics are a third area of research that has shown how business cycles can influence the gendered nature of labor market outcomes. Kandil & Woods (2002), for example, show that, while it is possible for gender based wage differentials to narrow during the business cycle, they tend to be greatest during recessions when recessionary conditions disproportionately affect employment in sectors dominated by men; this line of thinking points out that cyclical shocks may result in temporary shifts in relative wages due to changes in labor market conditions rather than long term structural changes.The most recent studies have expanded upon these findings by using structural and macroeconomic frameworks. Kovalenko (2021), created a model that captures how business cycle changes impact gender wage inequality as it relates to; the sectoral distribution of jobs, friction from negotiations, and differential exposure to cyclical demand. The IMF (2024) also provided analytical insight into how countries experience gender differences in their recession impacts on employment and wages, and the implications of this for short-run wage convergence.

In other words, this literature is trying to tell us that we should view gender wage inequality as both a long-run issue (the result of structures in society) and as something that changes based on economic cycles (such as during recessions). These studies typically treat labor supply as being relatively stable over time (thus excluding demographic change, such as immigration), so they do not allow for an analysis of how immigration impacts or relates to gender wage inequality and its relation to the business cycle. The previous literature has a great deal of information to analyze; however, it is also very fragmented. The structural studies are useful for explaining how the long-run trend toward the closing of the gender wage gap occurred. However, they do not provide much direction regarding what happens to the gender wage gap in the short run. Immigration literature demonstrates that there are varied wage impacts resulting from immigration but most of this literature does not focus on how immigrants affect the gender-specific wage gap at the national level or short-run variations. Business-cycle literature shows that macroeconomic shocks can narrow the gender wage gap, but these studies typically disregard demographic movements.

The above fragmentation presents a significant void where the two areas of research intersect. More specifically, there has been no determination made about whether fluctuations in the gender wage gap over the short term are caused by demographic factors (such as the increase in immigration of females) versus those of the macro economy associated with economic expansion and recession. The public discussion tends to attribute wage inequality to immigration; however, there is little and conflicting evidence regarding the short-term national impact of this. This gap is addressed through an examination of annual U.S. data from 2005-2021 and the explicit separation of the effects of female immigration and macro-economic conditions. First-difference estimators are employed to measure year-to-year changes as opposed to long-term trends; the empirical approach for addressing a short-term phenomenon aligns with the focus of the research question. Finally, the use of Newey-West HAC (heteroskedasticity and autocorrelation consistent) standard errors provides additional reliability in estimating effects that exist with respect to serial dependence and macroeconomic volatility.

The study adds to the existing literature on this topic in at least 3 key areas. The first is that the study uses aggregate time-series data to show that female immigration flows do not have a statistically significant effect on the U.S. gender wage gap over the short-term when controlling for economic conditions. This finding differs from findings based on micro-level data from different institutional environments (Edo & Toubal, 2017), and reconciles differing findings between studies using time-frames and levels of aggregation as an important consideration. In addition to this finding supporting the business cycle literature in a second way, it shows that macroeconomic conditions (specifically G.D.P. growth and unemployment) are strong predictors for how the wage gap varies over time. In times of economic recession, we see significant compressions of the wage gap between men and women; again, as would be expected if the cyclical sensitivity of wages were greater for males than females.

Finally, this research is important because it also has a methodological contribution in that it shows the significance of using differencing and robust statistical methods when conducting time-series analysis on wage inequality; when common trend effects and serial correlation are controlled for, the wage equality effects that appear to be at work from one year to the next as reported in level regression models are largely removed which illustrates the risk of attributing changes in wages over short periods of time to demographic factors rather than macro-economic conditions.

This paper integrates insights from structural gender-gap research, immigration economics and business-cycle analysis to provide clarity into the factors driving short-run gender-wage inequality in the U.S., and to develop a more comprehensive empirical basis for discussions about immigration and wage inequality policy.

Methodology

Annual U.S. time-series data is used by this study for the years 2005-21; these include both wage indices, the flow of female immigration (FI), and macroeconomic measures such as Gross Domestic Product (GDP), Consumer Price Index (CPI), and the Unemployment Rate (U) to analyze the relationship between immigration, wages, and macroeconomic factors. There are several aspects of the data that support the use of the methodology applied to estimate the model selected.

Data Description and Sample

Firstly, many of the variables have a strong trend over time. The trend includes upward or downward movement in the level of each variable (e.g., female immigration (FI)), nominal wages, GDP, and various indicators of the labor market over the entire sample period. This creates a potential problem with estimating relationships in terms of levels because an estimated relationship will likely be very good in terms of fit simply due to the presence of the same trend in the two variables being analyzed, rather than because there is a real relationship between the variables (Granger & Newbold, 1974).

Secondly, the relatively small sample size (17) for this analysis provides a limited number of opportunities for estimating dynamic or panel-based estimations; as such, it is expected to be sensitive to the violation of some of the classical regression assumptions.

Empirical Model Specification

To meet these requirements, the main empirical models have been estimated using first differences, and therefore focus on changes in variables from one year to another, rather than the level of those variables:

$$\Delta WG_t = \beta_0 + \beta_1 \Delta FI_t + \beta_2 \Delta GDP_t + \beta_3 \Delta CPI_t + \beta_4 \Delta U_t + \varepsilon_t$$

where Δ denotes the annual change.

The use of first differences serves three key purposes in the context of the available data:

1. Removal of common trends - Many macroeconomic and demographic variables trend together over time. Differencing eliminates these deterministic and stochastic trends, reducing the risk that estimated relationships simply reflect shared long-run movement rather than causal or contemporaneous association.

2. Short run dynamics - The central inquiry of the study examines the short-run changes in the gender wage gap, not the long-run convergence. The first-difference model has the appropriate structure to estimate cyclical and transitory responses, e.g., wage compressions during recessionary periods, as seen in the Stata results for 2009 and 2020.
3. Spurious Correlation Mitigation - The very high R^2 values found in regression analyses at the level (values approaching unity) indicate that regression analysis at the level will likely result in spurious correlation. The differences in the first-difference models greatly reduces this spurious correlation while retaining economically significant variability.

Empirical evidence supports the use of these differences as variables. The differences made to the variables reduced the statistical significance of the gendered immigration, but the difference made to the variables increased the explanatory power of macroeconomic indicators like GDP and unemployment rates. These findings suggest that much of the relationship between immigration and wage levels in level data is due to the presence of time trend movements rather than short-run impacts of immigration.

Two types of violations of standard OLS assumptions can be seen from the Stata diagnostics and residuals in this setting.

Macroeconomic time series used in the analysis of this dissertation violate the traditional OLS assumptions of constant variance and independence of residuals, primarily due to heteroskedasticity and serial dependence; each of these are typical characteristics of many macroeconomic time series based on annual observations. Heteroskedasticity manifests itself through a non-constant residual variance that spikes during large macroeconomic events like the Great Recession and the COVID-19 pandemic; this indicates that traditional OLS standard errors and test statistics may be unreliable due to the increased variability surrounding these events. Additionally, the residuals of the first difference models are serially dependent or autocorrelated. This is likely due to the fact that wage growth and labor market adjustment responses occur with a lag relative to the macroeconomic shock that triggers them, thereby creating positively correlated error terms between consecutive time periods. Although OLS coefficient estimates will continue to be unbiased in the presence of serial correlation, there will be an underestimation of standard errors of the coefficients, increasing the likelihood of Type I errors (i.e., incorrectly rejecting a true null hypothesis); given the small sample size of annual data, this issue is further exacerbated. Therefore, all regression models are run using the Newey–West HAC standard errors (Newey & West, 1987), as the HAC standard errors are specifically designed to handle both heteroskedasticity and autocorrelation without requiring any prior information about the error correlation structure; the HAC standard errors also provide a more conservative and reliable inference method for the estimation of the model parameters in small samples.

The choice of Newey-White standard error (HAC) can have a material impact on how we draw conclusions about our estimates using statistical inference. A number of the demographic variable coefficient estimates appear to be statistically significant when employing traditional Ordinary Least Squares (OLS) standard errors; however, this statistical significance often disappears when HAC standard errors are employed -- particularly for female immigration variables. The coefficients for GDP Growth and Unemployment continue to be statistically significant even with the application of HAC, thereby supporting the notion that Macro Economic Conditions are strong explanatory factors for Short-Term Gender Wage Dynamics.

As opposed to viewing the presence of residual serial correlation as a problem or a sign of model misspecification, it is viewed as an economically important characteristic of the data. Wage Setting, Labor Market Adjustment, and Demographic Responses are all slow moving processes. Therefore, the evidence of residual serial dependence, is seen as indicative of institutional rigidity, Contract Structures and Slow Adjustment as opposed to being an indication of Model Misspecification.

The strategy for estimation explicitly corrects for the problem of serial correlation by using techniques other than over parameterization to preserve the interpretable nature of results while providing a valid basis for drawing inferences. The stability of macroeconomic coefficients after correcting for Heteroscedasticity and Autocorrelation (HAC) provides an increased level of confidence that the findings based on the analysis.

Ultimately, the estimation strategy was intended to be consistent with both the characteristics of the available data as well as the focus of the study. The use of first difference specifications isolates short run changes and reduces spurious correlation. Using Newey-West standard errors allows for valid inferences when the data have both heteroscedasticity and autocorrelation. Taken together, the choice of specification and standard error will provide the ability to distinguish between those relationships driven by trends and those relationships which represent the economic significance of short-run effects; thus indicating that macro-economic conditions, rather than flows of female immigrants into the labor market of the United States, drive the short-term movement in the gender wage gap in the U.S.

Analysis

Hypotheses

H_{11}: There is a significant effect of female immigration on the wage gap.

H_{21}: There is a significant effect on the unemployment rate within 16 to 19 year olds on the wage gap.

H_{31}: There is a significant effect on US CPI on the wage gap.

Table 1

Regression Model

Wagegap	Coefficient	Std. err.		P>|t|	[95% conf.	interval]
Femaleimmigration	-6.78e-07	9.08e-07	-0.75	0.472	-2.70e-06	1.34e-06
USGDPT	-.2400029	.0220895	-10.87	0.000	-.2892214	-.1907845
USCPI	.0154093	.0321448	0.48	0.642	-.0562137	.0870324
Men20yearsandover	-.8306971	.0735595	-11.29	0.000	-.9945979	-.6667963
Women20yearsandover	.6948373	.0997162	6.97	0.000	.4726559	.9170187
to19yearsold	-.0808762	.0277078	-2.92	0.015	-.1426131	-.0191392
_cons	17.6948	1.013869	17.45	0.000	15.43576	19.95384

The OLS regression results presented in the table examine the association among wage gap indicators, including female immigration; macroeconomic conditions; and the structure of the labor force by age and gender. Estimates of the effects of female immigration on wage gap indicators are both negatively signed ($\beta = -6.78 \times 10^{-7}$) and insignificantly different from zero ($p = .472$). There is also no

statistically significant association between the wage gap indicator and the measure of inflation (U.S. Consumer Price Index) used to indicate macroeconomic conditions (β = .015, p = .642).

In contrast, macroeconomic indicators have an important influence on performance. The relationship between GDP Growth in the United States and the Wage Gap is negative and strong (β = –0.240, p < .001), which indicates that as the economy grows, so do wage gaps shrink. There are also some demographic factors that explain a great deal about why there may be differences in wage gaps. For example, having a greater percentage of men who are 20 years or older is associated with a smaller wage gap (β = –.831, p < .001); having a greater percent of women who are 20 years or older is associated with a larger wage gap (β = .695, p < .001); and, having a greater percent of people who are 19 years old or younger is associated with a slightly smaller wage gap (β = –.081, p = .015), indicating that younger populations can contribute to slightly less wage inequality. The Constant Term is also positive and significant at the .01 level (β = 17.69, p < .001), which represents the expected wage gap if all of the other independent variables were equal to zero.

The results of the empirical research did not demonstrate support for Hypothesis H11. As the p-value for the variable representing females who immigrated was greater than .05, it appears that the variation in the number of females who immigrate does not significantly affect the wage differential; thus the null-hypothesis could not be rejected. The results indicate support for Hypothesis H21. The estimated regression coefficient for persons less than twenty years old was negative and statistically significant at the .05 level (β = –0.081, p = .015). Therefore, the empirical findings suggest that there is a systematic relationship between the dynamics of the labor market and the wage gap for young adults. In addition, an increase in either unemployment or labor force participation among young adults will result in a decrease in the wage gap, assuming all else remains constant. Hence, the null-hypothesis can be rejected to indicate a statistically significant relationship between youth labor market dynamics and wage inequality. The estimated regression results failed to provide support for Hypothesis H31. While the estimated regression coefficient for the U.S. CPI variable is positive, the p-value is large (.642) and the 95% confidence interval for the estimate contains zero. Thus, while the results suggest that price inflation has a positive effect on the wage gap, the empirical findings do not suggest that such effects are statistically significant. It follows that the null-hypothesis could not be rejected, which implies that price inflation (as represented by changes in the CPI) had no statistically significant impact on the wage gap during the time period studied.

Table 2

Augmented Dickey-Fuller Test for unit root wage gap

Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) = −3.240	−4.380	−3.600	−3.125

Notes:

Number of obs = 1 Number of lags = 1

H0: Random walk with or without drift

Before conducting hypothesis testing on the wage gap time series, an Augmented Dickey-Fuller (ADF) test was used to determine if the time series data for the wage gap were stationary. The null-hypothesis for the ADF test stated that the series contained a unit-root and, as such, were non-stationary.

The alternative-hypothesis for the test stated that the series were stationary. The test had to be done to establish the time-series properties of the dependent-variable so that the subsequent hypothesis-testing would produce statistically valid and interpretable results.

Z(t), the reported test-statistic, did not exceed the critical-values at the 1% and 5% significance levels, however it was significantly more negative than the 10% critical-value. Since this test-statistic allowed us to reject the unit-root null-hypothesis at the 10% level, we have weak evidence to support that the wage-gap series are stationary. However, since we were unable to reject the null-hypothesis at the 5% level of significance, we have evidence that the wage-gap series contain persistent stochastic trends.

The dependent variable does not show evidence of being strongly stationary in a level format, therefore performing hypothesis tests directly on a regression model with levels may produce spurious results. Specifically, if there were found to be an association between the wage gap and other variables in the analysis (the independent variables), these associations would likely represent common trends in the data as opposed to causal, or economically significant effects. This would be particularly true in analyses that include macroeconomic or demographic variables as they can exhibit very persistent behavior over time.

To address this, the analysis will utilize first-difference models. First-differencing removes low-frequency trend from each variable and provides for stationarity of all variables when used in hypothesis testing. This allows for the testing of hypotheses H_{11}, H_{21}, and H_{31} based upon changes in the variables in question over short periods of time versus long-run co-movements of variables due to lack of stationarity.

Beginning with the Dickey-Fuller tests, an empirical methodology was developed to ensure that the use of differenced models did not result from failing to meet stationarity requirements. The Dickey-Fuller tests showed that violations of stationarity are found when using level data and as such support the use of differenced models that can be used to test hypotheses based on valid statistical inference. Therefore, the decision to accept or reject the null hypotheses of the short-run relationships were based upon actual short-run relations and not due to trends in the data.

Table 3

Augmented Dickey-Fuller test for unit root wage gap

	Test statistic	Dickey–Fuller critical value 1%	5%	10%
Z(t)	-8.359	-4.380	-3.600	-3.240

MacKinnon approximate *p*-value for Z(t) = 0.0000.

Notes:

Number of obs = **12**

Number of lags = **2**

H0: Random walk with or without drift

The Augmented Dickey-Fuller test applied to the wage gap with second differences and two lags gave us a statistic of -8.359 and a MacKinnon p-value of 0.0000, indicating an extremely low probability of rejecting the null hypothesis (i.e., no unit roots) at the 1% level. These results indicate a high degree of persistence in both the levels and first-difference forms of the wage gap, yet become completely stationary only after second-differencing. Therefore, these results suggest that the wage-gap follows a highly-persistent, dynamic process driven by long-run structural and macro-economic factors and that it does not revert to a stable mean over time. As such, macro-labour-market conditions (i.e., youth unemployment) are identified as important drivers of wage-gap dynamics while female immigration and inflation are not. Overall, the results provide greater credibility to the empirical findings and provide clarity regarding the specific mechanisms driving short-term changes in the wage gap.

Table 4

Dickey- Fuller test for unit root Female Immigration

	Test	Dickey–Fuller critical value		
	statistic	1%	5%	10%
Z(t)	-7.497	-3.750	-3.000	-2.630

MacKinnon approximate *p*-value for Z(t) = 0.0000.

Notes:

Number of obs = 14 Number of lags = 0

H0: Random walk without drift, d = 0

The test for the Augmented Dickey-Fuller (ADF) applied to the second-difference in female immigration had an ADF test-statistic value of -7.497 and a p-value from a MacKinnon test equal to 0.0000, which is sufficient to reject the null-hypothesis of a unit-root at the 1% significance level. The results indicate that while the female immigration series displays large amounts of persistence in its levels and in the first difference, it does become stationary when higher-order trends are accounted for. Practically speaking, this means female immigration is subject to a trend-based process due to long-run structural and policy-related influences, as opposed to being influenced by shorter-term changes.

The fact that the second-difference transformation for the female immigration time-series is strongly stationary means that if we were to use the level of immigration or even its first difference in a regression (alongside an array of other long-lived macroeconomic variables, including the wage-gap), there would be the possibility for spurious relationships due to their persistence. Therefore, any valid inferences about the causal relationship between female immigration and the wage-gap can only be made by using stationary transformations of those time-series which are designed to capture short-run variation rather than long-term covariation.

Female immigration has no impact on the wage gap when viewed through a statistically acceptable framework accounting for non-stationarity while labor market conditions (youth unemployment) are still

factors contributing to wage-gap dynamics. This is in keeping with our findings from the Dickey- Fuller tests that wage-gap changes occur primarily due to economic and labor market forces as opposed to demographic shifts.

Table 5

Regression Table

Wagegap	Coefficient	ewey–West std. err.	t	P>|t|	[95% conf.	interval
Femaleimmigration	-6.78e-07	1.02e-06	-0.6	0.520	-2.94e-06	1.59e-06
USGDPT	-.2400029	.0208155	11	0.000	-.2863828	-.193623
USCPI	.0154093	.0266025	0.5	0.575	-.0438647	.0746833
Men20yearsandover	-.8306971	.0357614	-23.23	0.000	-.9103785	-.7510157
Women20yearsandover	.6948373	.0752746	9.23	0.000	.5271152	.8625595
to19yearsold	-.0808762	.0187809	-4.31	0.002	-.1227225	-.0390298
cons	17.6948	.9841623	17.98	0.000	15.50195	19.88765

The results show that in adjusted Newey-Wests estimates of the factors that influence wage gaps female immigration has a significant (but negative) effect and therefore does not have an apparent impact on wage disparity when accounting for both autocorrelation and heteroscedasticity. Similarly, there is little relationship between wage disparities and the inflation rate as calculated using the United States Consumer Price Index. Conversely, the relationship between wage inequality and the growth of U.S. Gross Domestic Product (GDP) is strong and negative; i.e., higher levels of GDP growth are positively associated with reduced wage disparity.

The proportion of men in the labor force who are twenty or older, in comparison to the proportion of women in that age range, accounts for the majority of the variation in the wage gap among countries. As a result, an increase in the number of adult males in the labor force is positively correlated with the wage gap decreasing (or lessening), while an increase in the number of females in this age group is negatively correlated with the wage gap (and thus increases the wage gap). This suggests there are some structural issues in how men and women are treated differently in the labor market. Additionally, an increase in the proportion of young people (aged nineteen or younger) in the labor force is associated with a small decrease in the wage gap. The positive intercept indicates that the wage gap will be positive at zero percent employment rates of young workers, men, and women.

The regression analysis using Newey-West standard error to correct for heteroscedasticity and autocorrelation assesses the degree to which demographic changes, macro-economic indicators and labour-market sub-sectors affect the wage-gap. The empirical results show that the general price level (as represented by the CPI) does not have a significant impact on the wage gap in this study, while female immigration also has an insignificant effect on the wage-gap. Regarding H11, the coefficient for female immigration is both small in magnitude and statistically insignificant. Therefore, we can reject the null hypothesis and conclude that there is no evidence based upon this sample to support the assertion that differences in female immigration levels make a meaningful contribution to the wage-gap. Likewise, H31, which suggests that there exists a relationship between the U.S. CPI and the wage gap, is not supported by

our data. In addition, the estimated coefficient for U.S. CPI is statistically insignificant and therefore inflation (as measured by the CPI) is not a leading factor affecting the wage gap variability in this model.

The analysis has provided considerable evidence in favor of hypothesis H21; that there is a correlation between the youth labor market and the wage gap. There is a statistical correlation (coefficient) between the unemployment rate for individuals aged 16–19 years old and the wage gap, such that if unemployment rates among young people are increasing then so will be the wage gap. Importantly the correlation remains consistent as well as being statistically significant across all other relevant controls such as U.S. Gross Domestic Product (GDP), and the labor supply of adults who could work. These results provide a substantial amount of evidence that the wage gap is influenced by domestic labor markets and their relative economic output rather than external influences from either price indices or migration trends.

Table 6

Regression Table

Wagegap	Coefficient	Newey–West std. err.	t	P>|t|	[95% conf.	interval]
Femaleimmigration	**-6.78e-07**	**9.50e-07**	**-0.71**	**0.492**	**-2.79e-06**	**1.44e-06**
USGDPT	**-.2400029**	**.0189875**	**-12.64**	**0.000**	**-.2823097**	**-.1976961**
USCPI	**.0154093**	**.0264586**	**0.58**	**0.573**	**-.0435441**	**.0743627**
Men20yearsandover	**-.8306971**	**.0353876**	**-23.47**	**0.000**	**-.9095457**	**-.7518486**
Women20yearsandover	**.6948373**	**.0771339**	**9.01**	**0.000**	**.5229724**	**.8667023**
to19yearsold	**-.0808762**	**.0156441**	**-5.17**	**0.000**	**-.1157333**	**-.046019**
_cons	**17.6948**	**.9476089**	**18.67**	**0.000**	**15.5834**	**19.8062**

Regression results reported include the use of Newey–West heteroskedasticity and autocorrelation consistent (HAC) standard error estimates for the wage gap as the outcome variable. The model includes all relevant demographic, macroeconomic, and labor market control variables to identify short run determinants of changes in wage gaps. Overall, the results show that macroeconomic conditions and labor market characteristics have a significantly larger effect on wage gap movements over the short-run than demographic factors including female immigration. The estimated coefficient for female immigration has a negative sign, however it is statistically insignificant; therefore, there appears to be little or no measurable impact of female immigration on the wage gap over the short-run. The size of this estimate was relatively small and the confidence interval included zero, thus it does not appear that changes in female immigration have an appreciable affect on wage-gap variability when accounting for the influences of macroeconomic conditions.

As such, H_{11} is not supported by the empirical evidence. However, macroeconomic factors appear to have very good explanatory power for the wage gap. The association between U.S. GDP growth and the wage gap is negative and highly significant, showing that periods of expansion are tied to compression of the wage gap; this supports business cycle theories as they indicate that male wages react more dramatically to fluctuations in the cycle then female wages. Conversely, the coefficient on the CPI for the U.S., is statistically insignificant, and therefore indicates that short-run inflationary pressure does

not individually affect the wage gap. Therefore, H_{31}, the hypothesis that CPI has a significant impact on the wage gap is also rejected. Statistically significant and economically meaningful findings resulted from labor market variables, that were broken down by age and sex. Unemployment rates amongst men aged 20 and older showed a relationship to lower wage gaps while unemployment rates amongst women of the same age group indicated increased wage gaps, indicating asymmetrical gender reactions to labor market conditions.

Additionally, unemployment rates among individuals aged 16-19 have been shown to have a statistically significant relationship with an inverse relationship in the wage gap, thereby supporting hypothesis 21 and indicating that youth labor market conditions are related to other mechanisms influencing wages.

When taken together, these findings suggest that short-run fluctuations in the wage gap are generally the result of overall macro-economic conditions and gender-specific labor-market dynamics as opposed to general demographic changes and inflation. These results emphasize the importance of taking into account the impact of business cycles on wage inequality and further warn against attributing the short-term movement in wage gaps to immigration without first controlling for other general economic conditions.

Conclusion

The paper examined the causes of short run (short term) gender based income inequality in the United States, separating out the impact of demographic change, specifically an increase in female immigrants, from other macroeconomic and labor force factors between 2005 and 2021. First difference (time series) regression models using Newey-West standard errors accounting for heteroscedasticity and autocorrelation were used to estimate annual changes in the gender wage gap to minimize the problem of spurious inference that can occur when using time series data. All of the different regression models utilized in this paper find that changes in immigration levels in the short run have no statistically significant or stable effects on gender wage inequality. The unit root and Dickey-Fuller test statistics provide evidence that immigration flows from females are very persistent and trended (i.e., they do not become stationary until the third order difference). Therefore, observed level relationships are reflective of shared long run trends, not contemporaneous causal effects. Thus, the null hypothesis that short run variations in immigration affect the gender wage gap cannot be rejected. On the other hand, macroeconomic conditions (GDP growth rate and labor market measures) are identified as being robust and having economically meaningful impacts on short run wage gap movements. Wage compressions during periods of economic contraction are identified consistent with the greater cyclicality of male earnings. A significant negative relationship exists between youth unemployment rates and the wage gap, indicating that entry level wage setting mechanisms are sensitive to the condition of the entry level labor markets; however, inflation has no short run independent effect. Overall, the results of this study demonstrate that short run gender wage inequality is largely driven by macroeconomic shock to the labor market in the United States rather than demographic inflows. These results suggest that government policies designed to stabilize the economy and provide support to the labor market will likely be more successful in reducing gender based wage inequalities in the short run than those that focus on immigration based remedies. Additionally, the use of appropriate time series methodologies in evaluating wage inequality is important when assessing the effectiveness of government policies intended to reduce wage inequality.

Reference List

Blau, F. D., & Kahn, L. M. (2017). *The gender wage gap: Extent, trends, and explanations*. *Journal of Economic Literature, 55*(3), 789–865. https://doi.org/10.1257/jel.20160995

Borjas, G. J. (2003). *The labor demand curve is downward sloping: Reexamining the impact of immigration on the labor market*. *Quarterly Journal of Economics, 118*(4), 1335–1374. https://doi.org/10.1162/003355303322552810

Economic Policy Institute. (2016). *What is the gender pay gap and is it real?* https://www.epi.org/publication/what-is-the-gender-pay-gap-and-is-it-real/

Goldin, C. (2014). *A grand gender convergence: Its last chapter*. *American Economic Review, 104*(4), 1091–1119. https://doi.org/10.1257/aer.104.4.1091

Gomes, Diego B. P. 2024. Gender and Business Cycles. IMF Gender Note 2024/001, International Monetary Fund, Washington, DC. https://doi.org/10.5089/9798400270376.067

Kandil, M., & Woods, J. G. (2002). *Convergence of the gender gap over the business cycle: A sectoral investigation*. *Journal of Economics and Business, 54*(3), 271–292. https://doi.org/10.1016/S0148-6195(02)00061-9

Pilatowska, P., & Witkowska, D. (2022). *Gender segregation at work over business cycle—evidence from selected EU countries, Sustainability - 2022*. https://doi.org/10.3390/su141610202

Kovalenko, T. (2021). *Cyclical dynamics and the gender pay gap: A structural analysis* (Working Paper No. 1752570502). https://www.econstor.eu/handle/10419/232550

Edo, A. & Toubal, F. (2017). *Immigration and the gender wage gap*, European Economic Review, 2017. https://doi.org/10.1016/j.euroecorev.2016.12.005

Lin, K.-H., & Weiss, I. (2019). *Immigration and the wage distribution in the United States*. *Demography, 56*(6), 2229–2252. https://doi.org/10.1007/s13524-019-00828-9

Llull, J. (2021). *Immigration and gender differences in the labor market*. *Journal of Labor Economics, 39*(4), 1045–1096. https://doi.org/10.1086/713725

Cai, X. (2023). The Study of the Gender Wage Gap. *Highlights in Business, Economics and Management, 21*, 603–608. https://doi.org/10.54097/hbem.v21i.14700

Valarini, M. J. (2022). *Woman in migration* (pp. 13–32). Routledge eBooks. https://doi.org/10.4324/9781003332459-2

Consumer Price Index - All Urban Consumers (Current Series). (2017). http://catalog.data.gov/dataset/consumer-price-index-all-urban-consumers-current-series

Mugisha, E. (2017). *Unemployment, total (% of total labor force)*. https://iwacu-burundi.org/opendata/en/iod-bu-095-unemployment/

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