THE EFFECTS OF MACROECONOMIC SHOCKS ON EMPLOYMENT: THE CASE OF MEXICO*

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Resumen: Se estudian los efectos de choques macroeconómicos en empleo y salarios para el caso de México. Encontramos que trabajadores jóvenes y menos calificados son los más afectados por un choque económico en términos de desempleo, participación en la fuerza laboral y empleo en el sector informal. Se deriva un modelo teórico para estudiar los efectos de choques macroeconómicos en salarios y composición de empleo. Los resultados teóricos implican que las elasticidades de la oferta laboral en el sector formal e informal son cercanas a 0.75 y 0, respectivamente, y que ambas elasticidades de la demanda laboral son cercanas a 1.

Abstract: This paper studies the effects of macroeconomic shocks in employment and wages for the case of Mexico. I find that young and unskilled workers are the most affected by an economic shock in terms of unemployment, labor force participation and employment in the informal sector. I derive a theoretical model to study the effects of macroeconomic shocks on wages and employment composition. The theoretical findings imply that the elasticities of labor supply in the formal and informal sector are close to 0.75 and 0 respectively, and both labor demand elasticities are close to 1.

Clasificación JEL/JEL Classification: J21, J22, J23, J48

Palabras clave/keywords: México, empleo, salarios, choques, informalidad, employment, wages, shocks, informality

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1. Introduction

The current crisis has greatly affected countries around the globe. In its *World Economic Outlook* of 2009, the International Monetary Fund predicted that global output would decrease by 1.3 percent in 2009 and increase by only 1.9 percent in 2010 (IMF, 2009). But this number hides individual country effects: for example, the IMF report projected a decline in output of close to 4 percent this year for Mexico, and 1.5 percent for the rest of Latin America and the Caribbean. Moreover, the Millennium Development Goals are at risk of not being achieved by their deadline of 2015. An interesting research question is how much this decrease in national output affects labor market outcomes, like employment and wages, and what policy tools are available in order to diminish the negative effects of the crisis.

The topic is of great importance to policy makers. Some groups of workers can be more affected than others. In order for the policy maker to apply specific policies in benefit of those workers, the policy maker needs to know what type of workers are affected and the margin of the effect (wages, employment, etc). Once the effects are known, a theoretical framework is needed in order to devise strategies to counteract the effect of the crisis like wage subsidies, training programs, etc. In this paper, I address those two aspects for the case of Mexico.

Mexico has suffered two previous crises in recent years. These crises are different in how they started, their length, and their depth. The 1995 crisis caused a decline in GDP of 7 percent, although Mexico's recovery was relatively fast. By 1997, Mexico had the same real GDP as before the crisis. However, the 2001 crisis only caused a small decline in GDP, followed by stagnation and slow recovery until 2004. The 2008 crisis has caused a decrease of 10% in GDP. This crisis was caused by factors external to Mexico and not internal factors like the 1995 crisis. Even though the current crisis looks different to the 1995 and 2001 crises, they share some elements that can be helpful for understanding the possible effects of the current crisis on employment. For example, the current crisis is similar to the 1995 crisis in its depth, but it was caused by external factors like the 2001 crisis.

Researchers have been interested in the effects of a macroeconomic shock in terms of employment for a long time. McKenzie (2003) analyzes the 1995 crisis in Mexico. He finds that labor force participation was reduced given the crisis, an aspect I verify using different data. Verick (2009) finds that the group most affected by crises is young workers. He argues that policy makers need to devise wage subsidies, training programs and job search assistance programs. In

contrast to Verick (2009), I analyze the effect of shocks on different groups of workers and also analyze theoretically the conditions under which a wage subsidy would have a positive effect on formal employment in the presence of an informal sector. Fallon and Lucas (2002) analyze different macroeconomic shocks for a sample of countries. Their key finding is that equilibrium in the labor market is reached through wages not employment. However, they use annual data and if a crisis is short lived the negative consequences will not be seen. Indeed, in my analysis below I do find that employment is affected in the 1995 crisis but in the very short run. Hence, in order to fully analyze the effects of macroeconomic shocks, quarterly or monthly data are needed.

The goals of the paper are to analyze how the previous crises have affected employment in Mexico and also to use current information to compare the recent crisis with previous ones. I propose an empirical strategy that relies on constructing an event study as described in Jacobson, LaLonde and Sullivan (1993). The event study consists in ordering all crises with respect to a particular period. In this way, we can compare the effects of the three crises on the same graph according to their length. The event study makes it possible to calculate elasticities of the outcome variables with respect to changes in GDP.

The empirical findings are in line with findings in other countries (see for example Verick, 2009). Unskilled workers are more affected by macroeconomic shocks than highly skilled workers. Younger workers are more affected than workers in their prime or older workers. After the occurrence of a macroeconomic shock, some workers decide to leave the labor force (especially young workers), unemployment increases for all type of workers, employment in the informal sector expands relative to the formal sector, and relative wages of formal sector workers in terms of informal workers increase (or at least it does not decrease).

I also develop a model that aims to understand labor market flows and wage adjustments under crises periods. This model will be helpful to understand what policy tools are available in order to counteract the negative effects of macroeconomic shocks to a particular group of workers. In particular, the model allows for the inclusion of wage subsidies and (negative) profit taxes as a way to stimulate labor demand. These policy instruments will be effective depending on the magnitude of the elasticities of supply and demand. The results of the model imply that labor supply elasticities in the formal and informal sector are close to 0.75 and zero respectively, and that

labor demand elasticities in both sectors are close to one. Using these results, a 5% reduction in payroll taxes will diminish approximately 50% the effects of a negative shock of 10% in the economy.

The structure of the paper is as follows. Section 2 explains the previous crises in Mexico. Section 3 explains the data to be used in the current study. Section 4 explains the two empirical methods to estimate the effects of previous macroeconomic shocks on employment. Section 5 presents the results of the paper. Section 6 presents the theoretical model to understand how the labor market adjusts. Finally, Section 7 presents the conclusions of the study.

2. Macroeconomic Shocks

In order to measure the impact of the economic crisis on employment, we need to define what we mean by "crisis". In this note, "crisis" is defined as a fall in real Gross Domestic Product (GDP) per capita in two consecutive quarters. Another important statistical aspect is that the GDP series used has been detrended.

In figure A1, we can observe the evolution of GDP and GDP per capita in Mexico in the last 30 years. There have been six crises: 1981: IV, 1985: I, 1987: IV, 1995: I, 2000: IV, and 2008: III. Given data limitation (labor force surveys are not available for the period before 1987), the crises to be studied are 1995: I, 2000: IV and whenever possible the current crisis 2008: III. In the graph, we can see that those crises are different in their length and depth. While the crisis in 1995 lasted 11 quarters, the crisis in 2001 lasted 14 quarters. Moreover, the crisis in 1995 was caused by domestic problems, and the crisis in 2001 was caused by the decrease in economic activity in the United States and the September 11th attacks. The crisis in 1995 was more traumatic in the sense that GDP per capita decreased by close to 12 percent, while in 2001 GDP per capita decreased by 5 percent. However, Mexico recovered very fast after the shock in the first two quarters in 1995 while in the 2001 crisis, the recovery was stagnant.

One of the goals of the current study is to compare the 2008 crisis with previous crises. In this sense, the 2008-2009 crisis looks like the 1995 crisis. However, it is too soon to predict how Mexico will recover from this crisis. In the 1995 crisis, Mexico could recover fast through NAFTA, a weak exchange rate and a booming US economy. Those conditions are not currently valid. On the other hand, the 2001 crisis took longer to vanish. According to the IMF, Mexico is predicted to

grow less than 2 percent in 2010. It looks like the recovery process of the 2008 crisis will resemble more the 2001-2003 crisis.

3. Data and Facts

The employment data to be analyzed comes from the Labor Force Survey (called *Encuesta nacional de empleo urbano*, ENEU, until 2004, and *Encuesta nacional de ocupación y empleo*, ENOE, thereafter). The Labor Force Survey is a quarterly household survey and it is similar in structure to the *Current Population Survey* (CPS) in the United States. For example, households are interviewed for five consecutive quarters and then leave the sample. The ENEU survey period includes 1988-2004 and it includes large urban cities, hence it is only representative at the urban level and not at the national level. In the 1995: I crisis, 16 cities can be used as a panel if the panel starts before 1992, otherwise up to 32 cities can be used as a panel. In the 2000: IV crisis 34 cities can be used as a panel.[1] Nonetheless, the main advantage of using ENEU is its large sample size. In each quarter approximately 130 000 households are interviewed. Moreover, the survey includes rich demographic information as well as rich employment information (industry, occupation, hours, formal/informal). I use the Labor Force Survey instead of the Income and Expenditure Survey because the latter is conducted every two years, and it is possible that the labor market adjusts rapidly causing an underestimation of the true effect of the crisis. In order to increase the power of the statistical calculations, I will use quarterly data from the Labor Force Surveys.

The Labor Force Survey changed in 2004, and the new Labor Force Survey is representative at the national level. I will use the new Labor Force Survey (ENOE) in order to estimate the impacts of the current crisis on employment. Even though ENEU and ENOE have different sampling methods, I will restrict the ENOE sample to the same cities appearing in 2001 ENEU.[2] Hence, I try to make the results as comparable as possible across years.

[1] 1987-1991, 16 cities; 1992: I - 1992: II, 32 cities; 1992: III - 1993 III, 34 cities; 1993: IV - 1994: III, 37 cities; 1994: IV - 1995: IV, 39 cities; 1996: I - 1996: III, 41 cities; 1996: IV - 1997: IV, 43 cities; 1998: I - 1998: IV, 44 cities; 1999: I - 2000: II, 45 cities; 2000: III - 2000: IV, 47 cities; 2001: I - 2002: II, 48 cities; 2002: III - 2002: IV, 47 cities; 2003: I - 2003: II, 48 cities; 2003: III, 37 cities; 2003: IV, 36 cities; 2004: I - 2004: IV, 34 cities.

[2] I also drop from the analysis all those localities with less than 2 500 people because ENEU focuses only on urban areas.

The data on GDP at the national level comes from the National Statistical Office, *Instituto Nacional de Estadística y Geografía*, INEGI.[3] Yearly GDP at the national level can be found starting 1980, while yearly GDP at the regional level can be found starting 1993. I use only GDP at the national level in my estimation below.

An economic crisis has the potential effect of reducing the size of the labor force, increasing unemployment and changing wages. Hence, the outcome variables of interest are employment-population ratios, unemployment rates, the share of workers in the formal sector, and wages.[4]

The share of formal sector workers is important because only in this sector are workers entitled to social security. For example, a drastic decrease in the number of workers in this sector could mean a decrease in the health status of the overall population. In terms of tax revenue, it also means that the Social Security Institution has less money to invest in medical technologies and general supplies.

4. Empirical Strategy

Obtaining the causal effect of an economic crisis on employment is extremely difficult. The fundamental problem of causal inference arises: What would be the outcome in the absence of a crisis? Finding a good counterfactual is hard. Suppose that there is an economic shock that affects males under 25 years old. If we believe (generally correctly) that different demographic groups are imperfect substitutes between each other, a change in employment or wages to males under 25 will necessarily affect other demographic groups. Hence, any other comparison group is invalid.

Instead of focusing in the hard question of causal effects of macroeconomic shocks, I restrict my attention to a reduced form equation that relates macroeconomic shock trends with employment and wages. The strategy relies on constructing an event study. The event study

[3] www.inegi.org.mx

[4] I use the term formal sector workers as those workers who receive social insurance from their main job, while informal workers as workers who are not entitled to social insurance. Even though the informal sector is heterogenous I do not classify informal workers as salaried and self-employed given that the focus of the present study is to determine the effects of the crises in the formal sector, not how informal sector employment changes. The reader can consult the studies of Bosch and Maloney (2007) and Rodríguez (2007) for more information about how informal employment is determined.

methodology has been widely used in labor economics (see for example the works of Jacobson, LaLonde, and Sullivan, 1993 and Kaplan, Martinez, and Robertson, 2005). We know the crisis periods, so an easy way to observe the impacts of each crisis is just plotting the effects on employment for a determined number of quarters before and after the start of each macroeconomic shock. The great advantage of this exercise is that each macroeconomic shock can be compared under the same axis, so that differences in effects are more easily seen. The method consists on estimating the following regression for each outcome variable Y (in logs):

$$Y_{jrt} = \alpha_{jr} + \sum_{q=2}^{4} \beta_{qj} Qtr_t + \sum_{k=-12}^{16} \phi_{jk} \cdot 1(Event = k)_t + \varepsilon_{jt} \qquad (1)$$

The regression can be estimated for each demographic group j separately. It is important to mention that regression (1) is absorbing any permanent difference across demographic and regional groups in the sample (α_{jr}) as well as any seasonal effect (β_q). Qtr is a dummy variable for each quarter. If the coefficients φ are normalized to period -1, then the coefficients are interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. The variable *Event* is constructed as a dummy variable whenever these are k periods from the start of the macroeconomic shock. Although this method provides an elegant way to observe the effects of macroeconomic shocks, the great disadvantage is that it lacks a clear counterfactual. This is because all demographic groups are affected by the event at the same time. Hence, the implicit counterfactual is the trend before the event.

The elasticity of desired outcomes to changes in GDP is denoted as $\frac{\hat{\phi}_k - \hat{\phi}_{-1}}{\Delta \%GDP}$. The reference period elasticity is taken as that of the quarter before the crisis started. This number will be important in order to assess which outcomes are the most sensitive to changes in the economic environment.

5. Results

5.1. *Graphical Evidence*

This section analyzes the evolution of important labor market outcomes for different demographic groups. Given the lack of comparable

data for the whole period of analysis, I present the evolution of different outcomes from 1988-2004 (the final year of ENEU). In the next subsection, I compare outcomes for the three crises using an event study.

Figures A2 through A5 show the trends of the outcomes of interest. Figure A2 shows the evolution for males and females of the employment-to-population rate, unemployment rate, and the share of formal sector workers in total employment and the ratio of wages between the formal and informal sector. In terms of the employment-to-population ratio, males are more affected than females. This is intuitive given that females are increasing their labor force participation regardless of the economic environment. Nonetheless, findings in the US and Mexico show that females are becoming more like males (see for example, Arceo and Campos, 2009 for Mexico and Blau and Kahn, 2007 for the US) which means that the current and future crises should affect also the labor force participation of women. The behavior of the unemployment rate is very similar for both men and women. In both 1995 and 2001 crises, the unemployment rate increases by close to 50 percent for men and women. Similarly, the share of the formal sector in total employment decreases by close to 10 percent during crisis periods. However, the graphs show that the 2001 crisis took longer to reach its minimum level than the 1995 crisis.

An important aspect to mention in figure A2 panel C is the evolution of wages. The graph depicts the evolution of the ratio of hourly wage in the formal sector over the hourly wage in the informal sector. This ratio is generally larger than 1, especially for women, implying a larger (on average) hourly wage in the formal sector than in the informal sector. In crises periods, when there is a decrease in the share in the formal sector in total employment, the relative wage of formal sector workers in terms of informal workers increases, or at least it does not decrease. This is consistent with a model where labor supplies in the formal and informal sector are related, and where an increase in the supply of workers in the informal sector causes a decrease in their wage. This logic will be used later in the theoretical framework.

Figure A3 shows the employment-to-population ratio for demographic groups by age and education for all workers (there is no distinction between males and females). The figure shows that employment level of young workers is more sensible to changes in the economic environment than that of older workers, especially in the 2001 crisis. There are no differences in effects across education groups.

Figure A4 shows the unemployment rate for demographic groups

by age and education for all workers. In contrast to the employment-to-population ratio, the unemployment rate increases for all groups during all crises. If we compare changes in percent terms (rather than in absolute numbers) the most sensitive groups in the 1995 crisis are workers in their prime years and workers with only secondary school education (the unemployment rate increases more than 50 percent). Nevertheless, in absolute terms the increase in the unemployment of young workers increases by up to 7 percentage points in the 1995 crisis and by 4 percentage points in the 2001 crisis. Although the 2001 crisis was not as deep as the 1995 crisis, the unemployment trend for young individuals is the same in both cases. It seems that young workers are becoming more sensitive to changes in the economic environment.

Mexico does not have an unemployment insurance scheme. Workers in the formal sector pay payroll taxes and receive health insurance while workers in the informal sector do not pay payroll taxes and do not receive health insurance from their employers. In the presence of a macroeconomic shock, one can argue that the formal sector adjusts through decreases in the rate of hiring and also in the destruction of jobs. We expect these workers to be out of the labor force, unemployed or finding a job in the informal sector. If wages adjust to these changes, then after an increase in the supply of workers in the informal sector, we should expect a decrease in wages in that sector. In order to analyze whether these hypotheses are plausible, figure A5 presents the share of workers in the formal sector over time and the relative wage between workers in the formal and informal sectors. Across age groups, the share of workers in the formal sector decreases and this decrease is approximately equal to 10 percent. At the same time the relative wage increases by less than 10 percent. Across education groups we have a similar story. The 2001 crisis seem to have had a larger impact in the formal sector than the 1995 crisis. Hence, it is not clear whether the 2001 crisis affected the proportion of workers in the formal sector or something else is at stake given that the share of workers in the formal sector declined later than the start of the crisis.

In sum, figures A2 through A5 depict a clear picture of what happens after a macroeconomic shock. Males leave the labor force more rapidly than women. Unemployment affects all demographic groups but especially young workers. The share of workers in the formal sector decreases for all groups while the relative wage between formal and informal workers increases slightly. The next section quantifies the magnitude of such effects and compares them with the 2008 crisis.

5.2. *Event Study*

5.2.1. Effects on outcome variables

This section compares the current 2008 crisis with the previous two crises. I order employment outcomes according to time occurrence and analyze whether the effects of the current crisis on employment are similar to the effects from the previous crises. Instead of focusing on broad groups, I will analyze patterns by specific subgroups. I analyze groups by gender-age, and gender-education.

First, figure A6 shows the event study for GDP and GDP per capita. The figure shows that GDP decreased 10 percent in the 1995 crisis while the 2001 crisis GDP decreased by 5 percent. The current crisis looks very similar to the 1995 crisis in terms of GDP. In order to obtain the elasticity of the desired outcome with respect to changes in GDP, we only need to divide the effect in specific quarters by the estimate in GDP. For example, if the unemployment rate increases by 50 percent and GDP decreases by 10 percent, it implies an elasticity of unemployment rate with respect to GDP close to -5. In what follows, I will analyze first the effects on different outcomes and then I will calculate different elasticities.

Figures A7 through A11 show the results of the event study for all demographic groups and the outcomes of interest.[5,6] The event study helps to compare all the macroeconomic shocks under the same axis.[7] The effects are in percent terms such that the elasticity of the outcome with respect to GDP changes is obtained by dividing the effect of the outcome effect by the GDP effect. The figure also shows

[5,] In order to facilitate the reading of the graphs, I smoothed the outcome variable using a simple moving average with one lead and lag term and uniform weights. I use this method in order to avoid oversmoothing the outcome variable.

[6] Figures do not include standard errors or confidence intervals. The inclusion of confidence intervals complicates the reading of each graph. Nonetheless, standard errors are small and similar for each event period. For example, the standard error for event period 2 in employment, unemployment, share of formal across groups (on average) is equal to .01, .08, .02 respectively. Hence, estimates are precise for employment-population ratios and unemployment rates, However the estimate of the share of workers in the formal sector is too noisy. The current study focuses more in the economic significance of macroeconomic shocks rather than statistical significance. Certainly a loss of 10% in formal jobs for some type of workers is economically significant.

[7] Each dot in the graph is obtained from the coefficients $\phi_k - \phi_{-1}$ in regression (1).

that the current crisis affects more young males and females than previous crises. The larger effect on young workers can be interpreted as meaning that now average education is higher and young workers can substitute work for schooling in crises periods and that they can suffer unemployment rapidly after a negative shock. Prime-age workers do not decrease too much their employment status in previous crises compared to the 2008 crisis. Women do not seem to be affected in previous crises. However, the current crisis has caused a decline in employment for this group as well. As noted by previous research, women's labor supply is becoming more similar to men's labor supply. Thus, the current crisis has had a larger effect on women's labor force participation and employment than previous crises. Figure A8 shows the change in employment-to-population ratio by educational group. Male workers with less than secondary school education were the most affected in the 1995 and 2008 crises. In sum, figures A7 and A8 indicate that young workers and unskilled workers are the most likely to leave the labor force and lose jobs in response to a macroeconomic shock.

Figures A9 and A10 show the event study for unemployment by age and educational group respectively. Again the 2008 crisis looks like the 1995 crisis for males and females. In both crises, the unemployment rate increased by close to 50 percent. As previous figures show, young and unskilled workers are the most affected by the 2008 crisis. However, males are more affected than females in terms of unemployment. It is important to notice that highly skilled workers are not affected much by the current crisis as by previous ones.

Figures A11 and A12 show the impacts for the share of workers in the formal sector by age and educational group respectively. Both 1995 and 2008 crises are more or less similar, although it seems that the 1995 crisis had a larger negative effect on the share of formal workers. Moreover, the share in the formal sector reaches its minimum 3-4 quarters later than what it takes for the GDP to reach its minimum. Hence it is too soon to say something about how large the dip will be for the share of workers in the formal sector. Nevertheless, so far the results show alarge decline. Young and prime-age male workers have decreased their share in the formal sector by 5 percent, while young female workers have decreased their share by close to 10 percent. In terms of educational groups, unskilled female workers have decreased their share in the formal sector by 10% approximately, while workers with secondary education have decreased their share in the formal sector by 10 percent. On the other hand, males and females with

at least a high school education are not as strongly affected. The evidence of figures A9 through A12 indicates that the 2008 crisis has affected unskilled workers relatively more than skilled workers.

The share of formal sector employment in total employment can decrease either by a decrease in employment in the formal sector or an increase in informal sector employment, holding constant the level of employment in the formal sector. In order to analyze whether changes in the share of workers in the formal sector are driven by a decrease in employment in the formal sector, figure A13 shows the event study of formal employment for prime-age males, and for males and females with secondary education. The figure shows a decline in formal employment for both the 1995 and the 2008 crises. Hence, the fall in the share of the formal sector is both caused by a decrease in employment in the formal sector and an increase in informal employment. The fall in formal employment is especially relevant for unskilled workers.[8]

How do formal and informal wages react with these changes in the labor market? Figure A13 panels D through F include the percent change in the relative wage of formal workers in terms of informal workers. After a fall in formal sector employment and an increase in informal sector employment, the relative wage increases. This is consistent with the view that informal sector expands at the cost of a lower wage which increases the relative wage difference between formal and informal workers.

In sum, unskilled workers are more affected by macroeconomic shocks than highly skilled workers. Young workers are more affected than prime-age or older workers. After the occurrence of a macroeconomic shock, some workers lose their jobs or decide to leave the labor force (especially young workers), unemployment increases for all type of workers, employment in the informal sector expands relative to the formal sector, and relative wages of formal sector workers in terms of informal workers increase. These facts will be taken into consideration in the model I develop below.

5.2.2. Elasticities of outcome variables with respect to GDP

This section estimates the elasticity of outcome variables with respect to GDP. The elasticity can be estimated using the coefficients in re-

[8] The appendix A shows that workers who at least completed high school are not affected as unskilled workers. In general, the decrease in formal employment is mainly driven by jobs lost for unskilled workers.

gression (1) and the coefficients of a similar regression for GDP. The elasticity for each period t is estimated by dividing the percent change in the outcome variable Y with respect to the change in GDP:

$$\frac{\hat{\phi}_t^Y - \hat{\phi}_{-1}^Y}{\hat{\phi}_t^{GDP} - \hat{\phi}_{-1}^{GDP}} \tag{2}$$

The results are shown in table A1 for different elasticities with respect to 3 quarters after the start of the crisis (event period 2). The denominator is taken from total GDP and not GDP per capita. In general the table summarizes the results previously shown. The employment level of young workers is becoming more sensitive to the economic environment. The elasticities increased substantially between 1995 and 2008, especially for males. Unskilled workers are the group most affected by macroeconomic shocks in terms of leaving the labor force, unemployment, and employment in the formal sector. In fact, the current crisis has not affected total formal employment for highly-skilled workers (the elasticity of formal employment with respect to GDP changes is negative). In order to hire highly-skilled workers in the formal sector, firms invest in training programs, screening process, etc. This causes hiring costs and firing costs to be higher for highly skilled workers than for unskilled workers, and as a consequence formal firms do not terminate employment for both types of workers equally. More research is needed to investigate the actual mechanisms of labor adjustment across firms.

6. Theoretical Framework

6.1. *Model*

The decision of how to model the impacts of labor market policies on wages and employment when there are two sectors is complicated. Most of the literature on informal sector modeling focuses on what determines the size of the informal sector (see for example Loayza, 1996, or Gërxhani, 2004 for a review of the literature). Modern models include frictions such as in the work of Mortensen and Pissarides (1994) or Albrecht, Navarro and Vroman (2009) to evaluate the effects of labor market policies. However, a great disadvantage of these models is that they generally don't determine wages and employment at the same time. For example, the literature evaluating the size of

the informal sector takes wages as given and the size of the informal sector is taken as endogenous to labor regulation. In search models, the wages will be determined by Nash bargaining between the employers and employees. A recent model developed by Levy (2008) includes a competitive model determining both wages and employment. However, the model in Levy (2008) predicts that wages in the formal sector are equal to wages in the informal sector and that in response to macroeconomic shocks wages are affected and not employment.[9] Another model based on competitive equilibrium of the informal sector is due to Marrufo (2001). Her model is similar in spirit to the model I develop below. However, given that she is interested on the incidence of payroll taxation, she includes capital, models labor supply responses and also models responses in product demand. The model has two disadvantages: the model is complex which makes it harder to understand the main intuition of the model, and focuses only on changes in payroll taxes and not on macroeconomic shocks. Hence, the models previously developed do not provide a simple and unified framework about how to explainlabor market fluctuations, wages and employment, in response to macroeconomic shocks or changes in payroll taxes.

In this section, I provide a simple competitive framework to denote the interactions between the formal and informal sector. I follow the competitive model framework (Gruber, 1997; Katz, 1996) in order to determine wages and employment in equilibrium in both the formal and informal sectors. The goal is to understand how the equilibrium changes when there is a macroeconomic shock. Moreover, the final goal of this exercise is to provide policy recommendations, assuming the elasticities of labor supply and demand are known. Nevertheless, there is little work in Mexico and Latin America about the magnitudes of these elasticities, so the policy recommendations need to take this caution into consideration.

The model I present is a partial equilibrium model. Labor demand for a particular skill equals labor supply for that skill. There is one good or product in the economy, and labor is the only factor used to produce that good. It is a partial equilibrium model in the sense that I do not model how the labor movements of a worker with a particular skill affect workers with other types of skills. A general

[9] Unless one is willing to assume that wage rigidities cause employment in the formal sector to be affected rather than wages. Hence, a macroeconomic shock decreases employment in the formal sector, increases employment in the formal sector and reduces wages for informal workers. Such a framework is very similar to the model I present.

equilibrium model that takes these movements is out of the scope of this paper. Moreover, I assume that demand for the product is perfectly elastic so that labor fluctuations or macroeconomic shocks do not change the price of the product.

In this partial equilibrium model, I assume there are two sectors in the economy, formal and informal. The demand for formal sector workers depends only on wages for formal sector workers, $D^F(w_F)$. In equilibrium, the demand for formal workers needs to equal the labor supply of formal workers. The labor supply depends on wages in both the formal and informal sector, $S^F(w_F, w_I)$. The labor supply of formal sector workers is increasing with respect to its own wage but decreasing with respect to the informal sector wage. This labor supply reflects the fact that a higher wage in the informal sector will cause some workers to shift out the formal sector into the informal sector. The absolute value of the labor supply elasticities are denoted as $\varepsilon^F_{w_F}$ and $\varepsilon^F_{w_I}$. There is little knowledge about the magnitude of these elasticities. We know that labor supply elasticities are small, and close to zero for males in their prime age, but little is known about the labor supply elasticities for each sector. It is plausible to argue that $\varepsilon^F_{w_F} > \varepsilon^F_{w_I}$ or that formal sector workers are more sensitive to changes in their own wage than in the informal sector wage.

Demand for labor in the informal sector depends only on wages in the informal sector, $D^I(w_I)$. Supply of informal sector workers depends on wages in the formal and informal sector, $S^I(w_F, w_I)$. However, different parameters for labor supply elasticities in the formal and informal sector increases the complexity of the problem. Instead, we can use the fact that total labor in the informal sector plus labor in the formal sector is equal to total labor in the economy. I assume that there is no unemployment in the economy such that total labor is completely inelastic, $S = S^F + S^I$. Hence, labor supply in the informal sector is just obtained as $S^I(w_F, w_I) = S - S^F(w_F, w_I)$. This assumption requires more explanation. This assumption implies that labor supply in both sectors will adjust in order to reach an equilibrium. The model allows for different wages across sectors, and they are different given labor demand and supply. In other words, there are some workers who place a greater value on formal sector employment than on informal sector employment, and firms in the formal sector are more productive, and hence demand more workers at similar wage than informal sector firms causing wages to be different across sectors. Of course, there is the question of why we assume there is an informal sector in the first place. The current model's implicit assumption is that total demand in the formal sector is less

than total supply of workers even at a very low wage. Hence, the model by construction assumes the existence of an informal sector.[10]

The labor supply framework is consistent with findings that the informal sector is both composed of voluntary and involuntary employment in that sector. Maloney (2004) claims that workers in the informal sector are there given personal preferences, or that given individual preferences they may not be better off in the formal sector. However, the informal sector is heterogenous. Bosch and Maloney (2007) and Rodríguez (2007) find that informal sector employment increases in crises periods and that informal sector workers do not frequently shift into formal sector jobs or that informal sector workers move within the informal sector. Both results are consistent with the view that labor supply in the informal sector will depend on informal and formal sector wages, that total labor supply is inelastic, and that workers shift between sectors if there is not enough labor demand at current wages. The current model implies that informal sector wages are lower than formal sector wages, which is consistent with findings that wages for workers that move from the formal sector into the informal sector decrease on average by 13%, see for example Alcaraz, Chiquiar, and Ramos (2008).

The elasticity of labor demand in each sector is written as $\eta^x_{w_x}$ for $x = F, I$. Although there are no empirical estimates for these parameters, it is plausible that $\eta^F_{w_F} > \eta^I_{w_I}$ for the same proportional change in each wage. Demand in the formal sector is not as flexible as in the informal sector. Hence, given the same percent change in the wage it is likely that demand in the informal sector changes by more than in the formal sector.

Equilibrium in the labor market for a particular skill is obtained by solving the following system of equations:

$$D^F(w_F) = S^F(w_F, w_I) \tag{3}$$

$$D^I(w_I) = S - S^F(w_F, w_I)$$

which determine the optimum wages, (w^*_F, w^*_I), and determine the size of the formal and informal sector, $S^F(w^*_F, w^*_I)$. The final goal of

[10] A model at the individual level is beyond the scope of the paper. However, we can interpret the model as implying that individual preferences are heterogenous. Some individuals put more weight on leisure than others. Hence, some individuals will prefer the informal sector rather than the formal sector even with a lower wage in the informal sector. This rational decision does not leave them worse off.

the current model is to understand labor fluctuations when there are macroeconomic shocks and changes in payroll taxes. I model these effects as follows:

$$D^F[w_F(1-s)](1+A^F) = S^F(w_F, w_I) \tag{4}$$

$$D^I[w_I](1+A^I) = S - S^F(w_F, w_I)$$

where s is a subsidy as a percent of the worker's wage and A^F, A^I represent macroeconomic shocks as a percent of labor demand.

Totally differentiating both equations, defining the percent effect of macroeconomic shocks and subsidy as θ_F, θ_I and s_F, and finally assuming that the initial subsidy and shocks are equal to zero, we get the following effects:[11]

$$\Delta\%w_F = \frac{\left(\eta^I_{w_I} + \varepsilon^F_{w_I}\right)\left(\eta^F_{w_F} s_F + \theta_F\right) + \varepsilon^F_{w_I}\theta_I}{\eta^I_{w_I}\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right) + \varepsilon^F_{w_I}\eta^F_{w_F}} \tag{5}$$

$$\Delta\%w_I = \frac{\left(\varepsilon^F_{w_F}\right)\left(\eta^F_{w_F} s_F + \theta_F\right) + \left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right)\theta_I}{\eta^I_{w_I}\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right) + \varepsilon^F_{w_I}\eta^F_{w_F}}$$

$$\Delta\%L_F = \frac{\left(\varepsilon^F_{w_F}\eta^I_{w_I}\right)\left(\eta^F_{w_F} s_F + \theta_F\right) - \left(\eta^F_{w_F}\varepsilon^F_{w_F}\right)\theta_I}{\eta^I_{w_I}\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right) + \varepsilon^F_{w_I}\eta^F_{w_F}}$$

If labor supply in the formal sector and informal sector are not related by informal sector wages, , and we find the traditional formulas for changes in subsidies or macroeconomic shocks (Katz, 1996).

$$\Delta\%w_F = \frac{\left(\eta^F_{w_F} s_F + \theta_F\right)}{\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right)} \tag{6}$$

$$\Delta\%w_I = \frac{\left(\varepsilon^F_{w_F}\right)\left(\eta^F_{w_F} s_F + \theta_F\right) + \left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right)\theta_I}{\eta^I_{w_I}\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right)}$$

$$\Delta\%L_F = \frac{\left(\varepsilon^F_{w_F}\right)\left(\eta^F_{w_F} s_F + \theta_F\right)}{\left(\eta^F_{w_F} + \varepsilon^F_{w_F}\right)}$$

The idea of imposing a subsidy for workers, especially unskilled, in a contracting environment is not new (see for example, Ferreira,

[11] Appendix B includes the derivation of the model.

Prennushi, and Ravallion, 1999 and Phelps, 1994). The added value of the model is that it provides conditions for the wage subsidy to stimulate employment in the formal sector. For example, in terms of equation (5), the effect on formal employment of a subsidy will depend largely on the magnitude of the demand elasticity in the formal and informal sector and the labor supply elasticity in the formal sector. The next subsection interprets more thoroughly the implications of the model.

6.2. *Interpretation and Implications*

Although equations (5) are difficult to interpret given the number of parameters, it is possible to say a few things. Given a negative shock that affects equally both the formal and informal sector, the effect on formal (informal) wages decreases (in absolute value) the higher the elasticity of demand for formal (informal) workers is and the higher the labor supply elasticity of formal (informal) workers is (holding constant other parameters). The effect on labor demand will be lower the higher the elasticity of labor demand and the higher the elasticity of labor supply of informal workers. The interpretation of these results implies that formal sector workers will not be affected either in wages or employment because firms in the formal sector are not greatly affected by macroeconomic shocks (perfectly elastic demand). If demand is not perfectly elastic, then the effect will depend on other elasticities. For example, less elastic labor supply in the formal sector implies that the shock can be absorbed by wages rather than employment, and the same applies for informal sector workers. By the same token, if labor supply elasticity with respect to formal sector wages is greater than for informal wages, this implies that employment in the formal sector will be more affected than would be the case with higher elasticity for informal wages.

Figure A14 describes the effects on wages and employment for different elasticities under the assumption that there is a negative macroeconomic shock to both sectors equal to -10% (the same shock as to GDP) and there are no changes in wage subsidies. The y-axis is the percent change in the outcome, the x-axis is the labor demand elasticity in the formal sector ($\eta^F_{w_F}$), IS refers to Informal Labor Supply elasticity ($\varepsilon^F_{w_I}$), ID refers to Informal Labor Demand elasticity ($\eta^I_{w_I}$) and FS refers to Formal Labor Supply elasticity ($\varepsilon^F_{w_F}$). There is little knowledge on the values of these elasticities for Mexico or Latin America. Arceo and Campos (2009) estimate labor supply elasticities

for men and women in Mexico in 2000 and find that the elasticity for men is around 0.10 and that for women it is around 0.6. However they do not estimate labor supply equations for both formal and informal sector. Given the empirical estimates in the US and other developed countries, it is likely that both of these elasticities are lower than 1 and closer to zero. It is also possible that labor supply elasticity for formal sector wages is higher than for informal sector wages. The labor demand elasticities are more complicated to estimate. Hamermesh (1993) reports that the constant-output demand elasticity is around 0.33. But the model described above requires demand elasticities allowing for output to vary. This elasticity is obtained by dividing 1/0.33 which implies a labor demand elasticity of close to 3. Labor demand elasticity in Mexico and Latin America is probably lower than the one found for the US, given that there are more labor regulations in these countries than in the US. There are no estimates for the labor demand elasticity in the informal sector but it should not be too different from the formal sector elasticity and probably larger given lack of labor regulation in this sector.

Figure A14 implies interesting details about the possible magnitude of labor supply and demand elasticities. Panels A through C show the effect of a macroeconomic shock on formal and informal wages and formal employment for different elasticities. We know from figure A13 that formal employment has decreased by close to 10% for workers with secondary education or ages 25-50. But as workers with at least a high school education have not been affected, the change in formal employment is close to -6 percent. Relative wages between formal and informal sector have increased by between 2 and 5 percent. In the appendix A, I show that wages in the formal sector have declined by between 8 and 10 percent while in the informal sector they have decreased by between 10 and 15 percent. These numbers will be used in order to determine a plausible value for the labor demand and supply elastiticies.

Panel A in figure A14 indicates a large drop in formal sector wages when labor demand elasticity is low for both the formal and informal sector. As empirical data do not support such large drops in formal sector wages relative to informal sector wages, it is likely that both formal labor supply elasticity and formal labor demand elasticity are not zero or close to zero. Given that most estimates are close to each other for large values of the formal labor demand elasticity, it is hard to say something about the plausible values for those elasticities. We need to look at more evidence.

Panel B implies that a higher informal-sector labor demand elas-

ticity causes a lower drop in wages in the informal sector. Hence, we can rule out large values of the labor demand elasticity in the informal sector. A higher elasticity of labor supply in the formal sector increases the effect on wages in the informal sector. In the empirical analysis described above, I find that wages in the informal sector decrease relative to formal sector wages by a small proportion (2-5%), while wages in the informal sector have decreased by 10-15 percent. This implies that labor demand elasticity for informal workers is low and that labor supply elasticity for formal workers is greater than the labor supply elasticity for informal workers.

Panel C shows the effect of the macroeconomic shock in formal employment. From the figure, we can rule out large values of the labor demand elasticity in the formal sector given that the empirical data shows a drop in formal employment. This is consistent with what we find in panel B. In fact, it is likely that the elasticity of labor demand in the formal sector is greater than 0.5 but lower than 1.5, since we observe a decline in formal employment of close to 6 percent.

In sum, panels A through C in figure A14 depict a clear picture of the plausible values for the elasticities. The labor supply elasticity in the informal sector is zero or close to zero while the labor supply elasticity in the formal sector is larger, probably between 0.5 and 1. The labor demand elasticities in the formal and informal sector are close to 1, a surprising aspect given that we expected evidence pointing towards larger elasticity values for the informal sector. Nevertheless, it is possible that the labor demand elasticity is higher in the informal sector than in the formal sector but that it is not an order of magnitude higher.

6.3. *Implications for Public Policies*

In the model described above there are two ways to deter the effects of a negative macroeconomic shock. One way is to implement wage subsidies for labor. These subsidies can take the form of direct wage subsidies or a decrease in payroll taxes (although the model does not assign a value to social security benefits, or in other words the model assumes that workers do not value social security contributions). The other public policy option is to decrease profit taxes such that formal sector firms do not decrease wages or employment as much as they could. In the model above, a decrease in profit taxes can be interpreted as a less negative shock in A.

First of all, the first question is related to the empirical evidence of changes in payroll taxes in countries similar to Mexico or

other Latin American countries. Gruber (1997) finds that lower payroll taxes in Chile were shifted into higher wages, especially for skilled workers, with no positive employment effects, which is consistent with a perfectly inelastic labor supply. Kugler and Kugler (2009) study the increase in payroll taxes in Colombia in 1993. Payroll taxes increased by 10.3 percent. The rationale is that if wages are rigid downward (and not upward as in Gruber's case) then the increase in payroll taxes could have an effect on employment as well. Kugler and Kugler (2009) find that the increase in payroll taxes led to a 2 percent decrease in wages by and a 4.5% decrease in employment (and the effect was greater for unskilled workers, consistent with the idea of wage rigidity downwards or minimum wage). On the other hand, Frías (2008) analyzes the Social Security reform in Mexico in 1997. She finds that the 1997 reform, which decreased payroll taxes, increased wages without an effect on employment, except for large manufacturing plants which saw some small gains in employment.

In order to analyze the performance of a wage subsidy in the presence of a macroeconomic shock, I simulate equation (5) with different values of s_F and θ_F. I do the simulations with elasticities of labor supply in the formal and informal sector equal to 0.75 and 0 respectively, while labor demand elasticity in the informal sector is set to 1. Figure A15 presents the results of the simulation. The figure includes 4 different scenarios, a subsidy of 5 and 10%, and then a decrease in the tax rate paid by firms equal to 1% of demand in the formal sector. Firms in the formal sector get a -9% shock with this decrease in the tax rate. The figure shows that a wage subsidy of 5% can decrease the negative effect of the economic shock in terms of higher wages and more employment in the formal sector as compared to the benchmark case of no subsidy. For a labor demand elasticity in the formal sector close to 1, the negative effect is decreased by close to 50% in terms of wages and employment.[12]

The second question to ask is related to whether a decrease in payroll taxes makes sense as opposed to a decrease in the profit tax. In the short-run, a wage subsidy is superior in terms of employed labor to decreases in profit taxes for two reasons: *1*) A firm can modify capital and labor with a decrease in the profit tax, in other words, we only have an "output effect", *2*) a wage subsidy has both substitution

[12] I do not deal with the effects of the tax revenue used to finance the increase in wage subsidies. The point of the model is just to show the effects of shocks in wages and employment, and then how a wage subsidy affects those outcomes. A general equilibrium model that includes the responses to taxes is beyond the scope of this paper.

and output effects. These considerations imply that governments, at least in the short run, can mitigate the formal employment effects of a macroeconomic shock through wage subsidies. Nevertheless, the analysis above is meant to be used for short-run analyses given the possible effects of labor regulation and profit taxes on the creation of formal firms and formal employment in the long-run.[13]

A possible reform in adjustment costs that allow a more flexible hiring and firing process can exacerbate the decrease in employment when there is a negative macroeconomic shock. However, lower labor regulation can accelerate the job creation process in the recovery period. Hence, a way to increase formal sector jobs during the recovery period is to decrease regulation of labor. In order to avoid welfare losses for workers in periods of future crises, an unemployment insurance scheme should be alternatively discussed.

7. Conclusions

This paper studies the empirical and theoretical effects of macroeconomic shocks in employment and wages for the case of Mexico. Using an event study of the 1995, 2001 and 2008 crises, I find that young and unskilled workers are the most affected by an economic shock: they are the most sensitive to changes in employment (they either add to the unemployed or they decide to leave the labor force). Moreover, women's labor force participation resembles men's labor force participation in the current crisis. Also, highly skilled workers are not as affected by the current crisis as unskilled workers. In particular, there is no evidence that highly skilled workers are contributing to the increase in the informal sector employment or that they are suffering a significant decrease in formal sector employment.

In order to make policy recommendations, I derive a theoretical model in a partial equilibrium setting. The theoretical model pays special attention to changes in the proportion of workers in the formal

[13] The model presented above does not consider long-run issues, and this is certainly an important aspect to analyze. For example, Besley and Burgess (2004) analyze the long run effects of labor market legislation in India. States across time approved a legislation called the Industries Dispute Act which was passed in each state with different amendments, so that in the end some states ended up with pro-labor legislation while others with pro-employer legislation. Differences were stark: states that passed a pro-worker legislation did not grow in manufacturing employment, while pro-employer states did show an increase in manufacturing employment.

sector to workers in the informal sector, and wages in the formal and informal sector. The theoretical findings imply that the elasticities of labor supply in the formal and informal sector are close to 0.75 and 0 respectively, and that labor demand elasticities in the formal and informal sector are both close to 1. A negative macroeconomic shock of 10%, would require a wage subsidy of close to 10% in order to avoid a change in employment in the formal sector.

The current project does not address the mechanisms behind the negative effects of macroeconomic shocks. Future research should address what type of employment young workers do and in what activities they are involved in the absence of employment. It is possible that young workers do not go back to school but spend time in illegal activities or criminal behavior. If this hypothesis is correct, addressing the problem of employment in young workers has large positive externalities.

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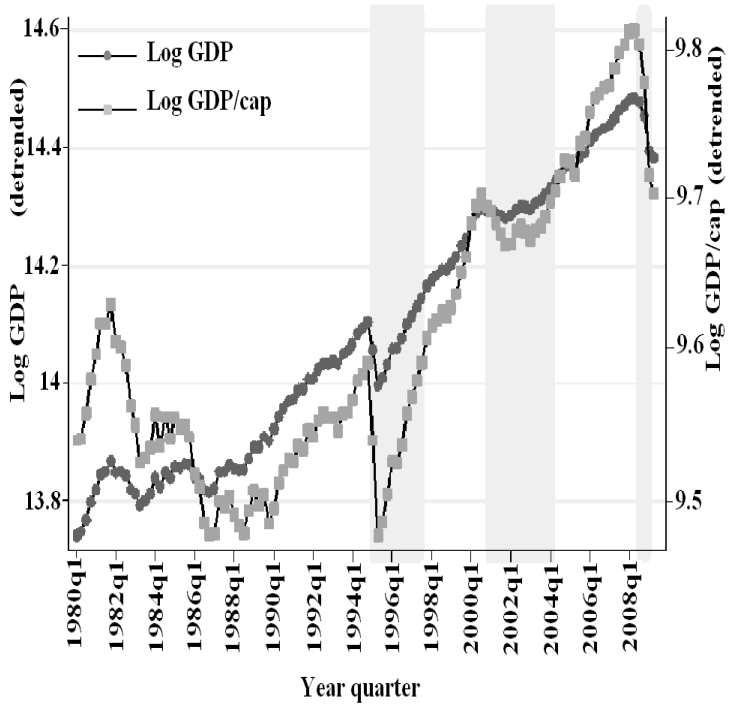
Appendix A

Figure A1

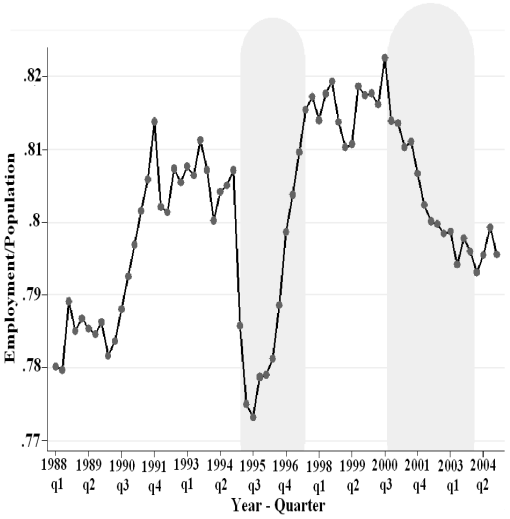
GDP and GDP per capita. Mexico 1980-2000



Note: GDP obtained from Statistical Office (INEGI). GDP detrended in 1993 prices (MXP millions). The series changed in 2008:I. Hence, I use information from 1980:I-2007:IV and then I use the new series in 2003 prices in order to obtain growth rates for 2008 and 2009. I apply these growth rates to the original series to obtain the series 1980-2009. Population for the period 1990-2009 is obtained from Conapo. In order to obtain population for the period 1980-1989, I use a constant growth rate using 1980 population data from the Statistical Office.

Figure A2
Employment, unemployment, share and relative wages in the formal sector: Males and females

A. Employment/Population: Males



B. Unemployment rate: Males

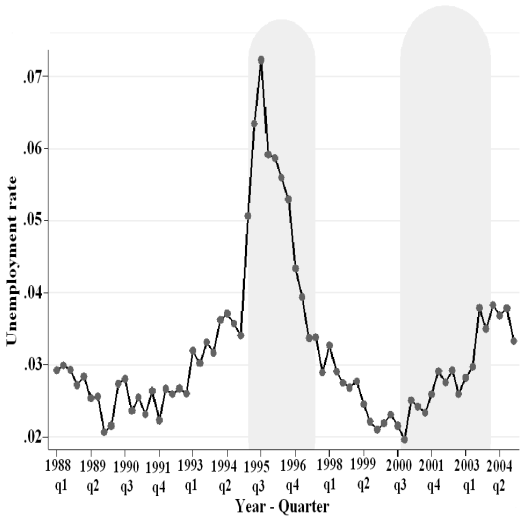
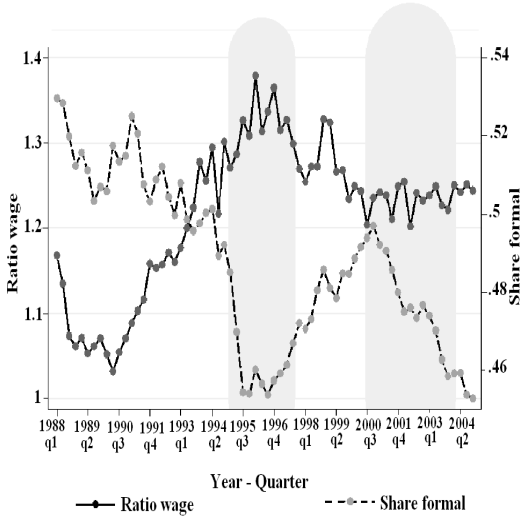


Figure A2
(*continued*)

C. Share formal and wages: Males



D. Employment/Population: Females

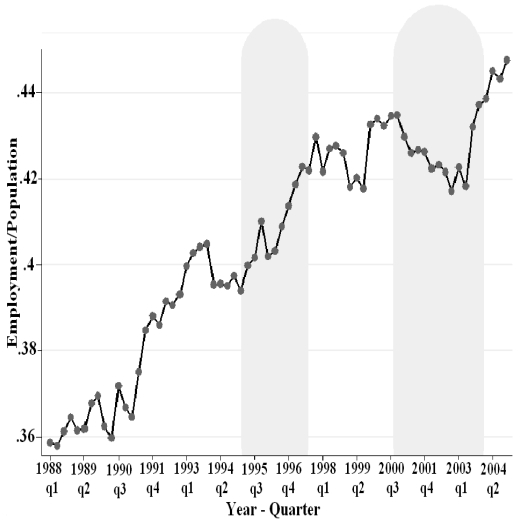
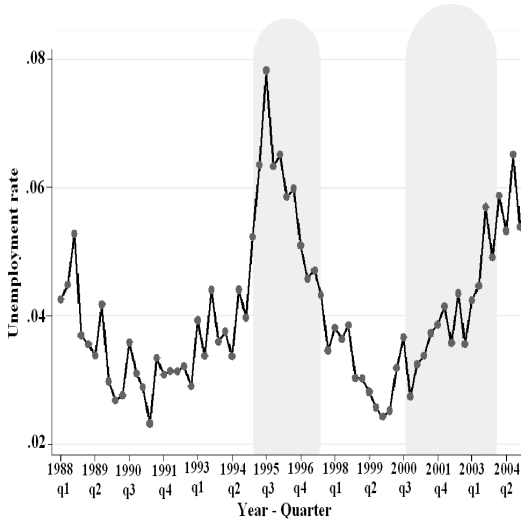
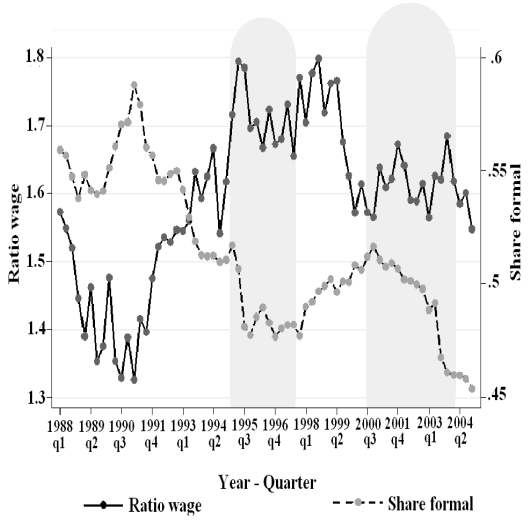


Figure A2
(*continued*)
E. Unemployment rate: Females

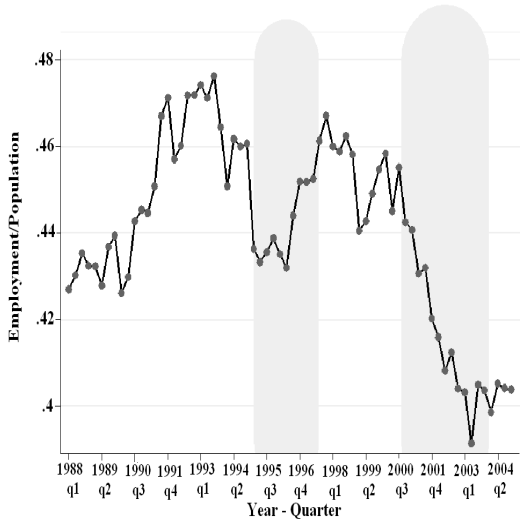


F. Share formal and wages: Females



Note: Data constructed using ENEU data. Shades represent crises periods.

Figure A3
Employment/Population by age and education
A. 15-24



B. 25-50

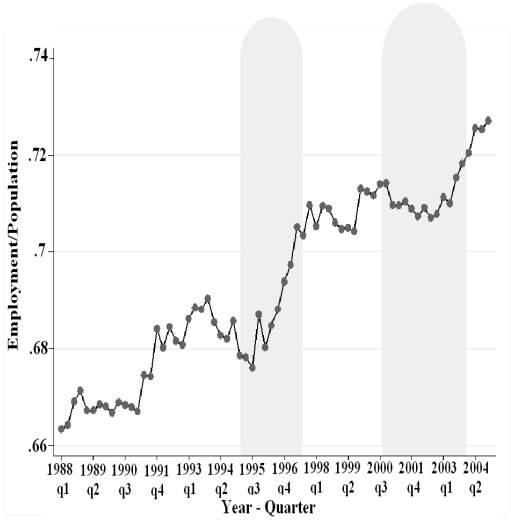
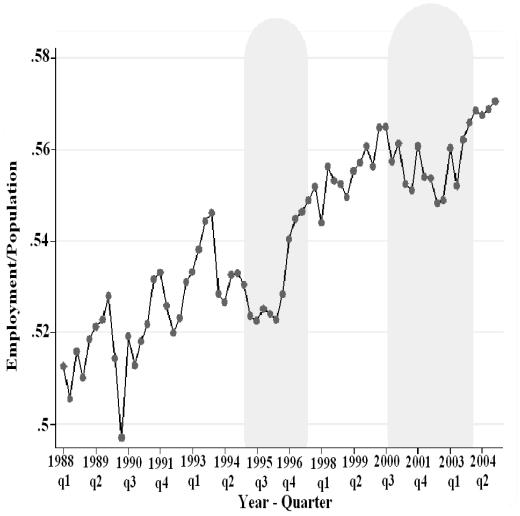


Figure A3
(*continued*)
C. 50 and over



D. Less than secondary school

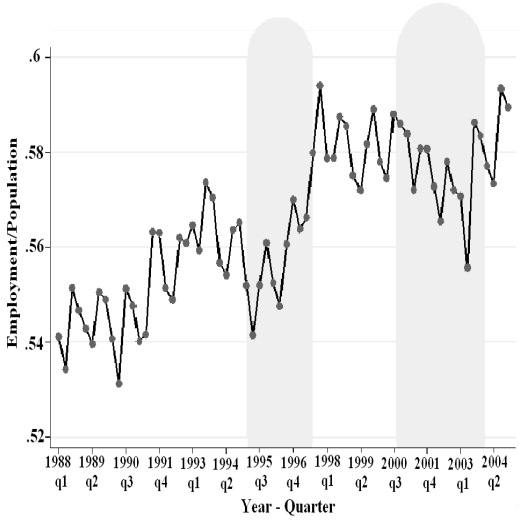
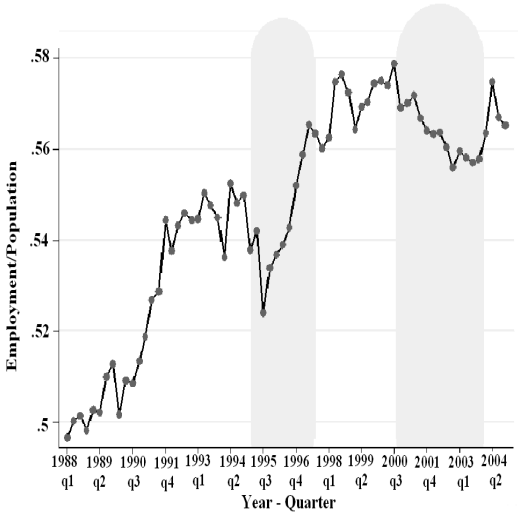
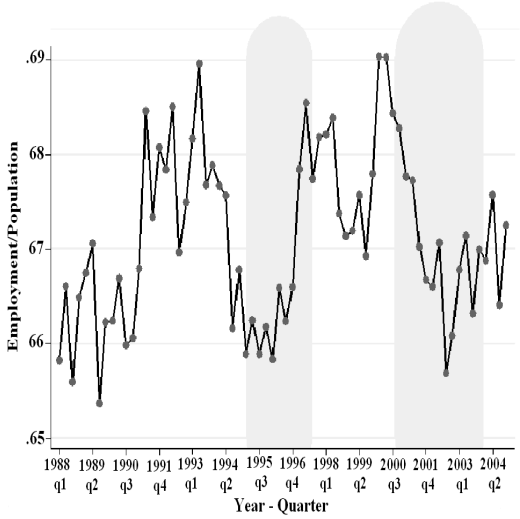


Figure A3
(*continued*)
E. Secondary school

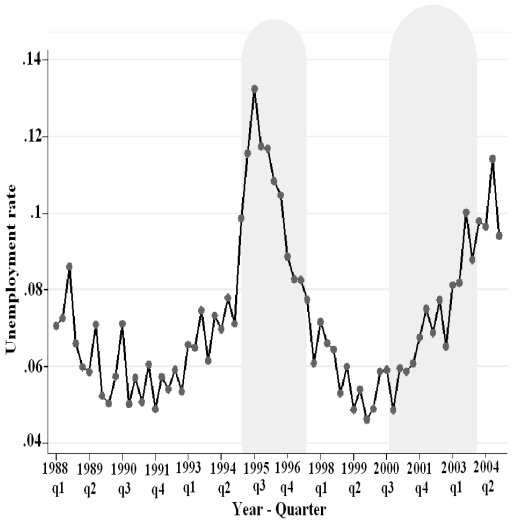


F. High school or more



Note: Data constructed using ENEU data. Shades represent crises periods.

Figure A4
Unemployment rate by age and education
A. 15-24



B. 25-50

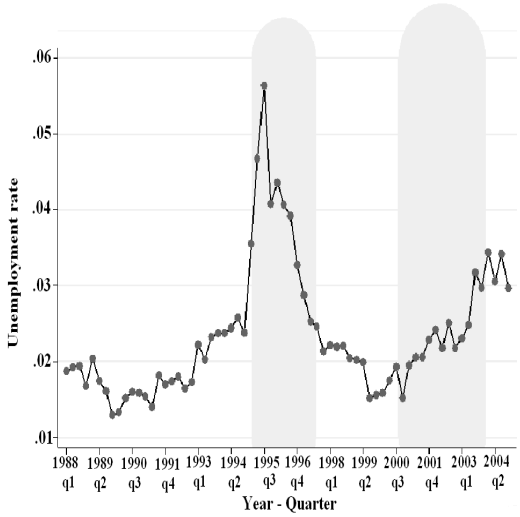
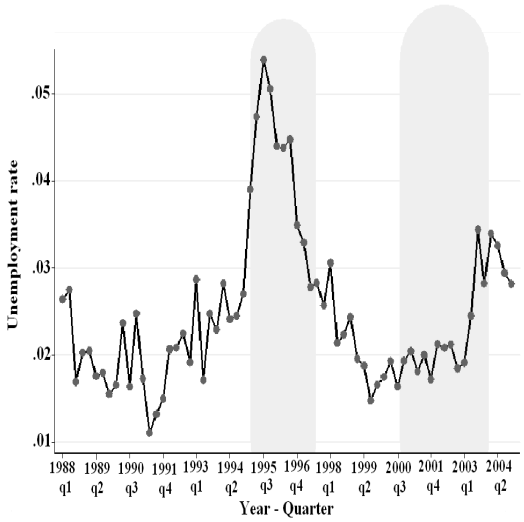


Figure A4
(*continued*)
C. 50 and over



D. Less than secondary school

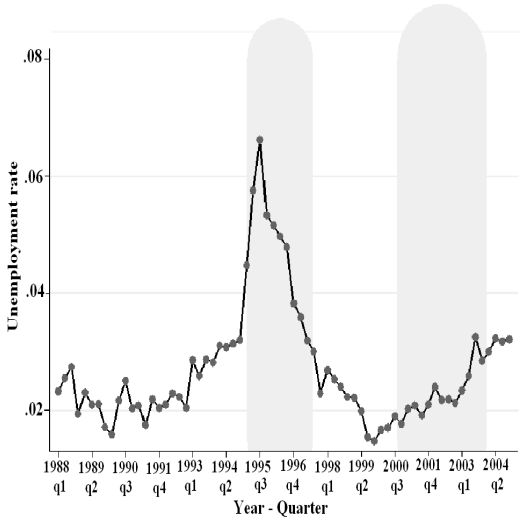
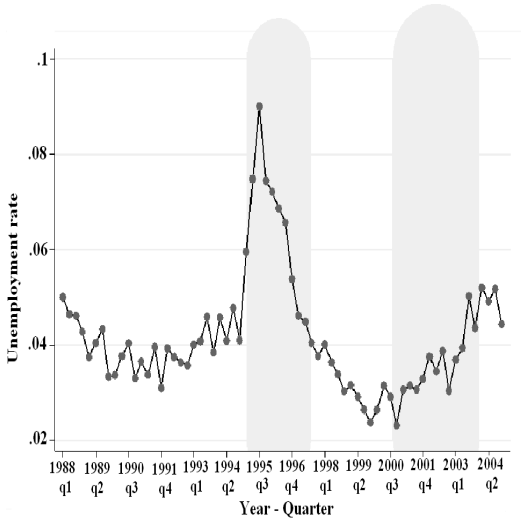
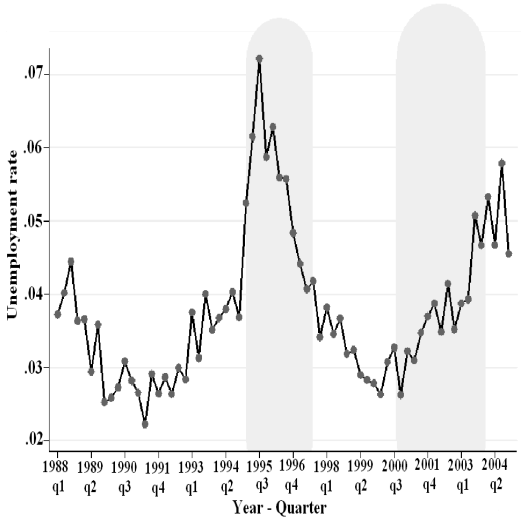


Figure A4
(*continued*)
E. Secondary school

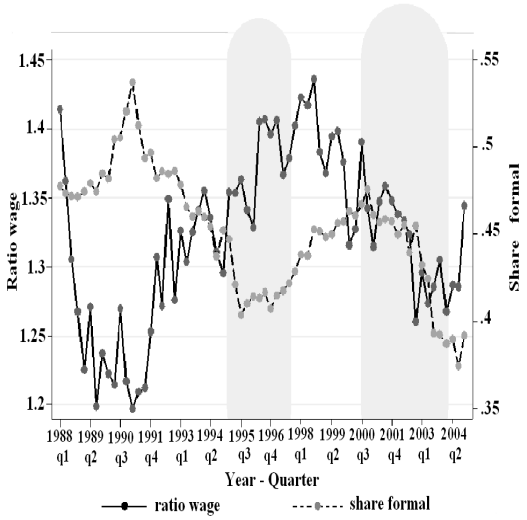


F. High school or more



Note: Data constructed using ENEU data. Shades represent crises periods.

Figure A5
Share of workers in formal sector and relative wage between formal and informal workers
A. Age: 15-24



B. Age: 25-50

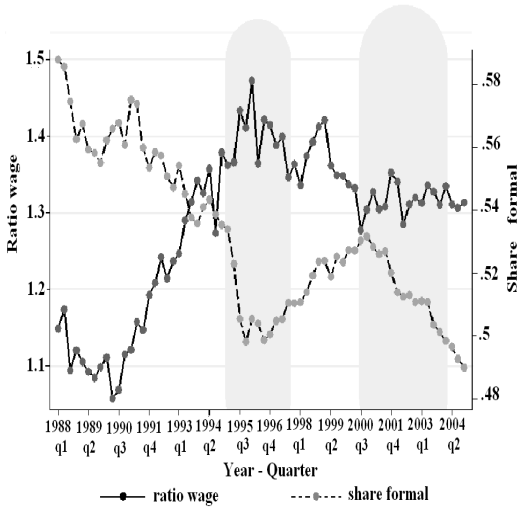
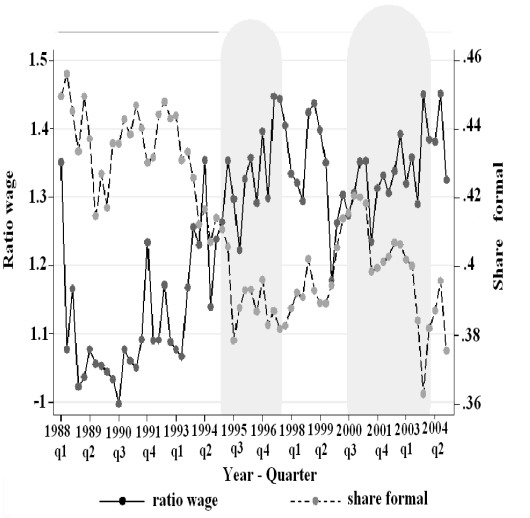


Figure A5
(*continued*)
C. Age: 50 and over



D. Education: Less than secondary school

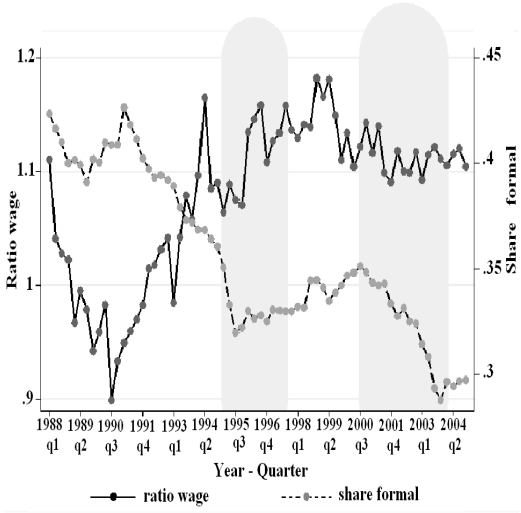
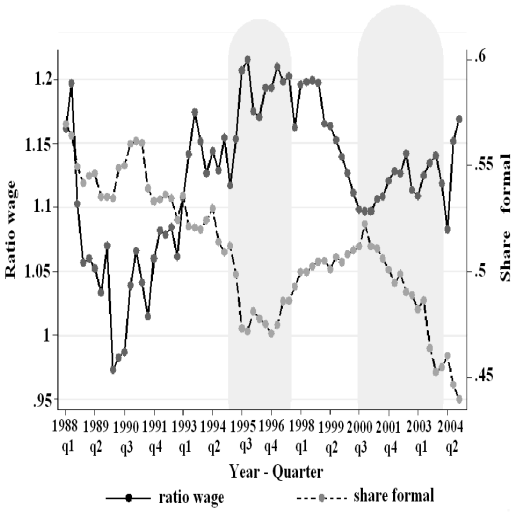
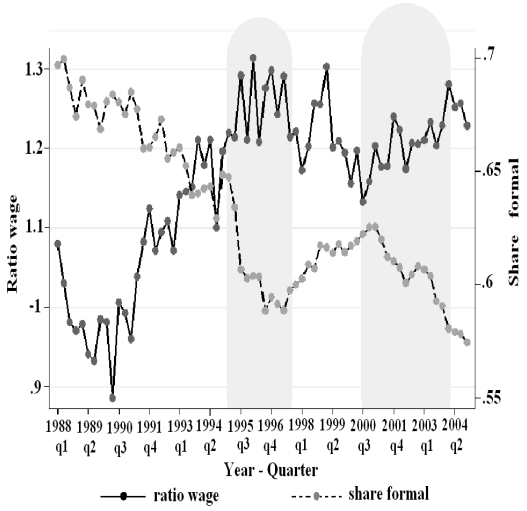


Figure A5
(*continued*)
E. Education: Secondary school

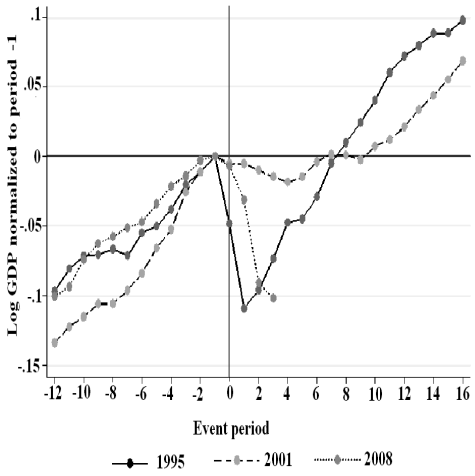


F. Education: High school or more

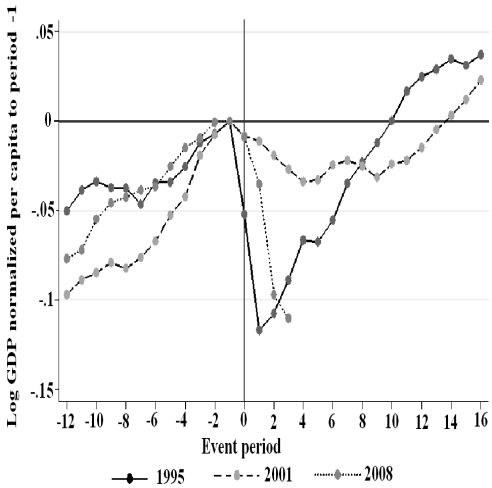


Note: Data constructed using ENEU data. Shades represent crises periods.

Figure A6
Event study: GDP and GDP per capita
A. GDP

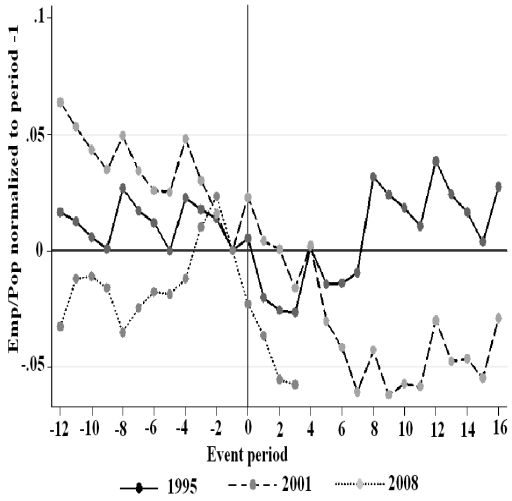


B. GDP per capita



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A7
Event study: Employment/Population by age group
A. Males 15-24



B. Males 25-50

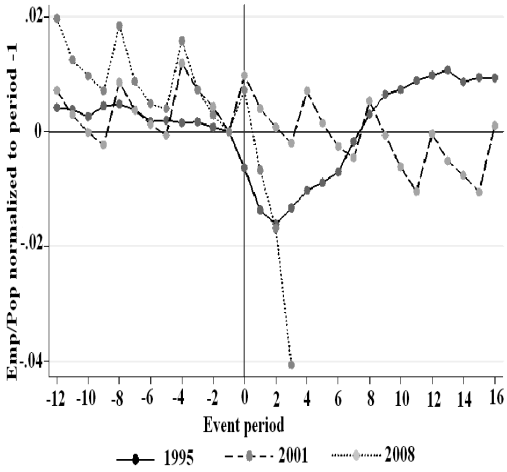
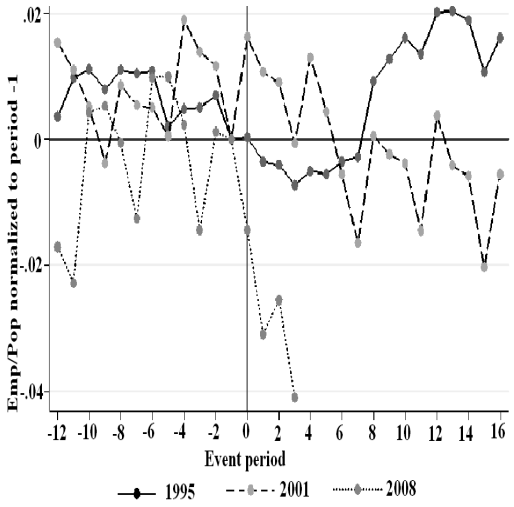


Figure A7
(*continued*)
C. Males 50 and over



D. Females 15-24

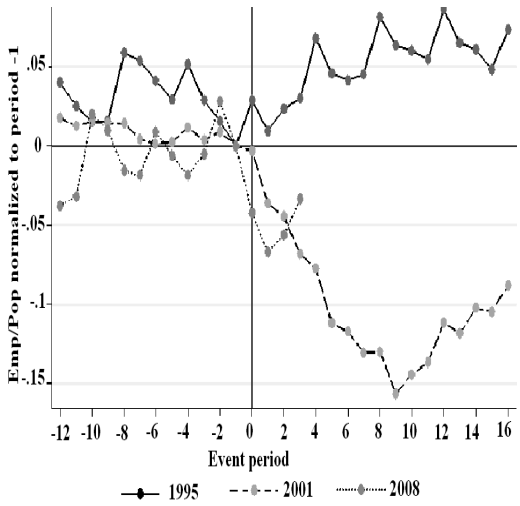
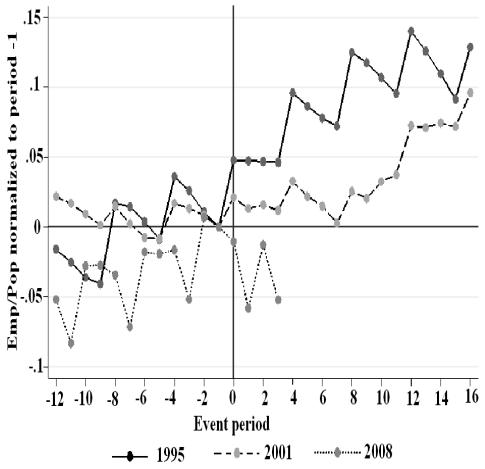
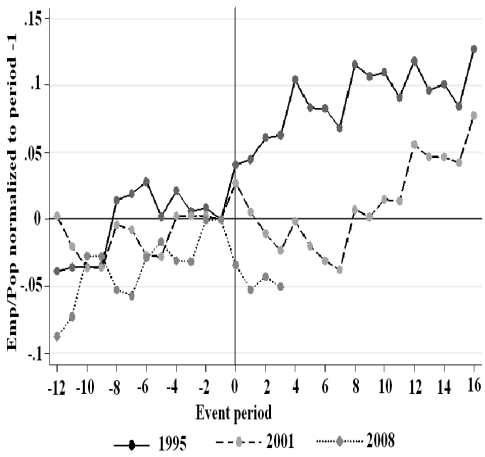


Figure A7
(*continued*)
E. Females 25-50

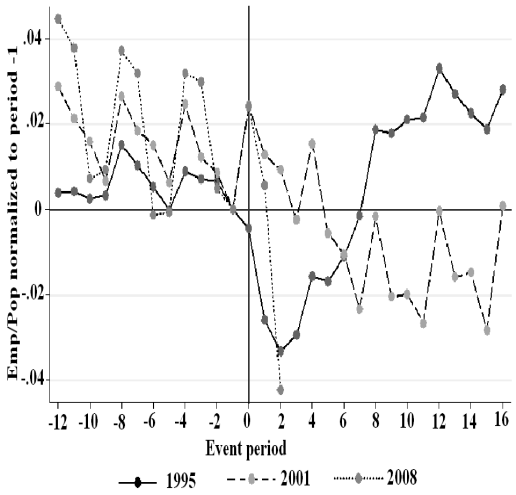


F. Females 50 and over



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A8
Event study: Employment/Population by education group
A. Males less than secondary school



B. Males secondary school

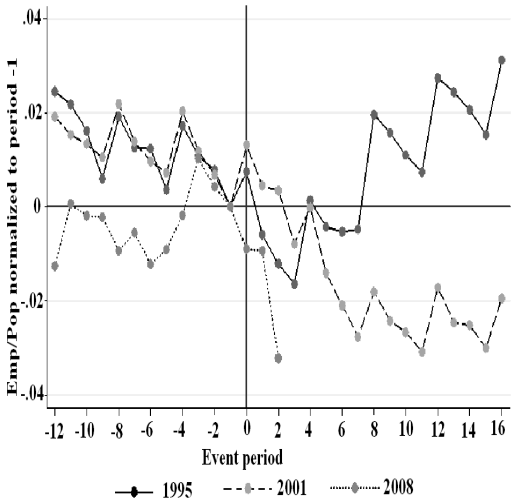
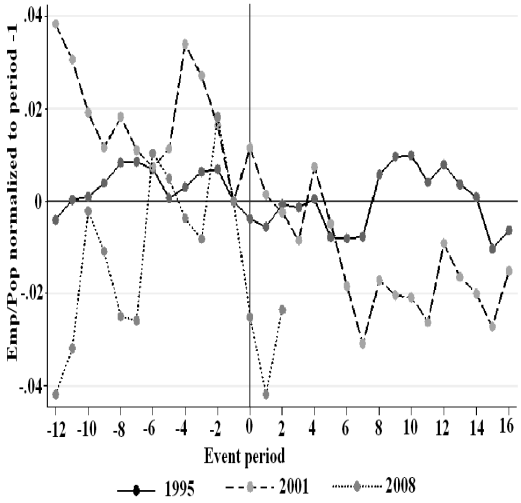


Figure A8
(*continued*)
C. Males high school or more



D. Females less than secondary school

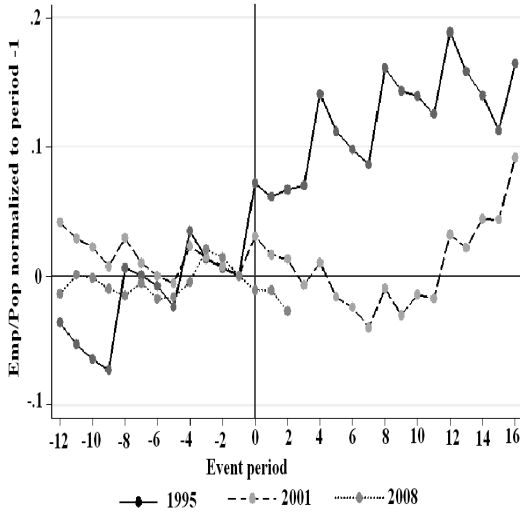
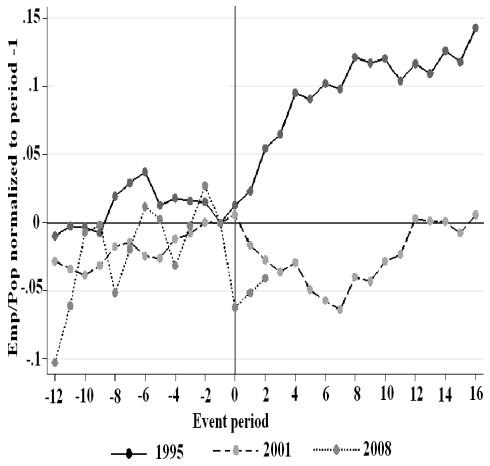
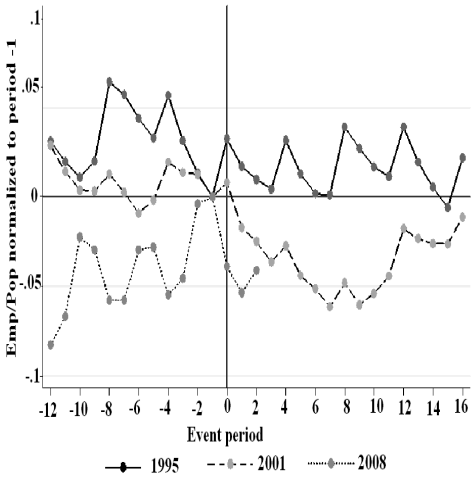


Figure A8
(*continued*)
E. Females secondary school

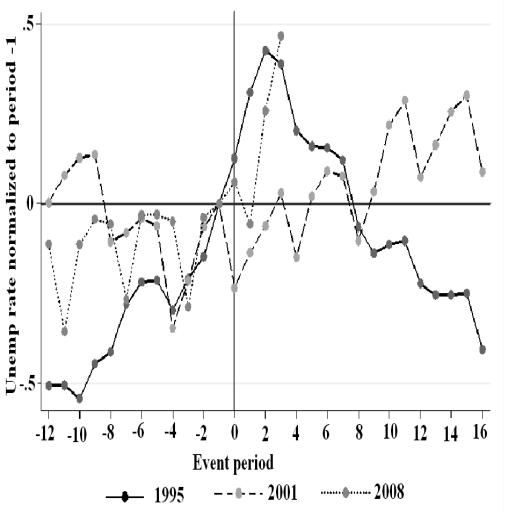


F. Females high school or more



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A9
Event study: Unemployment rate by age group
A. Males 15-24



B. Males 25-50

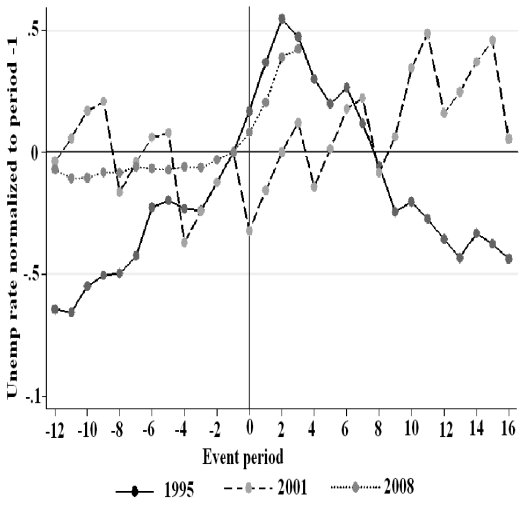
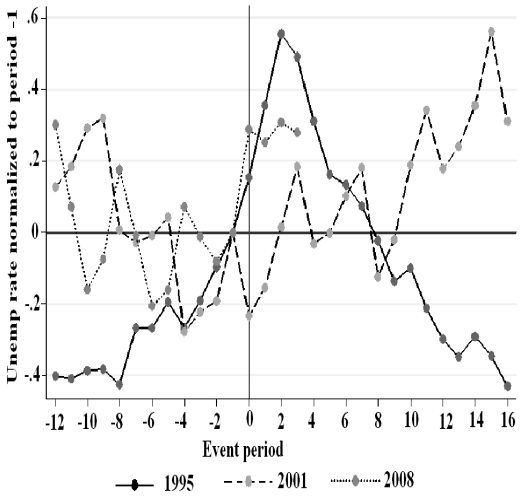


Figure A9
(*continued*)
C. Males 50 and over



D. Females 15-24

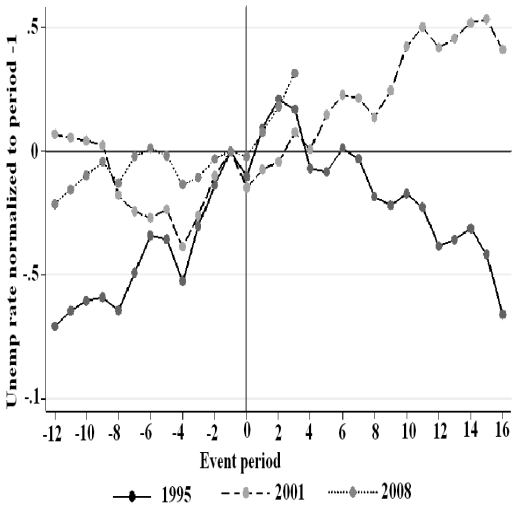
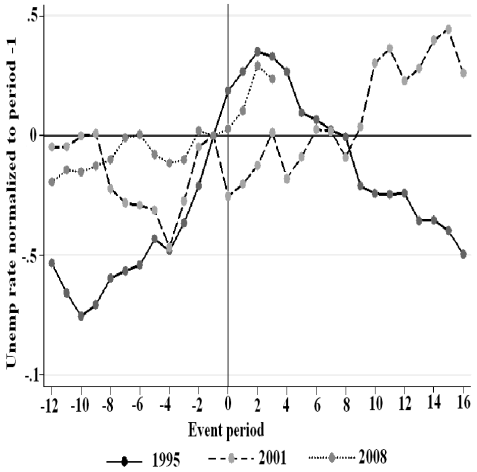
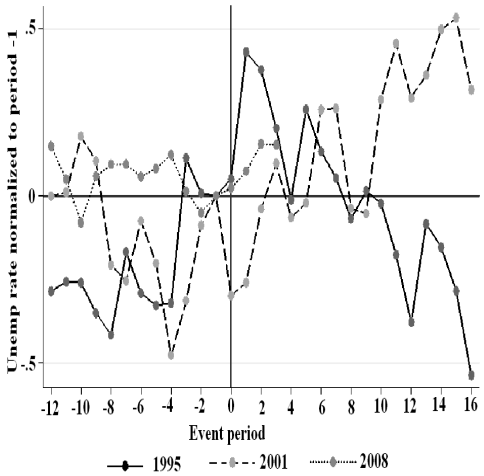


Figure A9
(*continued*)
E. Females 25-50

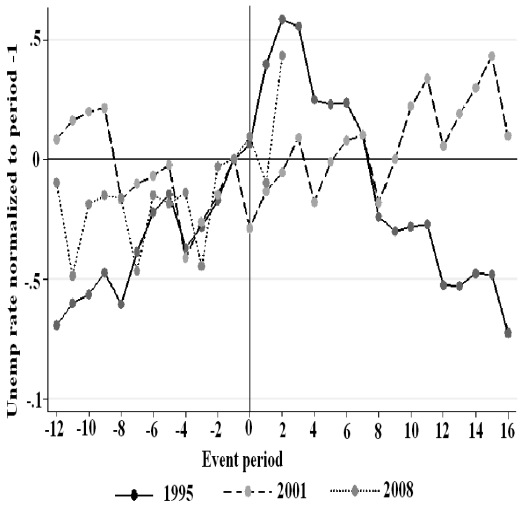


F. Females 50 and over



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A10
Event study: Unemployment rate by education group
A. Males less than secondary school



B. Males secondary school

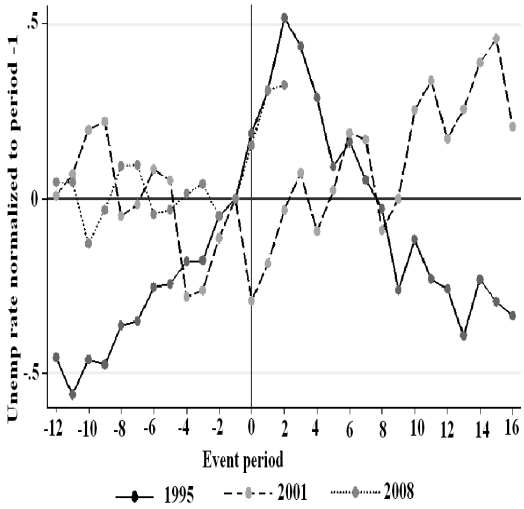
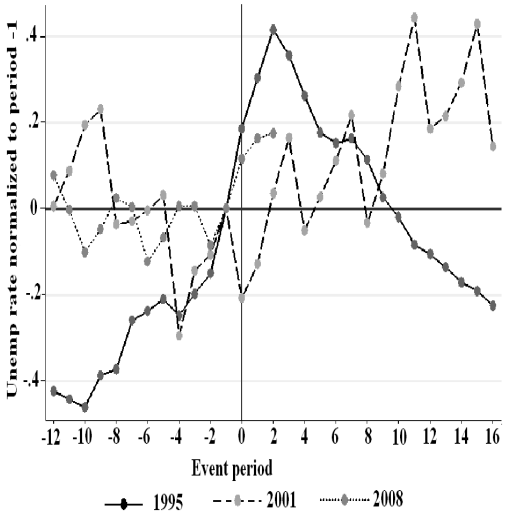


Figure A10
(*continued*)
C. Males high school or more



D. Females less than secondary school

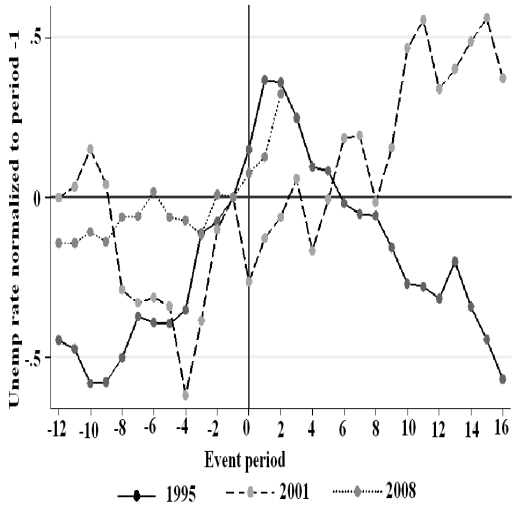
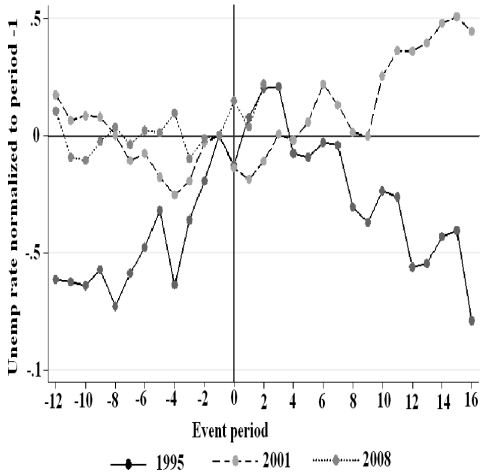
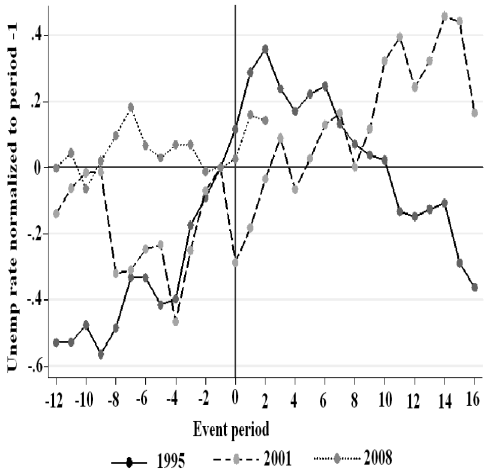


Figure A10
(*continued*)
E. Females secondary school

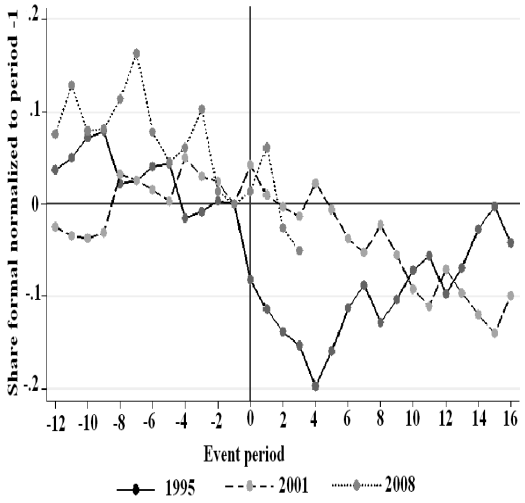


F. Females high school or more



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A11
Event study: Share in formal sector by age group
A. Males 15-24



B. Males 25-50

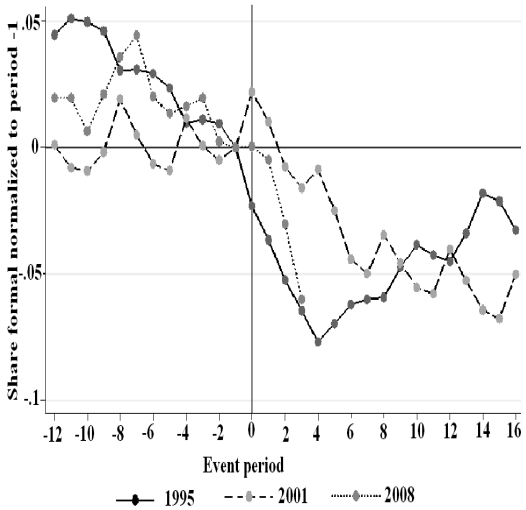
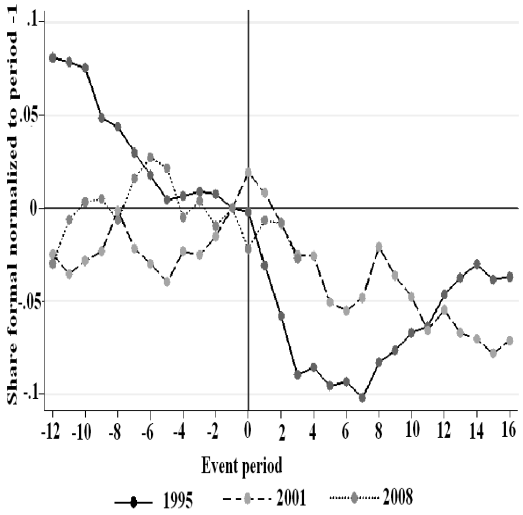


Figure A11
(*continued*)
C. Males 50 and over



D. Females 15-24

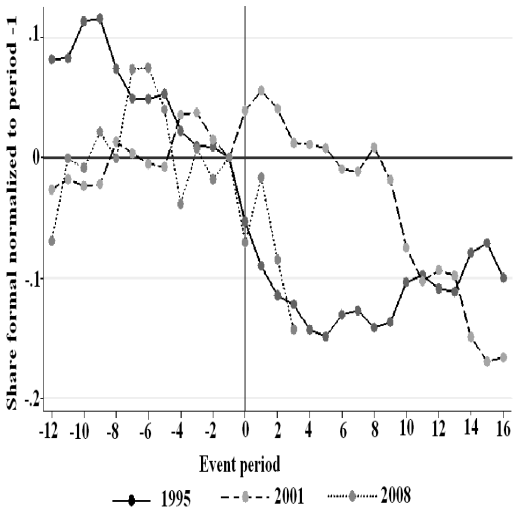
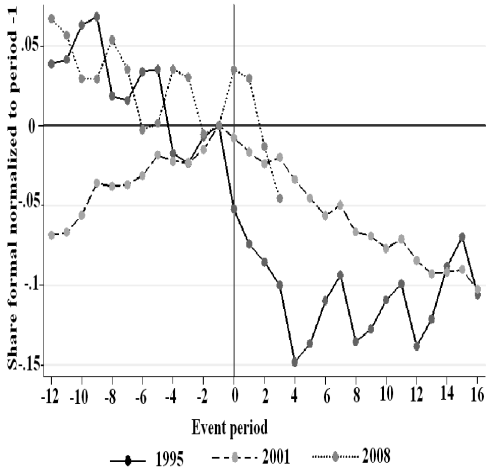
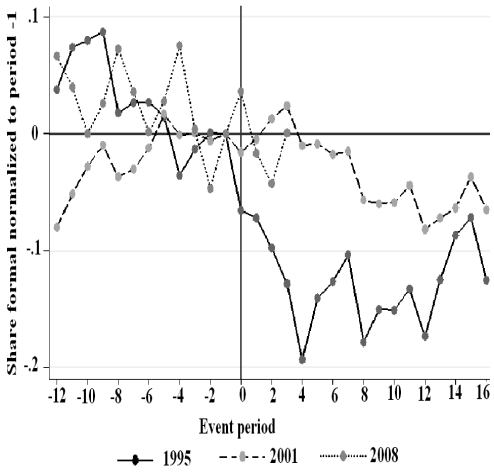


Figure A11
(*continued*)
E. Females 25-50

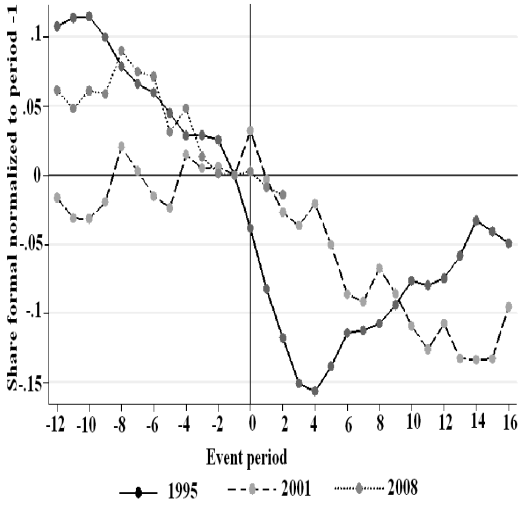


F. Females 50 and over



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A12
Event study: Share in formal sector by education group
A. Males less than secondary school



B. Males secondary school

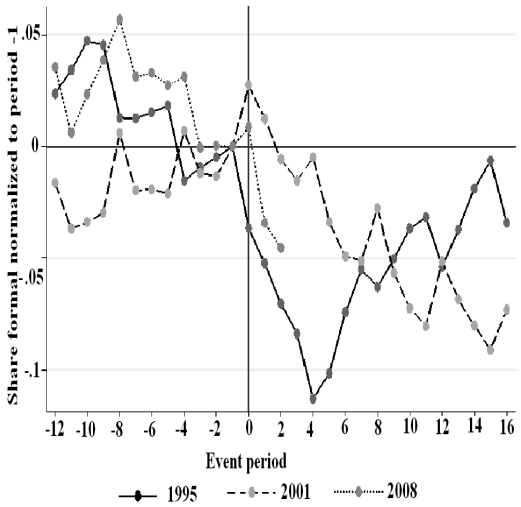
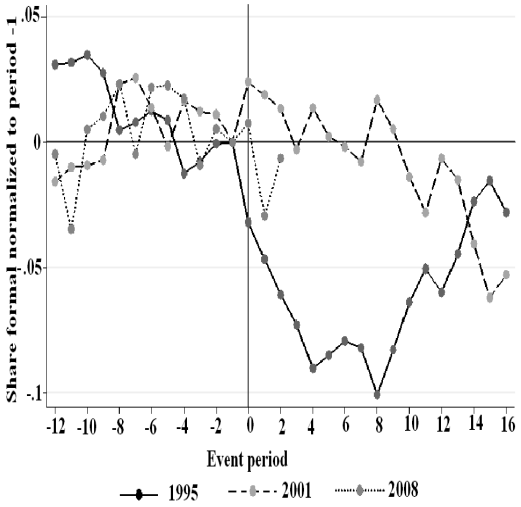


Figure A12
(*continued*)
C. Males high school or more



D. Females less than secondary school

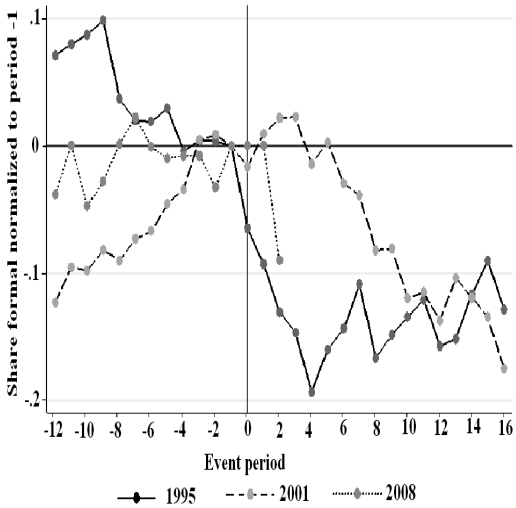
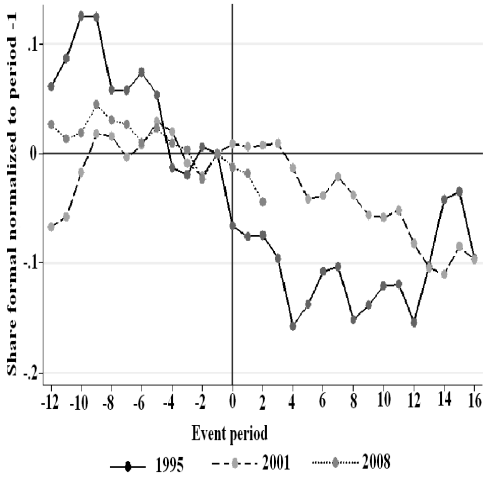
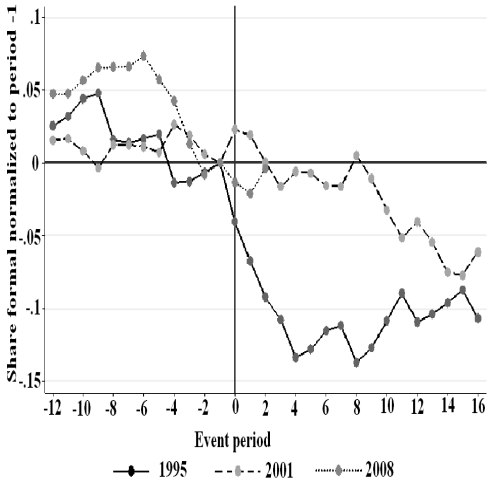


Figure A12
(*continued*)
E. Females secondary school

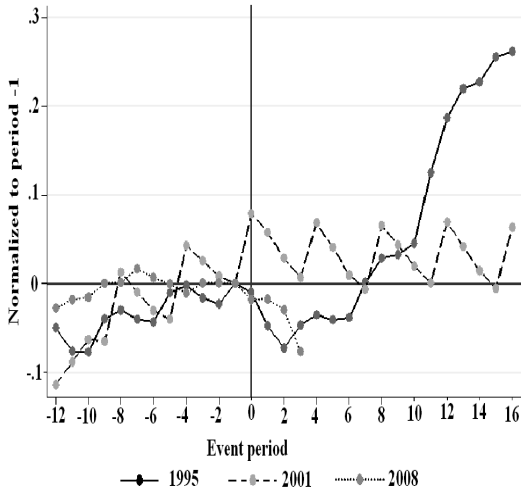


F. Females high school or more



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A13
Event study: Formal employment and relative wages
A. Formal employment: Males 25-50



B. Formal employment: Males secondary school

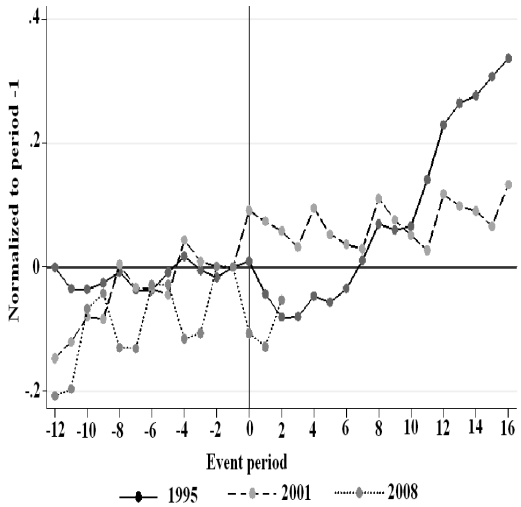
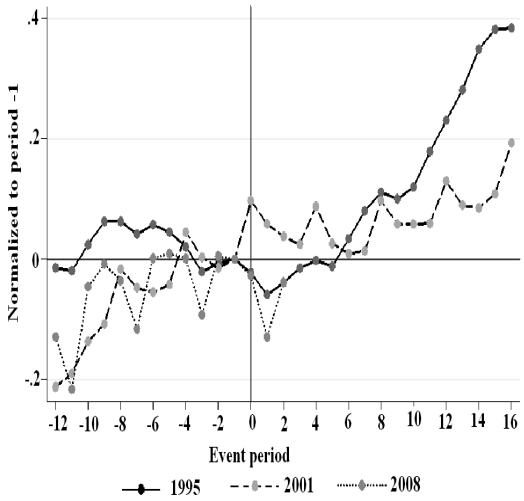


Figure A13
(*continued*)
C. Formal employment: Females secondary school



D. Relative wage F/I: Males 25-50

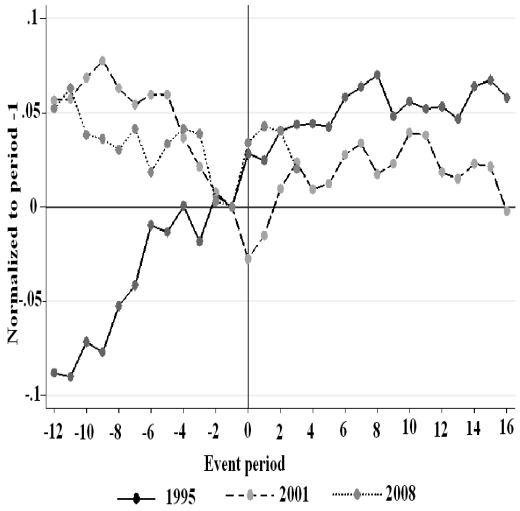
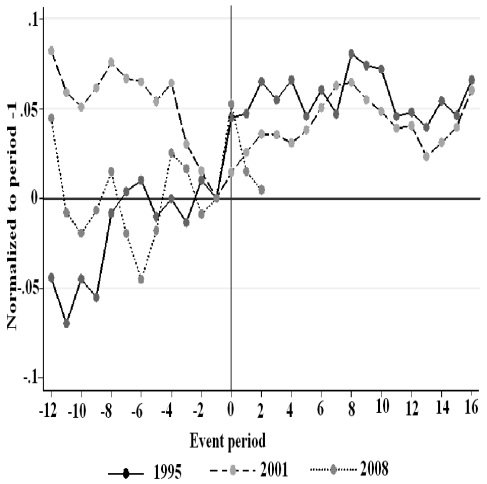
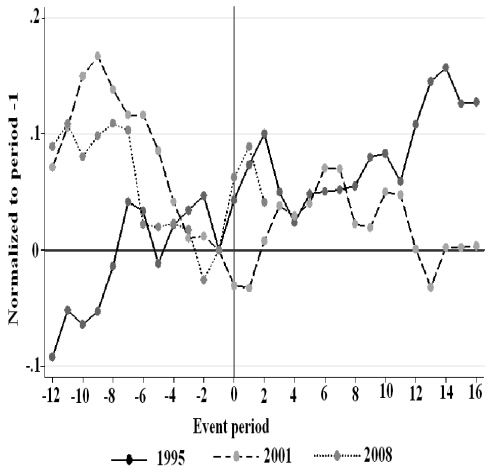


Figure A13
(*continued*)
E. Relative wage F/I: Males secondary school

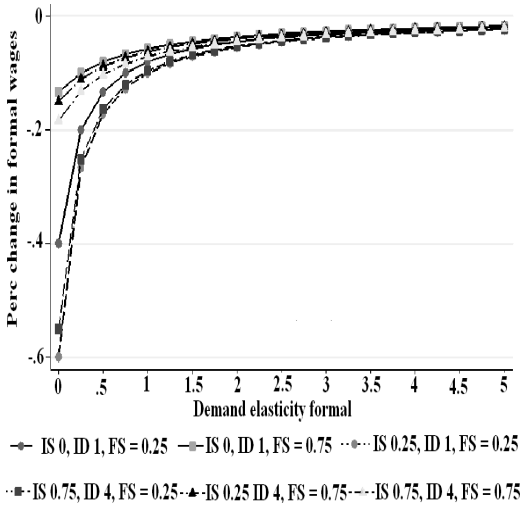


F. Relative wage F/I: Females secondary school



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure A14
Simulation of the model
A. Formal sector wages



B. Informal sector wages

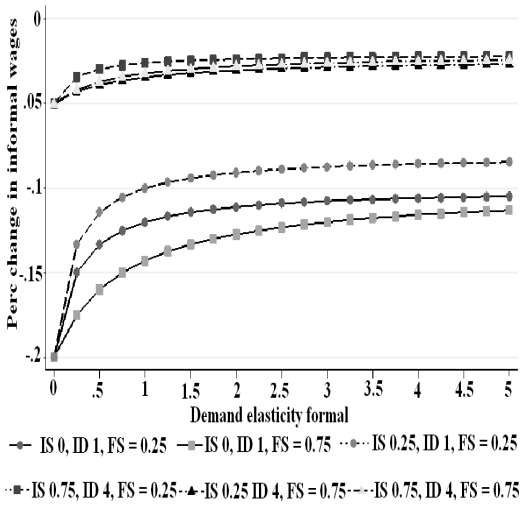
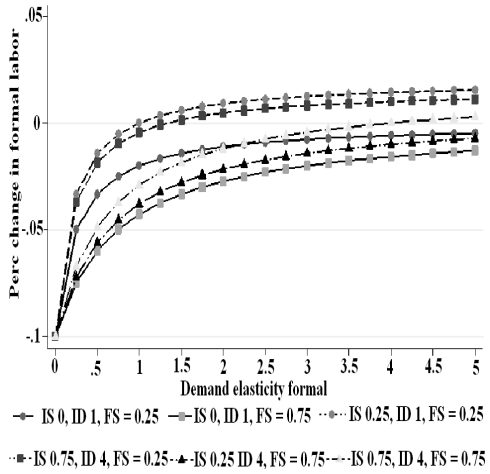


Figure A14
(*continued*)
C. Formal sector employment



Note: Simulations of equation (6). IS refers to Informal Labor Supply elasticity, ID to Informal Labor Demand elasticity, and FS to Formal Labor Supply elasticity.

Figure A15
Simulation of the model including wage subsidies
A. Formal sector wages

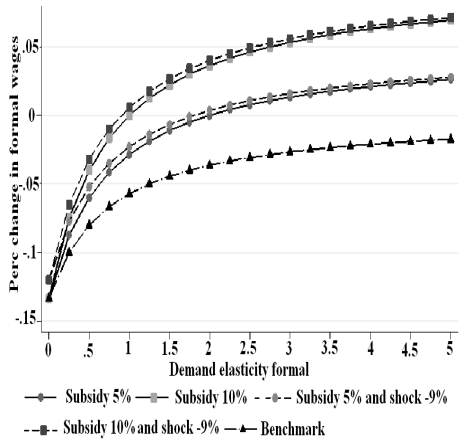
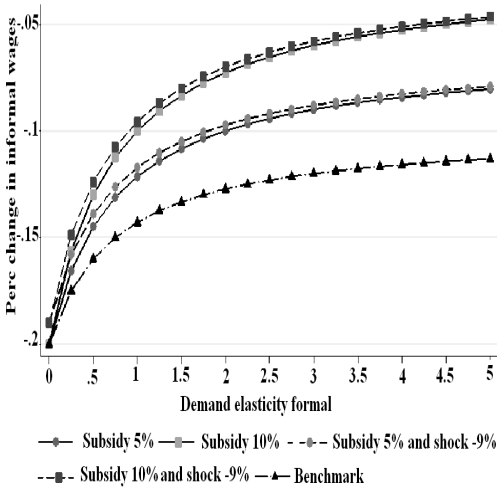
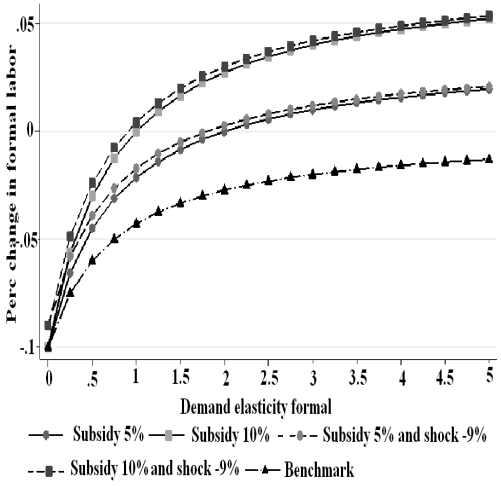


Figure A15
(*continued*)
B. Informal sector wages



C. Formal sector employment



Note: Simulations of equation (6). Labor supply elasticity in the formal sector is equal to 0.75, and in the informal sector is equal to 0. Labor demand elasticity in

the informal sector is set to 1. Shock of -9 percent only applies to formal sector, the informal sector still gets a 10 percent negative shock. The reason for this is that a decrease in the tax rate of firms only applies to formal sector firms. I am assuming that a decrease of 1 percent in the tax rate of firms is the same as a 1 percent positive shock to firms.

Table A1
Elasticities of outcomes with respect to GDP

Group	*Crisis*	*Emp/Pop*	*Unemp rate*	*% formal*	*Employment formal*	*Relative wage*
Males 15-24	1995	0.342	-5.404	1.468	1.590	-0.016
	2008	1.644	-4.660	0.934	1.945	-0.515
Males 25-50	1995	0.176	-5.305	0.549	0.429	-0.366
	2008	0.383	-7.814	0.738	0.499	-0.307
Males less than secondary school	1995	0.455	-8.192	1.453	1.607	-0.409
	2008	1.431	-7.693	0.677	1.700	0.085
Female less than secondary school	1995	-0.510	-5.379	1.440	0.728	-0.868
	2008	0.778	-4.387	1.485	1.980	0.717
Males secondary school	1995	0.154	-5.178	0.793	0.626	-0.982
	2008	0.583	-5.497	1.015	0.297	-0.511
Females secondary school	1995	-0.762	-1.686	1.094	0.342	-0.675
	2008	0.788	-2.940	0.854	0.514	-0.025
Males high school or more	1995	-0.033	-3.419	0.775	0.357	-0.302
	2008	0.342	-5.101	0.482	-0.714	-0.466
Females high school or more	1995	-0.047	-5.153	1.163	0.655	-0.051
	2008	0.591	-1.285	-0.157	-2.081	1.105

Note: Elasticities are calculated with respect to event 2 for each crisis.

Appendix B

Derivation of the Model

By totally differentiating equations (4) we get

$$\frac{\partial \log D^F}{\partial w_F} dw_F - \frac{\partial \log D^F}{\partial w_F} w_F ds + dA_F = \frac{\partial \log S^F}{\partial w_F} dw_F + \frac{\partial \log S^F}{\partial w_F} dw_I$$

$$\frac{\partial \log D^I}{\partial w_I} dw_I + dA_I = \frac{\partial \log S^F}{\partial w_F} dw_F - \frac{\partial \log S^F}{\partial w_F} dw_I \tag{7}$$

and defining $dA_F = \theta_F,\ dA_I = \theta_I,\ ds = s_F$, and the elasticities of labor demand and labor supply as

$$-\frac{\partial \log D^x}{\partial \log w_x} = \eta^x_{w_x} \quad \text{for} \quad x = F, I$$

$$\text{and} \quad \frac{\partial \log S^F}{\partial \log w_F} = \varepsilon^F_{w_F} \quad \text{and} \quad -\frac{\partial \log S^F}{\partial \log w_I} = \varepsilon^F_{w_I}$$

we can write equations (7) as

$$\begin{aligned} \Delta\%w_F \left(\varepsilon^F_{w_F} + \eta^F_{w_F}\right) &= \eta^F_{w_F} s_F + \theta_F + \varepsilon^F_{w_I} \Delta\%w_I \\ \Delta\%w_I \left(\varepsilon^F_{w_I} + \eta^I_{w_I}\right) &= \theta_I + \varepsilon^F_{w_F} \Delta\%w_F \end{aligned} \tag{8}$$

By solving equations (8) we get the equations written in (5).

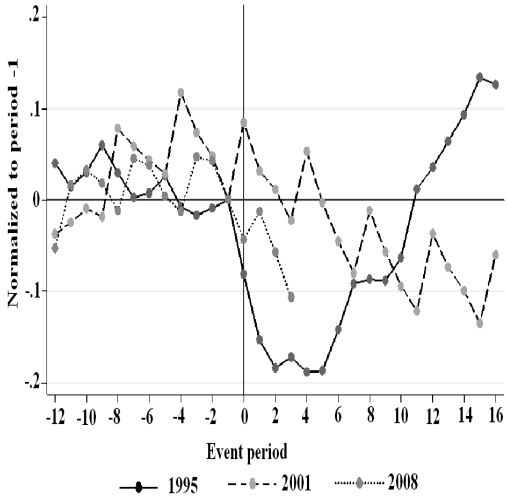
Equation (8) determines the optimum change in wages in the formal and informal sector $\Delta\%w_F$ and $\Delta\%w_I$, hence the change in formal labor is obtained by substituting the changes in wages:

$$\Delta\%L^F = \varepsilon^F_{w_F} \Delta\%w_F - \varepsilon^F_{w_I} \Delta\%w_I$$

Figure B1

Event study: Formal employment and relative wages

A. Formal employment: Males 15-24



B. Formal employment: Males HS

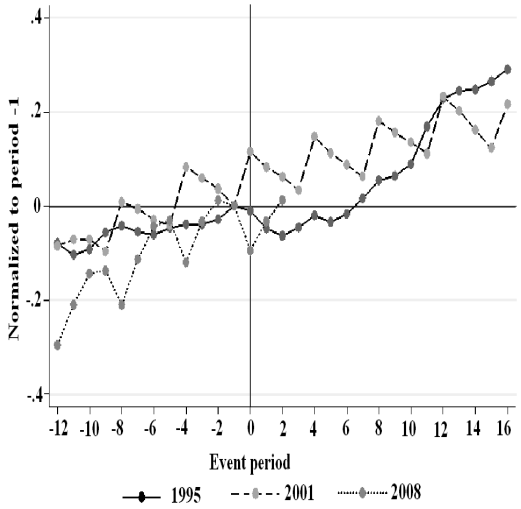
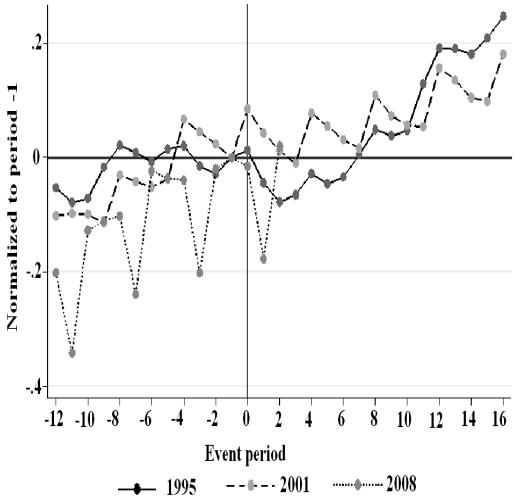


Figure B1
(*continued*)

C. Formal employment: Females HS



D. Relative wage F/I: Males 15-24

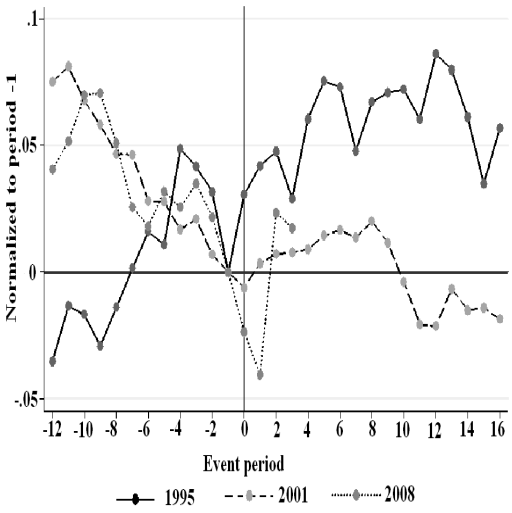
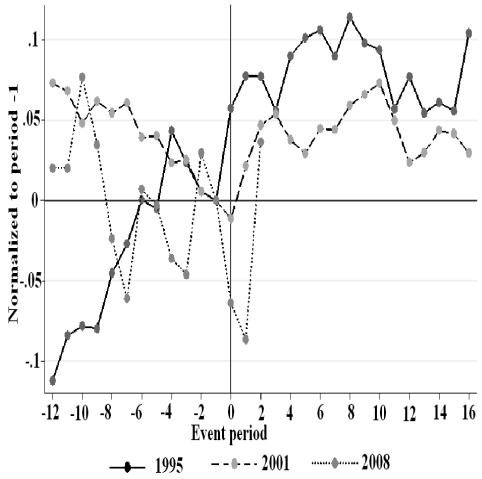
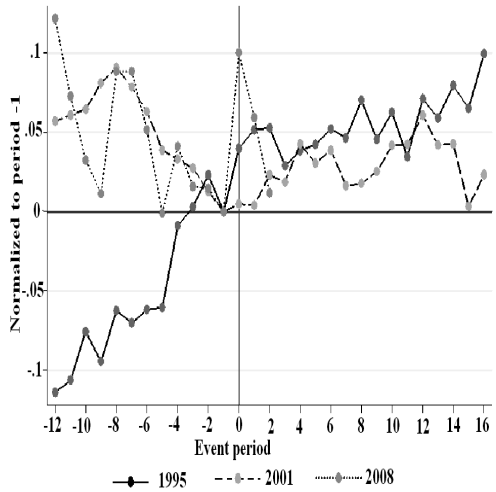


Figure B1
(*continued*)

E. Relative wage F/I: Males HS

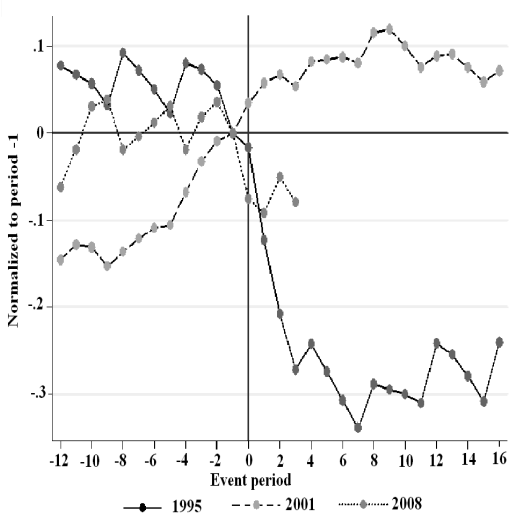


F. Relative wage F/I: Females HS



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}$ using regression (1). Each line represents a different regression.

Figure B2
Event study: Formal and informal wages
A. Formal: Males 15-24



B. Formal: Males secondary school

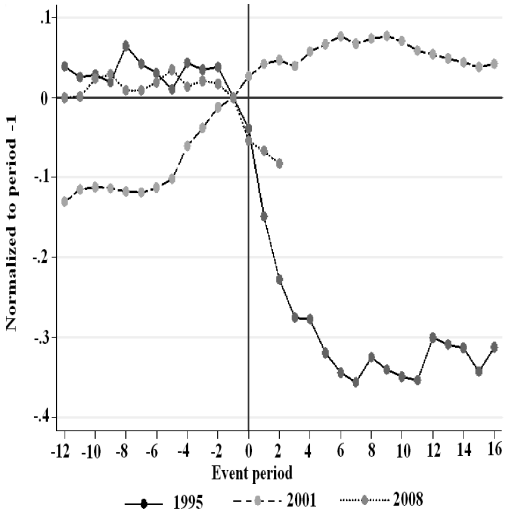
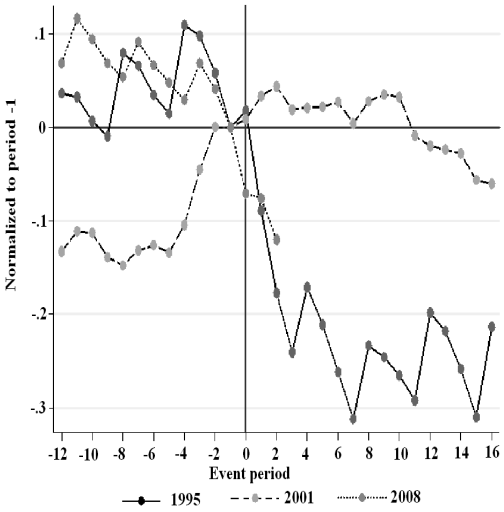


Figure B2
(*continued*)
C. Formal: Males high school



D. Informal: Males 15-24

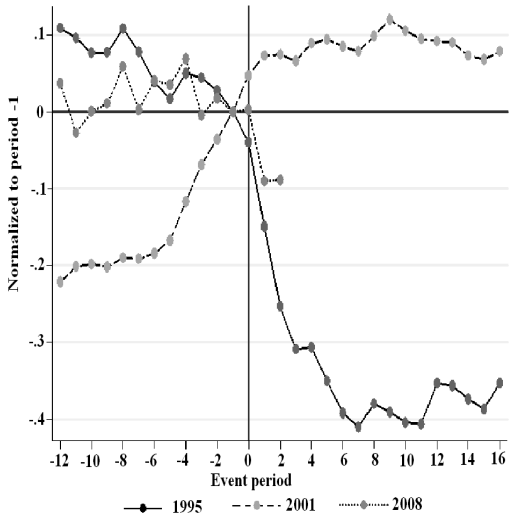
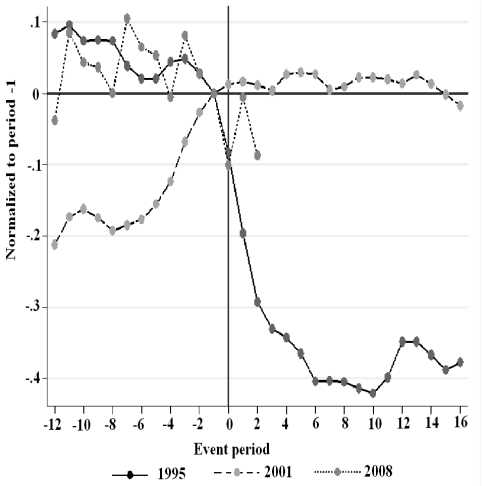
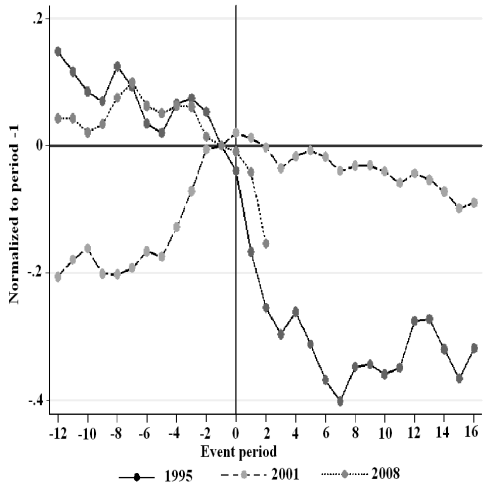


Figure B2
(*continued*)
E. Informal: Males secondary school



F. Informal: Males high school



Note: Each dot is interpreted as the mean effect of the outcome variable on that quarter with respect to period -1. Each dot is obtained from coefficient $\varphi_k - \varphi_{-1}1$ using regression (1). Each line represents a different regression.