ESSAYS IN LABOR ECONOMICS AND INFORMATION ECONOMICS

BY

YUSUF SONER BASKAYA

B.A., BOGAZICI UNIVERSITY, ISTANBUL, TURKEY, 1998

M.Sc., MIDDLE EAST TECHNICAL UNIVERSITY, ANKARA, TURKEY, 2001

M.A., BROWN UNIVERSITY, PROVIDENCE, RI, USA, 2002

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Yona Rubinstein, Advisor

Recommended to the Graduate Council

Date 5/9/07

Rachel M. Friedberg, Reader

Date 5/9/07

Herakles Polemarchakis, Reader

Date 5/9/07

David N. Weil, Reader

Approved by the Graduate Council

Date 5/14/07

Sheila Bonde, Dean of the Graduate School

TO GULENAY

FOR HER ENDLESS COURAGE AND ENDLESS SUPPORT

VITA

Yusuf Soner Baskaya was born in Hekimhan, Turkey on April 2nd, 1976. He received B.A. degree in Economics from Bogazici University, Istanbul, Turkey in July 1998, and M.Sc Degree in Economics from METU, Ankara, Turkey in July 2001. Between 1998 and 2001, he worked at the Research Department of the Central Bank of the Republic of Turkey as a Researcher. In 2001, he was awarded a fellowship by the Central Bank of the Republic of Turkey for studying at Brown University towards PhD in Economics.

In August 2001, he joined the Department of Economics at Brown University as a Ph.D student. In June 2002, he received M.A. degree in Economics from Brown University. During his studies at Brown University, he also served as a Teaching Assistant for several courses such as Financial Markets, Intermediate Macroeconomics, Introduction to Economics and Corporate Finance. Between Summer 2004 and Spring 2006, he also served as Teaching Fellow for Introduction to Econometrics. During 2006-2007 Academic Year, he visited Department of Economics at Dartmouth College, Hanover, NH, as a researcher and the instructor of undergraduate level econometrics course.

Starting from July 2007, he will continue to work at his previous position at the Central Bank of the Republic of Turkey, from which he was on-leave for his studies at Brown University. His research and teaching interests are labor economics with a focus on heterogeneities in labor market outcomes, macroeconomics with a focus on monetary economics and business cycles, information economics and applied econometrics.

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1.1 Introduction

The disparities in labor markets across demographic groups are addressed by a large body of literature. A particular observation in the United States is that blacks have less favorable labor market outcomes compared to whites. The analysis of potential sources of this gap between blacks and whites has attracted considerable attention both in the academia and by policymakers. However, there is still a lack of consensus about whether the labor market differences between blacks and whites reflect skill gaps or differential treatment based on the racial profiles of individuals for given skills, and this calls for more research focusing on sources of black-white employment differences in United States.

This study provides new insights by analyzing how within-race and between-race employment gaps evolve following minimum wage changes, and by showing whether skill gaps account entirely for differences across races. From the perspective of a firm, increases in the real value of legal minimum wages can be viewed as exogenous variations in the relative cost of employing unskilled labor. This can put downward pressure on firms' demand for unskilled workers, especially when minimum wages are above the equilibrium wages for unskilled workers.

Having stated the conditions potentially leading to disemployment of workers, a particular question relevant for the analysis of racial inequalities observed in the United States is whether race is one of the determinants of the marginal worker who has been laid off following an increase in minimum wages. Using a pooled cross section of males aged between 22 and 55 provided by the Current Population Survey March Supplement, this study aims to

identify whether race of a worker matters beyond his skills and job related characteristics in a firm's lay-off decisions following an increase in the cost of unskilled labor.

Although it has not been investigated explicitly, the link between minimum wage policy and racial differences in employment outcomes has already been mentioned in a couple of instances. For instance, Milton Friedman describes the minimum wage laws as possibly the most harmful policies in the United States for blacks when stating his views on several public policy issues during the broadcast of Richard Heffner's "Open Mind" aired on December 7th, 1975. According to Friedman, the minimum wage laws lead to discrimination against low-skilled individuals, most of whom are blacks. The studies, such as Mincer (1976), Ragan (1977), and more recently Deere et al (1995), document that the employment/population ratio of blacks is more sensitive to minimum wage variations compared to that of whites. Currie and Fallick (1996) shows that the federal minimum wage increase in 1980 and 1981 hurt black teenagers more than white teenagers.

However, despite these claims, no previous study has analyzed whether the differential effects of minimum wages on employment of black and white adults are driven entirely by skill differences. This study's motivation is to fill this gap in the literature. Variations in minimum wages can be perceived as exogenous shocks to demand for unskilled workers. Such large-scale variations in the labor market can be used as a natural experiment to get more insight into racial disparities in the United States. Large scale variations in the labor market are particularly useful in comparing the labor market outcomes of different demographic groups and in identifying the sources of these differences, as they allow for a better control for unobserved individual characteristics. However, as far as the variations in the labor demand due to minimum wage adjustments are concerned, a particular effort should be directed towards disentangling these effects from those originating from macroeconomic fluctuations. For this purpose, the paper provides evidence from various methodologies accounting for the endogeneity of timing of minimum wage adjustments with respect to business cycles.

This paper mainly shows that unskilled blacks are hurt relative to unskilled whites even

after accounting for skill differences within the group of unskilled individuals. In addition, minimum wage increases also widen the inequality among blacks, whereas it does not affect the inequality among whites. Finally, minimum wage variations do not significantly affect the employment of blacks and whites, who are unemployed before the policy change.

These results are also consistent with discrimination against blacks. Conditional on being employed prior to minimum wage increases, blacks are found to face higher decreases in employment when compared to whites with similar characteristics. Among the possible leading factors consistent with this finding, the differential supply responses of blacks and whites to minimum wage increases do not appear to explain the observed outcomes, since employment is determined by labor demand in the case of binding minimum wages. Furthermore, the findings indicate that minimum wage variations do not have a significant effect on the transition of blacks and whites from non-employment to employment, supporting the view that the differences in labor supply can not be part of the explanation. By documenting a link between a policy variable, i.e. minimum wages, and differences in job separations of comparable blacks and whites, the findings of this study also have important implications for public policy directed toward decreasing racial inequalities.

Following this introduction, Section 1.2 presents the links between this study and the studies on racial gaps in labor markets and the employment effects of minimum wages. Section 1.3 briefly describes the main issues regarding the implementation of the minimum wage laws in the United States. Section 1.4 describes the data and the empirical methodology of the paper. Sections 1.5 and 1.6 present the empirical results obtained by using alternative specifications and minimum wage measures, and the implications of these findings, respectively. Section 1.7 presents concluding remarks.

1.2 Existing Studies

This study is closely related with two different literatures, which have been characterized by a long list of studies and a complete lack of consensus. On one side, this study is related to the literature on the employment effects of minimum wages, in which there is still an ongoing

debate about whether higher minimum wages lead to declines in employment of unskilled workers. Mostly utilizing the state level aggregate data on the different demographic groups and variations in minimum wages across states and/or over time, there is a long list of studies based on defendable methodologies providing totally contradicting results. For instance, the studies by Card (1992 a,b), Katz and Krueger (1992) and Card and Krueger (1994, 2000) provide examples, in which the employment effects of minimum wages are found to be positive or insignificant. These findings are considered as a support for the *monopsonistic* market structure of labor markets in the United States. In contrast, most studies find negative effects on employment, in line with the basic predictions of the *law of demand* for an economy in which minimum wage is above the equilibrium wages for unskilled labor. Neumark and Wascher (1992, 1994, 1995, 2002) are a few examples of such studies. These studies also show that this effect is more pronounced for teenagers.

In the literature on the employment effects of minimum wages, the studies by Mincer (1976), Ragan (1977), Deere et al (1995) or Burkhauser et al (2000) are more closely related to this study in terms of their particular focus on different demographic groups. In particular, these studies also focus on whether the effects of minimum wages differ across different demographic groups and show that there are more sizable negative employment effects of minimum wages for blacks. These studies mainly utilize the state-level minimum wages and state-level panel data on the employment-population ratio of blacks and whites in different age groups. However, due to lack of individual level controls for skills differences and demographic characteristics of the individuals, the analysis of these papers provides no evidence about whether these results are due to skill gaps or factors beyond skill gaps. They argue that these results are due to the fact that there are more blacks in the low-wage groups, whose employment outcomes will be potentially affected by minimum wage variations. Although this explanation appears to be true, it is incomplete and a further investigation is necessary mainly for two further points. First, it is useful to test whether the same findings can be obtained with micro-data that incorporates information on various individual characteristics. Second, and more importantly, it is worthwhile to assess the possibility that the factors beyond racial skill gaps derive the racial differences in employment sensitivities to

minimum wage variations.

Using the federal minimum wage variations in 1980 and 1981 and data on the National Longitudinal Survey of Youth, Currie and Fallick (1996) focus on the effects of minimum wages on the employment of teenagers. Their findings also support a higher negative effect on blacks compared to whites. However, their analysis does not control for possible differences across races in the occupation and industry of employment. In addition, for the group of teenagers, it is difficult to isolate the effects of minimum wages on labor demand and supply, as a result of which it is hard to assess the relative role of skill gaps and other factors in the differential disemployment effect of minimum wages.

The methodology followed in this paper also provide new insights about the sources of racial differences in labor market outcomes. The early findings in the literature on the sources of black-white differences in labor market outcomes were based on static employment or wage regressions. These studies have provided mixed evidence about the sources of these differences, mainly due to the limitations they encountered in measuring the unobservable individual characteristics such as productive skills. The studies by Neal and Johnson (1996) and Altonji and Blank (1999) provides evidence showing that the absence of proper controls for the racial differences in family backgrounds or school qualities can lead to overestimation of earning and employment gaps between blacks and whites. However, when these differences are controlled by using variables that are not available in most of the datasets or for a wide range of demographic groups, the racial gaps in employment outcomes disappear.

These mixed results and the lack of generality in the latter results with respect to a wide range of demographic groups necessitate alternative ways of identifying the sources of racial differences in employment outcomes. As a way to remedy the problems due to unobserved skills, this study proposes the utilization of extra variations in the labor demand due to minimum wage variations to compare the changes in the employment status of blacks and whites who had similar skills and job-related characteristics before minimum wage changes.

Sizable exogenous variations in the labor demand, either due to macroeconomic fluctua-

tions or discrete changes in economic policies, offer a great opportunity to analyze whether factors beyond skill gaps are significant determinants of differences in labor market outcomes. For instance, the labor demand variations due to business cycles have recently been used in the literature to identify sources of racial differences. This study also follows a similar methodology in terms of using exogenous variations in the labor market for comparing changes in the employment of blacks and whites. However, one particular advantage associated with utilization of minimum wages as opposed to business cycles is that the interpretation of the results of this paper does not require any assumption about the labor supply behavior of blacks and whites, as long as the initial level of minimum wage is above the equilibrium wage for the unskilled labor[1]. Business cycles may affect the employment of adults both through labor demand and supply, whereas the role of variations in employment of adults due to labor supply related factors are considerably limited. Using minimum wage variations as part of the identification of sources of racial differences provides more concrete evidence about discrimination against blacks, through its more pronounced effect on the labor demand. Last but not least, unlike business cycles, minimum wage increases are direct outcomes of the economic policy choices. Therefore, their timing is predictable, at least when compared to timing of the recessions. It is my belief that the documentation of a link between the timing of policy changes and the changes in racial unemployment differences due to factors beyond skill differences offer important prospects for enhancing the policies directed towards providing equal employment opportunities across races.

Two more points deserve to be mentioned. First, this study is one of the few studies in the literature on the employment effects of minimum wages, which uses individual level data, and the empirical methodology and control variables used in this study is different from other studies[2]. Second, with its focus on individuals between 22 and 55 years of age, the results of this study may be more relevant to the question of how minimum wages affect

[1] An assumption for the labor supply behavior of the indivuals would still be needed in this analysis, if we used also included teenagers in the sample, as minimum wage variations would affect both employment decisions and school enrollment decisions of them. To identify the exact role of labor demand changes, we exclude them from the sample.

[2] See Linneman (1982), Neumark and Wascher (1995 b), Currie and Fallick (1996), Abowd et al (1999), Zavodny (2000) as examples of previous studies using micro data. Except for Linneman (1982) and Abowd et al (1999), all other studies focus only on young adults and teenagers.

poverty through affecting the employment outcomes of the adults. In contrast, most of the studies in the literature focuses on the effects of minimum wages on the employment of teenagers, as they are overrepresented in minimum wage jobs. However, considering the fact that these teenagers are typically not the main source of income in their families, those studies do not provide concrete evidence about how minimum wage variations affect the poverty status of families in the United States.

1.3 Minimum Wage Policy In the United States

Minimum wages have been actively used in the United States since the first half of the 20th Century as a policy tool aiming at decreasing wage inequality, reducing poverty and enhancing the income distribution[3]. In general, minimum wage is determined by Congress at the federal level, and adjusted in every couple of years considering the deterioration in its purchasing power over time due to inflation[4]. On the other hand, infrequent adjustments in the federal minimum wages have motivated a number of states to set their own state specific minimum wages above federal minimum wages and adjust them at different frequencies considering the labor market conditions in those states.

Wherever there are no state specific minimum wages or the state specific minimum wages set below the federal minimum wage, the federal minimum wage is the effective minimum wage. However, for states in which state specific minimum wages are above the federal minimum wage, the effective minimum wage is the state specific minimum wage. In last three decades, the federal minimum wages have been the effective minimum wages in around two thirds of all states. Considering the sample used in this study, the federal minimum wages have been binding in 35 states[5]. Due to existence of state-specific minimum wages besides federal minimum wages, there is a large degree of across-state minimum wage variations.

[3] At the federal level, the utilization of minimum wages dates back to Fair Labor Standards Act of 1938.

[4] See Figure 1.1 for the variations in the nominal and real value of the federal minimum wages. Considering the sample of this study, the federal minimum wages have been increased in 1991, 1992, 1997 and 1998. The Congress has made the most recent adjustment in federal minimum wages in January 2007. With this adustment, which is the first adjustment since 1998, the nominal federal minimum wage will be increased from 5.15 dollars per hour to 7.25 dollars per hour.

[5] See Table 1 for the list of these states.

Minimum wages are legally obligatory for a large number of firms and industries. During the sample period used in this study, approximately 90 percent of all workers in the United States were covered by the minimum wage laws. The exceptions in coverage are mostly the small firms in the retail and services industry and the agricultural sector[6].

In terms of the timing of federal minimum wage increases in the sample period used in this study, all of the adjustments in federal minimum wages took place during expansions except for the adjustment in 1991. This observation suggests that, besides the deterioration in the purchasing power of minimum wages, Congress may also be considering the macro-economic outlook and the general stance of the labor market, when deciding for increases in minimum wages. However, due to the existence of regional business cycles, the increases in minimum wages does not necessarily coincide with the periods of employment expansions in each state. On the other hand, for the states setting their own minimum wages, the timing of minimum wage adjustments is likely to be sensitive to local labor market conditions.

1.4 Empirical Analysis

1.4.1 Data

The sample consists of observations for the period between 1983 and 2004 provided by the Current Population Survey March Supplement (abbreviated as CPS-March hereafter). In particular, the sample includes black and white males between 22 and 55 years of age, who are not self employed.

In the literature, teenagers are the main focus group in most of the studies, as they constitute the large proportion of individuals with wages below or close to minimum wages. However, as suggested by a number of studies, such as Ben-Porath (1967), the employment decision of teenagers are also not independent of their school enrollment decisions. Minimum wage variations may affect both demand for teenagers and supply of teenagers by making school enrollment less attractive and giving incentives to teenagers to increase their labor

[6] In addition, due to limitations in the enforcement of minimum wage laws, cases of noncompliance are possible as well.

force participation[7]. This complicates the analysis of identifying whether individuals with similar skills with different racial profiles face different changes in their employment status, when labor demand changes. To disentangle the effect of variations in labor demand due to minimum wage variations from factors related to labor supply, the individuals below 22 years of age are excluded from the sample.

The possibility of differences in the changes in employment status of blacks and whites are investigated in two dimensions. First, the paper provides estimates of changes in probability of employment due to minimum wage increases conditional on working full time working in the previous year. In this analysis, the baseline results are obtained for the sample of individuals whose real wage is between one dollar and 50 dollars per hour in year 2000 dollars[8]. Second, we estimate the changes in probability of employment conditional on being not employed last year. In particular, Equation (1.2) is estimated for the sample of individuals who worked less than 4 weeks in the previous year. For the robustness of the results, the sample is extended to individuals who were employed in the previous year for less than 8 weeks and for less than 12 weeks.

Figures 1.2 to 1.5 provide some preliminary evidence about the relationship between the changes in real minimum wages and employment gaps across blacks and whites, as well as across high-skilled and low-skilled individuals within each race. For this preliminary analysis, the entire sample is separated into four groups with respect to individuals' races and whether the hourly earnings of the individual in the previous year is below minimum wage or not. The latter is taken as a skill measure. Figure 1.2 suggests that the absolute value of the employment difference between whites and blacks earning below minimum wage is positively correlated with minimum wage increases. On the other hand, Figure 1.3 suggests that no strong correlation between minimum wage increases and employment differences between skilled blacks and whites. Figure 1.4 suggests that the employment gap between skilled and unskilled blacks are weakly correlated with minimum wage increases.

[7] Neumark and Wascher (1995 a,b) find that the higher minimum wages have a bigger negative effect on the school enrollment of black teenagers compared to white teenagers whereas the employment of the blacks do not increase following the minimum wage increases.

[8] In different specifications, we also use different numbers between zero dollars and 4 dollars as the lower bound of skills, and found qualitatively similar results.

Finally, Figure 1.5 suggests that the employment gap between unskilled and skilled whites decline with higher minimum wages.

1.4.2 Model

The employment status of an individual at any point in time is a function of his demographic characteristics, skills, characteristics related to his occupation and the industry he is working at as well as the macroeconomic fluctuations and various economic policies through their effect on the labor markets. Let the employment status of an individual, denoted as E_{it}, be defined as:

$$E_{it} = \begin{cases} 1 \text{ if i is employed at time t} \\ 0 \text{ otherwise} \end{cases}$$

Let $X_{i,t}$ denote the vector of demographic characteristics and job-related characteristics. The skills of an individual relevant to his employment is represented by $S_{i,t}$. Finally, $MW_{i,t}$ denotes the real effective minimum wage at time t faced by individual i in the state he lives. In such a case, the employment status of a black and white individual can be written respectively as:

$$E^b_{i,t} = \beta^b_0 + \beta^b_1 X_{i,t} + \beta^b_2 S_{i,t} + \beta^b_3 MW_{i,t} + \beta^b_4 MW_{i,t} S_{i,t} + u^b_{i,t} \qquad (1.1.a)$$

$$E^w_{i,t} = \beta^w_0 + \beta^w_1 X_{i,t} + \beta^w_2 S_{i,t} + \beta^w_3 MW_{i,t} + \beta^w_4 MW_{i,t} S_{i,t} + u^w_{i,t} \qquad (1.1.b)$$

The Equations (1.1.a) and (1.1.b) allow for the possibility that variations in determinants of the employment outcomes may affect the employment of blacks and whites disproportionately. In particular, the superscripts "b" and "w" are used to distinguish the parameters associated with blacks and whites. Denoting race of an individual with a binary variable

R_i, which is equal to one for blacks and zero for whites, the employment outcome of any individual as a function of his race is equal to:

$$\begin{aligned} E_{i,t} &= R_i E^b_{i,t} + (1 - R_i) E^w_{i,t} \\ &= \gamma_0 + \gamma_1 X_{i,t} + \gamma_2 S_{i,t} + \gamma_3 MW_{i,t} + \gamma_4 S_{i,t} MW_{i,t} \\ &\quad + \gamma_5 R_i + \gamma_6 X_{i,t} R_i + \gamma_7 S_{i,t} R_i + \gamma_8 MW_{i,t} R_i + \gamma_9 S_{i,t} MW_{i,t} R_i + u_{i,t} \end{aligned} \tag{1.2}$$

Equation (1.2) suggests that the effect of minimum wage variations on employment of whites and blacks can be written respectively as:

$$\frac{\partial E_{i,t}}{\partial MW_{i,t}} = \gamma_3 + \gamma_4 S_{i,t} \tag{1.3.a}$$

$$\frac{\partial E_{i,t}}{\partial MW_{i,t}} = \gamma_3 + \gamma_8 + (\gamma_4 + \gamma_9) S_{i,t} \tag{1.3.b}$$

A couple of things deserve attention in Equations (1.3.a) and (1.3.b). For a moment, suppose the skill of an individual, $S_{i,t}$, is a binary variable equal to 1 for high-skilled individuals and zero for low skilled individuals. The condition associated with a differential effect of minimum wage variations one employment of low skilled and high skilled individuals is $\gamma_4 \neq 0$ for whites and $\gamma_4 + \gamma_9 \neq 0$ for blacks. On the other hand, for $\gamma_8 = \gamma_9 = 0$, there is no racial differences in the effect of minimum wages on the employment outcomes at all. For the unskilled individuals, γ_8 is the differential effect of minimum wages on employment of blacks. Finally, $\gamma_8 + \gamma_9$ is the differential effect of minimum wages on the employment of high-skilled blacks relative to high-skilled whites.

If the basic competitive market argument holds, one can expect the employment of unskilled individuals with wages less than the new minimum wage to decline with higher

minimum wages. On the other hand, the employment of the relatively more skilled individuals would be expected to remain the same or it may even increase if firms substitute a low skilled worker with workers who have higher skills. Therefore, the expected employment gap between the high skilled and low skilled individuals can widen after minimum wage increases.

As far as racial differences are concerned, one can expect the effect of minimum wage increases on the employment of high skilled blacks and whites to be similar. However, if the racial profile of the workers matters for who will be the marginal worker to be laid off following an increase in the cost of employing unskilled workers, minimum wage variations may result in different employment responses for unskilled blacks and whites. In such a case, minimum wage variations can not only increase the inequalities between racial groups for a given skill level, but also affect the within-race inequality unevenly.

1.5 Results

1.5.1 The Evolution of Differences Between and Within Races:

The empirical analysis focuses on whether blacks and whites face differences in probability of switches from employment to unemployment, as well as differences in probability of switches from unemployment to employment. Equation (1.2) is estimated separately for two different groups of individuals: the individuals who were employed in the previous year, and the individuals who were not employed in the previous year. In particular, the question of interest is how the employment status of four different groups of individuals, namely the low-skilled blacks, low-skilled whites, high-skilled blacks and high-skilled whites, are affected by minimum wage variations at time t, after controlling for the job-related characteristics and skill level measured in year $t-1$.

The main control variables used in the empirical analysis include age, marital status, full-time/full-year status, as well as controls for individuals' occupation, industry of employment, and state of residence. The specification also includes year fixed effects and the state-level aggregate unemployment rates, which account for macroeconomic and other aggregate

factors affecting the labor market outcomes. All specifications include the industry-year, occupation-year and state-year interactions as well. Finally, the logarithm of real wage per hour earned in previous year and the education level of the individuals are used as proxies for individuals' job related skills[9]. This is because the real wage at time $t-1$ contains information about how the productive skills of an employee was evaluated by the employer.

Minimum wage faced by an individual, $MW_{i,t}$, is the effective real minimum wage applicable in the state where the individuals is employed. Considering the implementation of the minimum wage laws, the effective real minimum wage is calculated as the higher of federal minimum wage and state specific minimum wage adjusted to year 2000 dollars. As a result, we observe minimum wage variations not only over time, but also across different states at a particular point in time.

One important issue to consider is the possible endogeneity of timing of minimum wage adjustments. For states determining their own minimum wages, the authorities in a particular state may decide on minimum wage increases during the times of expansion in a state's economy. For instance, if the authorities in a particular state raise minimum wage when the economy of that state experiences a recovery, the negative employment effects of minimum wages may be muted by a recovery in the labor market. This creates a major complication in the identification of racial differences in employment outcomes due to changes in labor demand to minimum wage increases. As a supporting evidence for this argument, Baskaya and Rubinstein (2007) recently shows that variations in the federal minimum wages have a negative effect on overall employment, whereas the variations in the state minimum wages have insignificant effect on employment. Considering the possibility that federal minimum wage adjustments are more exogenous than state minimum wage adjustment with respect to macroeconomic conditions, tastes and political preferences in each state, the study follows Baskaya and Rubinstein (2007) and focuses the states for which federal minimum wages were binding in each year, rather than the entire list of states. The estimates presented in the first column of Table 1.3, which have been obtained with the entire list of states with-

[9] Wage per hour is calculated as total earnings in previous year divided by total hours worked by the individual in previous year.

out distinguishing whether these states set their own minimum wage or not, demonstrate the rationale for this choice. These results clearly suggest that higher minimum wages are associated with higher employment of low skilled whites, and no variations in the employments of low-skilled blacks, and high skilled individuals. However, as mentioned above, these results might have been contaminated by the possible dependence of the timing of minimum wage adjustments to the macroeconomic factors, particularly the overall outlook of the labor market.

As a result, for the baseline analysis, Equation (1.2) is estimated with the sample of individuals living in states which did not set their own minimum wages and followed the federal minimum wages throughout entire sample period[10]. The reason why these results are considered to be more reliable is that the federal minimum wages are set for the entire country, and therefore they are much less likely to be determined according to considerations of political preferences and business cycle conditions in particular states. Even if the Congress considers the economic outlook of the entire economy when adjusting minimum wages, the heterogeneities in the business cycle experiences across these states substantially weaken the possibility that minimum wage increases in these states will be associated with recoveries in labor markets.

The second column of Table 1.3 present these results obtained for states following federal minimum wages. These results indicate that the low employment of unskilled whites show no changes or slight increases, whereas the employment of unskilled blacks decrease significantly, when the federal minimum wages increase. In addition, the employment of the high skilled whites and blacks are found to be insensitive to minimum wage variations, as can be expected. These suggest that the employment status of the low skilled blacks deteriorates relative to all other demographic groups, whereas the employment status of the low skilled whites relative to high skilled blacks and whites either do no change or slightly improve.

In terms of year 2000 dollars, the lowest value that minimum wages reached throughout out the sample has been approximately 4.5 dollars, as can be seen in Figure 1.1 as well. For

[10]The list of these states has been given in Table 1.1.

the individuals who earned 4.5 dollars per hour before minimum wages increase, a 100% increase in minimum wage is associated with a 2 percentage point decline in the employment of blacks, a 1.5 percentage point increase for whites. This is equivalent to a 10% increase in the number of low skilled blacks without a job, when the real value of minimum wages increases by 100%. In addition, the unemployment gap between high skilled blacks and low skilled blacks increases by 4-5 percentage points, whereas there is no significant change in the unemployment gap between high skilled and low skilled whites.

1.5.2 Results Obtained After Partialing Out Correlation Between Minimum Wages and Aggregate Unemployment Rates

As stated above, the main source of motivation for focusing on the states following minimum federal minimum wages is the potential dependence of the timing of minimum wage adjustments to business cycle conditions, which is more likely to be the case for the state-specific minimum wages. However, this results in a smaller sample than what is provided by CPS-March. Moreover, it is crucial to check the validity of the results obtained in the previous sections with an alternative measure. As a result, another set of results have been obtained by using an alternative measure of minimum wage variations. This alternative measure is generated after partialing out the part of minimum wages correlated with aggregate unemployment rates. In particular, Equation (1.4) is estimated for each state, and the residuals from these regressions have been used as the measure of variations in real minimum wages uncorrelated with aggregate labor market conditions in each state:

$$MW_t = \alpha_0 + \alpha_1 State\_Unemployment\_Rate_t + u_t \tag{1.4}$$

Table 1.4 shows the results obtained with this specification. For the comparison with the results presented in Section 1.5.1, the first column presents the results obtained for the states for which the federal minimum wage is the binding minimum wage. The second column presents the results obtained for the entire set of states. The results obtained for

both samples indicate that minimum wage variations have significant negative impact on the employment of unskilled blacks. On the other hand, the effect on the employment of unskilled whites, and skilled whites and blacks are found to be insignificant. Considering the results obtained for the states where federal minimum wage is binding, 100% percent increase in minimum wages are associated with 5 percentage point decline in the employment rate of blacks. In addition, the employment gap between the high skilled blacks and low skilled blacks increase by approximately 8 percentage points, if the real value of minimum wages are doubled. Compared to results for the states following federal minimum wages, the results obtained for the entire sample indicate slightly smaller decline in the employment of the low skilled blacks, and a smaller increase in the employment gap between the high skilled and low skilled blacks.

1.5.3 Switches From Non-Employment to Employment:

For the total effects of minimum wages, we also need to consider if minimum wage variations lead to switches from non-employment to employment. Unlike the case for the switches from employment to non-employment, it is worth noting that any difference in the changes in employment probabilities for individuals who are not working in the previous year may reflect both demand side and supply side factors. For instance, higher minimum wages may induce the individuals whose reservation wages were between old and new minimum wages to increase their labor supply. In an environment associated by search frictions, higher minimum wages may intensify the job search effort by the low skilled workers, as it increases the pay-off from employment.

Considering these possibilities, Table 1.5 presents the results for three different samples of individuals, who were not employed in most of the previous year. In particular, Equation (2) is estimated for individuals who were employed for less than 4 weeks, less than 8 weeks and less than 12 weeks. These results suggest that minimum wage variations do not have a differential effect on the employment status of blacks and whites who were not employed in the previous year, providing evidence for similar labor supply responses from blacks and whites following minimum wage increases.

When combined with the previous results, the results presented in Table 1.5 also supports the view that there is discrimination against blacks. In case where blacks had a higher tendency to switch from unemployment to employment than whites, the results in previous sections would also suggest that blacks separate from their jobs for finding new jobs. However, since the results suggest that no racial differences exist between blacks and whites, there is no reason to expect that blacks separate from their jobs themselves to find better jobs.

1.5.4 Results Obtained by Matching On Observable Characteristics:

Finally, although it may not be a big concern for blacks and whites who are already below a particular skill threshold, we may still consider the possibility that the distribution of skill and job related characteristics may differ across races in a way that biases the results. To account for this possibility, first the expected difference in the employment probabilities of blacks and whites are calculated for each year after matching on their observable characteristics such as education, industry, occupation, full-time/full-year status, hourly wages earned in previous year and state of residence. Then, the sensitivity of these differences to the changes in minimum wage is investigated. The expected difference in the employment probabilities of blacks and whites conditional on vector of observable characteristics X can be calculated as[11]:

$$\Delta_{i,t} = E\left[Employed_{i,t}|R_i = 1, X_{i,t}\right] - E\left[Employed_{i,t}|R_i = 0, X_{i,t}\right] \tag{1.5}$$

As can be seen in Figure 1.6, there is a negative relationship between Δ_i and the annual rate of change in the real value of federal minimum wages. This is consistent with the previous results suggesting that the employment of blacks relative to whites decrease in the periods following minimum wage increases. This may also suggest that the racial differences in distributions of skills and job-related characteristics may not be as major a factor as it would derive the results above.

[11] Since we match on a number of individual characteristics at the same time, we use propensity score matching for its computational convenience. Then, Δ_i is calculated for each year.

1.6 Interpretation of Results:

The analysis above indicates that minimum wage increases have important effects on the inequality across races and within racial groups. A particular finding is that minimum wage increases have negative effect on the employment of blacks whose earnings were below the new minimum wage, and much smaller effect on the employment of comparable whites.

Considering the results presented either in the second column of Table 1.3 or in the first and second columns of Table 1.4, the elasticity of employment of unskilled blacks with respect to real minimum wages ranges between -0.05 to -0.15, elasticity being higher for lower skill levels within the group of unskilled workers. In contrast, the elasticity for unskilled whites ranges between 0 and 0.025. The figures obtained for blacks are much smaller compared to previous studies, such as Deere et al (1995), Currie and Fallick (1996) or Burkhauser et al (2000 b). Moreover, this paper finds no significant negative employment effects for the whites whose earnings were around old minimum wages before the minimum wage increases. One factor behind these differences is the focus of these studies on the employment of teenagers and young adults.

However, there are other sources of concerns about previous estimates. In their analysis using CPS for the period between 1985 and 1992, Deere et al (1995) finds -0.33 for the adult high school drop-out blacks and -0.11 for high-school drop-out white adults. Using data on young adults between 16 and 22 for the period between 1979 and 1997, Burkhauser et al (2000) finds the elasticity of employment of blacks and whites with respect to minimum wages as -0.85 and -0.35, respectively. However, the results in both papers may be contaminated by the fact that they do not control for year fixed effects which potentially can create biased results.

Using NLSY for analyzing how federal minimum wage increases in 1980 and 1981 affected the employment of teenagers, Currie and Fallick (1996) finds that elasticity of blacks and whites is between -0.19 and -0.24. The analysis in this paper differs from Currie and Fallick (1996) in various dimensions, such as the focus group, the sample period and minimum wage measures. Moreover, this study also accounts for a wider range of factors, such as

occupation, industry, state and year fixed effects and business cycle indicators, the absence of which may bias the estimates on black-white differences.

Due to the reliance of this study on individual level data provided by CPS, we controlled for a detailed list of individual characteristics. This allowed for an explicit analysis of whether the racial differences in the sensitivity of employment status to minimum wage variations can entirely be explained by the fact that blacks constitute a large proportion of unskilled individuals. The results simply suggest that black-white differences exist in the employment effects of minimum wage increases even after racial skill gaps are controlled for. However, the possible mechanisms that generate these findings deserve to be investigated.

One possibility is different labor supply responses of blacks and whites to minimum wage changes. For instance, one may consider as a possibility that the separation blacks and whites from their jobs may reflect entirely their skills, whereas the overall differences in the employment rates of blacks and whites may mainly be driven by differential response of the labor supply of blacks and whites to minimum wage increases. However, it should be emphasized that the results above do not appear to be a outcome of racial differences in how labor supply is affected by minimum wage variations due to two main reasons. First, our sample choice already excludes the major group of individuals, i.e. individuals below age 22, whose labor supply may also respond to minimum wages. Second, it is important to note that the level of employment is determined entirely by the labor demand curve whenever minimum wage is binding. Therefore, further increases in minimum wages will lead to variations in the total employment through its effect on labor demand.

As shown in Table 1.5, the results obtained for individuals, who were not employed for almost entire year preceding minimum wage increase, do not indicate any difference between blacks' and whites' tendency to switch from unemployment to employment following an increase in minimum wages. This also rules out another labor supply related explanation for the racial differences in the employment outcomes. Due to its structure, the CPS-March shows whether the individual was employed or not in the previous year, and whether the individual is employed or not by the time of survey following minimum wage increase.

Therefore, one may argue that the similar results can alternatively be obtained if blacks who are simultaneously laid-off with whites find new jobs later than whites due to the skill gaps in job search. In other words, what appears to be unrelated with labor supply behavior at first glance may be reflecting racial gaps in job search skills. However, if this were the case, the results in Table 1.5 would indicate a significantly better re-employment performance for the unemployed whites. As a result, the differential response of employment of blacks and whites do not appear to be a supply related phenomena.

Having shown that the racial differences in employment variations are observed beyond skill differences and do not appear to be related with supply-side responses, a possible explanation is that firms have a greater tendency to lay-off blacks than whites in a discriminatory manner, when they need to reduce the number of employees following an exogenous shock to the unit price of unskilled labor.

For couple of reasons, we can also speculate that the taste for discrimination, as proposed by Becker (1957), appears to be a more likely explanation than the statistical discrimination. Statistical discrimination, by definition, is an outcome of an environment, where employers do not observe the productive skills of the employees, as a result of which they use the group statistics to distinguish between two workers who have same observable characteristics. However, the individuals whose employment status is more likely to be affected by minimum wages are mostly the unskilled workers, whose tasks are not complicated and the skill levels are more observable compared to high-skilled workers. Therefore, one may argue that the degree of uncertainty faced by an employer about unskilled individuals' productive characteristics would not be very high. In addition, we should account for the fact that the differential outcomes are observed for individuals switching from employment to non-employment. Presumably, these are the employees about whom the employers have observations to assess their on-the-job performances.

In the context of a taste-based discrimination model a la Becker, one can think of the increases in mandated minimum wage as being associated with falling relative cost of discriminating against a particular group. Let "d" denote the disutility that the employer

derives by employing a black. Suppose that both black and white workers are initially earning minimum wage denoted as w_t^m. If the employer derives disutility from employing a black worker, the black worker should have at least a productivity level equal to $w_t^m + d$. Suppose that the productivity of the white worker and black worker, assumed to be equal to A and $w_t^m + d$ respectively, satisfies $w_t^m < A < w_t^m + d$. In other words, the black worker may already be more productive relative to the white worker for a given level of wages.

If minimum wage is increased to A at time $t + 1$, the white worker will still remain employed. However, the effective cost of employing the same black worker, i.e. the wage cost and the non-pecuniary costs, increases to $A + d$, which exceeds the physical productivity of the black worker. As a result, we may be observing a differential increase in the unemployment of blacks in periods of minimum wages increases due to employers' taste for discrimination.

Finally, the relevance of these results for enhancing policies against inequality deserves to be mentioned. The results document a significant link between the timing of policy related changes in labor markets and potential increases in the employment gap across comparable individuals with different racial profiles. These results may suggest that there is a potential for the improvement in the current practices of the anti-discriminatory policies. In particular, the increases in minimum wages are a matter of policy choices. Therefore, their timing is predictable. Considering the possibility of noncompliance in the firms' practice of equal employment laws, the efficiency of existing policies may be enhanced by intensifying the surveillance in hiring/firing practices of the firms during of times of minimum wage increases.

1.7 Conclusion

In the United States, minimum wage laws are one of the major policies used actively with the objective to decrease the earnings inequality and poverty. However, little guidance has been provided so far by the existing literature about whether these goals are achieved or not. Despite these objectives of minimum wages, a particular deficiency is that there is

no previous study in the literature about how minimum wage variations affect the racial differences in the employment outcomes. It is important to analyze how the employment of blacks relative to whites respond to minimum wages, and identify the factors that may potentially lead to differential changes in employment of blacks and whites over the course of a minimum wage increase.

Being motivated by these points, the analysis in this paper presents a new set of evidence on sources of racial differences in employment outcomes as well as the employment effects of minimum wages. Considering the literature on the employment effects of minimum wages, this paper points out both efficiency concerns of the minimum wage laws through the negative effect of minimum wages on employment, and distributional concerns through its role in increasing racial disparities. Moreover, despite the focus of the existing literature on teenagers as the main group of minimum wage earners, it is worth noting that adults constitute 60-70 percent of minimum wage earners in the United States. In addition, it should be noted that 30 to 40 percent of the entire group of minimum wage earners are also the only income earners in their families. This underlines the implications of minimum wage increases also for poverty in the United States.

Despite the negative effects on employment, the polls indicate that minimum wage increases usually find massive public support. For example, according to the polls conducted by NBC News and Wall Street Journal in 1996, approximately 60 percent of all correspondents strongly support a minimum wage increase and an additional 20 percent somewhat increase minimum wage increases. The ratio of strong opponents is less than 10 percent. In terms of responses by racial groups, the ratio of blacks and whites favoring minimum wage increases are 95 percent and 75 percent respectively[12].

The large discrepancy between the ratio of black and white supporters of minimum wage increases is quite puzzling when the empirical findings of this paper is considered. The findings presented in this paper are associated with a high degree of scepticism about the potential of the minimum wage laws to alleviate the racial gaps. In particular, we observe that unskilled blacks face declines in their employment relative to unskilled whites,

[12]For a more detailed analysis, see Waltman (2000).

and skilled whites and blacks. The skill gaps do not appear to be the only factor, behind the deterioration of their employment prospects relative to unskilled whites. This implies that policies directed towards skill gaps will not eliminate this outcome entirely. Moreover, the analysis provides no evidence about whether minimum wage increases are associated with differential labor supply responses for blacks and whites. All these findings together underline discrimination as one of the possible factors behind observed outcomes. In particular, firms may not be acting in a color-blind manner in their lay-off decisions following an increase in the price of unskilled labor, especially if employers have a taste for discrimination.

Although this study provides concrete evidence on how racial employment differences evolve in periods of minimum wage variations, the further research focusing on the other measures of employment outcomes, such as changes in hours of employment, part-time/full-time status, hourly earnings may reveal some new evidence on how racial inequalities evolve during periods of minimum wage changes. Also, as argued above, the results appear to be consistent with a taste-based discrimination model. However, some extra work is still necessary to identify the exact channel for discrimination, which is crucial for designing appropriate anti-discriminatory policies or increasing the effectiveness of existing policies.

Table 1.1: Categorization of States With Respect to Their Adoption of Federal Minimum Wages During Entire Period Between 1983 and 2004

States In Which Federal Minimum Wages Have Been Effective in Entire Sample	States Which Implemented State Specific Minimum Wages at some point between 1983 and 2004
1) Alabama	1) Alaska
2) Arizona	2) California
3) Arkansas	3) Connecticut
4) Colorado	4) Delaware
5) Florida	5) District of Columbia
6) Georgia	6) Hawaii
7) Idaho	7) Iowa
8) Illinois	8) Maine
9) Indiana	9) Massachusetts
10) Kansas	10) Minnesota
11) Kentucky	11) New Jersey
12) Louisiana	12) Oregon
13) Maryland	13) Rhode Island
14) Michigan	14) Vermont
15) Mississippi	15) Washington
16) Missouri	16) Wyoming
17) Montana	
18) Nebraska	
19) Nevada	
20) New Hampshire	
21) New Mexico	
22) New York	
23) North Carolina	
24) North Dakota	
25) Ohio	
26) Oklahoma	
27) Pennsylvania	
28) South Carolina	
29) South Dakota	
30) Tennessee	
31) Texas	
32) Utah	
33) Virginia	
34) West Virginia	
35) Wisconsin	

Table 1.2: Basic Characteristics of Blacks and Whites

	Blacks Earning Below Minimum Wage		Whites Earning Below Minimum Wage	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Real Wage Per Hour	3.76	1.49	3.61	1.58
Age	33.53	9.66	33.20	9.64
Ratio of Married	0.33	0.47	0.47	0.50
Ratio of Full-Time Workers	0.71	0.46	0.75	0.43
Ratio of Full-Year Workers	0.53	0.50	0.60	0.49
Ratio of High School Graduates	0.43	0.50	0.35	0.48
Ratio of Individuals with Some-College Education	0.20	0.40	0.23	0.42
Ratio of Individuals with College Degree	0.07	0.25	0.17	0.37
Number of Observations	6309		40602	

	Blacks Earning Above Minimum Wage		Whites Earning Above Minimum Wage	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Real Wage Per Hour	15.87	147.89	18.23	94.86
Age	37.38	9.40	37.68	9.33
Ratio of Married	0.52	0.50	0.70	0.46
Ratio of Full-Time Workers	0.74	0.44	0.87	0.34
Ratio of Full-Year Workers	0.66	0.47	0.79	0.41
Ratio of High School Graduates	0.41	0.49	0.35	0.48
Ratio of Individuals with Some-College Education	0.25	0.43	0.24	0.43
Ratio of Individuals with College Degree	0.15	0.36	0.28	0.45
Number of Observations	75633		774174	

Table 1.3: The Effect of Minimum Wages on Employment Outcome of Blacks and Whites

	All States	States For Which Federal Minimum Wages Are The Effective Minimum Wages
	(1)	(2)
Black	0.037	0.048
	(0.056)*	(0.021)**
Log(Hourly_Wage(t-1))	0.021	0.011
	(0.01)***	(0.353)
Black x Log(Hourly_Wage(t-1))	-0.043	-0.076
	(0.028)**	(0.029)**
Log(Minimum Wage)	0.026	0.021
	(0.019)**	(0.273)
Log(Minimum Wage) x Log(Hourly_Wage(t-1))	-0.007	-0.002
	(0.141)	(0.83)
Black x Log(Minimum Wage)	-0.077	-0.135
	(0.021)**	(0.005)***
Black x Log(Minimum Wage) x Log(Hourly_Wa	0.028	0.048
	(0.019)**	(0.025)**
Education Control	Yes	Yes
Age, Age-Squared, Marital Status Control	Yes	Yes
Full-Year/Full-Time Status Control	Yes	Yes
Industry/Occupation/State/Year Fixed Effects	Yes	Yes
Aggregate Unemployment Rate Control	Yes	Yes
Number of Observations	526073	416272
R-Squared	0.235	0.245

P-Values For the Hypothesis That The Effect of Minimum Wages On Employment is Zero:

Blacks Earning 4.5 dollars per hour	0.29	0.06 (h)
Whites Earning 4.5 dollars per hour	0.00 (g)	0.02 (h)
Blacks Earning 15 dollars per hour	0.87	0.25
Whites Earning 15 dollars per hour	0.41	0.12

Notes: (a) Coefficients give the probit marginal effect, where the values in pharanthesis are the p-values for the hypthesis that the corresponding parameter is equal to zero. (b) Sample includes black and white males between 22 and 55 for the years between 1983 and 2004. (c) Minimum wage variable is the effective minimum wage for each state. (d) Includes industry-year, occupation-year and state-year interactions. (e) *: Significant at 10%, **: Significant at 5%, ***: Significant at 1%. (f) The list of the states used for results in Column 2 is given in Table 1.1. (g) Zero effect of minimum wages is rejected against positive effect of minimum wages on employment. (h) Zero effect of minimum wages is rejected against negative effect of minimum wages on employment.

Table 1.4: The Effect of Minimum Wages on Employment Outcome of Blacks and Whites (Using Minimum Wage Variations Uncorrelated With State Unemployment Rates)

	States For Which Federal Minimum Wages Are The Effective Minimum Wages	All states
	(1)	(2)
Black	-0.043	-0.032
	(0.009)***	(0.027)**
Log(Hourly_Wage(t-1))	0.009	0.009
	(0.000)***	(0.000)***
Black x Log(Hourly_Wage(t-1))	0.003	0.003
	(0.024)**	(0.004)***
Log(Minimum Wage)	0.012	0.015
	(0.577)	(0.271)
Log(Minimum Wage) x Log(Hourly_Wage(t-1))	-0.009	-0.004
	(0.287)	(0.463)
Black x Log(Minimum Wage)	-0.116	-0.100
	(0.023)**	(0.015)**
Black x Log(Minimum Wage) x Log(Hourly_Wag	0.042	0.034
	(0.047)**	(0.044)**
Education Control	Yes	Yes
Age, Age-Squared, Marital Status Control	Yes	Yes
Full-Year/Full-Time Status Control	Yes	Yes
Industry/Occupation/State/Year Fixed Effects	Yes	Yes
Aggregate Unemployment Rate Control	Yes	Yes
Number of Observations	416272	526073
R-Squared	0.240	0.235

P-Values For the Hypothesis That The Effect of Minimum Wages On Employment is Zero:

Blacks Earning 4.5 dollars per hour	0.00(g)	0.02 (g)
Whites Earning 4.5 dollars per hour	0.91	0.15
Blacks Earning 15 dollars per hour	0.78	0.91
Whites Earning 15 dollars per hour	0.12	0.60

Notes: (a) Coefficients give the probit marginal effect, where the values in pharanthesis are the p-values for the hypthesis that the corresponding parameter is equal to zero. (b) Sample includes black and white males between 22 and 55 for the years between 1983 and 2004. (c) Minimum wage variable is the alternative measure obtained as residual of Equation (4). (d) Includes industry-year, occupation-year and state-year interactions. (e) *: Significant at 10%, **: Significant at 5%, ***: Significant at 1%. (f) The list of the states used for results in Column 2 is given in Table 1.1. (g) Zero effect of minimum wages is rejected against negative effect of minimum wages on employment.

Table 1.5: Effect of Minimum Wages on Transition from Non-Employment to Employment

	Employed Less Than 4 Weeks In Previous Year		Employed Less Than 8 Weeks In Previous Year		Employed Less Than 12 Weeks In Previous Year	
	States For Which Federal Minimum Wages Are The Effective Minimum Wages	All states	States For Which Federal Minimum Wages Are The Effective Minimum Wages	All states	States For Which Federal Minimum Wages Are The Effective Minimum Wages	All states
	(1)	(2)	(1)	(2)	(1)	(2)
Black	-0.763	-0.581	0.609	0.604	0.546	0.556
	(0.498)	(0.674)	(0.467)	(0.289)	(0.332)	(0.118)
Hourly_Wage(t-1)	-0.057	-0.061	0.096	0.038	0.039	0.025
	(0.535)	(0.183)	(0.009)***	(0.209)	(0.077)*	(0.135)
Black x Hourly_Wage(t-1)	-0.073	-0.090	-0.214	-0.164	-0.104	-0.086
	(0.642)	(0.507)	(0.016)**	(0.025)**	(0.132)	(0.082)*
Log(Minimum Wage)	1.284	-0.406	0.339	-0.327	-0.110	-0.189
	(0.222)	(0.544)	(0.523)	(0.377)	(0.771)	(0.391)
Log(Minimum Wage) x Hourly_Wage(t-1)	0.033	0.038	-0.057	-0.023	-0.024	-0.016
	(0.558)	(0.175)	(0.012)**	(0.206)	(0.078)*	(0.117)
Black x Log(Minimum Wage)	0.071	-0.380	-0.942	-0.794	-0.799	-0.736
	(0.961)	(0.723)	(0.246)	(0.146)	(0.195)	(0.058)*
Black x Log(Minimum Wage) x (Hourly_Wage(t-1)	0.025	0.034	0.126	0.094	0.061	0.050
	(0.788)	(0.666)	(0.019)**	(0.036)**	(0.132)	(0.09)*
Education Control	Yes	Yes	Yes	Yes	Yes	Yes
Age, Age-Squared, Marital Status Control	Yes	Yes	Yes	Yes	Yes	Yes
Full-Year/Full-Time Status Control	Yes	Yes	Yes	Yes	Yes	Yes
Industry/Occupation/State/Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Aggregate Unemployment Rate Control	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	834	1091	2501	3214	4839	6284
R-Squared	0.230	0.191	0.091	0.081	0.073	0.064

P-Values for the Hypothesis That the Minimum Wages Effect the Employment Status of The Blacks And Whites Differently

Individuals Earning 4.5 Dollars Per Hour	0.89	0.77	0.42	0.25	0.24	0.13
Individuals Earning 15 Dollars Per Hour	0.81	0.96	0.58	0.68	0.62	0.98

Notes: (a) Coefficients give the probit marginal effect, where the values in pharanthesis are the p-values for the hypthesis that the corresponding parameter is equal to zero. (b) Sample includes black and white males between 22 and 55 for the most of the previous year. Sample covers years between 1983 and 2004. (c) Minimum wage variable is the alternative measure obtained as residual of Equation (4). (d) Includes industry-year, occupation-year and state-year interactions. (e) *: Significant at 10%, **: Significant at 5%, ***: Significant at 1%. (f) The list of the states used for results in Column 2 is given in Table 1.1.

Figure 1.1: Nominal and Real Federal Minimum Wages

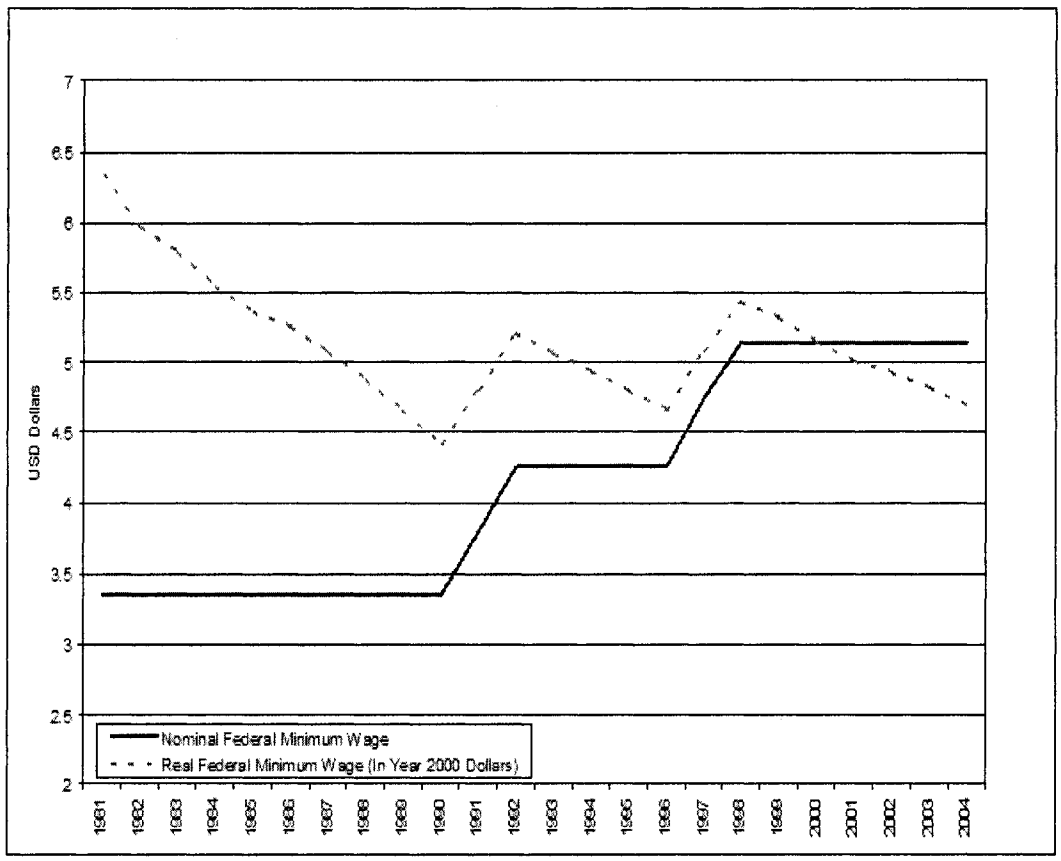


Figure 1.2: Employment Gap Between Blacks and Whites and Annual Changes In Minimum Wages (Individuals Earning Below Minimum Wage)

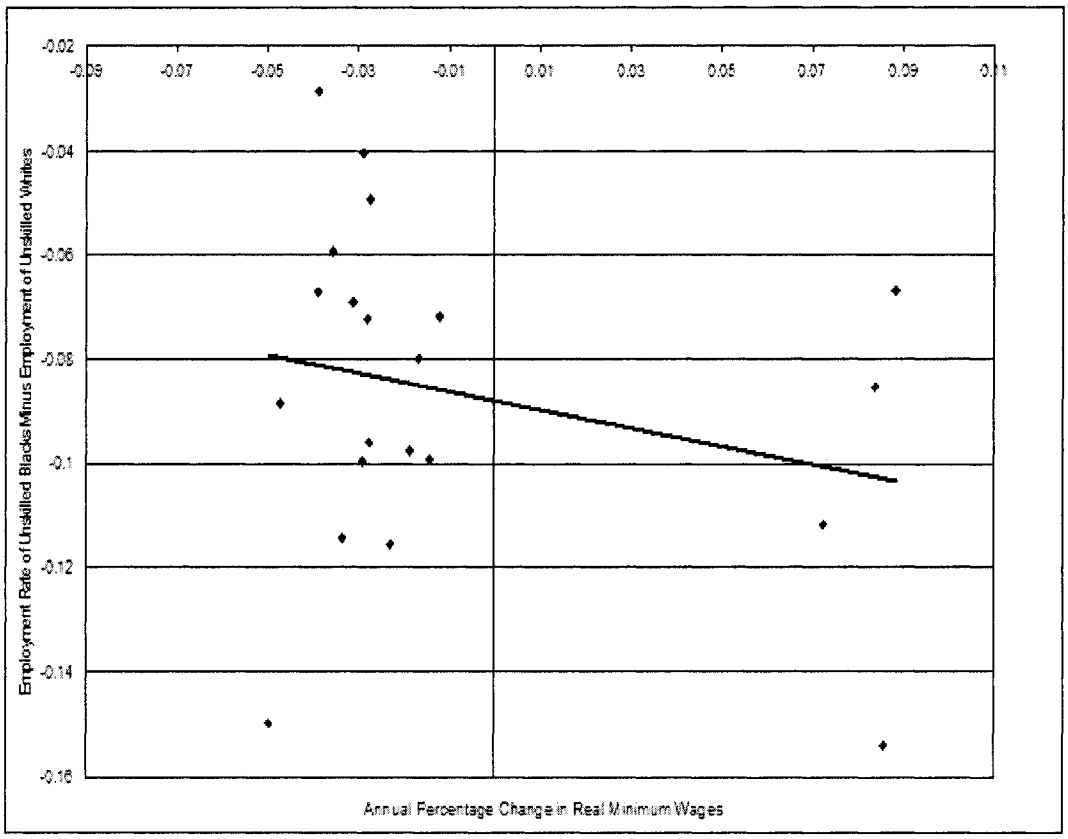


Figure 1.3: Employment Gap Between Blacks and Whites and Annual Changes In Minimum Wages (Individuals Earning Above Minimum Wage)

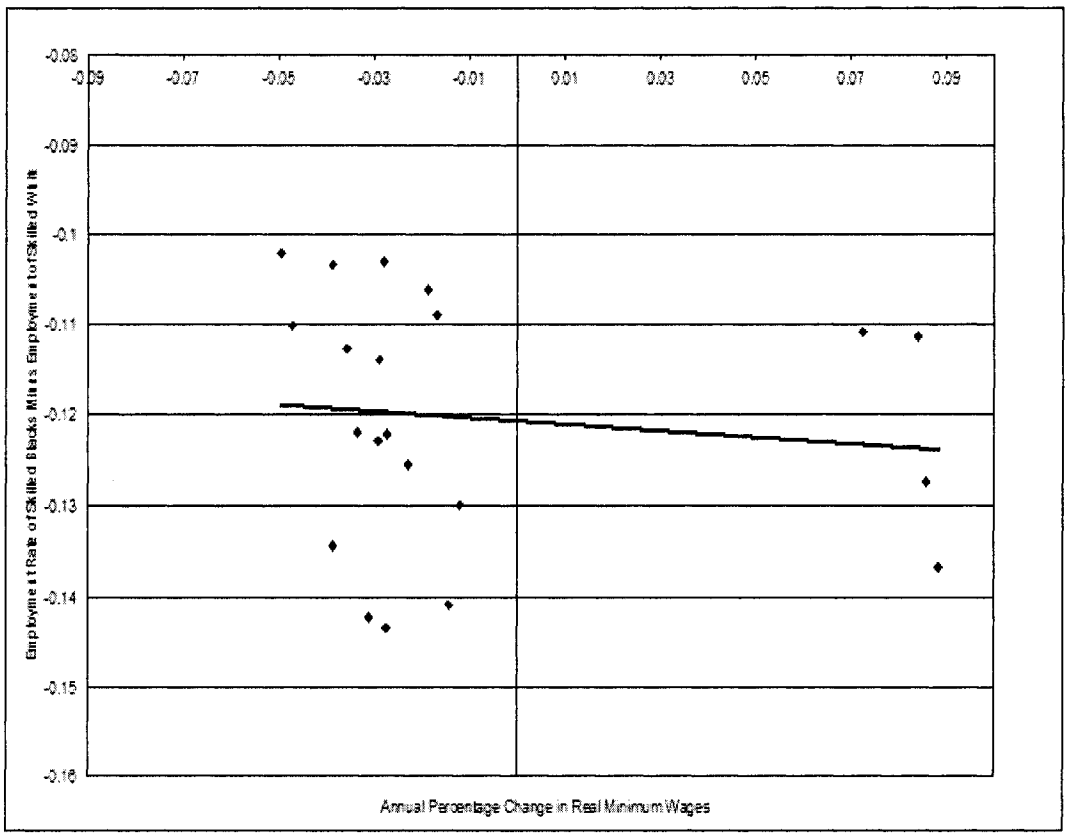


Figure 1.4: Employment Gap Between Blacks Earning Below and Above Minimum Wages

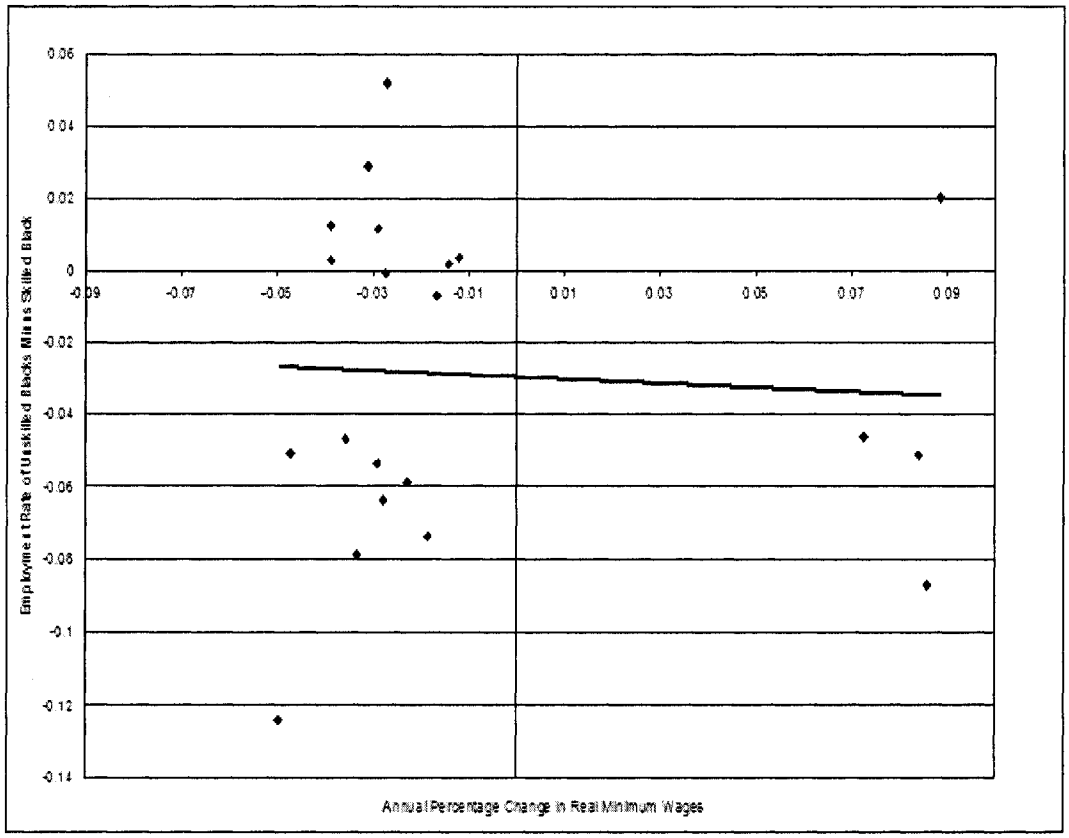


Figure 1.5: Employment Gap Between Whites Earning Below and Above Minimum Wages

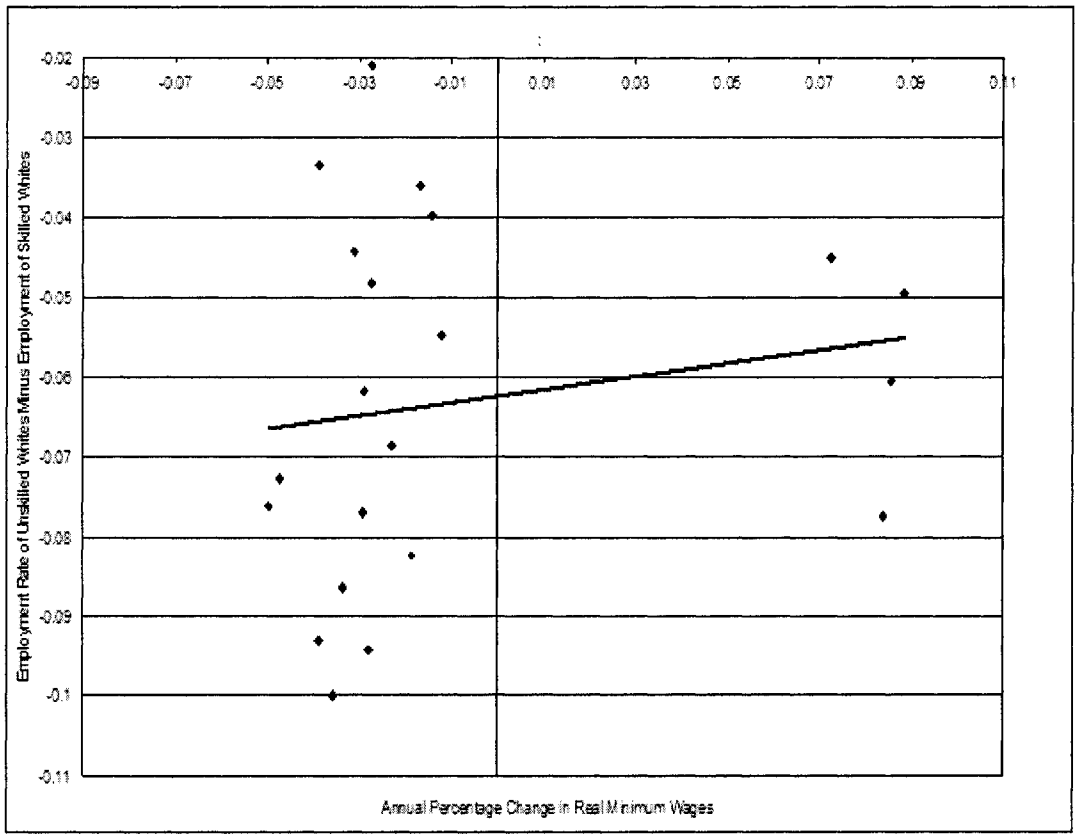
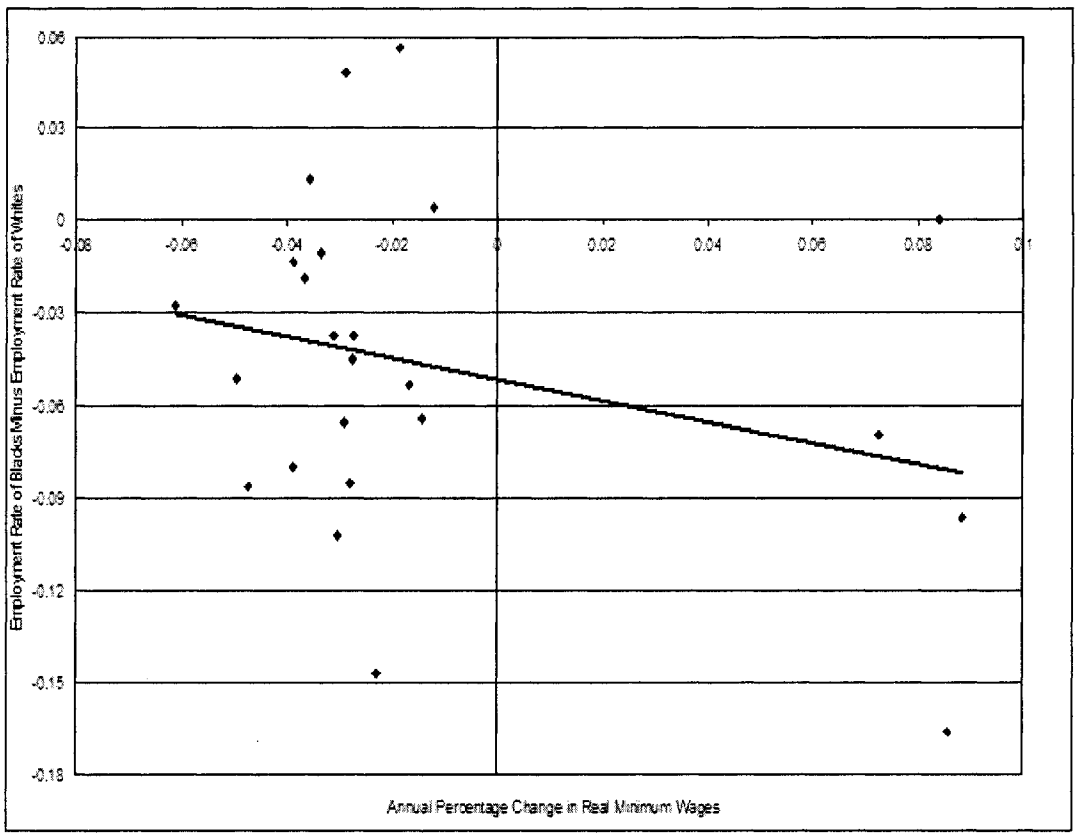


Figure 1.6: Employment Gap Between Blacks and Whites and Annual Changes In Minimum Wages (Individuals Earning Below Minimum Wage) - Matching Results



Chapter 2

Business Cycles and Black-White Employment

2.1 Introduction:

It has been widely observed that there are striking differences in the labor market outcomes between blacks and whites in the United States. In general, blacks have significantly higher unemployment rates, longer unemployment spells, lower earnings and lower labor force participation compared to whites even after controlling for the observable characteristics such as education, experience or occupation[1]. In addition, conditional on observables, the unemployment rate of black males is approximately twice that of white males. A number of studies have pointed out that these racial differences in employment are exacerbated during recessions[2]. This pattern is clearly illustrated in Figure 2.1, which shows the sharp decreases in black employment, relative to white employment, during economic downturns.

Attributing these differentials solely to race is problematic given the inability of researchers to adequately control for a worker's skill. In the presence of unobserved skills correlated with both race and employment, black-white differences might arise naturally during recessions if the least-skilled workers are fired first. In the context of wage regressions, Neal and Johnson (1996) demonstrate the effect of unobserved skills on the estimates of racial wage gaps. They find large racial wage gaps in a Mincerian wage regression using standard controls such as education and experience. However, once they introduce

[1] See Altonji and Blank (1999) for comprehensive reviews of black-white labor market differentials.
[2] See Freeman (1973), Clark and Summers (1981), Hoynes (2000).

the Armed Forces Qualifying Test (AFQT) score, instead of education, as a proxy for pre-market skills of individuals, the estimated black-white wage gap for males decreases by three quarters and the female wage gap loses significance entirely[3]. Unfortunately, variables such as AFQT scores are not widely available in larger datasets such as the Current Population Survey (CPS). Thus, researchers are forced to balance a trade-off between analyzing smaller data sets with a larger variety of skill measures, such as the NLSY, and analyzing larger nationally representative datasets containing fewer measures of skill, such as the CPS.

In this study, we estimate the effect of business cycles on the employment probabilities of black and white workers, utilizing hourly wages earned in the prior year as a measure of a worker's productive skill. While business cycles provide exogenous variations in employers' demand for labor, the wages earned by a worker may provide information about how the productive skill of a worker is assessed by an employer. Therefore, our methodology enables us not only to circumvent some of the criticisms associated with biases due to unobservable individual skills, but also to utilize standard large representative datasets, such as the CPS.

Our analysis relies on the assumption that the wages received last year by a worker can serve as a better measure for the productive skills of an individual as evaluated by employers, compared to measures such as years of schooling or standardized test scores. It is worth noting that our analysis does not require the equality of wage and productivity of a worker at any point in time. We simply require a black worker to be at least as productive as a white worker earning the same wage. This is also consistent with the findings of the literature on black-white earning gaps suggesting that black workers are never found to be overpaid compared to whites conditional on observable skill and job characteristics. As a result, using wages as a measure of skill could potentially underestimate the productivity of black workers.

Using the data on males aged between 22 and 64 provided by CPS for the period between 1976 and 2003, and NLSY 1979 cohort of males, we provide empirical estimates for both the impact of recessions on black-white differences in employment probabilities and on black-

[3] Altonji and Blank (1999) shows additional empirical examples highlighting the sensitivity of empirical findings to various specifications and controls.

white differences in unemployment duration. Additionally, we attempt to provide some insights into the mechanisms underlying these racial differences in employment outcomes. Specifically, we try to distinguish between differences in labor supply versus differences in labor demand as the prime determinant of these racial differences in employment.

The findings of this study can be summarized as follows. At the external margin, we find that blacks experience a higher increase in the probability of unemployment over the recession compared to whites conditional on individual and job characteristics and on having earned same wages in the previous year. In particular, we find that the increase in the unemployment probabilities experienced by blacks due to recessions is 0.5 percentage points higher than what whites experience. This number can alternatively be stated as blacks facing 1.5 times what whites face as the increase in the unemployment probability over the recessions. We find that the greatest differences in black-white employment are observed in the second and third quartile of the wage distribution. Consistent with the theoretical predictions in the literature, such as Oi (1962), or the empirical findings of previous studies, such as Hoynes (2000), we find no race differences in employment outcomes over recessions for high skill workers, defined here as workers in the highest quartile of the wage distribution. However, quite surprisingly, we also find no differences in the least skilled group or the lowest quartile of the wage distribution. Our results also show that, conditional on the current state of the economy, lagged recessions affect the current employment probability of black workers significantly, but have a negligible effect on the employment of white workers. This is consistent with our finding that, at the internal margin, blacks experience sharper increases in unemployment durations relative to whites during recessions.

These results indicate that there are significant differences in employment outcomes across races even after controlling for skill and productivity differences. However, we cannot determine whether these racial disparities are driven by racial differences in labor demand or labor supply without further analysis. We examine differences in black-white labor supply over recessions using self-reported reservation wages of black and white youth from the NLSY. These results suggest that there are no differences in the labor supply behavior of equally productive whites and blacks. This finding provides some evidence that the black-

white employment difference during a recessions is driven mainly by differences in labor demand for black and white workers. We argue that our results are consistent with the predictions of a queuing model, where blacks and whites are ranked differently by employers in the lay-off list in case of a need to reduce number of workers in the firm. Our results are also compatible with model of discrimination where the search costs of finding a white worker for a prejudiced employer are lower during periods of high aggregate unemployment.

The rest of the paper is structured as follows. Section 2.2 of the paper presents the data utilized in this study. Section 2.3 introduces the empirical methodology, while Section 2.4 presents the empirical results. In Section 2.5, we briefly evaluate the robustness of the results by considering whether the wages can provide a reasonable account of relative skills of blacks and whites as well as by providing complementary results using NLSY data. Section 2.6 provides interpretations of our results with the emphasis on whether individuals differing only by race encounter different labor market outcomes and whether our empirical results provide any insight about racial discrimination. Section 2.7 presents the concluding remarks.

2.2 Data

In our analysis, we use the Current Population Survey (CPS) March Supplement from 1976 to 2003[4]. Our dataset provides observations on the employment status, wages and demographic characteristics of approximately 700,000 individuals. Our sample includes observations on black and white males who are between 22 and 64 years old. Individuals who are self-employed or working without pay are excluded from the sample. We use the logarithm of real wages per hour as the skill measure, where the real wage per hour is calculated as annual nominal wage divided by number hours that an individual worked in that year, adjusted by Consumer Price Index taking year 2000 as the base year. Since the data on annual hours of employment is not available for the years prior to 1976, we focus

[4]This dataset is available at www.ipums.org.

only on the period between 1976 and 2003. We exclude the individuals whose real wage per hour is below $5 and above $500 in year 2000 dollars.

Our sample period contains three economic downturns, namely 1980-1982 recession, 1990-1991 recession and 2001-2002 recession, as dated by the Business Cycle Dating Committee of National Bureau of Economic Research (NBER). We define the variable "business cycle" as a dummy variable, which takes one for the years of recessions, and zero for other years. However, in the definition of this variable, we slightly depart from recession years determined by NBER Business Dating Committee. Since we are mainly interested in unemployment differences that emerge in periods of weak labor demand, we redefine the recession years in our baseline analysis by including also 1983 and 1992-1993 as recession years[5]. This choice incorporates the idea that there may be a delay in observing the effects of economic slowdowns on labor markets. However, it is worth noting that the results obtained by using the business cycle years stated above do not yield significant differences when compared to results obtained by using NBER Business Cycle years[6]. We also estimate our main specifications by using the state level unemployment rate, provided by the Bureau of Labor Statistics, as an alternative measure of business cycles.

For further robustness of our results, we use the data from the National Longitudinal Survey of Youth 1979 cohort (NLSY79). This is a nationally representative sample of youth who were between the ages 14 and 22 in 1979. The NLSY79 resurveys participants annually from 1979 through 1994 and is biannual following 1994. We restrict our sample to black and white males, who worked in the prior year from 1979 through 1998[7]. We exclude observations where individuals were in the military or self-employed. We also exclude observations where the hourly wages were less than $5 or greater than $500. This

[5] These two years are coupled with considerably high unemployment rates, when compared with the annual unemployment rates in the post Second World War period. See Rubinstein and Tsiddon (2004) for a similar choice. See also Bewley (1999), who also considers 1992 and 1993 as recession years due to high unemployment and low level of economic activity, despite the fact that the aggregate output had already started increasing again by then.

[6] Although we do not report the results obtained by using exact NBER dates, we should note that they are similar to the baseline results that we report here. The results obtained using the NBER dates are available upon request from authors.

[7] The 2003 NLSY public use the CD-ROM does not provide an historically consistent employment variable for 2000 and 2002. This prevented us from analyzing data beyond 1998.

leaves us with a sample of 53,000 observations from approximately 6,000 individuals. It is worth emphasizing that the NLSY data is particularly suited to our study since, in addition to containing basic information on demographic characteristics and labor market outcomes, it contains information on tenure, and the Armed Forces Qualifying Test (AFQT) - a standardized aptitude test. The NLSY data also contains a measure of the local labor market unemployment rate which we use as an alternative measure of aggregate fluctuations in labor markets[8]. Finally, the NLSY data provides information on self-reported reservation wages for the period between 1979 and 1986. These self-reported reservation wages allow us to ascertain the racial differences in labor supply due to aggregate fluctuations.

2.3 Methodology

In order to compare the labor market outcomes of blacks and whites with similar characteristics, we mainly estimate the changes in the employment probabilities of blacks and whites due to business cycles by using CPS March Supplement as a short panel, thanks to the structure of the questions in this survey. In particular, CPS provides answers for whether the individual was unemployed last week, and how much his earnings was and how many hours he worked last year. Combining this information with our business cycle measure gives us the opportunity to analyze how the employment of blacks and white change when the labor demand of the firm fluctuates due to factors which are entirely exogenous to the workers' individual characteristics. In our analysis, we control for all standard demographic and skill variables, industry, occupation and geographic controls. Beyond these, as a major extension on the existing literature, we use the logarithm of the hourly wages earned in the previous years as a proxy for skills of an individual relevant to his particular job.

Using superscripts "b" and "w" for parameters and variables corresponding to blacks and whites respectively, the determinants of employment status of blacks and whites can be written as follows:

[8] Due to confidentiality issues the NLSY does not provide state of residence, thus we are forced to use this measure in lieu of a business cycle measure based on state level unemployment rates. The NLSY provides the local unemployment rates as a categorical variables in the public use file to protect confidentiality of participants.

$$
\begin{aligned}
Y_{i,t}^{b} &= \gamma_0^{b} + \gamma_1 X_{i,t} + \gamma_2^{b} BC_t + \gamma_3 W_{i,t-1} + \gamma_4 W_{i,t-1} BC_t + \varepsilon_{i,t}^{b} \\
Y_{i,t}^{w} &= \gamma_0^{w} + \gamma_1 X_{i,t} + \gamma_2^{w} BC_t + \gamma_3 W_{i,t-1} + \gamma_4 W_{i,t-1} BC_t + \varepsilon_{i,t}^{w}
\end{aligned}
\tag{2.1}
$$

In Equation (2.1), the dependent variable $Y_{i,t}$ stands for the employment outcome of individual i at time t, which shows whether the individual is working or not in our main specification. $W_{i,t-1}$ is the natural logarithm of real wage per hour earned last year, and BC_t is defined as a dummy variable, which is equal to 1 for a recession year. The vector of other covariates, denoted by $X_{i,t}$, represents the standard demographic controls such as marital status, years of schooling, age, age squared and job-related variables like union status, tenure, industry, occupation and geographical location, as well as full-/part-time status and full-/part-year status[9].

Using Equation (2.1) and defining the dummy variable R_i which takes 1 for a black individual and zero for a white individual, the equation that we estimate can be written as:

$$
Y_{i,t} = R_i Y_{i,t}^{B} + (1 - R_i) Y_{i,t}^{W} \tag{2.2}
$$

which can be rewritten as:

$$
Y_{it} = \alpha_1 + \alpha_2 X_{i,t} + \alpha_3 W_{i,t-1} + \alpha_4 R_i + \alpha_5 W_{i,t-1} BC_t + \alpha_6 BC_t + \alpha_7 R_i BC_t + \varepsilon_{i,t} \tag{2.3}
$$

In our main exercise, we are interested in the changes in employment probabilities due to business cycles, where dependent variable $Y_{i,t}$ in Equation (2.3) takes the value of 1 if an individual is working, and 0 if he is either unemployed or out of labor force[10]. In

[9] The individuals working 35 hours or more are considered as full-time workers. The individuals working 46 weeks or above are considered as full-year workers. Some of the variables mentioned above as being included in $X_{i,t}$ are available only in NLSY79 and used for the robustness of the baseline results.

[10] $Y_{i,t}$ variable used in our baseline analysis is defined consiering whether the individual is working or not, rather than whether the individual is employed or unemployed consistent with the standard textbook definition of unemployment. This choice reflects our view that the individuals' seperation from a job may

Equation (2.3), the coefficient on α_5 provides the estimate of differential effect recessions on individuals with different skills. In this specification $\alpha_5 W_{i,t-1} + \alpha_6$ gives the percentage change in the unemployment probability of a white worker with a skill level equal to $W_{i,t-1}$ due to a recession, whereas α_7 gives the extra percentage point increase in the unemployment probability of comparable blacks.. Therefore, having a statistically significant estimate for α_7 provides evidence for whether equally productive blacks and whites experience differences in employment outcomes.

We also determine whether the recessions have differential effect on the unemployment durations of blacks and whites. For this, we use the data provided by CPS on the continuous weeks of ongoing unemployment. In such an examination, we use the control variables outlined above as well as variables like non-labor income and the total family income to control for the opportunity cost of job search across individuals.

We further utilize the data provided on the black and white youth surveyed by National Longitudinal Survey of Youth to check the robustness of our baseline results to the factors about which CPS was silent. With the use of NLSY, we control not only for the variables listed in $X_{i,t}$ vector above, but also other potential determinants of employment outcomes such as tenure and time invariant heterogeneity across individuals. Finally, we use NLSY data to see if the reservation wages of blacks and whites differ from each other in terms of their level and sensitivity to recessions, which provides some preliminary insights about whether supply factors may affect the differences in employment outcomes that we observe over business cycles.

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be a more relevant question in the analysis of racial differences in employment, as the individuals may get out of the labor force for being discouraged for actively looking for jobs. However, although not reported here, we also obtained similar results by using a specification where $Y_{i,t}$ was defined in line with in standard definition of employment and unemployment.

2.4 Basic Results

2.4.1 Black-White Unemployment Differences:

Table 2.1 presents the estimates for the racial differences in the changes in the unemployment probabilities due to recessions controlling for demographic (age, marital status) and job characteristics (industry, occupation, part-time/full-time and part year/full year) as well as skill measures like years of schooling and wages, measured in previous years. The results in the first column of Table 2.1 shows that blacks face 1.7 percentage point higher unemployment probability during expansions, given all other characteristics except for education and wages in the previous year. When the economy is disturbed by a recession, whites face 0.7 percentage point increase in their unemployment probabilities, whereas blacks face a 1.3 percentage point increase[11]. In the second column, we introduce the education level into the regression as a measure for the productive skills of an individual. The inclusion of education decreases the black-white unemployment differences during expansions to 1.6 percentage points, whereas the observed black-whites differences in changes in unemployment probabilities do not change substantially. In column 3, we further introduce log hourly wages measured in the previous year as a proxy for skill. With the introduction of wages as a skill measure, we again find that blacks face twice as much an increase in the probability of unemployment as whites do.

The reason why we find similar results in all of these three specifications is due to the restriction in these specifications that the recessions do not have differential effect on the unemployment probabilities of individuals with different skills. However, this would be quite a strong assumption. In particular, one would expect that the firms would be laying off workers with low skills first whenever they need to reduce the employment. To account for this possibility, the fourth column allows for the effect of the recessions to differ with respect to education level, and fifth column allows for differential effect of recessions both due to education level and the wage level. In particular, we find that increase in the unemployment probability faced by blacks is 1.4-1.6 times what whites experience. In

[11] As expected, we find that older, married workers as well as full-time workers and full-year worker face lower unemployment probabilities.

particular, for individuals whose hourly wage level is 5 dollars in the previous year, increase in the unemployment probability of whites is around 1 to 1.5 percentage points depending on their education level, whereas the same figure for blacks is 1.4 to 1.9 percentage points. For individuals whose hourly wage level is 10 dollars in the previous year, increase in the unemployment probability of whites is around 0.5 to 1.0 percentage points depending on their education level, whereas the same figure for blacks is 1.0 to 1.5 percentage points.

The comparison of the results in columns 1-3 with results in columns 4 and 5 simply suggests that the previous specifications simply overestimate the black-white differences in the increase in unemployment probabilities. This is compatible with the motivation we provided in the introduction. In particular, in the absence of proper measures for unobserved skill differences across races, black-white differences will be overestimated. However, black-white differences implied by column 5 is smaller than the differences implied by the column 4, suggesting that the introduction of log hourly wages as a skill measure and allowing for the effect of recessions to vary across individuals with different hourly wages reduces the bias in the racial differences in changes in unemployment probabilities. However, it is still worth noting that there are significant large gaps across blacks and whites in the increase in the unemployment probabilities over the recessions.

Table 2.2 analyzes the black-white employment differences over the business cycle by using state level unemployment rates as the business cycle measure, rather than the binary BC variable defined in line with recession periods in the United States. This helps us not only to verify the robustness of our main results to the way that the business cycle variable is defined, but also to calculate how the black-white differences in employment probabilities respond to 1 percentage point increases in the aggregate state level unemployment rates. In a similar fashion, columns 1-3 in Table 2.2 provides estimates of the black-white differences in the change in the unemployment rates due to worsening labor market conditions, without allowing for the effects to vary across skill levels. These specifications roughly suggest that a 1 percentage point increase in unemployment rate leads to 60 percent higher increase in the unemployment probabilities of blacks compared to whites. However due to a similar reason as indicated above, these results can be regarded as overestimates of the racial gaps.

When we allow for the effect of 1 percentage point increase in the aggregate unemployment rates to vary across skill levels, we find similar that blacks face 30 to 50 percent higher increases in the unemployment probabilities.

In general, due to various factors affecting the relationship between the wages and employment, it is possible to observe differences in degrees of racial disparities in different parts of the wage distribution. For instance, one may expect to see smaller race gaps in the changes in employment probabilities of highly skilled workers. We test such an hypothesis by splitting the sample along different quartiles of the wage distribution. The results presented in Table 2.3 show that the biggest black-white differences in recessions are observed, surprisingly, in the second quartile of the wage distribution (between 10.8 dollar per hour and 16 dollars per hour in year 2000 dollars). These results suggest that in recessions all workers with very low skills experience large increases in unemployment probability regardless of their racial profile. This may be explained as the employers may not be distinguishing between workers under a certain skill threshold for one reason or another, whenever they need to decrease the size of the workforce they employ. The interesting observation is the non-linearity in the effect observed in the higher parts of the wage distribution. The absence of such differences in the upper parts of the wage distribution can be related to high costs of hiring and firing individuals who have high skills, where firms may regard individuals with high skills as quasi-fixed capital over the business cycle as suggested by Oi (1962), and would be reluctant to dismiss them during recessions considering the cost they would face to replace them once the economy starts picking up again. This leaves the 2nd quartile or "middle class" black workers as those facing differential employment outcomes relative to their white counterparts during recessions.

2.4.2 The Lagged Effects of Recessions on Black-White Employment Differences

When using business cycle dates as a proxy for exogenous variations in labor demand, we mainly exploit the fact that the demand for labor is a derived demand, which responds to

the variations in the demand for output. For various reasons, the periods of contraction in output may not exactly coincide with the timing of lay-off. For instance, it may take time for the firms to realize the need for reducing the number of workers due to changing demand conditions, or to take necessary actions to lay-off employees. As a result, one can expect to observe that the black-white employment differences can be affected throughout entire periods of a recession, rather than only during the initial periods of a recession. In addition, if the recessions have differential lagged effect on the employment probabilities for blacks and whites, we may observe differences across races in the timing of the peak points of the unemployment rates.

Considering these possibilities, we analyze whether having a recession in the previous year has differential effect on blacks and whites, conditional on current phase of the business cycle. Such an analysis can provide an answers for whether the racial gaps widen even more in longer recessions. Furthermore, it helps us to examine whether blacks still continue to face increases in their unemployment probabilities, even after the negative impact of recessions on employment probabilities of whites start to disappear.

We estimate our baseline regression by adding two new indicators as explanatory variables. The first indicator, denoted as BC(-1) in Table 2.4, takes the value 1 if a recession was observed in the previous year and zero otherwise. The second variable is the interaction term between BC(-1) and the dummy variable for race. The coefficient on the former shows whether the recessions have lagged effect on the employment probabilities of all individuals, whereas the coefficient on the latter shows whether the lagged recessions have a differential impact on the employment probabilities of blacks.

Table 2.4 provides a striking evidence suggesting that blacks are affected negatively when the previous year has been a recession, whereas there is no such effect on the employment probabilities of whites. As a result, the observed unemployment differences across blacks and whites are likely to widen in longer recessions. In addition, blacks may continue to face declines in their probability of employment even after the economic recovery starts to be observed, whereas the duration of the negative effect of recessions on whites' employment

probabilities is limited with the duration of the recession. Thus, the recessions as experienced by blacks effectively span a longer time period compared to what whites experience as recessions.

The differential impacts of lagged recessions on the employment probabilities of blacks and whites simply imply that the peak of the unemployment rates of whites precede the peak of the unemployment of blacks. In particular, we can use Figure 2.2 to present these findings visually. At this point, it is worth emphasizing that early theoretical literature analyzing the black-white employment differences in the context of a dynamic search model generates predictions consistent with our empirical finding. For instance, Carroll and Rolph (1973) show that the unemployment rates of blacks and whites may have different characteristics over time if the hiring decision of an employer depends on the racial profile of the applicant for the vacancy either due to taste or the use of race as a signal for worker's unobservable productivity. McCall (1970, 1972) shows that, in a case associated with the employers having taste against blacks, they may be fired during recessions at a higher intensity as a result of a decline in the discriminating employers' search cost for finding whites. As a result, as the recession continues, the decomposition of the pool of unemployed individuals is likely to change in a way that the relative number of blacks in the group of unemployed may increase[12].

2.4.3 Black-White Unemployment Duration Differences

The analysis in the previous section has mainly focused on the black-white differences in employment status. However, the unconditional data from CPS suggests that the sample average of number of consecutive weeks that blacks have been without a job (and looking for a job) is 1.31 weeks compared to 0.69 weeks for whites, suggesting that blacks usually face longer unemployment spells[13]. To examine whether the equally productive blacks

[12] In addition, McCall(1972) and Carroll and Rolph (1973) predict that the members of the non-prefered racial group will be hired only if the labor markets are necessarily tight, which we will address in another study.

[13] By definition, the data on the continuous weeks of unemployment excludes the people who get out of labor force. This may lead to the underestimation of the differences in the intensity of recessions felt by blacks relative to whites, as more blacks tend to be out of labor force during recessions.

and whites experience different changes in unemployment durations over business cycle, we regress the number of consecutive weeks of unemployment on standard human capital measures, industry and occupation variables, job-specific controls and business cycle measures. It is worth noting that the duration data provided by CPS measures the ongoing unemployment spells rather than completed spells, as the duration question is asked only to the individuals who were unemployed during the reference week for the survey. In the absence of corrections for this selectivity problem, we would be left with biased estimates of the black-white differences in the intensity of unemployment. To circumvent the selectivity problem, we impute the value 0 for those who are employed. The reason why we take this approach is the lack of credible instrumental variables that would predict unemployment but would not be correlated with the intensity of unemployment except through unemployment itself.

The results of this exercise are reported in Table 2.5. Controlling for the relevant characteristics about individuals' skill level, demographic characteristics, region, industry and occupation, we find that blacks experience 0.4 weeks higher unemployment duration compared to whites during expansionary periods. In recessions, whites experience an increase of 0.4 weeks of unemployment duration, whereas blacks' unemployment duration increases by 0.6 weeks.

2.5 Further Empirical Results:

Although the analysis in previous sections gives new insights on the sources of employment dynamics for blacks and whites, it still has some limitations resulting from the structure of the dataset. We use the data provided by NLSY79 to check the robustness of the previous results to the introduction of three additional controls, which were absent in CPS. First, NLSY79 provides information on the tenure differences across individuals, which is potentially correlated with race and therefore may affect the estimates of racial unemployment differences. Second, NLSY79 also allows us to control for AFQT, which is another commonly used skill measure which mostly accounts for the skills of the individuals acquired

prior to the labor market. Third, CPS March Supplement is a pooled cross-section, and does not allow us to control for the time-invariant heterogeneity across individuals. In addition to these issues, NLSY79 also provides another robustness check for the sensitivity of the results to how we account for business cycles, thanks to the different structure of the variable accounting for the state of the overall labor market and the business cycle. Apart from the robustness tests on the basis of NLSY, we also conduct some more robustness checks using CPS with a particular focus on whether wages would serve as a plausible skill measure, considering various factors that would potentially weaken the wage-productivity relationship.

2.5.1 Differences in Tenure

As a result of the absence of the data in CPS March Supplement, the analysis in the preceding sections could not control for tenure differences, which may be an important determinant of employment status over business cycles. For instance, if black workers have accumulated less tenure in a particular firm than whites for one reason or another, then black workers would be more likely to be dismissed than white workers in a case where the employers lay-off employees on the basis of seniority. Therefore, the absence of a control for tenure differences in the previous section leaves our analysis open to the possibility that the tenure differences across blacks and whites can affect our empirical results about employment outcomes over business cycles.

We address the role of tenure differences in black-white unemployment differences by using two different methodologies. First, we reestimate our baseline regression also by controlling for the tenure differences with the data provided by NLSY79. These results, shown in Table 2.6, suggest that tenure differences do affect the employment outcomes. However, the main findings of this study in terms of the black-white employment differences over business cycles are robust to the inclusion of the tenure control.

As an alternative to these results, we use CPS in a way to provide an indirect way of addressing effect of tenure differences on our baseline results by focusing on individuals

who have at most one year tenure. In this exercise, we simply isolate the workers who report a change in their occupation or their industry from the prior year in CPS, under the assumption that these workers are newly hired employees and thus would all have at most 1 year of tenure. If tenure differences are the main determinants of the results we reported in Section 2.4, then we should find insignificant differences across blacks and whites for those workers with low tenure. Table 2.7 shows the results of this exercise. Although the point estimates of the effects of increased state unemployment rates on the unemployment of both white and black workers is greater than in the baseline specification, we still find, in accordance to our previous results, that a 1 percentage point increase in unemployment rate leads to 60 percent higher increase in the unemployment probabilities of blacks compared to whites. However, it is worth noting explicitly that these results may need to be interpreted with some caution, given the imprecise manner that we classify newly hired workers.

2.5.2 Controlling For Pre-Market Factors Affecting Skills

Compared to CPS, another advantage of NLSY79 is the availability of a wider set of measures, which may account for the different dimensions of skill differences across individuals. In the existing literature, pre-market factors affecting productive skills, proxied by individuals' percentile-rank in Armed Forces Qualifying Test (AFQT), is found to be one of the determinants of the labor market outcomes of the individuals. As far as our analysis is concerned, by considering the well-documented strong correlation between an individual's AFQT scores and race, we can conclude that the absence of such a measure may bias the results presented above in the direction of finding a larger racial gap than the actual in the changes in the employment probabilities over business cycles. Table 2.8 suggests that the inclusion of AFQT does not affect the baseline results presented above. In other words, we find that blacks and whites face similar differences in the changes in employment probabilities in recessions, even after accounting for a wider range of factors affecting productive skills. Moreover, the significance of the wages as a skill measure is no affected by inclusion of AFQT to the regression. This finding suggests that wages convey information about productive skills of individuals beyond the information conveyed by AFQT or other skill

measures.

2.5.3 Other Robustness Checks

Following the theoretical and empirical literature on the compensation determination, one may think of a number of reasons why the wage earned by an individual may deviate from his productivity at any point in time. These factors, such as the existence of monopsonies, delayed compensation schemes or differences in fringe benefits or promotion possibilities may weaken the pay-productivity relationship at any point in time. Although these factors may raise concerns about the plausibility of the use of wages earned in the previous year as a skill measure, it is worthwhile to reemphasize that these issues would not affect our main conclusions about racial unemployment differences, as long as the wage-productivity differences are not systematic across races in a way that blacks would be overpaid compared to whites for a given level of physical productivity. However, we further try to control for the factors that may potentially affect the productivity-pay relationship so as to conclude that the results mentioned above are not an artifact of improper controls for skill differences across races.

CPS dataset provides information about the size of the firms, measured as the number of employees, which can provide some information about the degree of competition that the firm faces in the labor market. The size of the firms may matter for our analysis for various reasons. For example, the size of a firm could affect the wage-productivity relationship, because large firms may need to pay higher "efficiency wages" to workers compared to small firms, either due to higher cost of monitoring or in order to decrease the worker absenteeism. In such a case, if blacks are mostly employed in large-scale firms, the lack of control for firm size may overestimate their productivity relative to whites. Alternatively, if the large and small firms have systematic differences in their sensitivity to business cycles and the firm size and race are correlated with each other, then the lack of control for firm size may bias the results. Considering these possibilities, we estimate our main regression

by using the firm size data provided by CPS[14]. The results that we present in Table 2.8 show that the previous findings are robust to the variations in the employer size.

To alleviate concerns about the heterogeneities in the contracts, we focus on the group of the workers in particular occupations, for which almost entire compensation is equal to the wages earned, so that the relationship between wages and productivity would be stronger. An example of such a group in our sample is waiters, who are paid minimally by their employer but earn most of their income from tips left by customers. Therefore, the amount these workers would receive would depend on the number of customers served, the amount (and price) of food ordered and the level of service performed by these people. Unfortunately, there are not enough waiters in the data to precisely estimate the differential effect of recessions on black and white workers[15]. However, we reestimate our regressions in the same spirit by focusing only on salesmen, for whom the most part of the compensation comes in the form of commissions for the sales they make. Therefore, unlike most of the occupations in our dataset, the hourly earnings for a salesman can be interpreted as a more direct evidence their productivity. Our sample of salesman involve approximately 30,000 observations, for which the power of the test would not be a big problem. The results presented in Table 2.9 show that the black-white differences in the employment probabilities increase further during the recessions, after controlling for hourly real earnings and other skill measures, as well as the industry of the individuals.

2.6 Interpretation of The Estimation Results

The results presented in previous sections show that blacks face much higher increases in the probability of unemployment and unemployment durations compared to whites over the recessions. As mentioned in the introduction, the literature on the sources of black-white

[14] Due to the restrictions on the availibility of the firm and plant size in CPS dataset, the estimations in this part of the study are based on the period between 1988 and 2003.

[15] It is worth noting that the point estimates that we find for the black-white employment differences using this sample are similar to the point estimates that we found in other specifications. However, due to low statistical power of our tests as a result of having only 2000 waiters in our sample, we fail to reject the reject to hypothesis that the black-white differences is not significantly different from zero.

differences in the employment outcomes is surrounded by long-lasting debates associated with a lack of consensus on sources of black-white differences and relevant policies to close black-white gaps. Considering the standpoint of the literature and our findings, we first address whether we can conclude that individuals who are comparable in their labor market characteristics but differ in their racial profile face different employment outcomes over recessions. We then analyze the question of whether -or under what circumstances- we can attribute these differences to discrimination against blacks in the United States.

2.6.1 Sources of the Variations in Employment Outcomes Across Races

In all our specifications discussed above, we find that there are significant racial differences in the increases in unemployment probabilities due to recessions at time t for a given level of wages earned at $t-1$ and other job related characteristics. We argue that, conditional on wages, the black-white employment disparities in recessions are not driven by unobserved productivity differences. However, if black workers were overpaid relative to their productivity, then our inferences would clearly be incorrect. This possibility is unlikely, as noted in the introduction, the findings in the standard wage regressions suggest that blacks may be underpaid for their productive skills, in which case our estimates provided above would be a lower bound for the negative differential effects of recessions on the employment probabilities of blacks[16]. In addition, the plant-level studies in the literature, which jointly estimate the productivity and the earning functions of blacks and whites, find that the relative earnings of blacks do not exceed their relative productivity when compared to whites[17]. Furthermore, in the absence of evidence in the literature suggesting systematic differences across races in terms of the job contracts for given industry, occupation and other job related characteristics, we think that the racial differences in the variations in employment status across races are driven not only by racial skill gaps but also by other factors beyond the skill gaps. Finally, the results obtained with the sample of salesmen, for whom we argue that the hourly earnings can be regarded as a more direct measure

[16] See Altonji and Black (1999) for the review of the literature on racial differences in earnings.
[17] Hellerstein, Neumark and Troske (1999).

of marginal product, suggest that there are significant differences across the employment outcomes of equally productive blacks and whites.

2.6.2 Do The Results Suggest Discrimination Against Blacks?

Having established that the racial differences in employment are not driven by unobserved productivity, we strive to examine the mechanisms that determine these racial employment disparities. Specifically, we aim to address the question of whether discriminatory forces generate these racial differences in employment. We acknowledge that changes in the employment status of workers may occur both due to variations in labor demand and labor supply. Thus, in order to establish whether discrimination drives these racial differences, we need to conduct additional empirical analysis about the labor supply behavior of blacks and whites.

Considering factors such as job search costs, net financial worth and the existence of other outside options as determinants of an individual's decision for switching to non-employment from employment, one may argue that blacks are not more likely to separate from their jobs compared to whites with similar demographic and job-related characteristics. In addition, given the financial constraints they would face and the costs including the potential human capital depreciation during periods of unemployment and lower level of future returns to human capital due to forgone tenure and experience, it may be argued that blacks are not more capable of affording higher amount of leisure during recessions than whites. However, one possibility that makes our results compatible with a supply-driven phenomenon is that blacks and whites have different preferences for leisure or perceptions about their outside options. In the analysis below, we aim to provide some insights about whether blacks and whites differ in their labor supply behavior by using data on self-reported reservation wages of blacks and white youth for the years between 1979 and 1986 provided by NLSY79[18],[19].

[18] Borus (1982), Feldstein and Poterba (1984) and Holzer (1986) are early studies addressing determinants of the reservation wages. These studies show no differences in the *level* of reservation wages across blacks and whites.

[19] As Freeman (1978) suggests, the subjectivity of the self-reported reservation wages data may require

As a prelude to the test of whether blacks and whites differ in their labor supply behavior over business cycles, let $W^0_{i,t}$ and $W^R_{i,t}$ denote respectively the wage offers and reservations wages of individual i at time t, and let the binary variable $Y_{i,t}$ denote whether the individual is working or not. Representing the random factors affecting the employment status by $\varepsilon_{i,t}$, probability that individual i will work at time t can be written as:

$$P(Y_{i,t} = 1) = f(W^O_{i,t} - W^R_{i,t}, \varepsilon_{i,t}) \tag{2.4}$$

where $f(\cdot)$ is such that $f_1 \geq 0$ and $P(Y_{i,t} = 1) = 0$ if $W^O_{i,t} - W^R_{i,t} < 0$ $i = 1, 2$.

Let $t-1$ and t represent an expansion year and a recession year respectively. Considering the determinants of employment status, we can conclude that $W^O_{i,t-1} - W^R_{i,t-1} > 0$ for individuals observed to be working at $t-1$. In an economy where the wage offers and the reservation wages are procyclical, i.e. $W^O_{i,t} \leq W^O_{i,t-1}$ and $W^R_{i,t} \leq W^R_{i,t-1}$, if individual 1 is observed to be unemployed whereas individual 2 is still observed to be working at time t for given values same values $W^O_{i,t-1}$ and $W^R_{i,t-1}$, we can conclude that either the reservation wage of individual 1 has not declined as much as that of individual 2, or the wage offer for individual 1 has declined at much higher a rate, or both of these have occurred. We can use this prediction to disentangle variations in labor demand and labor supply as a source of changes in employment status. If two comparable individuals have similar reservation wages over business cycles, we can conclude that the observed differences in their employment status reflect differences in the variations in demand for these individuals. In particular, we estimate:

$$W^R_{it} = \mu_i + \alpha_1 + \alpha_2 X_{i,t} + \alpha_3 R_i + \alpha_4 BC_t + \alpha_5 R_i BC_t + \varepsilon_{i,t} \tag{2.5}$$

where R_i takes 1 for blacks or 0 for whites, BC_t measures the variations in the aggregate demand for labor, $X_{i,t}$ gives the set of individual's job-related characteristics affecting his

some caution in the interpretation of the results. However, as long as there are no systematic racial differences in degree of such a subjectivity across different phases of the business cycles, we can use them as measures of changes in labor supply behavior across time.

reservation wages and μ_i represents the time-invariant differences across individuals. $X_{i,t}$ involves measures like industry, occupation, education status, part-time/full-time status, potential experience, marital status. We also control for the individual's search costs by using his past wages, family income as well as a control for the time-invariant individual specific factors affecting the search costs. In addition, we proxy for the individuals' expectations about the future job arrival opportunities under three different assumptions about how the individuals form their expectations, by using measures such as the leads of the business cycle variables and lags of the business cycle variables. In each case, we also allow for potential heterogeneities in the expectations across races by also introducing the interactions of these variables and the dummy variable controlling for race.

The results in Table 2.11 indicate for all specifications that blacks and whites do not show significant differences in terms of their reservation wages both in expansions and the recessions. In general, we find that the reservation wages are mostly acyclical. Our findings also indicate that the higher level of education and skill, being married, age and having access to outside financial sources as proxied by the family income have positive effect on the reservation wages, as would be predicted by labor supply models. Although these results are obtained just for a short time period and for white and black youth aged between 14 and 22 in 1979, they provide evidence suggesting that blacks and whites do not differ in their labor supply behavior. As a result, we argue that the racial differences in employment are driven mainly by racial differences in the demand for labor, rather than racial differences in the supply.

Following the finding that the racial differences in employment are due to differences in labor demand, we explore the notion that these differences could be driven by discrimination. In general, one may think of two main possibilities consistent with our results. First, firms may be hiring low skilled minorities in line with Affirmative Action Laws in expansions and dismissing them during recessions. If all new hires were offered the same compensation as part of Affirmative Action Laws regardless of their productivity and blacks have relatively low productivity, then this could explain our results. Alternatively, the second possibility is that there may already be discrimination against blacks during expansions,

which becomes more severe with recessions, leading to increased unemployment among blacks during recessions.

The insights provided by the literature on the hiring practices due to affirmative action support the view that the view that blacks hired via affirmative action do not have a weaker job performance[20]. Furthermore, even if the firms hire minorities more intensively so as to satisfy the legal requirements due to affirmative action laws, they would be expected to have incentives to conduct more intensive employee search and evaluation within the group of minorities, as a result of which qualification and productivity gap between black and white male employees may be closed. We argue that, on the basis of these finding that Affirmative Action Laws would not explain the employment patterns we observe in our results.

Our results are consistent with a model of discrimination in both expansions and recessions. Specifically, our findings are consistent with the empirical predictions of employer search models or queuing models, such as McCall (1970, 1972) or Carroll and Rolph (1973), where prejudiced employers may have a preference for whites over blacks. In particular, the employers' prejudice may lead to a case where whites are preferred over blacks in the hiring process. However, if the employers face search costs for hiring white workers which increases as the number of unemployed whites decrease, then they will not hire blacks until the pool of available white workers is below a certain threshold.

However, following employers' preference for whites, we may observe blacks to have a higher tendency to be laid-off during the recessions than a comparable white for two reasons. First, blacks may be on the top of the potential lay-off list among existing employees due to employers' preferences for whites. Second, due to the recession, the number of unemployed whites may increase for one reason or another, as a result of which the employers may see the recessionary periods as an opportunity to hire whites in terms of lower search costs. Therefore, as long as there are unemployed whites in the labor market, employer may have

[20] By using a sample of 3000 private firms, Holzer and Neumark (1999) show that blacks employed under affirmative action are not less productive than white workers. Also, Lewis (1997) shows that the performance differences between black males and white males employed by federal government under Affirmative Action were not significant.

an extra incentive to lay-off blacks to change the employee composition in line with his preferences.

The predictions about the behavior of aggregate unemployment rates of blacks and whites coming out of the search models discussed above can be presented by using Figure 2.2. First, the peak and trough of black unemployment rate are observed with a lag compared to those of whites. In particular, white employment would be expected to start the recovery earlier than the black employment, if the employers face necessarily low cost of hiring a white worker during early phase of the expansion. Furthermore, the unemployment rates for blacks would be expected to increase sharply once white unemployment exceeds a particular level. Finally, we would expect to observe different levels of sensitivity of unemployment rates of blacks and whites to the macroeconomic fluctuations. These points are clearly supported by our findings suggesting higher increases in the unemployment probabilities for blacks, as well as the finding that blacks who have not lost their jobs during a recession still face significant increases in risk of job loss during the first year of expansions, unlike the comparable whites.

By construction, our analysis focuses on the changes in the employment probabilities of individuals who have already been observed by employers on the job. This may suggest taste or distaste for a particular group as the main factor behind discrimination. Considering the length of the expansionary periods in our sample, we think that employers' taste may be the main source of their prejudice for whites or against blacks. However, this should not be perceived as if our results are entirely inconsistent with the predictions of a statistical discrimination model due to two main reasons. First, depending on the length of time between hiring date of an employee and the recession, it is possible that employers might have not completed learning process about the workers' productive skills such that they might have used race as a signal for productive skills of the workers. Second, the results may still be consistent with the predictions of statistical discrimination model, if the black workers have a prior belief that they would be first to be laid-off, as a result of which they would have a lower job attachment than whites.

2.7 Conclusion

It has been well documented that blacks and whites have substantial differences in labor market outcomes, including the sensitivity of their employment status to cyclical fluctuations in economy. Difficulties in controlling for the unobservable skills of workers complicated prior attempts at assessing the sources of these racial employment discrepancies. Using wages as a measure of productivity, we show that equally productive blacks and whites experience differences in their labor market outcomes during the periods of economic downturn. In particular, we find that increases in the unemployment probabilities of blacks are one and the half times what comparable whites experience when the economy is hit by a recession. We further find that there are no apparent racial differences for the highest skilled individuals in the labor market. In addition, conditional on the current state of the economy, a recession in the previous year significantly decreases the employment probabilities of blacks, whereas such an impact is absent for whites. Given that we assume that a black worker is as productive as a white worker earning the same wage, we argue that these results are likely to represent a lower bound for the black-white differences in employment probabilities over business cycles. If blacks are truly underpaid due to employer discrimination, then our results would underestimate the effects of recessions on the racial disparities in employment probabilities. Nevertheless, we prefer to act cautiously in our analysis considering the contentious debates surrounding the reliability of many of these wage studies.

We argue that our results clearly suggest that black-white employment differences in recessions are not driven by differences in productive skills. We show that our results are robust under a myriad of specifications and controls, including tenure differences, firms size differences or implicit controls for heterogeneities in contracts. We further show that these patterns are robust to the elimination of time invariant heterogeneity across individuals. Finally, these results are robust to the controls of pre-market factors, measured using AFQT score. There is a large literature emphasizing the role of racial differences in pre-market factors as a major determinant of racial disparities in the labor market. Most famously,

Neal and Johnson (1996) showed that in the context of wage regressions the inclusion of AFQT scores reduced the racial wage gaps by approximately 75%. However, as this paper suggests, black-white differences in employment exist even after accounting for differences in pre-market factors leading to differences in skill levels.

Although, as we argue, these black-white employment differences are not driven by differences in productivity, they could potentially be driven by racial differences in labor demand or labor supply over the business cycle. Using reservation wage data from the NLSY 1979 cohort of males we show that there are no significant differences in the reservation wages of black and white individuals in this data. However, even though we have to be cautious in making population-wide generalizations from the results in this data set, we nevertheless conclude that the results do provide some evidence showing that the racial differences in employment are mainly driven by changes in labor demand rather than labor supply. There is very little empirical evidence concerning the racial differences in labor supply over the business cycle. Previous studies examining black-white employment difference in business cycles essentially ignored possible effects of labor supply differences in generating the racial employment gaps. Although we find no evidence suggesting that these racial differences are borne as results of differences in labor supply, we strongly believe that there is a great need for more comprehensive research on the differences in the labor supply behavior of blacks and whites over the business cycle.

A number of authors such as Carroll and Rolph (1973), McCall (1972) developed theories based on search models to examine the racial disparities in employment over the business cycle. Their models show that if the search costs of hiring a white worker for a prejudiced employer are lower in recession, then black employment will fall in recessions as prejudiced employers can easily find white workers. Additionally, in the initial expansion period prejudiced employers would only hire blacks when their search costs for finding white workers were high enough. This would generate a pattern where the recovery of black employment would significantly lag behind white employment in an expansion. We show that our results are compatible with such models of discrimination over business cycles, where we find large racial differences in employment in recessions. Furthermore, we find that the recovery

of black employment in initial expansions significantly lags the recovery of white employment as the lagged recessions affect the employment of black workers and not that of white workers during the early phase of an expansion.

In this study, we have comprehensively examined the nature and the extent of racial differences in employment over business cycles. Using a novel approach to tackle the difficulties of controlling for unobserved skill differences across groups, we show that the differences in employment outcomes between black and white workers are due mainly to differential changes in labor demand. We further show that a part of these labor demand differentials may stem from discrimination by employers who lay off black workers disproportionately during economic downturns. Whereas we have focused mainly on the prediction of taste based discrimination models, these patterns could also reflect statistical discrimination. Unfortunately, we cannot distinguish between these two models of discrimination. However, there is some potential to disentangle these hypothesis by analyzing the differences in the hiring practices between blacks and whites during the early periods of an expansion.

Table 2.1: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]	Working[1]	Working[1]	Working[1]	Working[1]
Black	-0.022	-0.021	-0.019	-0.017	-0.016
	(0.001)***	(0.002)***	(0.002)***	(0.001)***	(0.001)***
BC	-0.007	-0.008	-0.007	-0.016	-0.026
	(0.002)***	(0.002)***	(0.002)***	(0.001)***	(0.001)***
Black*BC	-0.007	-0.007	-0.007	-0.005	-0.005
	(0.003)**	(0.003)**	(0.003)**	(0.002)**	(0.002)**
Wages (t-1)	-	-	0.011		0.007
	-	-	(0.001)***		(0.001)***
Wages(t-1)*BC					0.004
					(0.002)***
Highschool	-	0.015	0.013	0.011	0.010
	-	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Some College	-	0.019	0.017	0.013	0.012
	-	(0.001)***	(0.001)***	(0.001)***	(0.001)***
College	-	0.022	0.017	0.015	0.013
	-	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Highschool*BC				0.007	0.006
				(0.003)***	(0.002)***
SomeCollege*BC				0.012	0.011
				(0.003)***	(0.003)***
College*BC				0.012	0.012
				(0.003)***	(0.003)***
Constant	0.670	0.670	0.670	0.670	0.670
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
R^2	0.150	0.150	0.150	0.150	0.150
Number of Obs.	676804	676804	676804	676804	676804

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes controls for full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.2: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]	Working[1]	Working[1]	Working[1]	Working[1]
Black	0.001	0.001	0.002	0.007	0.004
	(0.000)	(0.000)	(0.000)	(0.005)	(0.005)
SUR	-0.006	-0.006	-0.006	-0.009	-0.017
	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.001)***
Black*SUR	-0.004	-0.004	-0.004	-0.004	-0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)**	(0.001)**
Wages (t-1)	-	-	0.012	-	0.002
	-	-	(0.001)***	-	(0.001)***
Wages(t-1)*SUR	-	-	-	-	0.003
	-	-	-	-	(0.000)***
Highschool	-	0.016	0.014	0.014	0.014
	-	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Some College	-	0.020	0.017	0.014	0.008
	-	(0.001)***	(0.001)***	(0.006)***	(0.006)
College	-	0.022	0.017	0.017	0.000
	-	(0.002)***	(0.002)***	(0.001)***	(0.006)
Highschool*SUR	-	-	-	0.004	0.000
	-	-	-	(0.003)	(0.000)
SomeCollege*SUR	-	-	-	0.008	0.001
	-	-	-	(0.003)***	-0.001
College*SUR	-	-	-	0.008	0.003
	-	-	-	(0.003)***	(0.001)***
Constant	0.670	0.670	0.670	0.720	0.670
	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***
R^2	0.150	0.150	0.150	0.150	0.150
Number of Obs.	676804	676804	676804	676804	676804

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is defined as the state level unemployment rate, therefore the results show the black white differences due to 1 percentage point increase in the unemployment rate. (6) This specification also includes controls for full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%, ***:Significant at 1%.

Table 2.3: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]			
	1st Quartile	2nd Quartile	3rd Quartile	4rth Quartile
Black	-0.026	-0.015	-0.007	-0.008
	(0.003)***	(0.002)***	(0.002)***	(0.003)***
BC	-0.050	-0.050	0.007	-0.02
	(0.02)***	(0.031)**	(0.035)	(0.003)
Black*BC	-0.003	-0.009	-0.005	-0.001
	(0.005)	(0.005)**	(0.005)	(0.001)
Wages (t-1)	0.031	0.007	0.011	-0.012
	(0.004)***	(0.005)	(0.005)	(0.002)***
Wages(t-1)*BC	0.013	0.014	-0.012	-0.003
	(0.009)	(0.010)	(0.010)	(0.003)
R^2	0.140	0.140	0.140	0.140
Number of Obs.	169201	170324	168945	168334

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes controls for education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) The minimum and maximum of each quartile of the hourly real wage distribution is as follows: 1st Quartile: 5 USD-10.8 USD, 2nd Quartile: 10.8 USD-15.9 USD, 3rd Quartile: 15.9 USD - 22.5 USD, 4th Quartile: 22.5 USD and above.

(8) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.4: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]
Black	-0.014
	(0.001)***
BC	-0.022
	(0.009)
Black*BC	-0.003
	(0.002)**
BC(t-1)	-0.007
	(0.005)
Black*BC(t-1)	-0.007
	(0.003)***
Wages (t-1)	0.007
	(0.001)***
Wages(t-1)*BC	0.004
	(0.002)***
Constant	0.670
	(0.002)***
R^2	0.150
Number of Obs.	676804

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes controls for education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.5: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Duration of Unemployment[1]
Black	0.352
	(0.030)***
BC	0.431
	(0.176)***
Black*BC	0.140
	(0.060)***
Wages (t-1)	-0.055
	(0.020)***
Wages(t-1)*BC	-0.070
	(0.037)***
Constant	3.001
	(0.114)***
R^2	0.090
Number of Obs.	676804

Notes:
(1) Variable Definition: Duration of unemployment measures number of weeks that the individual was unemployed continuously. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.6: Determinants of Employment Outcomes for Blacks and Whites Over the Business Cycles - NLSY79

	Working[1]	Working[1]
Black	-0.024	-0.021
	(0.014)*	(0.015)
Unemp rate 3% to 6%	-0.068	-0.071
	(0.042)*	(0.042)*
Unemp rate 6% to 9%	-0.084	-0.090
	(0.042)***	(0.042)***
Unemp rate 9% to12%	-0.106	-0.115
	(0.046)***	(0.046)***
Unemp rate 12% to 15%	-0.101	-0.104
	(0.053)***	(0.053)***
Unemp rate >15%	-0.198	-0.209
	(0.065)***	(0.066)***
Black x Unemp rate 3% to 6%	0.007	0.008
	(0.015)	(0.016)
Black x Unemp rate 6% to 9%	0.010	0.008
	(0.015)	(0.016)
Black x Unemp rate 9% to12%	-0.005	-0.009
	(0.018)	(0.018)
Black x Unemp rate 12% to 15%	-0.042	-0.044
	(0.027)*	(0.027)*
Black x Unemp rate >15%	-0.070	-0.079
	(0.043)*	(0.044)**
Log Hourly Wage	0.020	0.020
	(0.014)	(0.014)
Tenure	-	0.0001
	-	(0.000)***
Constant	0.734	0.727
	(0.316)*	(0.175)**
R-squared	0.22	0.22
Observations	50697	50697

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Tenure: Completed number of Months working for the same employer. (2) Sample: males over 18 years of age. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) Unemp Rate refers to the categorical variable describing the local unemployment rate faced by an individual (6) This specification also includes education, interaction of skill measures with business cycle variables, marrital status, age, age-squared, individual fixed effects Full time/Part Time status, Full Year/Part-Year status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.7: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]
Black	0.006
	(0.012)
BC	-0.023
	(0.003)***
Black*BC	-0.004
	(0.002)***
Wages (t-1)	-0.026
	(0.007)***
Wages(t-1)*BC	0.005
	(0.001)***
Constant	0.815
R^2	0.09
Number of Obs.	81539

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age with one year tenure. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.8: Determinants of Employment Outcomes of Blacks and Whites Over the Business Cycles - NLSY79

	Working'	Working'	Working'
Black	-0.006	-0.008	-0.010
	(0.015)	(0.014)	(0.016)
Unemp rate 3% to 6%	-0.009	-0.078	-0.066
	(0.014)	(0.037)***	(0.043)
Unemp rate 6% to 9%	-0.015	-0.083	-0.065
	(0.015)	(0.040)***	(0.043)
Unemp rate 9% to12%	-0.050	-0.171	-0.159
	(0.016)***	(0.040)***	(0.046)***
Unemp rate 12% to 15%	-0.073	-0.195	-0.188
	(0.019)***	(0.046)***	(0.052)***
Unemp rate >15%	-0.107	-0.208	-0.205
	(0.023)***	(0.054)***	(0.059)***
Black x Unemp rate 3% to 6%	-0.014	-0.013	-0.010
	(0.016)	(0.016)	(0.017)
Black x Unemp rate 6% to 9%	-0.015	-0.013	-0.012
	(0.014)	(0.016)	(0.017)
Black x Unemp rate 9% to12%	-0.017	-0.015	-0.015
	(0.018)	(0.019)	(0.020)
Black x Unemp rate 12% to 15%	-0.047	-0.045	-0.045
	(0.026)**	(0.025)*	(0.026)**
Black x Unemp rate >15%	-0.079	-0.076	-0.076
	(0.04)***	(0.040)**	(0.041)**
AFQT Percentile Score	0.001	0.001	0.001
	(0.000)***	(0.000)***	(0.000)***
Log Hourly Wage	-	0.067	0.065
	-	(0.017)***	(0.017)***
Education Control			Yes
Constant	0.782	0.741	0.745
	(0.057)***	(0.057)***	(0.057)***
R-squared	0.26	0.27	0.27
Observations	50657	50657	50657

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. AFQT Percentile Score: The percentile received on the AFQT computed using the 1989 methodology. (2) Sample: males over 18 years of age. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) Unemp Rate refers to the categorical variable describing the local unemployment rate faced by an individual (6) This specification also includes education, interaction of skill measures with business cycle variables, age, age squared, marital status, Full time/Part Time status, Full Year/Part-Year status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.9: Employment Outcomes for Blacks and Whites Over Business Cycles - CPS March

	Working[1]
Black	0.002
	(0.003)
BC	-0.018
	(0.002)***
Black*BC	-0.003
	(0.001)***
Wages (t-1)	0.014
	(0.003)***
Wages(t-1)*BC	0.004
	(0.000)***
Firm-Size Controls	Yes
Constant	0.770
	(0.002)***
R^2	0.140
Number of Obs.	381637

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. Schooling variables are defined as dummy variables, were the highschool dropouts are the omitted category. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. Due to the data availibility, sample is between 1988 and 2002. The recession years are 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.10: Employment Outcomes for Black and White Salesmen Over Business Cycles - CPS March

	Working[1]
Black	0.090
	(0.039)***
SUR	-0.014
	(0.007)***
Black*SUR	-0.018
	(0.006)***
Wages (t-1)	-0.005
	(0.011)
Wages(t-1)*SUR	0.003
	-0.002
Constant	0.850
	-0.060
R^2	0.105
Number of Obs.	30239

Notes:

(1) Variable Definition: Working=1 if the individual is working, zero if he is either unemployed or our of labor force. Black=1 for blacks, 0 for whites. Full year=1 if the person works for 48 or more weeks. Full Time refers to working more than 35 hours per week. (2) Sample: males between 22 and 64 years of age. (3) The results reported are obtained with a linear probability model. (4) Numbers in parentheses are the robust standard errors. (5) BC is equal to 1 if the year is a recession year, and zero otherwise. The recession years are 1981-1983, 1991-1993, 2001-2002. The results with NBER Recession Years are available upon request. (6) This specification also includes education, education time business variable, full-time/full-year status, age, marital status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Table 2.11: Determinants of Reservation Wages of Blacks and Whites

	Reservation Wages[1]
Unemp rate 3% to 6%	0.152
	(0.202)
Unemp rate 6% to 9%	0.143
	(0.206)
Unemp rate 9% to12%	0.100
	(0.211)
Unemp rate 12% to 15%	0.073
	(0.213)
Unemp rate >15%	0.029
	(0.220)
Black x Unemp rate 3% to 6%	-0.045
	(0.168)
Black x Unemp rate 6% to 9%	-0.150
	(0.147)
Black x Unemp rate 9% to12%	-0.111
	(0.148)
Black x Unemp rate 12% to 15%	-0.048
	(0.137)
Black x Unemp rate >15%	-
	-
Log Hourly Wage	0.081
	(0.033)**
Constant	-1.843
	(1.629)
R-squared	0.84
Observations	4422

Notes:

(1) Variable Definition: Reservation Wage: Log of the hourly wage required for respodent to accept a job offer (2) Sample: males over 18 years of age includes both working and non working individuals. (3) The data is collected from 1979 to 1986 only (4) Numbers in parentheses are the robust standard errors. (5) Unemp Rate refers to the categorical variable describing the local unemployment rate faced by an individual (6) This specification also includes education, age, age squared, marital status, logarithm of family income, individual fixed effects, Full time/Part Time status, Full Year/Part-Year status, year fixed effects, region fixed effects, the industry fixed effects and occupation fixed effects. (7) *:Significant at 10%; **:Significant at 5%; ***:Significant at 1%.

Figure 2.1: Difference Between Unemployment Rates of Blacks and Whites (1970-2004)

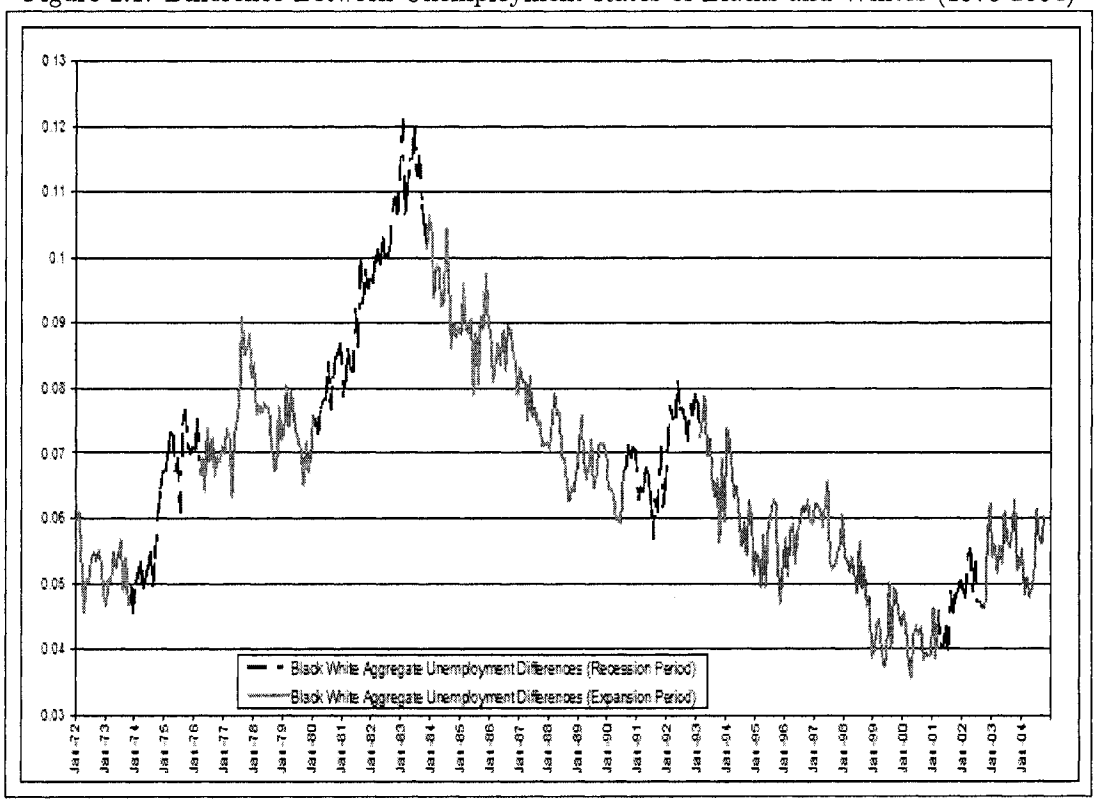
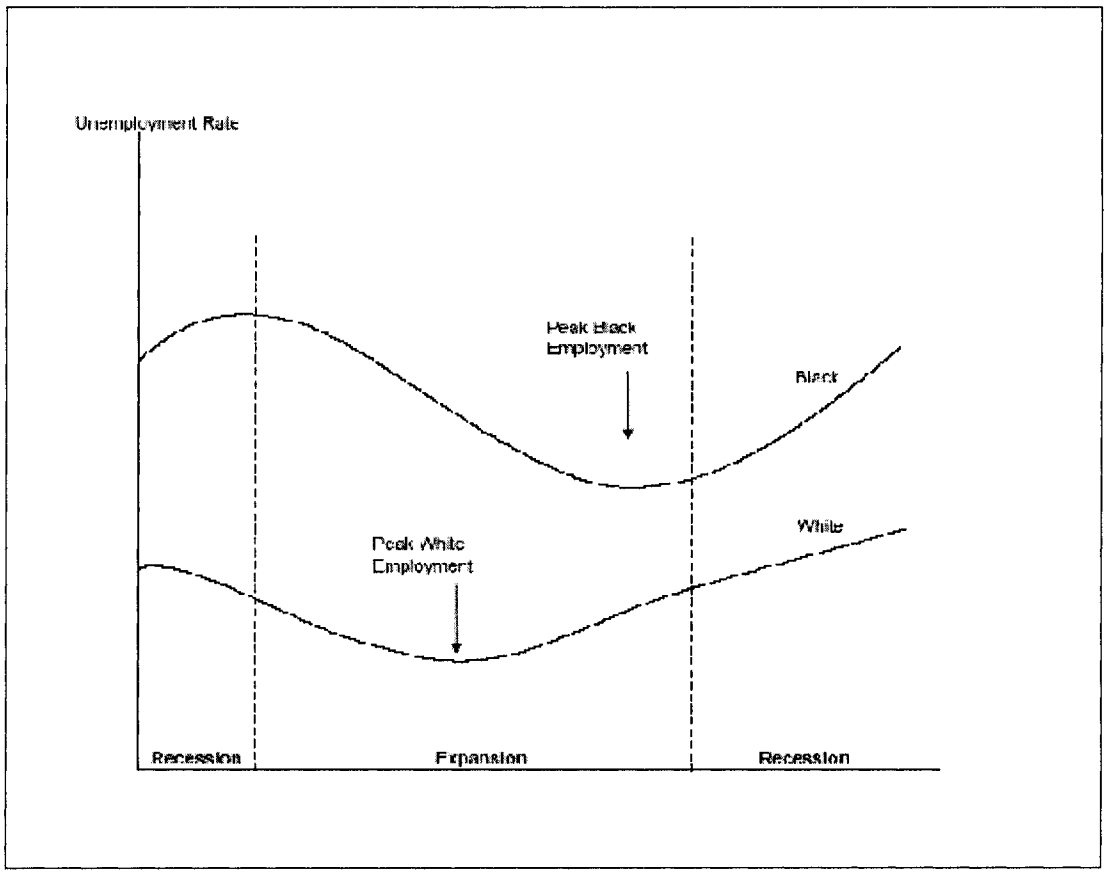


Figure 2.2: Predicted Time Series Pattern of Black and White Unemployment Rates



Chapter 3

The Welfare Effects of Public Information in Imperfectly Competitive Markets

3.1 Introduction

The last couple of decades have been eyewitness to rapid changes in the availability of information relevant for firms operating under uncertainty. For instance, public institutions, private consultancy firms, media and the markets provide a wider range of information compared to past about the factors that affect firms' profits. As an example, an airline company, which needs to set prices for the holiday season a few weeks in advance without knowing the exact cost of the service, may extract information from fluctuations in the market price for oil or other input prices. In a similar manner, an ever increasing availability of market demand forecasts or consumer surveys provided by public sources may provide information for firms facing uncertainty about demand for its product.

The quality of the information received by firms has important implications not only for the firms' profits but also for social welfare. For instance, depending on precision of information conveyed by the markets about costs, the consumers may face a high degree of inefficient variations in the prices and the quantities of goods. In addition, the quality of information that firms receive may affect their market entry decisions, especially if there are sunk costs associated with entry. Such possibilities call for the determination of an optimal information dissemination policy and for an understanding of how the factors affecting firms' optimization would affect the implementation of the policy. With this motivation,

this paper analyses the equilibrium and welfare implications of providing more precise public information relevant for firms' profit maximization problems.

When the firms make their decisions under uncertainty, the policy maker has the potential to affect the equilibrium outcome and social welfare, through affecting what firms know about the economic structure. In particular, the precision of the public information received by firms may be relevant for firms' profits and social welfare. For example, the forecasts of market demand or cost of production may contain noise and errors due to the limitations in the information processing capacities of these agencies. Alternatively, the input prices may fluctuate in a way that its information content about future values of production costs may differ from period to period.

A firm's optimal degree of attention to private and public signals is not independent of the market environment in which it interacts with other firms. The effect of the precision of public information on firms' profits and social welfare potentially depends on the fundamental characteristics of the markets and firms' behavior, such as the type and degree of strategic interaction, the mode of competition of the firms and the information structure of the economy. When firms have access to more than one source of information, their optimization problem also involves determining the optimal weight of each source of information. However, when firms interact with each other strategically, firms may use the common sources of information for coordinating with each other.

A relevant question that emerges is whether the optimal policy is sensitive to the differences in the market environment. Any institution releasing public information relevant to firms may not be able to observe whether the firms produce substitutes or complements, or whether firms use prices as opposed to quantities as the strategic choice variables. The type of competition within a particular industry or strategies determined by a given firm may differ across time or different markets, as supported by empirical evidence[1]. As Maggi (1996) suggests, firms may differ across time with regard to whether they use quantities or prices as a strategic variable. Policy makers may not be able to observe directly the basic

[1] For instance, see Feenstra and Levinsohn(1995) for the analysis of the mark-up behavior in automobile industry in United States.

characteristics of the market or firms' behaviors. This creates motivation to assess whether policy makers can implement an efficient level of transparency with limited information on the market structure.

The main results of this study can be summarized as follows: The full precision of the public information is always the most desirable outcome, as can be expected. However, for various reasons, full precision may not always be attainable. In those cases, it is shown that the main determinant of optimal policy is the initial level of precision of public information relative to private information and the degree of correlation between these two sources. In the case of uncorrelated public and private information, social welfare monotonically decreases with deterioration of public information's precision. However, in the case of correlated signals, the effect of noise in public information on social welfare is non-monotonic. In this situation, social welfare attains its minimum level at a unique finite level of precision of public information, for given precision of private information. The value of social welfare, associated with zero information content of public information, is determined mainly by the precision of private information.

Whenever the signals observed by the firms have a necessarily high degree of correlation between each other, the findings about the non-monotonic nature of the welfare effects of the precision of public information is robust to the type of competition, and the degree of strategic interaction across firms. This implies that the policy maker can implement the optimal policy even in the absence of a wide information requirement about the other characteristics of the economy. However, social welfare's sensitivity to policy depends on the nature of goods and the information content of private signals.

In the case of uncorrelated public and private signals, we obtain less general welfare results. Except for the case of cost uncertainty in Cournot competition with complementary goods and demand uncertainty in Cournot competition with substitutable goods, the results imply that policy makers should target the maximum attainable level of precision of public information. In contrast, these two particular cases lead to welfare results similar to the case of correlated signals for some particular levels of strategic interaction across firms.

In the case of uncorrelated signals, it is also worth noting that returns to providing more precise information increases with the higher precision of public information. This differs substantially from the welfare gains from improving precision of public information where the firms observe only public signals.

The results of study are related with two different literatures. First, this study is closely linked with the literature on effect of uncertainty and information on equilibrium and social welfare in imperfectly competitive markets. With different information structures, the previous literature, starting with Novshek and Sonnenschein (1982), Vives (1984), Gal-Or (1986) and Shapiro (1986), has focused on firms' information sharing incentives and how social welfare responds to mode of competition, and the nature and degree of strategic interaction. These studies show that the welfare effects of information in these markets are extremely sensitive to the fundamental characteristics of the market, mentioned above. For instance, Vives (1984) shows that in a model with demand uncertainty, the better information is improving ex-ante social welfare in Bertrand, whereas the opposite is true in Cournot. Shapiro (1986) shows that the more precise information about the rivals' cost increases welfare with Cournot competition. In contrast with these studies, this study evaluates the welfare effects of public information in imperfectly competitive markets. This paper shows that a higher degree of variance in the public signals has similar welfare effects, regardless of the type of competition, the nature of strategic interaction and the source of uncertainty. This is important because the policy maker who aims at maximizing ex-ante social welfare by determining the optimal degree of precision in its information releases may be uncertain about whether firms use prices or quantities as their strategies. Therefore, there may be a need for delivering the welfare maximizing policy without knowing what the strategy set of the firms are. The analysis in this paper suggests that, in general, policymakers can implement the optimal policy regardless of whether firms play a Cournot game or a Bertrand game.

Apart from the literature on the welfare effects of uncertainty in oligopolistic markets, this paper is also related to the literature on the welfare effects of public information and the optimal level of transparency. The welfare effects of publicly provided information has

recently attracted a considerable interest in microeconomics and macroeconomics literature. For instance, in a different context from imperfectly competitive markets, Morris and Shin (2002) argue that the possibility of non-monotonic welfare effects of precision in public information arises only if the actions of the private decision makers have a necessarily high degree of strategic complementarity. However, our analysis suggests that high degree of strategic complementarity across firms' actions is not necessary for the precision of the public information to have non-monotonic effects on social welfare. In particular, the analysis of this paper shows that higher precision may be detrimental to social welfare beyond a certain level of precision depending on the precision of private information, even when the private agents' decisions are strategically substitutes or even when there is no strategic interaction across firms. Whenever we allow for correlated signals, the non-monotonic welfare effects of public information emerges even without strategic interactions across private decision makers. A particular implication of this result for imperfectly competitive markets is that a policy maker can improve welfare through providing less precise information even for monopolistic firms.

The study is structured as follows. Section 3.2 presents the basics of the model framework. Section 3.3 presents the equilibrium. Section 3.4 presents welfare results concerning the variations in the precision of the publicly available information. In particular, Sections 3.4.1, 3.4.2 and 3.4.3 analyze the optimal policy under different assumptions about the information structure and show that different welfare implications may arise depending on whether public and private sources of information coexist and whether the private observations and publicly available observations on the uncertain factors are correlated with each other. Section 3.5 presents the conclusion and some remarks for future research.

3.2 The Model

3.2.1 Basic Characteristics of the Model

Consider a two-firm differentiated oligopoly model where the firms operate under uncertainty. This uncertainty may be about demand for the firms' products or the net cost of

production upon entering the market. The entry into the market requires a fixed cost for both firms, which is assumed to be same for both firms for simplicity. The firms' first stage problem also involves forming their optimal prediction about the uncertain factors affecting their profits. The firms are assumed to form their expectations conditional on their private observations and the publicly available observations, where the dissemination of the latter is either controlled or influenced by the actions of the policymaker.

The economy is populated with a representative household deriving utility from the leisure and goods produced by the firms. Equation (3.1) presents the preferences of the representative household[2]:

$$U(q_1, q_2, l) = \alpha(q_1 + q_2) - \frac{\beta}{2}(q_1^2 + q_2^2) + \gamma\,(q_1 q_2) + l \tag{3.1}$$

The function $U(q_1,q_2,l)$ is quadratic and strictly concave in the goods produced by the firms, denoted by q_1 and q_2. The goods produced by each firm may be substitutes or complements to each other, depending on the sign of γ. The household is endowed with 1 unit of time which is divided between labor and leisure, where leisure is denoted by l. The parameter β gives us how the consumers value consuming different varieties at the same time as opposed to consuming more of the same type of good. As higher values of β are associated with a higher level of disutility due to consuming more of a particular variety as opposed to consuming each good in similar quantities for given value of γ and prices, higher β can be viewed as being associated with a greater "love of variety". The extent of complementarity or substitutability across goods is determined by the value of γ. The goods become complements to each other when $\gamma > 0$, and substitutes to each other when $\gamma < 0$, where in both cases the firms' decisions will depend strategically on the decisions of other firms. In the special case where $\gamma = 0$, the demand of the household for a particular variety becomes totally independent from the consumption of the other variety, as a result of which

[2]This utility function is frequently used in industrial organization literature (Vives (1984, 1985, 1988), Dixit (1979)), and international trade literature (Ottaviano, Tabuchi and Thisse (2002)). These preferences yield linear demand functions for the differentiated goods q_1 and q_2, which in return allows for computational tractability in equilbirium strategies under uncertainty and the welfare effects of variations in the precision of public information.

the strategic interaction across firms disappears and each firm gets monopoly power on its product.

The production technology is assumed to be linear in labor, where each firm needs a particular level of labor input, denoted by T, to produce 1 unit of output. The firms are assumed to face uncertainty either about the production technology and unit labor cost or the demand for its product. In such a set-up, each firm decides on the entry to the market in the first stage and the optimal level of output or prices in the second stage conditional on their information set, while taking the optimal strategy of the rival firm as given. Following the common practice in the literature, the demand uncertainty is characterized by a directly unobservable intercept term in the demand function, represented by α, and cost uncertainty is characterized as uncertainty on parameter T.

In order to have sensible demand functions for each good, we assume $\beta \geq |\gamma|$. This assumption is necessary in order to get invertible demand functions for each product. It also allows us to obtain a situation, where the own-price-effect for any good is greater than the cross-price effects[3]. In the case that β is equal to γ, the goods become perfect substitutes, leading to the generic case of Bertrand competition associated with discontinuities in the demand functions depending on the relative prices quoted by each firm. In addition, α is assumed to be greater than $\frac{2\beta+\gamma}{T}$, which is necessary for consumers to have positive marginal utility from the consumption of each variety, even when they consume the maximum amount of goods attainable with the production technology[4].

Without loss of generality of the results with respect to variations in the precision of public information, we consider a case with $\beta = 1$ and $-1 < \gamma < 1$ for simplifying the notation. The solution for each consumer's optimal choice for q_1 and q_2 yields the demand functions for each good:

[3] Having $\beta \geq |\gamma|$ is also necessary and suffcient for the uniqueness of equilibrium strategies of the firms.

[4] The marginal utility will also depend on the prices set by each firm. For the information structure, we assume that the signals received by the firms are normally distributed, which technically allows for the negative prices or extremely high prices. Especially in the latter case, the restriction on α may not be sufficient to obtain positive marginal utilities. With additional distributional assumptions, we can reduce the probability of obtaining negative marginal utilities to great extend. However, compared with the analytical tractibility of a case with normal distribution, this can be seen as a minor point.

$$q_i = \frac{\alpha}{(1+\gamma)} - \frac{1}{1-\gamma^2}p_i - \frac{\gamma}{1-\gamma^2}p_j \quad \forall i,j = 1,2,\ i \neq j \tag{3.2}$$

For investigating whether the optimal policy is robust to the mode of competition, the model is solved both under the assumption that firms are engaged in Bertrand type competition and Cournot type competition. In the rest of the analysis, the superscripts "b" and "c" are used to distinguish between the variables and the expressions that are part of equilibrium in the case of Bertrand competition and the Cournot competition, respectively. Denoting firm i's expectations of a random variable X by $E^i[X]$ and the entry costs for the firms as F , expected profit functions conditional on its information set can be written respectively as[5]:

$$E^i\left[\Pi_i^b\right] = E^i\left[p_i(\tfrac{\alpha}{1+\gamma} - \tfrac{1}{1-\gamma^2}p_i - \tfrac{\gamma}{1-\gamma^2}p_j) - WT(\tfrac{\alpha}{1+\gamma} - \tfrac{1}{1-\gamma^2}p_i - \tfrac{\gamma}{1-\gamma^2}p_j)\right] - F^i \tag{3.3}$$

$$E^i\left[\Pi_i^c\right] = E^i\left[q_i(\alpha - q_i + \gamma q_j) - WTq_i\right] - F^i \tag{3.4}$$

3.2.2 Information Structure

Let U denote the source of uncertainty faced by the firm. The firms are assumed to have a prior on U, which is drawn from uniform distribution over real line. Each firm receives a public signal and a private signal about U. Arrival of the signals and the basic information structure are common knowledge. The only private observation is the value of the private signal. Information structure is taken as exogenous by the firms in the sense that there is no strategic information revealing by the firms. Denoting the public signal by z and private signal received by firm i by x_i, the information structure in this economy is summarized as follows:

[5] Here, the discount rate of each firm is assumed to be equal to zero without loss of generality.

$$x_i = U + w + \sigma_x \varepsilon_i; \qquad w \sim N(0,1), \ \varepsilon_i \sim N(0,1); \ \forall i = 1,2$$

$$z = U + \sigma_w w + \sigma_z \nu; \qquad v \sim N(0,1); \tag{3.5}$$

$$E[\varepsilon_i \varepsilon_j] = E[\varepsilon_i w] = E[w\nu] = E[\varepsilon_i v] = 0 \ \ \forall i = 1,2$$

$$U = \begin{cases} \alpha & \text{in case of demand uncertainty} \\ T & \text{in case of cost uncertainty} \end{cases}$$

The existence of exogenous public signals along with the private signals is the key difference of this model, compared to previous literature on the welfare effects of the precision of information received by the imperfectly competitive firms. The private and public signals here can be viewed as unbiased predictors about the uncertain parameters, which differ in their precision. The error terms of the signals are governed by w, v, ε_1 and ε_2, which are independently distributed with standard normal distribution. Following the assumptions above, x_i and z are normally distributed conditional on U with means equal to U and variances equal to $\sigma_x^2 + 1$ and $\sigma_z^2 + \sigma_w^2$, respectively. In particular, due to Gaussian structure of the information set of the firms, the precision of public and private signal are give as $(\sigma_z^2 + \sigma_w^2)^{-1}$ and $(\sigma_x^2 + 1)^{-1}$ respectively. For a given level of σ_x^2 and σ_w^2, and increase in σ_z^2 corresponds to a deterioration of the relative precision of publicly available information.

The specification of the information structure allows for the possibility that the private and the public signals are correlated with each other. In particular, $\sigma_w \neq 0$ corresponds to having correlated signals. Such a correlation may be induced by the variations in the common spatial and time dependent factors affecting the private forecasts and publicly available forecasts about uncertain factors.

In this set-up, the firms' optimization problem not only involves their entry decision and quantity or price choice upon entry, but also optimal information extraction problem conditional on the private and the public signals they observe. At this point, we assume that firms use Bayes' rule to update their beliefs on uncertain factors conditional on their

information set. As a result, firm i's expectation on parameter U conditional on the signals it receives can be found as:

$$E^i[U] = \eta x_i + (1-\eta)z \tag{3.6}$$

where $\eta = \frac{\sigma_z^2+\sigma_w^2-\sigma_w}{\sigma_z^2+\sigma_w^2+\sigma_x^2+1-2\sigma_w}$.

Equation (3.6) implies that the firms should attach more weight to the signal which is more precise. In particular, when $\sigma_z = \sigma_w = 0$ and/or $\sigma_x = \infty$, the private information becomes irrelevant for the firms' problem. On the other hand, when $\sigma_w = \infty$ and/or $\sigma_z = \infty$, the public information becomes extremely noisy, and η becomes equal to 1 implying that the firms should only consider the private signal in their decision making. In this sense, η can be interpreted as the degree of relevance of the private information relative to public information.

3.3 Equilibrium

Given the consumer preferences, production technology and the information structure described above, the firms' optimal strategy choice yields the first order conditions given in Equations (3.7) and (3.8):

$$p_i = \frac{1-\gamma}{2}E^i[\alpha] - \frac{\gamma}{2}E^i[p_j] + \frac{1}{2}E^i[T] \quad \forall i,j,\ i \neq j \tag{3.7}$$

$$q_i = \frac{1}{2}E^i[\alpha] + \frac{\gamma}{2}E^i[q_j] - \frac{1}{2}E^i[T] \quad \forall i,j,\ i \neq j \tag{3.8}$$

The Walras-Nash Equilibrium in this economy consists of the prices or the quantities set by the firms and the levels of labor supplied by the household, such that:

(1) The household maximizes his utility given the prices that he faces.

(2) The firms maximize their expected profits through their entry decisions to the market in the first stage of the game and the choice of optimal prices or quantities in the second stage of the game conditional on their information sets by taking the decision of the rival firm as given. In the equilibrium of this game, the firms give their best response to their conjectures about the rival's behavior and this conjecture is confirmed.

(3) All markets clear.

The propositions 1.a, 1.b, 2.a and 2.b summarize the equilibrium prices and quantities set by the firms as a function of the private and public signals they observe.

Proposition 1.a In a structure with differentiated goods producers competing a la Bertrand, if the firms find it optimal to enter the market in the first stage, $(p_i, p_j) = (A^b z + B^b x_i + C^b, A^b z + B^b x_j + C^b)$ constitutes unique set of prices set by the firms, where $A^b = \frac{2-2\gamma}{2+\gamma}\frac{1-\eta}{2+\gamma\eta}$, $B^b = \frac{(1-\gamma)\eta}{2+\gamma\eta}$ and $C^b = \frac{T}{2+\gamma}$.

Proposition 1.b In a structure with differentiated goods producers competing a la Cournot, if the firms find it optimal to enter the market in the first stage, $(q_i, q_j) = (A^c z + B^c x_i + C^c, A^c z + B^c x_j + C^c)$ constitutes unique set of quantities set by the firms, where $A^c = \frac{2(1-\eta)}{(2+\gamma)(2+\gamma\eta)}$, $B^c = \frac{\eta}{2+\gamma\eta}$ and $C^c = -\frac{T}{2+\gamma}$.

Proposition 2.a In a structure with differentiated goods producers competing a la Bertrand, if the firms find it optimal to enter the market in the first stage, $(p_i, p_j) = (A^{b'} z + B^{b'} x_i + C^{b'}, A^{b'} z + B^{b'} x_j + C^{b'})$ constitutes unique set of prices set by the firms, where $A^{b'} = \frac{2}{2+\gamma}\frac{1-\eta}{2+\gamma\eta}$, $B^{b'} = \frac{\eta}{2+\gamma\eta}$ and $C^{b'} = \frac{1+\gamma}{2+\gamma}\alpha$.

Proposition 2.b In a structure with differentiated goods producers competing a la Cournot, if the firms find it optimal to enter the market in the first stage, $(q_i, q_j) = (A^{c'} z + B^{c'} x_i + C^{c'}, A^{c'} z + B^{c'} x_j + C^{c'})$ constitutes unique set of prices set by the firms, where $A^{c'} = -\frac{2(1-\eta)}{(2+\gamma)(2+\gamma\eta)}$, $B^{c'} = -\frac{\eta}{2+\gamma\eta}$ and $C^{c'} = \frac{\alpha}{2-\gamma}$.

Proof In the case of Bertrand competition, the price set by each firm has to be a linear function of the signals in its information set, given as $p_i = A^b z + B^b x_i + C^b$. After taking $E^j[p_i]$ and inserting this to the best response functions of firms, one can show that $A^b = \frac{2-2\gamma}{2+\gamma}\frac{1-\eta}{2+\gamma\eta}$, $B^b = \frac{(1-\gamma)\eta}{2+\gamma\eta}$ and $C^b = \frac{T}{2+\gamma}$. A similar proof applies for the case of Cournot as well[6].

Propositions 1.*a*, 1.*b*, 2.*a* and 2.*b* show that the firms' optimal response to the signals depends on the value of γ, which determines whether goods are complements or substitutes as well as the degree of strategic interaction. Both in the case of Cournot and Bertrand competition, the equilibrium strategies chosen by the firms become more sensitive to both private signals and public signals for lower values of γ, as can be see in Propositions 1.a and 1.b. In other words, we expect the firms producing highly substitutable (weakly complementary) goods respond more to the variations in the values of the signals compared to the firms producing weakly substitutable (highly complementary) goods, regardless of the mode of competition.

For a given entry decision of the firm, if the signals are unbiased estimators of the unit cost parameter, the changes in the precision of the public and private signals do not affect the expected values of the variables set by the firms[7]. Therefore, welfare effects of the precision of information will work through the second moments of the variables set by the firms. As long as the variations in the precision of information received by the firms do not affect the firms' entry decision to the market, such variations will not affect the expected levels of prices and quantities.

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[6] Alternatively, one can use infinite order expectations for each firm and show that the equilibrium is associated with the strategies stated above. This proof, although it serves also as a proof of uniqueness of the equilibrium, is not given here as it is quite long. However, it is available upon request.

[7] This can be seen by taking the expected value of each equilibrium quantity and price. For example, for the case of Bertrand, $E[p_i] = (A^b + B^b)\alpha + C^b \ \forall i$, where A^b, B^b and C^b are given in Proposition 1 and $A^b + B^b = \frac{1+\gamma}{2+\gamma}$, which is independent of σ_z^2, as well as σ_x^2 and σ_w^2. The same implication can be shown for the case of Cournot as well.

3.3.1 Entry Decisions of the Firms

Since firms are not able to observe the exact unit cost of production or the level of demand, their entry decision depends on their expectations about the 2nd stage profits, which they form conditional on the signals they observe. The entry condition for each firm can be written as:

$$E^i[\Pi] - F^i > 0; \qquad i = 1, 2 \tag{3.9}$$

Considering the equilibrium prices and quantities set by the firms in the second stage of the game and using equilibrium weights for private and public signals given in Propositions $1.a$, $1.b$, $2.a$ and $2.b$, the entry conditions for the case of Bertrand and Cournot can be given as follows:

$$\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2) = \Lambda - \frac{1}{1-\gamma}(A^h)^2(\sigma_z^2+\sigma_w^2) - \frac{1}{1-\gamma^2}(B^h)^2(\sigma_x^2+1) - F > 0; \quad h = b,\ b' \tag{3.10}$$

$$\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2) = \Lambda - (1+\gamma)(A^j)^2(\sigma_z^2+\sigma_w^2) - (B^j)^2(\sigma_x^2+1) - F > 0; \qquad j = c,\ c' \tag{3.11}$$

where Λ represents the parameters independent of the precision of the signals.

One can note from Equations (3.10) and (3.11) that the functions $\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2)$ and $\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2)$ decrease at a constant rate with less precise public information, when the public information is the only source of information for the firms. However, in the case of both public and private signals, the impact of the precision of public information on the expected profits and therefore firms' entry decision depends also on the precision of the private information and the correlation between public and private information. Whenever

the signals are not correlated, it can be shown that functions $\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2)$ and $\Pi(\sigma_z^2, \sigma_x^2, \sigma_w^2)$ decrease with higher σ_z^2, except for the case of Bertrand competition with necessarily high degree of substitutability across goods, and Cournot competition with necessarily high degrees of complementarity across good. On the other hand, if the private and public signals have a necessarily high degree of correlation, increase in σ_z^2 affects expected profits negatively for necessarily low values of σ_z^2, and positively beyond a particular value of σ_z^2. In other words, in the case of correlated signals, there is a certain unique level of precision of public information different from zero, where social welfare attains its minimum. Table 3.3 summarizes the results concerning the effect of higher noise in public information on expected profits.

3.4 Welfare Analysis

Through their effect on the variance of the quantity of goods produced, as well as the covariance between these quantities, changes in the precision of public information also affects the expected utility of the representative household and social welfare. The utility function shown in Equation (3.1) implies that the representative household derives disutility from a greater variance in the consumption of q_1 and q_2. On the other hand, higher covariances across the consumption of different varieties will be welfare increasing, or not, depending on whether the goods are complements or substitutes. In the case of complements (i.e. $\gamma > 0$), the consumer will have a higher expected utility with a greater covariance in the quantities, whereas the opposite is true in the case of substitutes (i.e. $\gamma < 0$). The welfare analysis is conducted considering three main potential cases about the information structure, namely the case of no private signals, uncorrelated public and private signals, and finally the case where public and private information is correlated with each other.

3.4.1 The Case of No Private Information:

One important question regarding the welfare effects of public information is whether the coexistence of private and public signals leads to different policy implications. In general,

publicly available information can be the only information that firms receive. In such a case, firms' optimal signal weighting problem disappears. Denoting the public signal by z, equilibrium strategies for the case of Bertrand and Cournot competition can be given respectively as follows[8]:

$$p_i = \frac{1-\gamma}{2+\gamma} z + \frac{T}{2+\gamma} \quad \forall i, j, \quad i \neq j \tag{3.12}$$

$$q_i = \frac{1}{2+\gamma} z - \frac{T}{2+\gamma} \quad \forall i, j, \quad i \neq j \tag{3.13}$$

Using the equilibrium strategies chosen by firms, the objective function of policymakers can be written for the Bertrand and Cournot cases respectively as follows:

$$E\left[SW^b\right] = \Psi - \left(\frac{1-\gamma}{2+\gamma}\right)^2 \sigma_z^2 \tag{3.14}$$

$$E\left[SW^c\right] = \Psi - \left(\frac{1}{2+\gamma}\right)^2 \sigma_z^2 \tag{3.15}$$

where SW denotes social welfare, the superscripts "b" and "c" stand for Bertrand and Cournot results respectively, and Ψ denotes the terms independent from σ_z.

In Equations (3.14) and (3.15), there are two main points worth noting about the welfare effects of public information. First, social welfare decreases monotonically, as the variance of public information increases. Therefore, in a case where firms have access only to public information, the highest possible degree of precision yields the highest social welfare regardless of the type of competition and the degree of strategic interaction.

Second, in the case of no private information, social welfare functions given in Equations (3.14) and (3.15) are linear in the variance of public information. This implies that welfare

[8]The analysis in this section considers only the case of demand uncertainty. Similar results hold also for the case of cost uncertainty as well. In addition, without loss of generality of the results, σ_w is assumed to be equal to zero in this part of the analysis.

gains from increasing the precision of public information by one unit is independent from the existing level of precision of public information. In the case where firms receive both public and private information, this contrasts with the welfare effects of public information.

3.4.2 The Case of Public and Private Information with Uncorrelated Errors

When firms have access to more than one signal, the precision of each signal affects social welfare and firms' profits through two different channels. In this case, the precision of the public signals not only affects the degree of uncertainty faced by the firms, but also the optimal weights assigned to each signal. As a result, the improvements in the precision of public information for a given precision of private information affects the welfare not only by providing more information to the firms about the parameter of uncertainty, but also by making firms increase their reliance on public information. The coexistence of these two signals is associated with fundamentally different results when compared to the results in the preceding section.

In Bayesian-Nash equilibrium, the social welfare function for the case of Cournot and Bertrand can be written as follows:

$$E[SW^c] = \Psi_1 - (1-\gamma)\left[\frac{2}{2+\gamma}\frac{1-\eta}{2+\gamma\eta}\right]^2(\sigma_z^2+\sigma_w^2) - \left[\frac{\eta}{2+\gamma\eta}\right]^2(\sigma_x^2+1) \tag{3.16}$$

$$E[SW^b] = \Psi_2 - (1-\gamma)\frac{1+\gamma^2}{(1+\gamma)^2}\left[\frac{2}{2+\gamma}\frac{1-\eta}{2+\gamma\eta}\right]^2(\sigma_z^2+\sigma_w^2) - \frac{1-\gamma}{1+\gamma}\left[\frac{\eta}{2+\gamma\eta}\right]^2(\sigma_x^2+1) \tag{3.17}$$

where Ψ_1 and Ψ_2 represent the terms independent of precision of public and private signals. In special case that the correlation between z and x_i is zero, η is equal to $\frac{\sigma_z^2}{\sigma_z^2+\sigma_x^2+1}$

As Equations (3.16) and (3.17) show, changes in the precision of publicly provided information will not only have a direct effect, but also an indirect effect through the equilibrium weights given to signals by the firms. As a result, it can be shown that the functions given in Equations (3.16) and (3.17) become convex functions of σ_z^2 except for some specific cases associated with certain parameter values.

Proposition 3 In a case where the firms have access to uncorrelated public and private signals, social welfare decreases monotonically with lower degree of precision in the public signals, except for the case of Cournot competition with complementary goods[9]. In addition, due to the convexity of expected social welfare functions in σ_z^2, the welfare gains from higher precision increases as the precision of the public information increases.

Proof It can be shown in the case of uncorrelated z and x_i that $\frac{\partial E^i[SW]}{\partial \sigma_z^2} < 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} > 0$ for all cases, except for the case of Cournot competition with demand uncertainty with necessarily high values of γ and the case of Cournot competition with cost uncertainty with necessarily low values of γ. For the case of Cournot competition with high γ or cost uncertainty with low values of γ, it can be shown that there exists a $\frac{\partial E^i[SW]}{\partial \sigma_z^2} < 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} > 0$ whenever $\sigma_z^2 < \widetilde{\sigma}_z^2$ and $\frac{\partial E^i[SW]}{\partial \sigma_z^2} > 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} < 0$that $\frac{\partial E^i[SW]}{\partial \sigma_z^2} < 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} > 0$ whenever $\sigma_z^2 < \widetilde{\sigma}_z^2$ and $\frac{\partial E^i[SW]}{\partial \sigma_z^2} > 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} < 0$ whenever $\sigma_z^2 > \widetilde{\sigma}_z^2$.

The higher variance in public information will decrease welfare by directly introducing noise in the firms' decisions. However, social welfare decreases at a decreasing rate with higher σ_z^2 as the firms substitute σ_z^2 with σ_x^2 at an increasing rate as public information becomes noisier.

[9] The exception is the case of necessarily high degree of complementarity across goods in a Cournot model with cost uncertainty and necessarily higher degree of substitutability across goods in a Cournot model with demand uncertainty. In this case, we obtain a non-monotonic welfare effect of precision in publicly available information.

The findings given in Proposition 3 are presented graphically in Figures 3.1 and 3.2 for the case of Bertrand and Cournot with demand uncertainty, respectively[10]. In both cases, the welfare attains its maximum value when there is no uncertainty on the parameters relevant to firms' problem (i.e. σ_z^2 is equal to zero) and monotonically decreases with higher noise in the z, suggesting that increasing the precision of public information will necessarily enhance social welfare.

Comparison between the case of no private information and uncorrelated public and private information gives rise to an important policy implication whenever the policymaker faces costs associated with improving the precision of public information. As shown in Section 3.4.1, whenever there are no private signals, the welfare gains from improving the precision of public information is constant. Therefore, in the case of fixed unit costs of precision, the policy maker can find it optimal to increase the precision of public information regardless of initial precision level, as long as the marginal social benefit of increasing the precision is higher than the marginal cost. In contrast, whenever there is more than one source of information, the welfare gains from providing better information increases at an increasing rate. However, if there are fixed unit costs for providing more precise information, the policy maker may have different incentives to provide more precise public information depending on the initial value of precision. These points can be seen by the numerical example given in Figure 3.1 and Figure 3.2. In Figure 3.1, one can note that the welfare gain from decreasing σ_z^2 from 800 to 600 is almost zero, whereas the welfare gain from decreasing σ_z^2 from 500 to 300 is around 0.004 and welfare gain from decreasing σ_z^2 from 300 to 100 is around 0.01 units, for a given market structure, and the degree of strategic interaction across firms.

3.4.3 The Case of Public and Private Information with Correlated Errors

Another possibility about the information structure is that public and private signals received by a firm may be correlated with each other due to various reasons. For instance,

[10]The programs generating Figures 1 through 7 are available upon demand from the author.

in case of demand uncertainty, if public and private signals are obtained from surveys conducted in a particular geographic region, or with similar demographic group, we may expect the prediction errors of these signals to be correlated with each other. This case is characterized by having $\sigma_w \neq 0$ in Equation (3.5). When there is a necessarily high degree of correlation between the private signals and the public signals, social welfare shows non-monotonic responses to changes in the precision of public information, as Proposition 4 suggests.

Proposition 4 When the public and private signals have necessarily high negative or positive correlation with each other, social welfare functions attain a global minimum for a finite value of σ_z^2, regardless of the nature of the strategic interaction, the source of uncertainty and the mode of competition.

Proof Considering the expected social welfare functions given in Equations (3.16) and (3.17), for a necessarily high value of σ_w^2, it can be shown that there exists a unique value of σ_z^2 denoted by $\widehat{\sigma}_z^2$ such that $\frac{\partial E^i[SW]}{\partial \widehat{\sigma}_z^2} = 0$. In addition $\widehat{\sigma}_z^2$ is such that $\frac{\partial E^i[SW]}{\partial \sigma_z^2} < 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} > 0$ whenever $\sigma_z^2 < \widehat{\sigma}_z^2$ and $\frac{\partial E^i[SW]}{\partial \sigma_z^2} > 0$ and $\frac{\partial^2 E^i[SW]}{\partial (\sigma_z^2)^2} < 0$ whenever $\sigma_z^2 > \widehat{\sigma}_z^2$.

Proposition 4 implies that there is a level of precision of the public information denoted by $\widehat{\sigma}_z^2$, where the policy maker can improve welfare by moving in either direction. However, it is worth noting that social welfare increases at an increasing rate with higher precision if $\sigma_z^2 < \widehat{\sigma}_z^2$, whereas it increases at a decreasing rate with deterioration in the precision of public information when $\sigma_z^2 > \widehat{\sigma}_z^2$. In the case of correlated signals, whenever $\sigma_z^2 > \widehat{\sigma}_z^2$, the welfare loss resulting from higher noise in z is partly mitigated, as the necessarily high degree of correlation across signals will make the firms put even more weight to their own private signals compared to what can be observed in the absence of correlation. The result holds both for negative and positive correlation.

As can be seen in Equations (3.16) and (3.17), the expected value of social welfare will be constant and equal to Ψ_1 and Ψ_2 for Cournot and Bertrand cases respectively,

whenever either public or private information is entirely precise. In the absence of correlated signals, social welfare converges to this fixed number monotonically as σ_z^2 approaches to zero. However, due to the correlation between the public and private signals, the firms decrease their weight on the public signal at a slower rate as σ_z^2 increases. As a result, social welfare will fall sharply with deterioration in the precision of the public signal until firms assign a necessarily high weight to the private signals. Beyond a particular value of σ_z^2, social welfare starts increasing again, as firms increase their reliance on private signals, which have become increasingly more reliable than public signals, as public signals become relatively less precise. In the limiting case that public information is not precise at all, i.e. $\sigma_z^2 = \infty$, social welfare converges to a finite value which is strictly lower than Ψ_1 and Ψ_2, as long as the private information is not entirely precise, i.e. $\sigma_x \neq 0$. This suggests that the level of social welfare associated with $\sigma_z = \infty$ is dominated by the first best outcome, which would be associated with full precision in either public or private signals.

The results presented in Figures 3.3 through 3.6 show the effect of changes in the precision of public information on welfare for different types of competitions and sources of uncertainty. As can be observed from Figures 3.3 through 3.6, there is a unique value of σ_z^2 for which the ex-ante social welfare attains its minimum when the private and public signals are correlated with each other. This brings about two different welfare implications for the policy maker depending on whether the existing precision of public information is better or worse than the welfare minimizing point. If the public information is already more noisy than this level, policy maker can increase the noise to infinity, that is to provide totally uninformative public signals, to improve social welfare. On the other hand, if the existing precision of the public information is higher than the threshold value for σ_z^2 at which social welfare attains its minimum, then increasing the quality of the public information by reducing its noise content leads to a higher ex-ante social welfare.

3.4.4 Welfare Effects of Public Information in Monopolistic Markets:

Monopoly power may emerge in this game depending on the value of γ. Whenever $\gamma = 0$, the firm has the sole power to determine the demand for its product by setting the price, as can be seen in Equation (3.2). In this particular case, the profit maximizing level of price is given as[11]:

$$p_i = \frac{1}{2}\left(\eta x_i + (1-\eta)\, z\right) + \frac{T}{2} \tag{3.18}$$

where x_i and z are as given in Equation (3.5) and $\eta = \frac{\sigma_z^2+\sigma_w^2-\sigma_w}{\sigma_z^2+\sigma_w^2+\sigma_x^2+1-2\sigma_w}$. In the absence of strategic interactions across firms, the equilibrium weights given to each signal is entirely determined by the precision of x_i and z. Denoting all the elements of social welfare function that are independent from σ_z^2 by Ψ, the expected social welfare function can be written as:

$$E\left[SW^{mon}\right] = \Psi - \left[\frac{1-\eta}{2}\right]^2 (\sigma_z^2 + \sigma_w^2) - \left[\frac{\eta}{2}\right]^2 (\sigma_x^2 + 1) \tag{3.19}$$

As before, we focus on both cases of correlated (i.e. $\sigma_w \neq 0$) and uncorrelated (i.e. $\sigma_w = 0$) public and private signals in this framework. Similar to the case of duopoly, it can be shown that the welfare associated with full precision of public information is equal to Ψ, whereas the welfare associated with zero precision of z will be $\Psi - \frac{(\sigma_x^2+1)}{4}$. However, in the case that the signals have a necessarily high degree of correlation, social welfare will show a non-monotonic response as public information becomes more noisy, whereas there will be a monotonic response in the case of uncorrelated signals, as shown by Figures 3.7. This result implies that the previous results are robust with respect to different assumptions about the market structure. Therefore, from the perspective of optimal policy, the main consideration of the policy maker should be whether the signals received by the firms are correlated or not.

[11]The analysis in this section provide an example for the case of demand uncertainty, but qualitatively similar results hold for the case of cost uncertainty.

The results associated with the case of monopoly are also important from another perspective. The social value of public information has recently been investigated by the influential study of Morris and Shin (2002) in a setting other than an oligopoly game. The analysis of Morris and Shin (2002) suggests that a high degree of strategic complementarity across decisions of the agents is necessary for the non-monotonic welfare effects of public information. In such a case, the public information also has as a coordinating role, as a result of which firms assign too much weight to public signals. In contrast, the results obtained for the case of monopoly suggest that the strategic interaction across private decision makers is not necessary for concluding that noisy public information may have social value. This also suggests that existing results about welfare effects of public information may not be generalized for evaluating the social values of public information in oligopolistic markets.

3.4.5 Effect of Public Information on Expected Profits Revisited:

In order to conclude that the policymaker can increase social welfare through the choice of precision of public information, one should consider whether the policymaker's optimal choice of precision of public information is also consistent with positive expected profits by the firms[12]. Table 3.3 and Table 3.4 summarize how expected profits and social welfare respond to variations in σ_z^2 under different assumptions about the information structure, the nature of strategic interaction, the source of uncertainty and the mode of competition. In particular, except for the case of demand uncertainty in Bertrand competition with substitutes and Bertrand competition with cost uncertainty with complements, the variations in σ_z^2 affect the expected profit levels of firms and social welfare in a similar way. As a result, the policymaker will not deter firms in general from entry with its choice of the precision of the public information.

[12] If the fixed cost of entry is necessarily high, the expected profit of the firms can be negative for all values of σ_z^2 . In such a case, value of expected utility of the representative agent will be equal to zero for all values of σ_z^2. Instead, we focus on a non-degenerate case where the expected profits are non-negative for at least some value of σ_z^2.

3.5 Conclusion

The quality of the information utilized by economic agents is one of the key determinants of equilibrium outcomes and economic efficiency. In the particular case where the firms operate under uncertainty, precision of information received by firms have potential effects on the firms' quantity and price setting problems, market entry decisions as well as consumer surplus. This paper addresses whether there is an active role for regulating the quality of the public information available to the firms. The analysis in this paper particularly focuses on the question of whether fundamental characteristics of markets have an impact on optimal policy decisions. It is also crucial to determine whether welfare improving policy is feasible even when the fundamental characteristics of markets, such as degree of strategic interaction or mode of competition may be unobserved by the policymaker. The analysis above considers a case where firms have access to both publicly available information and their own private source of information. In such a case, variations in the quality of public information affects the equilibrium outcomes and economic efficiency both through affecting the information content of the public signals and through affecting the weights that firms assign to the private and publicly available information.

The findings indicate that policymakers can increase social welfare in general through affecting the quality of the publicly available information even when they have limited information about the type of competition, source of uncertainty and the degree of strategic interaction. The analysis above shows that policymakers should mainly try to determine whether the private observations of firms and the publicly available information is correlated with each other or not. If the full precision is not possible, then the public information should be as precise as possible whenever the public and private signals are uncorrelated with each other. On the other hand, in the case of correlated signals, the effects of public information on social welfare is non-monotonic, and policy makers can improve social welfare by reducing the precision of public information, if the precision of public information is necessarily low.

Another important finding is that policymakers can improve social welfare by reducing the quality of public information in the case of a monopolistic market structure. In other

words, policymakers can improve welfare by reducing the quality of public information and diverting firms towards private information sources even when the firms do not have strategic interaction with other firms. This contrasts with the recent findings of Morris and Shin (2002), who argue that non-monotonic welfare effects of the precision of public information arises for necessarily high degree of strategic complementarity across decision-makers, where the public information also has a coordinating role. The results of this paper indicate that the precision of the public information may affect social welfare non-monotonically also when there is strategic substitutability across the decisions of the firms or there is no strategic interaction at all.

The analysis above provides new insights about the social value of public information and the role of information dissemination policy in imperfectly competitive markets even with a standard model environment. However, it is important to acknowledge that the model above involves a couple of assumptions about the market structure and the information structure. For instance, the paper has utilized a standard differentiated oligopoly model with entry and a Gaussian information structure in a similar way to the previous literature. In addition, the model assumes that the precision of the private information is exogenous and firms do not engage in information sharing arrangements. Some further research, which will incorporate alternative assumptions about these points, will provide more insights about the role of quality of public information in affecting the economic efficiency.

Table 3.1: Equilibrium Weights Given to Public and Private Signals - Case of Demand Uncertainty

	A^b	B^b	A^c	B^c
$\eta = 0$	$\frac{1-\gamma}{2+\gamma}$	0	$\frac{1}{2+\gamma}$	0
$\eta = 1$	0	$\frac{1-\gamma}{2+\gamma}$	0	$\frac{1}{2+\gamma}$

Notes:
(1) The superscripts "b" and "c" denote Bertrand and Cournot.
(2) $A^b$and A^c are the weights given to public signals.
(3) $B^b$and B^c are the weights given to public signals.

Table 3.2: Equilibrium Weights Given to Public and Private Signals - Case of Cost Uncertainty

	$A^{b'}$	$B^{b'}$	$A^{c'}$	$B^{c'}$
$\eta = 0$	$\frac{1}{2+\gamma}$	0	$-\frac{1}{2+\gamma}$	0
$\eta = 1$	0	$\frac{1}{2+\gamma}$	0	$-\frac{1}{2+\gamma}$

Notes:
(1) The superscripts "b" and "c" denote Bertrand and Cournot.
(2) $A^b$and A^c are the weights given to public signals.
(3) $B^b$and B^c are the weights given to public signals.

Table 3.3: Effects of Higher Noise in the Public Signals on Profits

	Cournot				Bertrand				Monopoly	
	Demand Uncertainty		Cost Uncertainty		Demand Uncertainty		Cost Uncertainty		Demand Uncertainty	Cost Uncertainty
	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes
Only Public Signal	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.
Uncorrelated Public and Private Signals	D.D.R.	U-Shaped (4)	U-Shaped (3)	D.D.R.	D.D.R.	U-Shaped (4)	D.D.R.	D.D.R.	D.D.R.	D.D.R.
Correlated Public and Private Signals	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)

(1) D.C.R. refers to "decreasing at constant rate". D.D.R. refers to decreasing at a decreasing rate.

(2) U-Shaped refers to the case where the welfare initially fals and increases monotonically with Sigma-Squared-Z.

(3) For necessarily high degree of complementarity.

(4) For necessarily high degree of substitutability.

(5) For necessarily high degree of correlation in the public and private signals.

Table 3.4: Summary of the Results for the Welfare Effects of Higher Noise in the Public Signals

	Cournot				Bertrand				Monopoly	
	Demand Uncertainty		Cost Uncertainty		Demand Uncertainty		Cost Uncertainty		Demand Uncertainty	Cost Uncertainty
	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes	Complements	Substitutes
Only Public Signal	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.	D.C.R.
Uncorrelated Public and Private Signals	D.D.R.	D.D.R.	U-Shaped (3)	D.D.R.	D.D.R.	D.D.R.	D.D.R.	D.D.R.	D.D.R.	D.D.R.
Correlated Public and Private Signals	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)	U-Shaped (5)

(1) D.C.R. refers to "decreasing at constant rate". D.D.R. refers to decreasing at a decreasing rate.

(2) U-Shaped refers to the case where the welfare initially fals and increases monotonically with Sigma-Squared-Z.

(3) For necessarily high degree of complementarity.

(4) For necessarily high degree of substitutability.

(5) For necessarily high degree of correlation in the public and private signals.

Figure 3.1: The Effect of Precision of Public Information on Welfare with Uncorrelated Signals: Case of Bertrand with Demand Uncertainty

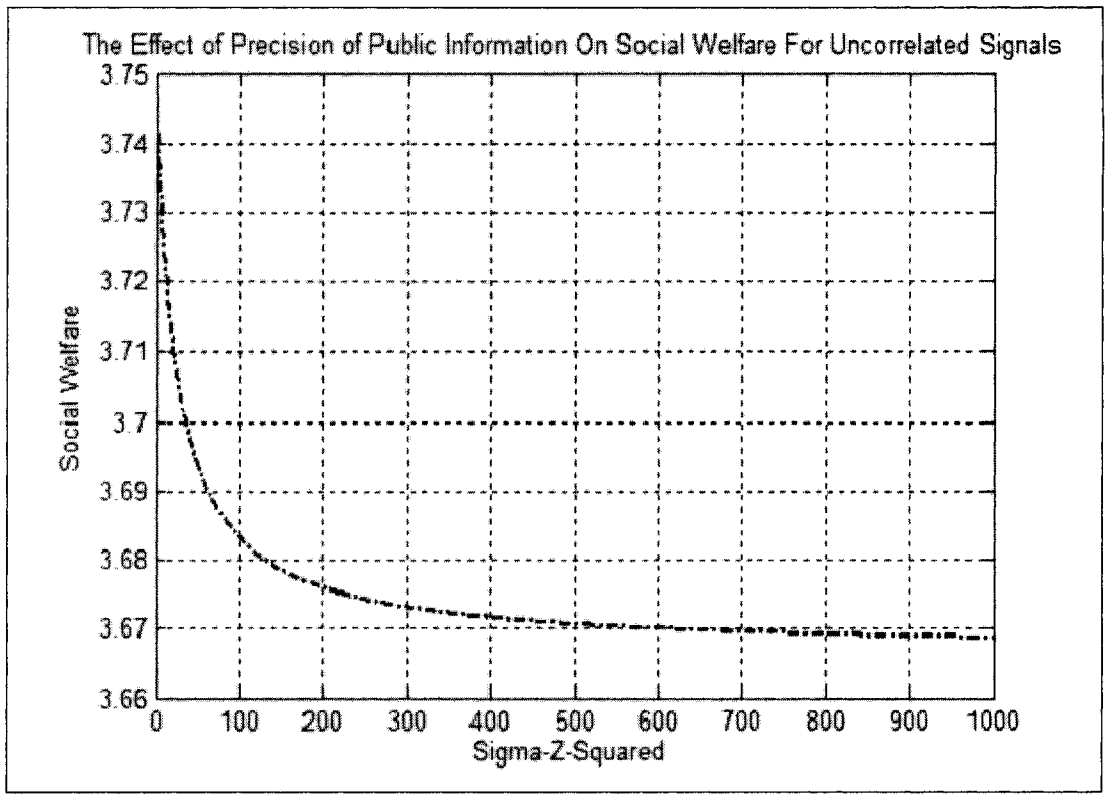


Figure 3.2: The Effect of Precision of Public Information on Welfare with Uncorrelated Signals: Case of Cournot with Demand Uncertainty

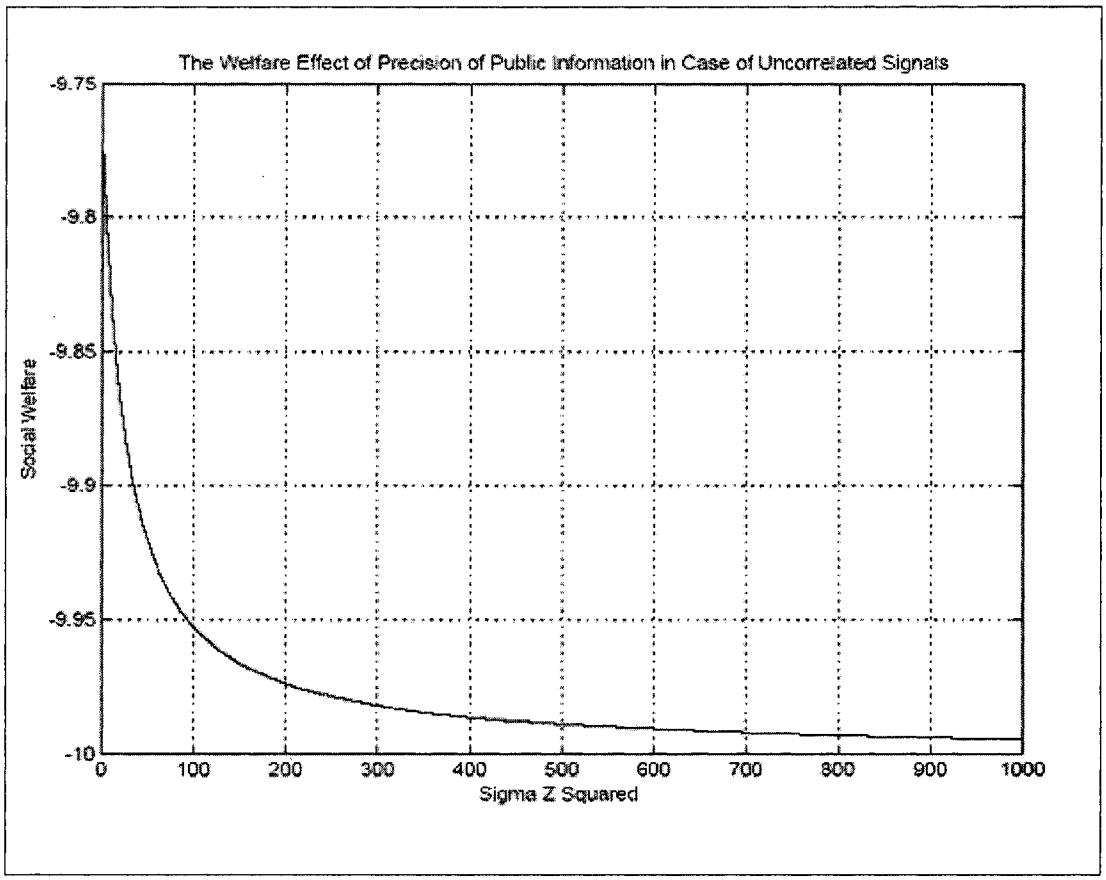


Figure 3.3: The Effect of Precision of Public Information on Welfare with Correlated Signals: Case of Bertrand with Demand Uncertainty

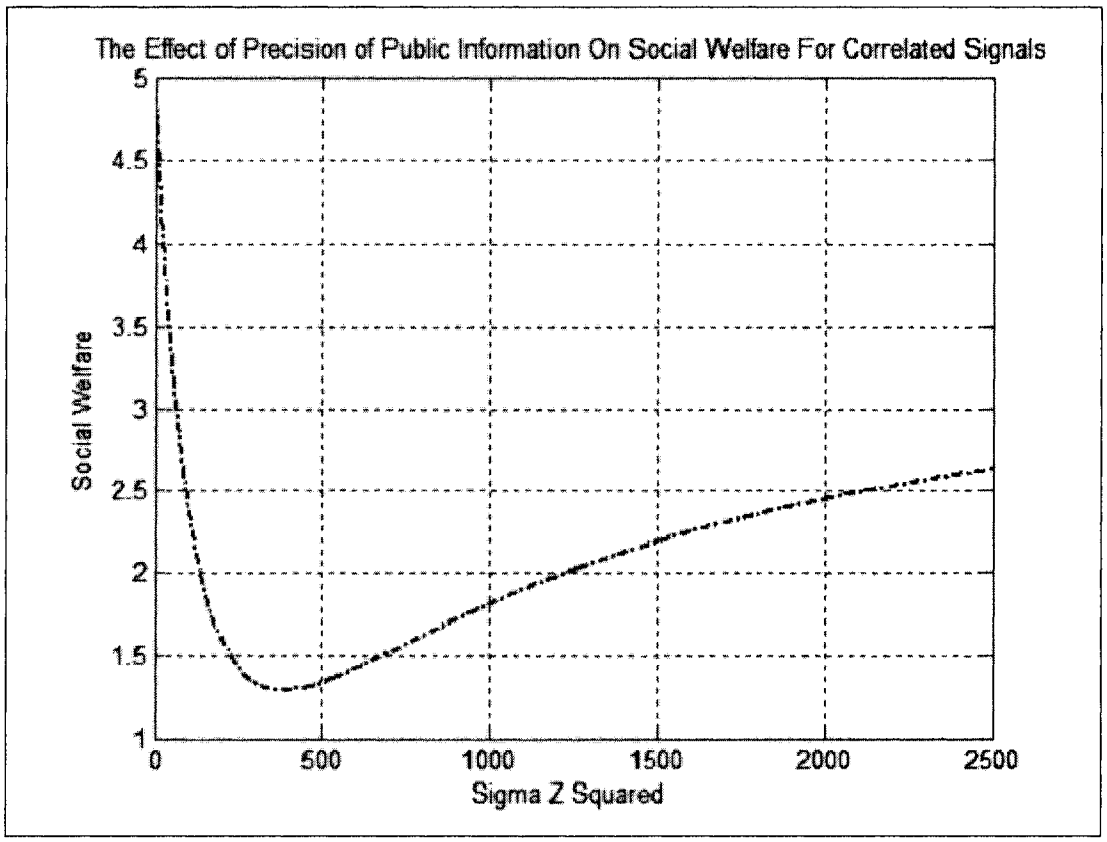


Figure 3.4: The Effect of Precision of Public Information on Welfare with Correlated Signals: Case of Cournot with Demand Uncertainty

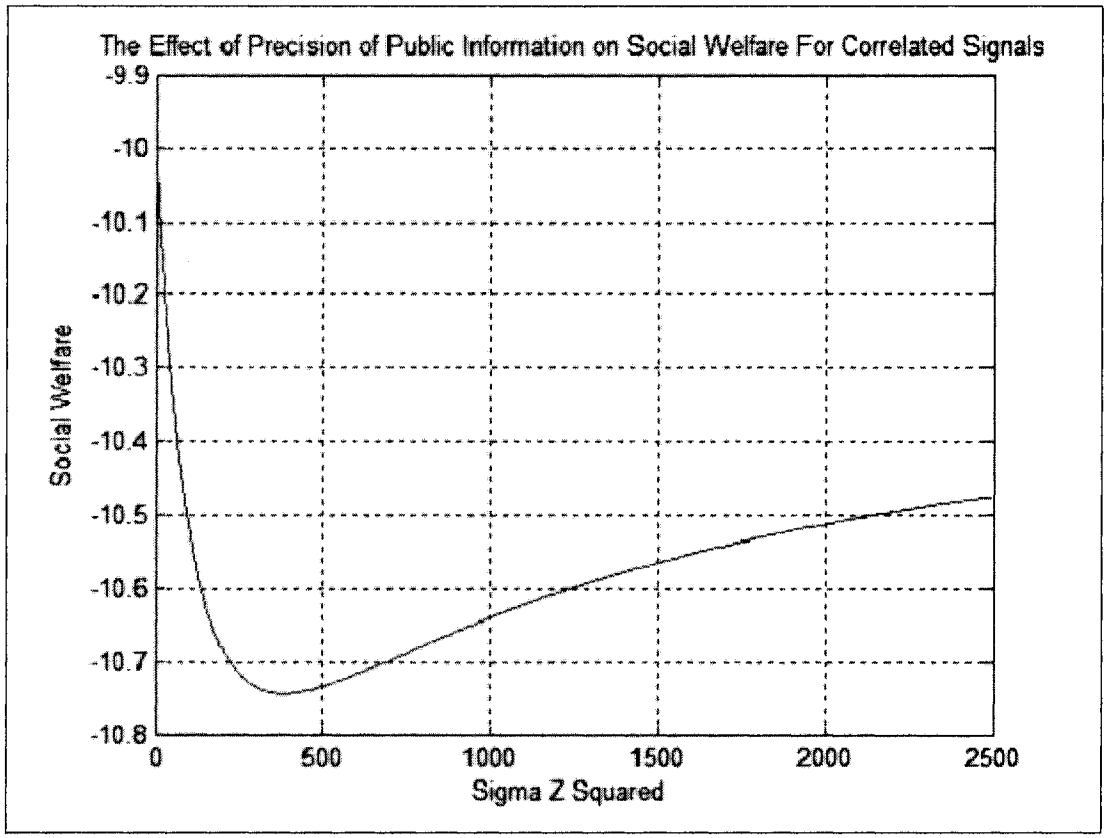


Figure 3.5: The Effect of Precision of Public Information on Welfare with Correlated Signals: Case of Bertrand with Cost Uncertainty

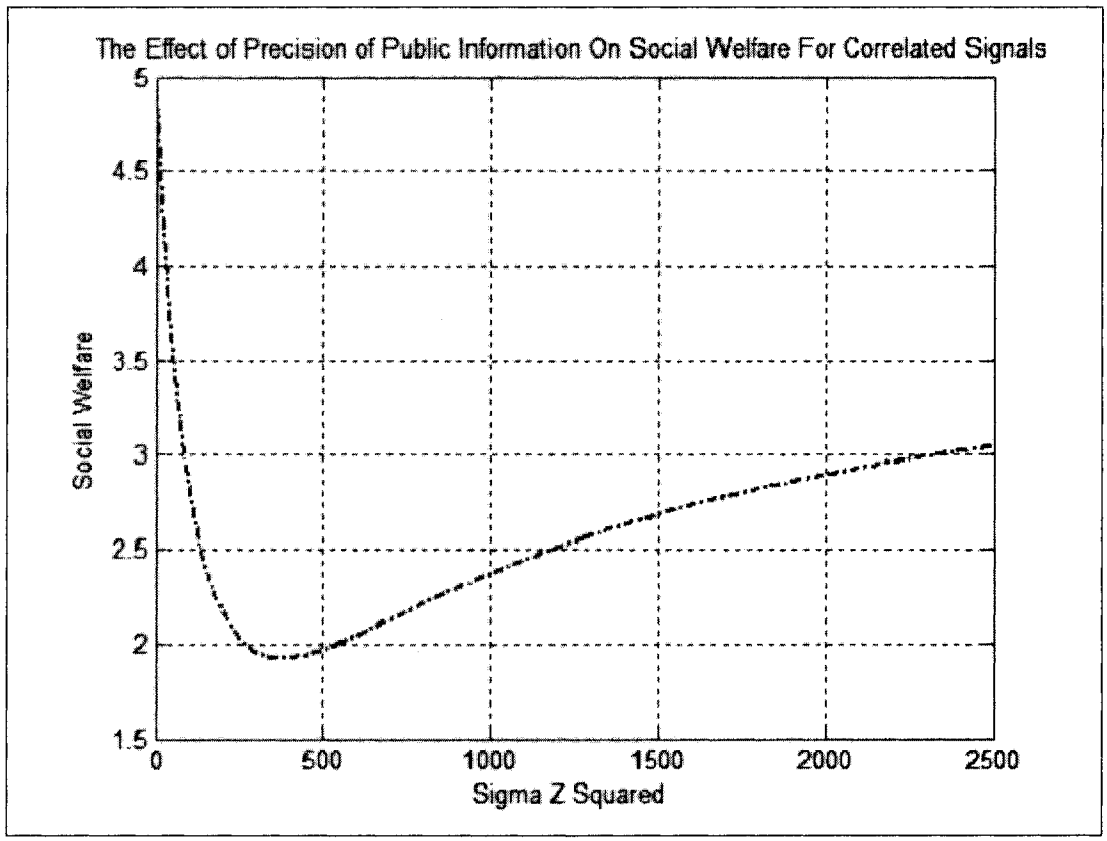


Figure 3.6: The Effect of Precision of Public Information on Welfare with Correlated Signals: Case of Cournot with Cost Uncertainty

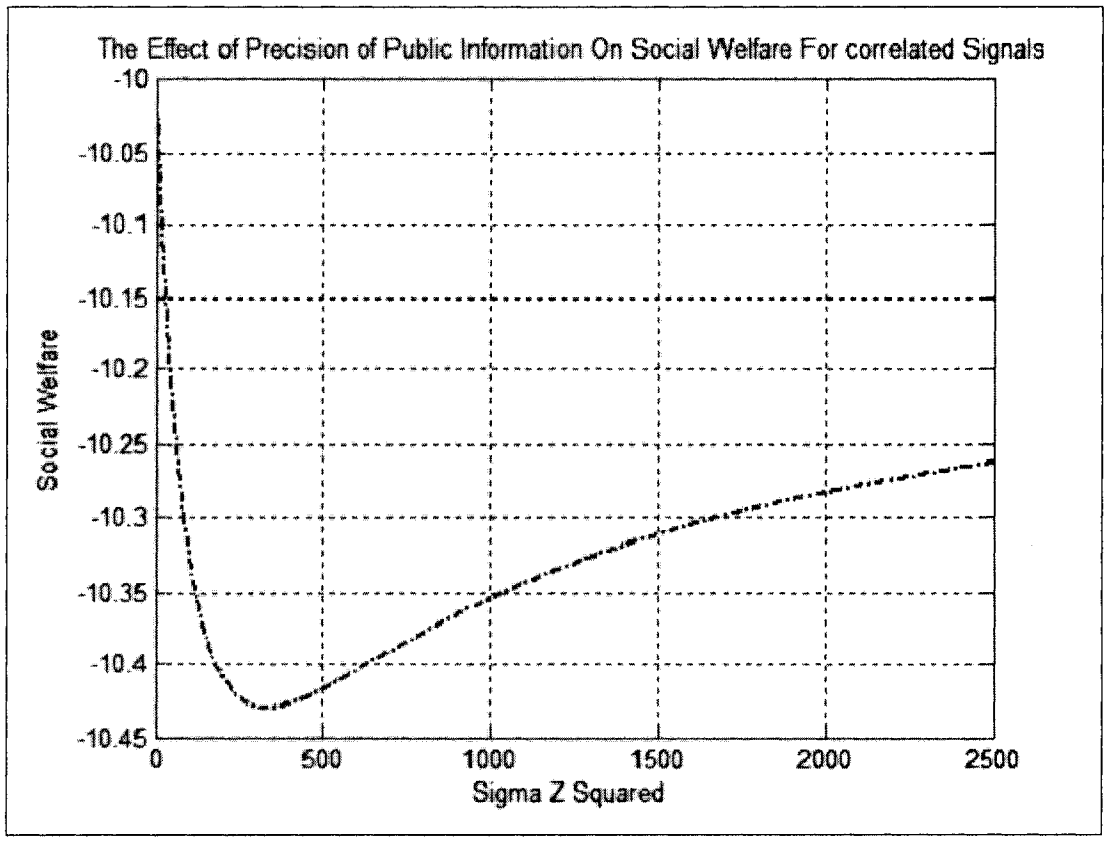
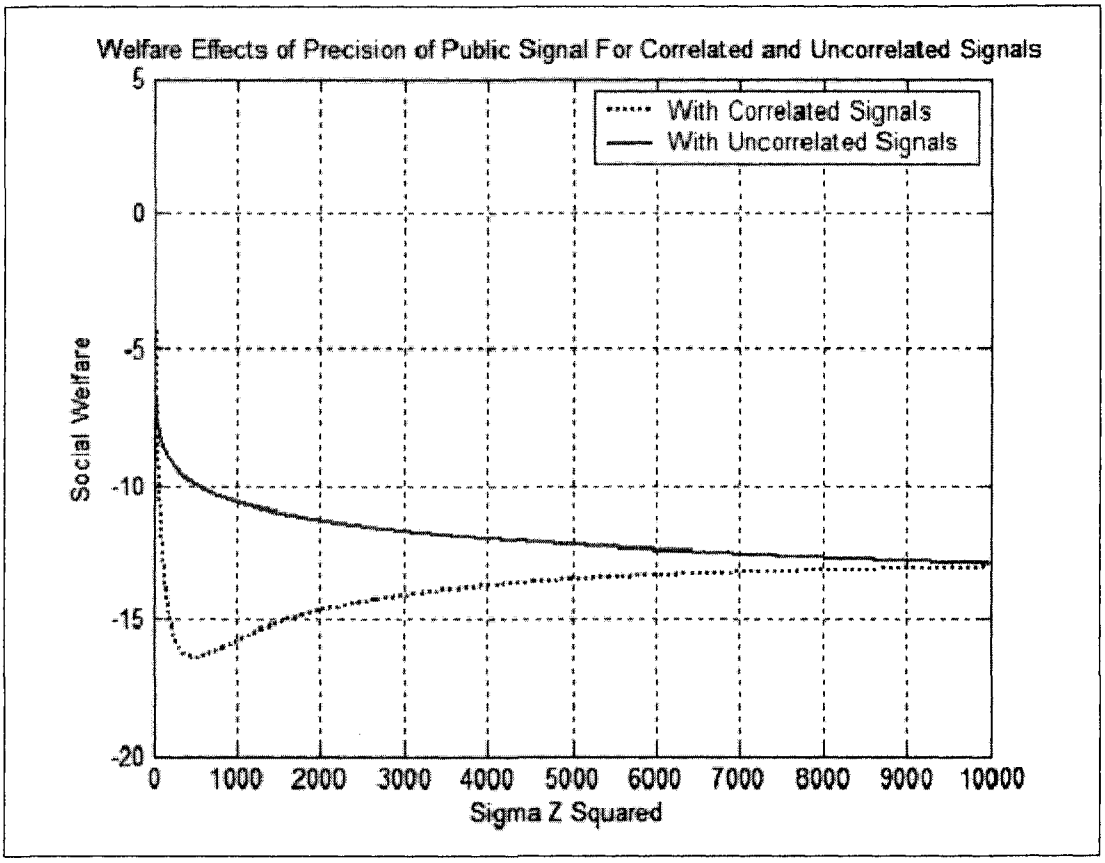


Figure 3.7: The Effect of Precision of Public Information on Welfare: Case of Monopoly with Demand Uncertainty



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