The Effect of the Vietnam War on Female Labour Force Participation

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Abstract

War-induced demographic shocks have been shown to increase female labour force participation (FLFP). However, existing evidence predominantly stems from developed nations which may not fully capture the dynamics in developing contexts due to differing levels of economic development and institutional frameworks. To explore the effect of conflict on female labour market outcomes in developing countries, this paper examines the impact of the Vietnam War on women's labour market outcomes 14 to 43 years after its conclusion. To this end, I match comprehensive historical data on ordnance deployed by the United States in Vietnam to microdata and exploit district-level variation in exposure to ordnance. Leverating an OLS and difference-in-differences empirical strategy. I find that going from the 1st quantile to the median in exposure to ordnance increases the probability of Southern women working by 3.84 percentage points. I also find that this effect is persistent until present day. On the other hand, I find no effect of exposure to ordnance on the probability of working for Northern women, and all men throughout Vietnam. I further explore whether an increase in FLFP in the South was driven by higher demand for female labour due to a shortage in male workers. Using the Vietnam Enterprise Survey, I conclude that female labour supply increased without concomitant increase in demand; firm located in Southern districts which experienced higher exposure to ordnance did not exhibit a lower ratio of male to female workers.

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1 Introduction

Women's decision to participate in the labour market is shaped by cultural norms, which in itself, are shaped by historical events (Alesina et al., 2013). One such event is war. Through a variety of mechanisms, but primarily through demographic shocks, war can lead to a revision in cultural norms which previously prevented women from actively participating in the labour market (Goldin and Olivetti, 2013). These war-induced changes in norms do not simply revert back to their *antebellum* states at the conclusion of the war, but can persist as the new cultural norm (Teso, 2019; Boehnke and Gay, 2022; Gay, 2023). Given the disruptive nature of war, this paper studies the persistent effects of the Vietnam War on women's labour market opportunities.

With a female labour force participation (FLFP) rate of over 75 percent, Vietnam's FLFP is exceptionally high for a lower-middle income country. Both the negative shock to the sex ratio due to Vietnam War and the country's socialist legacy have been credited for promoting gender equality in Vietnam (Banerji et al., 2018). However, the extent to which each factor plays a role in shaping women's labour market outcomes is less clear, and one which this paper investigates.

There exists an extensive body of work which documents that conflict can lead to higher FLFP in developed countries. They are also informative with regards to the transmission channels. The first channel through which FLFP can increase due to war is through the negative income shock brought on by the death or departure of husbands. Well documented is that married women and widows in France, Germany and the United States increased their labour supply during WW1 and WW2 to smooth their household consumption (Goldin and Olivetti, 2013; Gay, 2023; Braun and Stuhler, 2023). The second channel that has been highlighted is that a shortage of male workers ('missing men') can cause an increase in demand for female labour (Acemoglu et al., 2004; Rose, 2018; Boehnke and Gay, 2022). Finally, culture has been shown to be an important transmission mechanism for both the generation directly affected by the shock and subsequent generations. For example, Gay (2023) show that daughters and daughters-in-law of women who experienced higher WW1 casualties were more likely to be working.

However, how demographic shocks alter the labour market outcomes of women in developing countries remains an under explored area of research (Teso, 2019; Fenske et al., 2022; Rogall and Zárate-Barrera, 2020). Most evidence on the nexus between demographic shocks and FLFP stress that the manufacturing sector, which grew rapidly throughout WW1 and WW2, played a pivotal role in the creation of jobs for women (Goldin and Olivetti, 2013; Rose, 2018). This leaves the question of the demand-and-supply dynamics of female labour in a war-time economy which is characterised by lower levels of industri-

alisation unanswered (Fenske et al., 2022).

Moreover, while the literature has predominantly focused on female labour market outcomes in terms of FLFP, how demographic shocks affect female entrepreneurship has been overlooked. It is conceivable that a lack of demand for female labour (e.g. due to cultural reasons) may encourage women to start their own businesses to smooth household consumption.[1] In the case of Vietnam, the share of female-managed businesses is exceptionally high at 57 percent in 2001.[2] Given the ambiguity regarding the demand-and-supply mechanisms underpinning the nexus between war and FLFP in developing economies, this paper additionally explores (1) the extent to which female workers replaced male workers in Vietnam, and (2) whether female entrepreneurship increased as a result of the Vietnam War.

More broadly, this paper speaks to the literature on the long-term impact of war. The empirical studies in this field focus on establishing whether the 'Conflict Trap' does or does not exist. With regards to the persistent effect of the Vietnam War, Miguel and Roland (2011) find no impact on consumption and poverty 23 years after the war. Also pertinent to this paper is the finding by Riano and Valencia Caicedo (2024) that unexploded mines due to the Laotian Civil War, and which the US was also heavily involved in, still negatively impacts the country's nighlight activity and human capital today. This paper revisits the question of how US foreign policy in Southeast Asia still affects the economic development of the region today by incorporating a gender dimension. This an important question to study because understanding the role women play in post-war economic reconstruction has important policy implications since (civil) war is a salient feature of many developing countries.

While Kreibaum and Klasen (2015) have previously examined the effect of the Vietnam War on FLFP, this paper differs from theirs in three distinct ways. First, I use as my main explanatory variable the total number of ordnance jettisoned rather than the 1979 sex ratio since this accounts for the fact that North Vietnam had a lower sex ratio before and after the Vietnam War compared to South Vietnam.[3]. Thus, using 1979 sex ratio as a proxy for the Vietnam War is not an accurate proxy since ordnance is associated with lower sex ratio in the South but not the North (Figure B.4 of the Appendix). This paper also uses a higher level of disaggregation (i.e. districts rather than province). This allows for a more precise understanding of the effect of the Vietnam War, and also

[1] Churchill et al. (2021) find that early life exposure to bombs dropped during the Vietnam War is positively associated with self employment, although the differential impact of ordnance exposure on male and female workers was not explored.

[2] Author's calculations using the 2002 VHLSS.

[3] Author's calculations using the 1960 and 1969 Statistical Yearbook of Vietnam. One reason for why the sex ratio was lower in the North prior to 1975 is because the bulk of the war for independence from France was fought in the North and not the South.

enables me to compare how exposure to ordnance impacts female labour market outcomes even *within provinces*. Finally, I expand the outcomes studied by focusing also on female entrepreneurship.

In this paper, I take advantage of the fact that this was an unusually well-documented historical event. In particular, the Theatre History of Operations Reports (THOR) dataset, which records the geolocation of every ordnance dropped by the the US Armed Forces since WW1, is used to calculate district-level exposure to the Vietnam War. I then match district-level bombing intensity to the 2009 IPUMS Population and Housing Censuses, as well as the 2002 to 2012 Vietnam Household Living Standards Survey. Using an OLS estimation strategy, I find that there is large regional heterogeneity in the effect of exposure to the Vietnam War on female labour market outcomes on the extensive margin. In what was South Vietnam, an increase in exposure to ordnance from the first quantile to the median increases the probability of women working by 3.84 percentage points 23 years after the end of the war. I obtain similar estimates for Southern women even after 43 years. For Northern men and women, and for Southern men, I find that exposure to ordnance had a statistically insignificant effect on the probability of working. I validate my results with a difference-in-differences (DiD) strategy which exploits variation in exposure to ordnance across districts and age cohorts. I find that the effect of bombing on the probability of working is largest for Southern women who were aged 24 to 30 at the time of reunification in 1975. For Northern women and for all men, I obtain negative and statistically significant results across most age groups although the estimates are close to zero.

In terms of whether the increase in female labour supply was driven by an increase in demand for female labour, I employ a fixed effects model and utilise the Vietnam Enterprise Survey from 2002 to 2018. I find a lack of evidence of substitution towards female labour since Northern and Southern firms located in districts which experienced higher levels of ordnance did not exhibit a lower ratio of male to female workers. Instead, I find that exposure to ordnance is positively associated with the share of businesses managed by women. More specifically, going from the first quantile to the median in exposure to ordnance increases the share of female-managed businesses by 3 percentage points. I interpret this result as being reflective of a means through which women smoothed out their household consumption given low demand for female labour.

I complement my analysis with casualties data from the from the Situation Report Army File (SITRA) which records casualties by nationality for missions in South Vietnam. I exploit district-level variation in exposure to death rates, and the results confirm my main results on female labour market outcomes on both the extensive and intensive margin.

The rest of this paper proceeds as follows: Section 2 provides an overview of the

Vietnam War, Section 3 details my source of data, Section 4 outlines my empirical strategy, and Section 5 analyses the results. Finally, Section 6 concludes.

2 Overview of the Vietnam War

2.1 The Vietnam War

Vietnam was under French colonial rule from 1858 which culminated in the defeat of the French Union by the Viet Minh communist revolutionaries in the Battle of Dien Bien Phu in 1954. Following French exit from Vietnam, the country was split along the 17th Parallel pursuant to the Geneva Conference with the North being a Communist state led by Ho Chi Minh, and the South as a capitalist state under US-backed Ngo Dinh Diem. Although the country was split into two, Viet Cong (VC) revolutionaires sought to reunite the country under communist rule, sending support in the form of manpower and material to insurgents in the South pursuant to the 'Road to the South' plan (Daddis, 2015).

President Kennedy initially opposed military intervention, but the backdrop of the Cold War and the Diem administration's incompetence in addressing communist insurgency ultimately led to the deployment of 200,000 troops in South Vietnam in 1965. After President Kennedy's assassination, President Johnson and President Nixon continued their predecessor's policy towards invovelement in Southeast Asian geopolitics. By 1973, there were over 500,000 troops in South Vietnam which ended with US defeat and subsequent withdrawal in 1973 (Dell and Querubin, 2018).

It is worth noting that the war occurred against a backdrop of large cultural and economic differences between the North and South. Specifically, the Democratic Republic of Vietnam ('North Vietnam') had a higher level of industrialisation at the onset of the war thanks to its endowment in natural resources (especially coal) and French investment in the manufacturing sector under its colonial rule (Cima, 1989). However, the government of the North also discouraged private enterprise, emphasising instead the role of central planning in economic development. By contrast, South Vietnam had a relatively nascent industrial capacity and instead expanded and traded rice and rubber (CIA, 1960). In contrast to the North, South Vietnam operated under a market-oriented economy until 1975. By the time the country reunified in 1975 with the Fall of Saigon, the two economies did not converge and the initial differences were amplified further as the Communist Part of Vietnam (VCP) failed to contain private enterprises in the South (Cima, 1989).

The scale and chaotic nature of the Vietnam War cannot be understated. Throughout the war, Vietnam experienced the most intense bombing in history with a combined

tonnage of bombs dropped equalling three times as much by weight as the European and Pacific theatre in WW2 combined (Miguel and Roland, 2011). Bombing efforts were primarily directed towards the Southern regions and concentrated along the 17th Parallel, reflecting the US' emphasis on quelling insurgent activities in the South over addressing communist presence in the North (Daddis, 2015; Dell and Querubin, 2018). US counterinsurgency (COIN) in South Vietnam has also been characterised as favouring an approach of 'overwhelming firepower' (Dell and Querubin, 2018).

US targets in North and South Vietnam is summarised in Table 1. Column 2 shows that agricultural and civilian targets made up the majority of targets in the South, and reflects areas which the US believed to be currently under or particularly susceptible to VC control (Dell and Querubin, 2018). On the other hand, civilian and agricultural targets made up the minority of Northern targets, with infrastructure making up the vast majority. Northern patterns of bombing reflect US' objective of dismantling the secretive supply networks, notably the Ho Chi Minh and Sihanouk Trails, which the VC used to incite insurgent activity in the South (Riano and Valencia Caicedo, 2024).

Table 1: Summary of ordnance targets, by region

	North	South
Agriculture	0	107
Civilian	34649	810947
Infrastructure	468053	156051
Industry	17914	4321

Source: Author's calculations using THOR.

Not only was this an expensive war to fight, it was also extremely costly in terms of lives lost. One conservative estimate of North and South Vietnamese casualties puts the total killed at 791,000, of which 655,000 were males above the age of 15 (Hirschman et al., 1995). The Vietnam War also led to large sex imbalance, particularly amongst those of prime working age (i.e. 25 to 54) in 1979 (Merli, 1998). While accurate estimates for the number of widows resulting from the Vietnam War do not exist, Figure B.6 in the Appendix shows a positive relationship between provincial bombing intensity and share of women who are widows. Additionally, Figure A.6 in the Appendix shows that the sex ratio imbalance was particularly apparent among those in the South who were of prime working age at the conclusion of the war.

2.2 Women during the Vietnam War

Anecdotal evidence from the Vietnam War era is abundant with stories of how women filled in for men (Turley, 1972; Banister, 1985; Cima, 1989). However, the majority of these stories emerge from the North of Vietnam, with the evidence from South Vietnam being parsimonious in comparison.

Building on the growing public debate for equal women's rights from the 1930s, the government of the DRV mobilised women into the workforce by arguing that the fight for gender equality was tantamount to the emancipation of the peasants. In 1966, the Central Committee of the North issued Directive 99/CT-TU which explicitly stated that women would be inducted into management roles. Throughout the war, the DRV emphasised that women had 'three responsibilities': (1) replace men to free them to join the front line, (2) encourage husbands and sons to enlist, and (3) participate in combat if required. The success of the pro-female propaganda is evident as in 1967, 15 percent of village administrative council presidencies were occupied by women (compared to 0.5 percent in 1962) (Turley, 1972). More broadly, FLFP in the North grew from 60 percent during the pre-war era to 80 percent in 1966 (Turley, 1972). However, the extent to which Northern women were galvanised to fill in for absent male workers in male-intensive sectors – and subsequently remained – is questionable. Panel (b) of Figure A.7 in the Appendix shows that the share of Northern women in manufacturing and construction was at 10.14 percent and 1.67 respectively. By 1999, the share of working women in North Vietnam in manufacturing had dropped to 4.74 percent, and to less than 1 percent in construction. This would suggest that, much like in the US and Germany, women left male-intensive sectors once peace had been reinstated.

Unlike their Northern counterparts, Southern women were less exposed to Socialist ideology and pro-female policies. Contemporary reports highlight that Southern women enjoyed less economic and social freedoms than Northern women (Turley, 1972). Without mobilisation, Confucian ideology which emphasised the subordinate role of women prevailed (Nguyen and Tran, 1980). In modern times, Southern women report more conservative attitudes towards FLFP and had a lower FLFP rate of 80.3 percentage in 2009 (4.9 percent lower than in the North). In 1989 and 1999, this gap in FLFP between North and South was larger at approximately 7 percentage points.[4] While FLFP may be lower in the South, Figures A.7, A.8 and A.9 in the Appendix reveals that the share of working women in manufacturing grew from 12.64 percent in 1989 to 15 percent in 1999, then again to 20.38 percent in 2009. Moreover, the number of bombs dropped on a district is positively correlated with FLFP in the South but not the North as shown in Figure A.4.

[4] Author's calculations using the 1989, 1999 and 2009 PHC.

This would suggest that 'economic pressures' led women to enter the labour market in the South, whereas Socialism played a more important role in mobilising women in the North.

Given the difference in intensity of exposure to war-induced demographic shocks between the North and the South, and the initial difference in political frameworks, this paper examines the extent to which 'economic pressures' from the Vietnam War explains high FLFP rates in Vietnam.

3 Data

3.1 Historical data

Data on ordnance dropped by the US in Vietnam between 1965 and 1975 comes from the Theatre History of Operations Reports (THOR). THOR was collated under the guidance of Lieutenant Colonel Jenns Robertson and combines raw data on ordnance dropped in Vietnam from the Combat Air Activities Files (CACTA), the Southeast Asia Database (SEADAB), and Strategic Air Command Combat Activities Report (SACOACT) which are housed at the US National Archives.[5] THOR thus represents the most comprehensive source of data on ordnance dropped on Vietnam during the Vietnam War, not only recording the geolocation of bombs, missiles and rockets jettisoned, but also the quantity and load weight. THOR also contains the target type and damage assessment of each sortie, although this information is of secondary importance as this paper assesses the aggregate effect of ordnance on female labour market outcomes. Since THOR contains the geolocation of sorties, I am able to match ordnance activity to contemporary provincial boundaries and calculate the total number of bombs, missiles and rockets dropped on each province during the Vietnam War.

I complement data on ordnance dropped on Vietnam with casualties data using the Situation Report Army File (SITRA) which are also housed at the US National Archives and records ground combat operations by the US Army between May 1966 and December 1973. The SITRA contains data on casualties by operation, which are disaggregated by nationality. The geolocation of operations are provided, enabling me to estimate total casualties by district. However, SITRA only records operations in South Vietnam and is therefore only used as a form of robustness check. I also assume that Vietnamese civilian deaths recorded are from the district they died in, and exclude Vietnamese who were part

[5] CACTA contains monthly data on air combat missions flown in Southeast Asia by the US and allied forces between 1 October 1965 and January 31 1971. The SEADAB is the successor to the CACTA and records air combat missions flown in Southeast Asia by US and allied forces between January 1971 and June 1975. SACOACT contains data on air combat missions flown in Southeast Asia by the Strategic Air Command between 6 January 1965 and 31 October 1975.

of the Vietnamese Air Force or Marine Corps. This is a fair assumption since Vietnamese civilians who died as a result of US involvement were either communist sympathisers or were collateral damage. However, these estimates are likely to be a lower bound estimate since civilian deaths were generally suppressed (Lewy, 1980).

3.2 Microdata

Three main sources of microdata are used in this paper.

The first is the cross sectional Population and Housing Census (PHC) of 1989, 1999 and 2009 which was downloaded from the IPUMS website. The PHC of 1989 wave captures 5 percent of the population ($N = 2,626,985$), the 1999 wave captures 3 percent of the population ($N = 2,368,167$), and the 2009 wave captures 15 percent of the population ($N = 14,177,590$). The PHC are used to assess the labour market outcomes 14, 24, and 34 years after the end of the Vietnam War. While the 2009 PHC contains district-level information, previous waves of the PHC only contains province-level information.[6] Thus, the 1989 and 1999 PHC are only relied upon to conduct province-level analyses (Section B.1 of the Appendix).

I also rely on the Vietnam Household Living Standards Survey (VHLSS) of 2002 to 2012. The VHLSS is conducted by the GSO biennially and is representative at the province level. The VHLSS contains demographic information, as well as information about employment including labour force participation and sector of employment. The PHC and VHLSS are especially useful for understanding women's labour market outcome since it captures both informal and formal workers.

Throughout my analyses on the extensive margin, I restrict observations to those between 15 to 64. Since internal migration may bias results, I eliminate individuals who are reported to have migrated to another province within the past 5 years in the PHC. While this does not perfectly address the issue of internal migration, since I am only able to control for the effect of post-war migration, there exists qualitative evidence for why internal migration may not pose as much of a threat to unbiased estimation; after the conclusion of the war in 1975, the VCP pursued major repatriation efforts, particularly amongst Southern migrants who moved to urban areas during the war (Dang et al., 1997). Additionally, the VCP strictly suppressed rural to urban migration in the aftermath of the war through the use of internal passports ('ho khau') (Anh, 2003). Even amongst migrants who had been encouraged by the government to relocate to newly-established 'New Economic Zones', the move proved to be short-lasting with many returning to their home village. Finally, collective farming before economic reform in 1986 ('Doi Moi')

[6] Provinces are the first subnational unit, and districts are the second subnational unit.

cemented the barriers to and increased the costs for internal migration (Anh, 2003).[7] Still, one might worry that migration within districts may be much more prevalent than migration across provinces. Thus, I repeat my analyses at the district-level below with province-level exposure to ordnance and the results can be found in Section B.1 of the Appendix.

To understand whether firms increased their demand for female labour, I utilise the Vietnam Enterprise Survey (VES) of 2001 to 2018. The VES is conducted annually by the GSO and covers the universe of registered firms in Vietnam.[8] The VES is composed of a 'short questionnaire' and a 'long questionnaire'. The former records basic details about each firm including the VSIC industry code, firm type (i.e. state owned enterprise, cooperative, foreign owned enterprise, or private enterprise), and the number of employees by gender. This module of the VES is answered by all registered firms, whereas the 'long questionnaire' is answered by firms who have been randomly selected to do so. For further details on the sampling process of the VES, please refer to Nguyen and Lim (2023). Since my main dependent variable for my analysis on the intensive margin is the ratio of male to female workers of each firm, I employ only the short questionnaire.

Since district boundaries have changed over time in Vietnam, I rely on the method proposed by McCaig et al. (2024) to create consistent district boundaries over time.

4 Empirical Strategy

Guided by the fact that North and South Vietnam experienced different economic systems between 1954 and 1975, and that four times as many bombs were dropped in the South compared to the North, I implement all models below separately for North and South Vietnam.

4.1 Extensive Margin: Linear Probability Model

To assess the impact of the Vietnam War on female labour market outcomes on the extensive margin, I implement the following linear probability model (LPM):

$$Work_{it} = \beta_{1t}\ln(BMR)_d + \beta_{2t}(\ln(BMR_d) \times Female_i) + \mathbf{X}_i + \delta_p + \varepsilon_{idt} \quad (1)$$

[7] A feature of the 2014 VHLSS is that the place of birth of each household member is asked. In 2014, 91.4 percent the sample reside in the same province which they were born in.

[8] There was no legal for a business to register themselves prior to 2004. After 2004, businesses with 10 or more permanent employees are required by law to obtain a business registration certificate (McCaig and Pavcnik, 2015).

where in $t \in \{2001, 2003, 2005, 2007, 2009, 2011, 2012\}$ and corresponds to the VHLSS cross sectional survey year. The dependent variable, $Work_i$, takes the value of 1 if individual i has work. The variable $\log(BMR_p)$ is the natural log of bombs, missiles and rockets jettisoned between 1965 and 1975 on district d. $Female_i$ takes the value of 1 if individual i is female, while the interaction term $\log(BMR)_d \times Female_i$ assesses the differential impact of ordnance on the probability of working for male and females in the labour force. $\mathbf{X}_i$ contains a vector of individual-level controls which include gender, age and its square, years in education, marital status, number of children, a dummy for ethnic minority status and a dummy for urban-dwelling. Province fixed effects (δ_p) are included to control for time-invariant within-province differences, and also allows me to exploit within-province variation in exposure to ordnance activity. The coefficient of interest, $\beta_{1t} + \beta_{2t}$, gives the conditional full marginal effect of ordnance exposure on the probability of working for females in year t, whereas β_{1t} gives the OLS estimate for males. Standard errors are clustered at the district level.

4.2 Extensive Margin: Difference in Differences Model

I then exploit a combination of variation in timing and spatial exposure to the Vietnam War by implementing a difference-in-differences (DiD) strategy. More specifically, I compare the probability of working across age cohorts and districts. I implement the model separately for women in the North and South Vietnam using the 2009 PHC since this is the only year for which district-level information is provided. The empirical specification takes the following form:

$$Work_{icd} = \phi_c + \sum_c \gamma_c(\ln(BMR_d) \times Age_{icd}) + \ln(PpnDensity_d) + \mathbf{X}_i + \delta_p + \varepsilon_{icd} \quad (2)$$

where $Work_{icp}$ takes the value of 1 if individual i in age cohort c in district d has work. Age_{icd} is a set of dummy variables which takes the value of 1 if individual i is in age cohort c and resides in district d. In this equation, $\log(PpnDensity_d)$ is the natural log of the population density of district d in 2009. ϕ_c is the age cohort fixed effect, and other variables are as in equation (1). Standard errors are clustered by district and age cohort.

4.3 Intensive Margin: Fixed Effect Model

To complement my analysis of the impact of the Vietnam War on female labour market outcomes on the extensive margin, I assess the degree to which firms substituted wards

female labour. To this end, I employ a fixed effect model where the aim is to understand whether the ratio of male to female workers was smaller in firms which experienced higher bombing intensity, within the same firm type and industry. Thus, the fixed effects model takes the following form:

$$WorkerRatio_{h\tau} = \pi_\tau \ln(BMR)_d + \delta_p + \alpha_j + \phi_k + \varepsilon_{hd\tau} \tag{3}$$

and is estimated for the years $\tau \in \{2002, 2003, ..., 2018\}$. The dependent variable, $WorkerRatio_h$, is the ratio of male to female workers in firm h in year τ. α_j and ϕ_k are the 4-digit VSIC industry and firm type fixed effects respectively, and other variables are as in equation (1). Standard errors are clustered at the district level.

5 Results

5.1 Extensive Margin

The results for the impact of exposure to ordnance on the probability of working is shown in Figure 1, and reveal that there was indeed large regional heterogeneity in the impact of exposure to ordnance on the probability of working. More specifically, Panel (a) illustrates the effect of bombing in the North and shows that the Vietnam War had a statistically insignificant effect on the probability of working for women between 2001 and 2011 (except 2009). On the other hand, Panel (b) provides evidence that exposure to bombing had a positive and statistically significant impact on female labour market outcomes on the extensive margin for Southern women between 2001 and 2011, but not men. The coefficient associated with the probability of women working in the South in 2001 ($\beta_{1t}+\beta_{2t}$) translates to an increase in the probability of working by 3.84 percentage points when going from the 1st quantile to the median in exposure to ordnance ($\approx$ 268 percent increase). Throughout all waves of the VHLSS, $\beta_{1t} + \beta_{2t}$ remains statistically significant and the magnitude remains largely unchanged, suggesting the presence of the persistent effect of the Vietnam War on FLFP in the South. Additionally, the interaction term β_2 is statistically significant for Southern observations at the 1 percent level for all years, except in 2007 where it is significant at the 10 percent level (see Table A.1 in the Appendix).

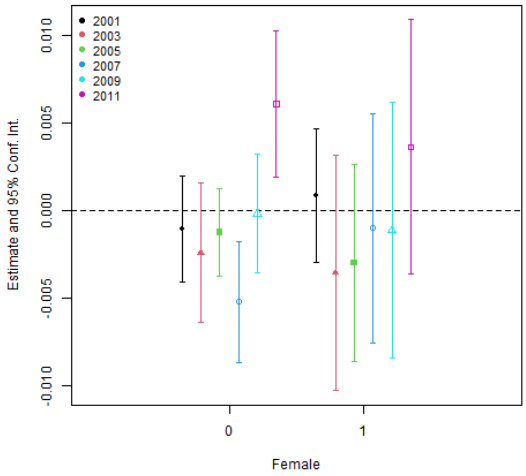
When assessing instead the impact of provincial exposure to ordnance on the probability of working, the results in Figures B.7 and B.14 in the Appendix resembles those in Figure 1. They also provide evidence that exposure to ordnance led to an increase in FLFP in the South even as early as in 1989 (i.e. 14 years after the end of the war). Panel

(a) and (b) uses all available waves of the PHC and here, going from the 1st quantile to the median (≈ 725 percent increase) in provincial ordnance exposure is associated with an increase in the probability of working for Southern women by 2.75 percentage points in 1999. I also obtain similar results for later years, and for results using the VHLSS. Moreover, the results using casualties provide qualitatively similar results as can be seen from Figure A.20 in the Appendix.

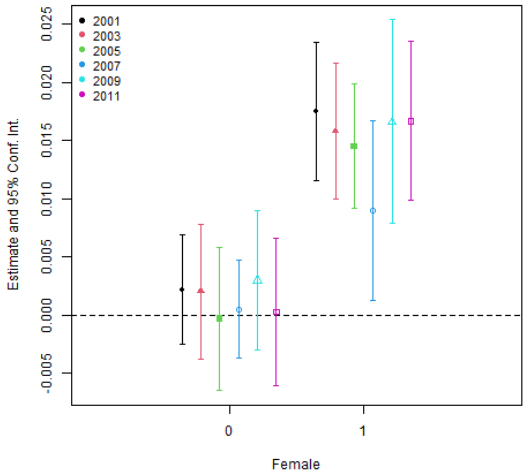
Figure 1: Impact of district-level ordnance on the probability of working

Without province F.E.

(a) North

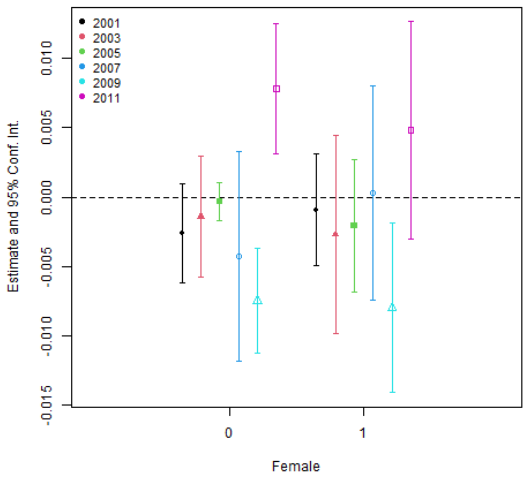


(b) South

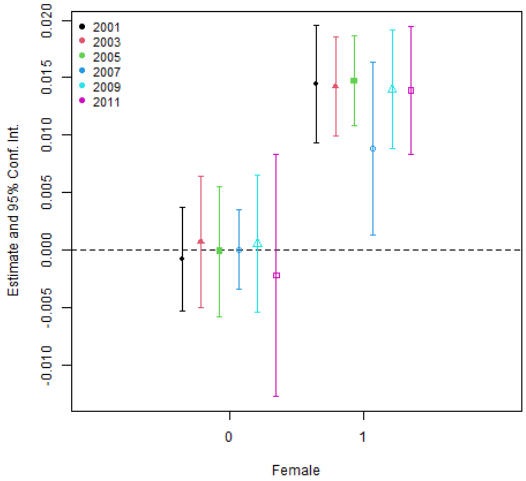


Without province F.E.

(c) North



(d) South

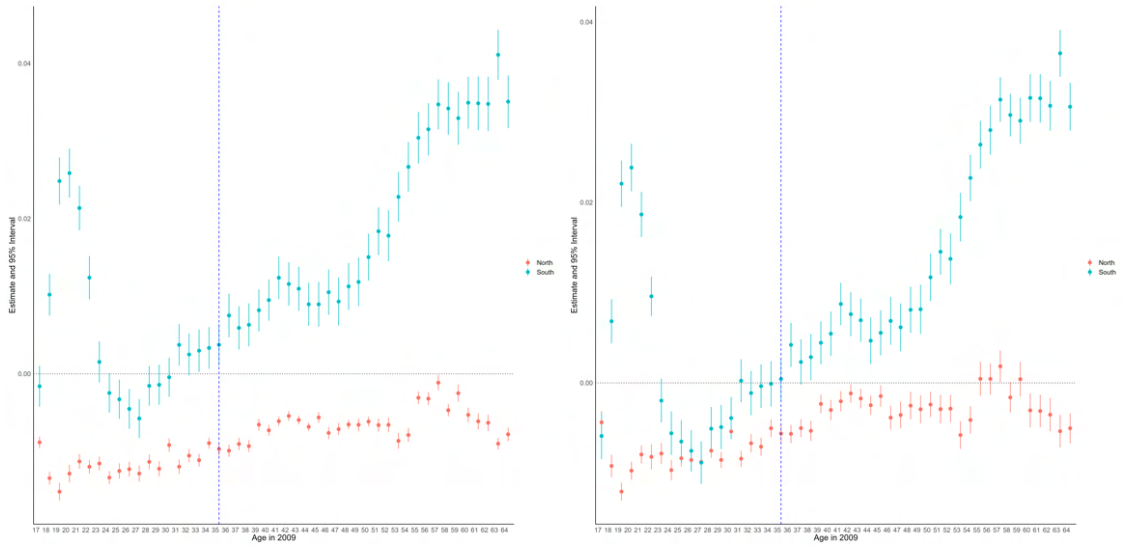


As an alternative empirical strategy and to examine the effect of ordnance across

birth cohorts and districts, I employ a DiD model as specified by equation (2) using the 2009 PHC. The results for female workers in North and South Vietnam are provided in Figure 2 and provides further reassurance that the effect of ordnance differed greatly for Northern and Southern women, and that exposure to ordnance is positively associated with the probability of women working in the South. More specifically, Figure 2 shows that Northern women of all ages (i.e. born before and after the war) were negatively (and statistically significantly) affected by the Vietnam War. By contrast, the coefficient γ_c is positive and largest for Southern women aged 58 to 64 and which corresponds to women who were aged 24 to 30 at the conclusion of the Vietnam War. This points towards the fact that women aged 24 to 30 were the most likely to be induced to enter the labour market during or immediately after the Vietnam War, and remained in the labour market even after 34 years. In specifications where I replace $\ln(BMR)$ with $\ln(Casualties)$ or province-level bombing as the main explanatory variable, the estimate is also largest for those aged 24 to 30 at the time of reunification (see Figure A.20, B.8 and B.15 of the Appendix).

Figure 2: Impact of ordnance on the probability of working for females, by age

(a) Without province F.E. (b) With province F.E.



5.2 Intensive Margin

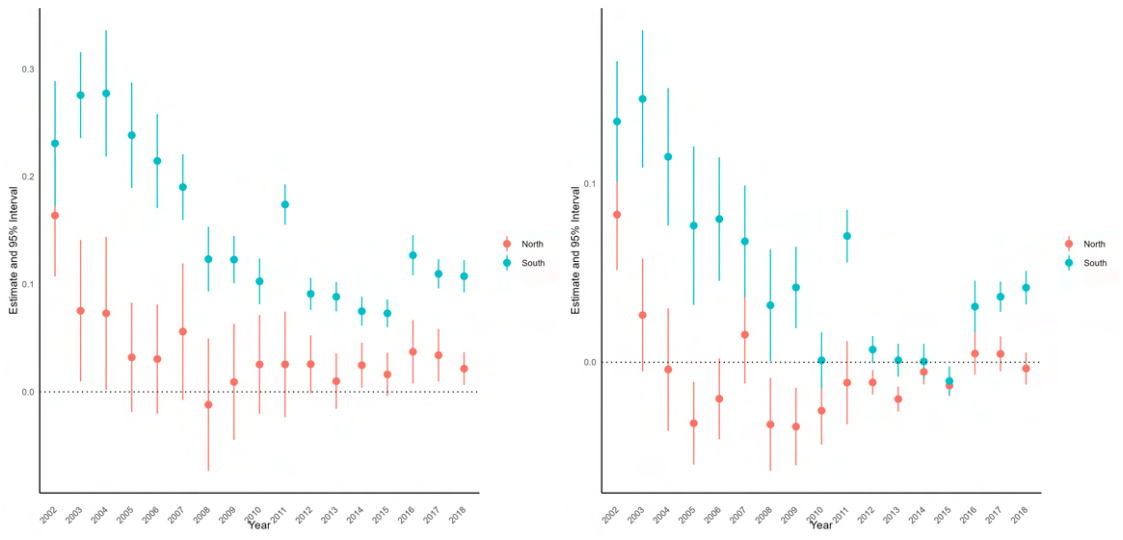
Turning now to whether women entered the labour market in response to increased demand for female labour, I compare the effect of bombing on the ratio of male to female workers at the firm-level across districts but within the same province, firm type and industry. The results for the fixed effect model given by equation (3) can be found in Figure 3.

For firms located in the North, the coefficients for π_τ are predominantly statisti-

cally insignificant between 2002 and 2011. Similarly, Southern firms which are located in districts that were more exposed to ordnance did not replace male workers with female workers either, as the estimates for π_τ are positive and statistically significant at the 5 percent level for all years. When replacing district-level exposure to ordnance with casualties, I also find that Southern firms which are located in districts which experienced higher casualties had a higher ratio of male to female workers as can be seen in Figure A.22 of the Appendix. The lack of substitution towards female labour in the formal sector may be reflective of prevailing patriarchal norms, and would point towards the lack of demand for female labour among registered businesses in spite of war-induced demographic shocks. Indeed, exposure to ordnance is associated with a decrease in the probability of working for a wage for Southern women as can be seen in Figure A.18 of the Appendix.

Figure 3: Impact of ordnance on firm-level ratio of male to female workers

(a) without industry F.E. (b) with industry F.E.



Given the lack of demand for female workers, Southern women may have been forced to smooth their consumption by setting up their own business. A key feature of businesses in Vietnam is that they are predominantly household businesses in the informal sector. In fact, registered businesses constitute a minority of business activity in Vietnam and employed 67 percent of non-agricultural workers in 2001 (McCaig and Pavcnik, 2018). Household businesses also tend to be managed by women, whereas men were more likely to be working outside the home for a wage; in 2001, 24 percent of female workers received a wage, whereas the share of male workers receiving a wage was 42 percent.[9]

To examine whether the Vietnam War spurred female entrepreneurship, I employ the 2002 to 2006 VHLSS which collects information on whether a household operates a business

[9] Author's calculations using the 2002 VHLSS.

in the non-agricultural sector ('household business'). These may be registered or informal businesses, and the VHLSS also records the household member who is most knowledgeable about such business.[10] Here, I assume that the member who is most knowledgeable both started and manages the business. Restricting my observations to household businesses, I examine the impact of ordnance on the probability that the business is managed by the female household member by replacing the dependent variable in equation (3) with a dummy variable which takes the value of 1 if the business is managed by a female and 0 otherwise.

The results in Table 2 provide support for the hypothesis that due to low demand in female labour, Southern women were induced to start their own enterprise in districts that were more exposed to ordnance. When assessing the impact of ordnance on the probability that a household business is managed by a female across all sectors as in Panel I of Table 2, the estimates for the South are positive and statistically significant for the years 2001 and 2003, but not 2005. In 2001, going from the first quantile to the median in district-level exposure to ordnance increases the share of female-managed businesses by approximately 3 percentage points. This effect is reduced to 1.15 percentage points in 2003, and becomes statistically insignificant in 2005. One reason why the effect may have diminished over time is due to the fact that as Vietnam underwent structural transformation, workers reallocated out of household businesses and into the formal sector. This effect was particularly pronounced between 2002 and 2006 when the US-Vietnam Bilateral Trade Agreement was signed, and which saw tariff reductions in the manufacturing sector by 20 percentage points on average (McCaig and Pavcnik, 2018). On the other hand, the results for North Vietnam are statistically insignificant for all specifications. Moreover, the effects of trade-induced structural transformation appear to be concentrated in the South as can be seen in Figures A.8 and A.9 of the Appendix where the share of Southern women in manufacturing grew from 15 percent to 20 percent between 1999 and 2009, but reduced in the North. When using casualties and province-level exposure to ordnance as the explanatory variable, the results are in line with those found below (Tables A.2 and Table B.1 and B.2 of the Appendix respectively).

[10]Since the majority of businesses in Vietnam are unregistered, the VHLSS would better capture the effects of ordnance on female entrepreneurship than the VES. For example, 70 percent of businesses recorded in the 2002 VHLSS did not have a business registration certificate.

Table 2: Impact of ordnance on the probability of businesses being female-managed

I. Without industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0077	0.0046	0.0095	0.0111***	0.0043*	0.0037
	(0.0129)	(0.0051)	(0.0129)	(0.0035)	(0.0021)	(0.0022)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	6,899	7,567	5,581	10,817	12,383	9,149
R^2	0.02074	0.01121	0.01719	0.00646	0.00717	0.00699
Within R^2	0.00041	0.00016	0.00070	0.00126	0.00020	0.00015

II. With industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0089	0.0021	0.0032	0.0067*	0.0011	0.0014
	(0.0075)	(0.0043)	(0.0102)	(0.0037)	(0.0017)	(0.0035)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	6,899	7,567	5,581	10,817	12,383	9,149
R^2	0.29506	0.19072	0.30741	0.32577	0.23479	0.35296
Within R^2	0.00077	4.02×10^{-5}	0.00011	0.00066	1.64×10^{-5}	2.97×10^{-5}

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

All specifications include province fixed effects.

6 Conclusion

In this paper, I examine how the Vietnam War, one of the most intense episodes of bombing, affected women's labour market outcomes 23 to 43 years after its conclusion. I use comprehensive historical data on US sorties in Vietnam between 1965 and 1975 and exploit district-level variation in exposure to bombing. First, I find that women who resided in districts which experienced greater exposure to US ordnance were more likely to work in the South but not the North. This may be explained by the fact that South Vietnam suffered a far greater demographic shock than the North due to experiencing 4 times as much ordnance activity. Although I find that greater exposure to ordnance led to an increase in the probability of working for Southern women, I also show that this was not driven by an increase in demand for female labour. In other words, firms did not substitute towards female labour in the face of shortage of male workers. Instead, one of ways in which women increased their labour supply was by starting their own businesses.

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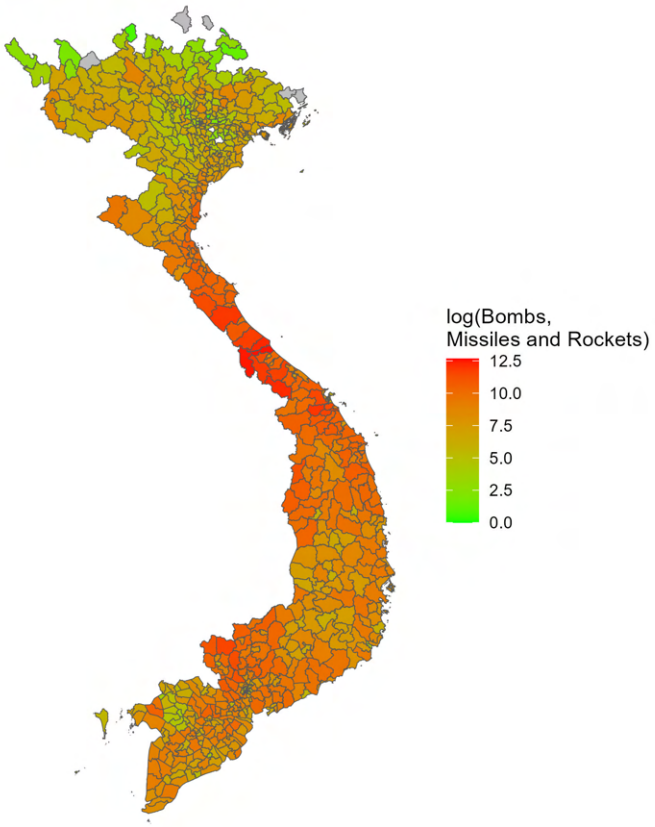
A.1 Descriptive Statistics

Figure A.1: Summary of bombing intensity



Source: Author's calculations using SITRA.

Figure A.2: Summary of casualties

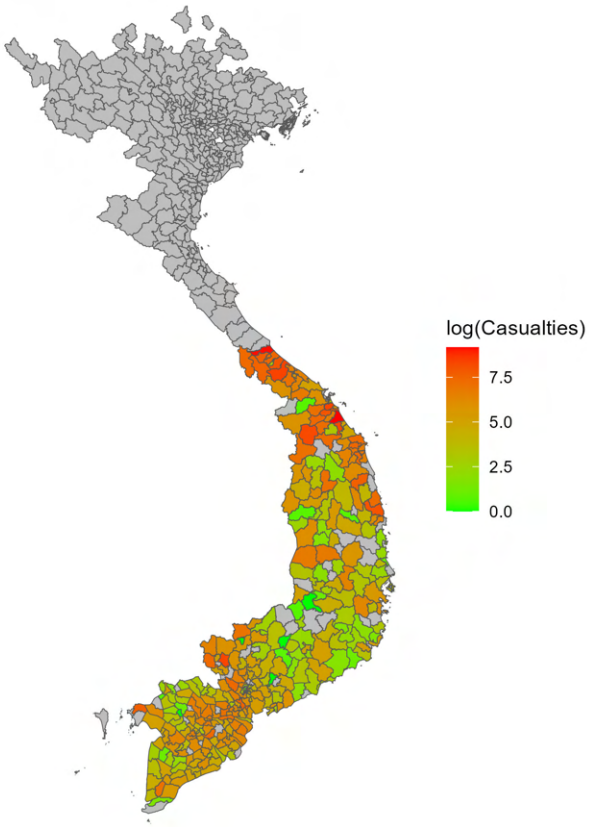
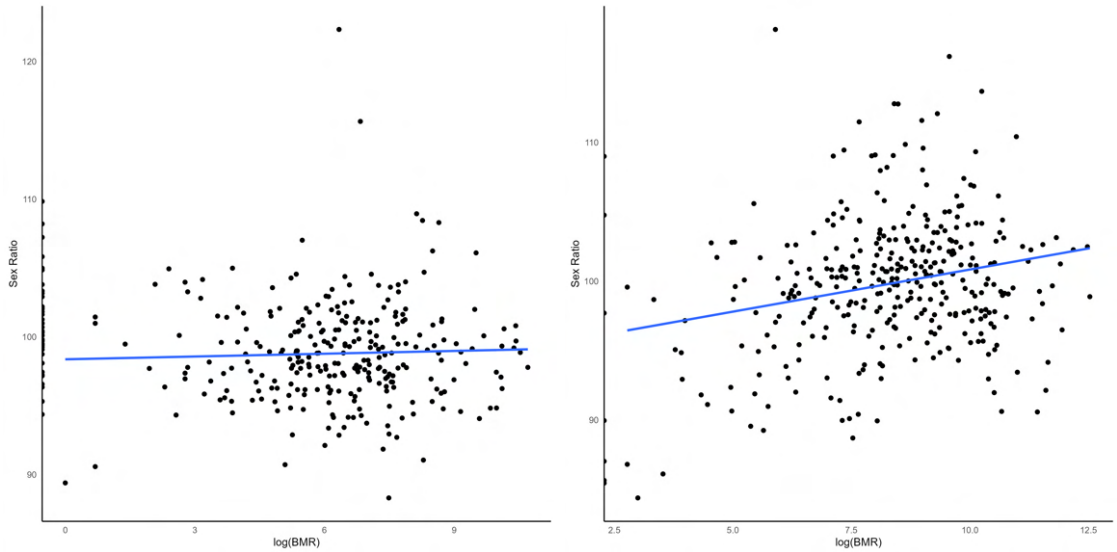


Figure A.3: Bombing intensity versus sex ratio

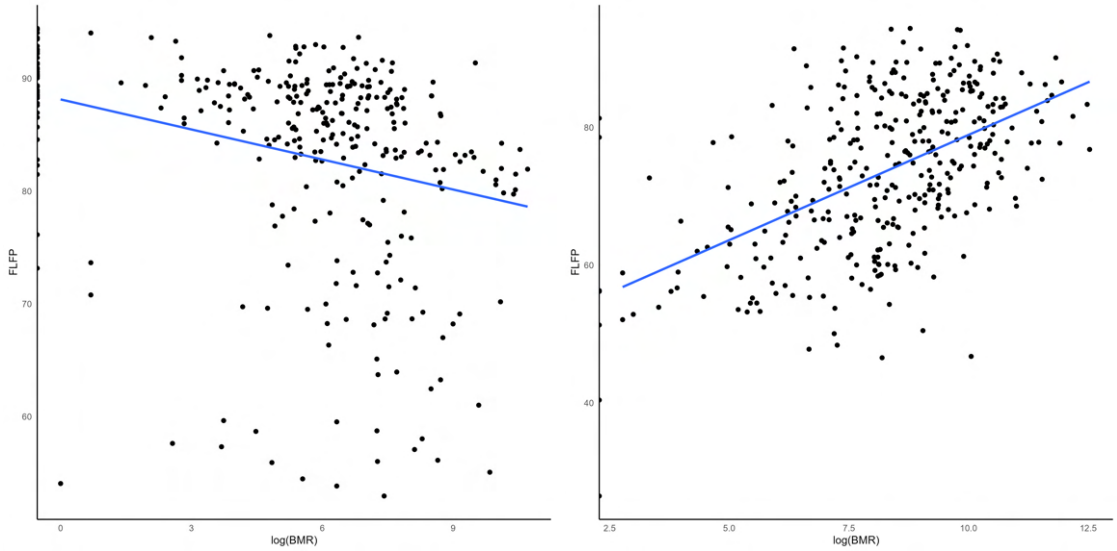
(a) North (b) South



Source: Author's calculations using the 2009 PHC.

Figure A.4: Bombing intensity versus FLFP

(a) North (b) South

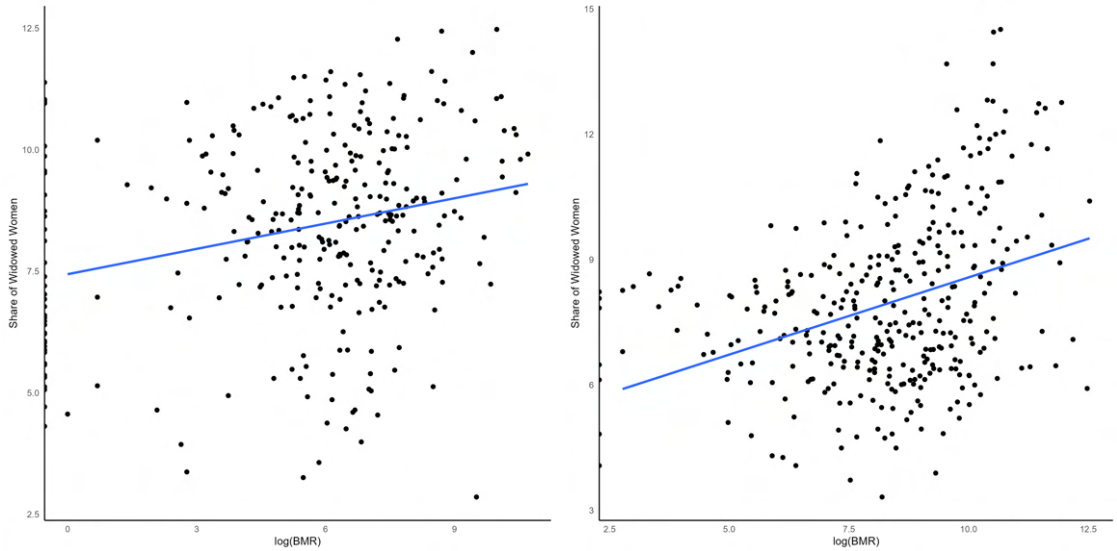


Source: Author's calculations using the 2009 PHC.

Figure A.5: Bombing intensity versus share of women widowed

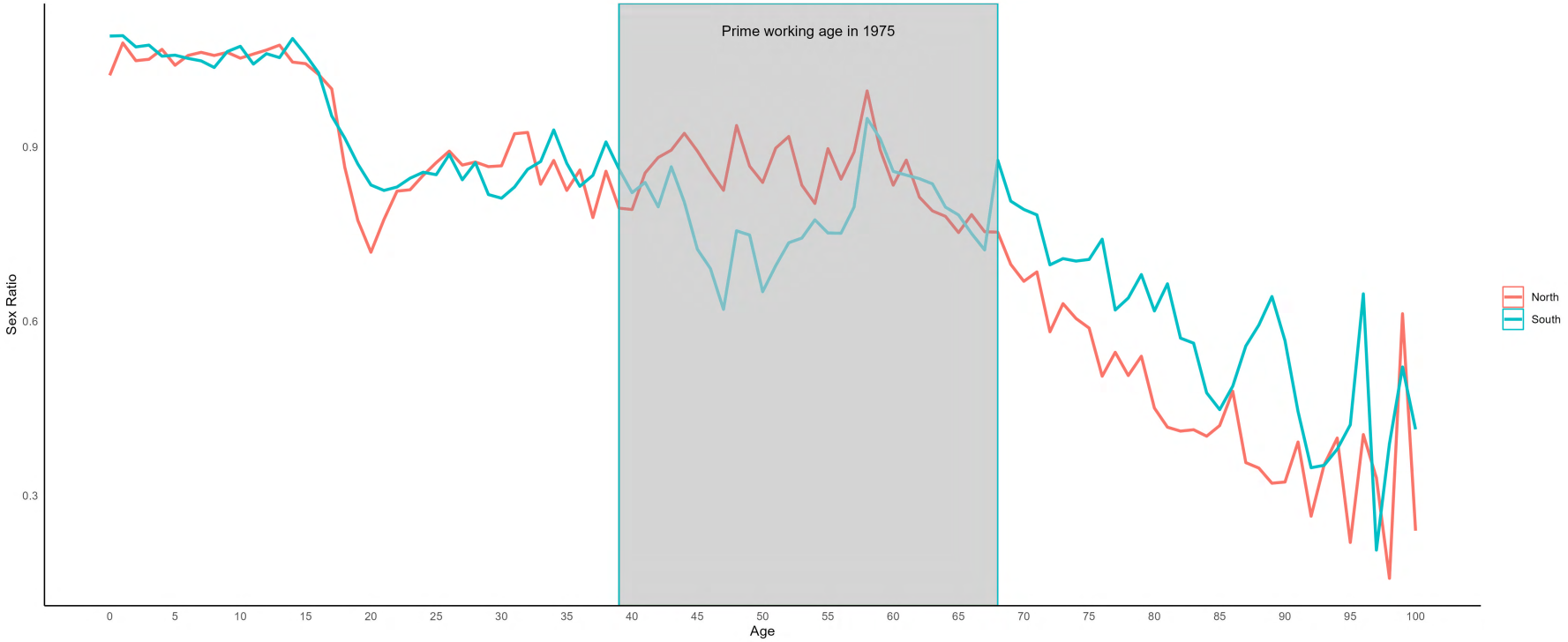
(a) North

(b) South



Source: Author's calculations using the 2009 PHC.

Figure A.6: Sex ratio by birth cohort

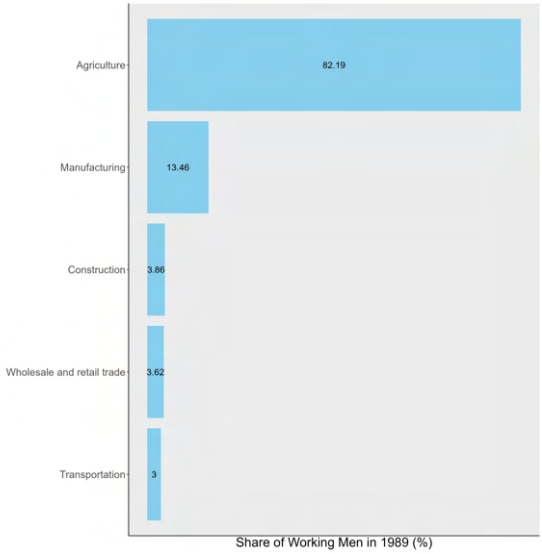


Source: Author's calculations using 1989 PHC.

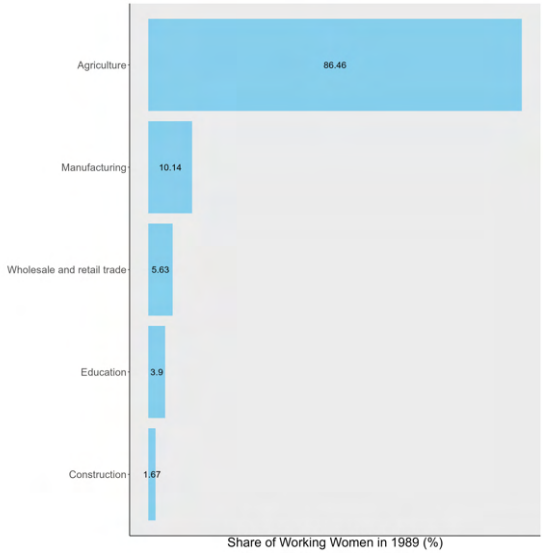
Figure A.7: Industry composition of the male and female workers in 1989

North

(a) Male

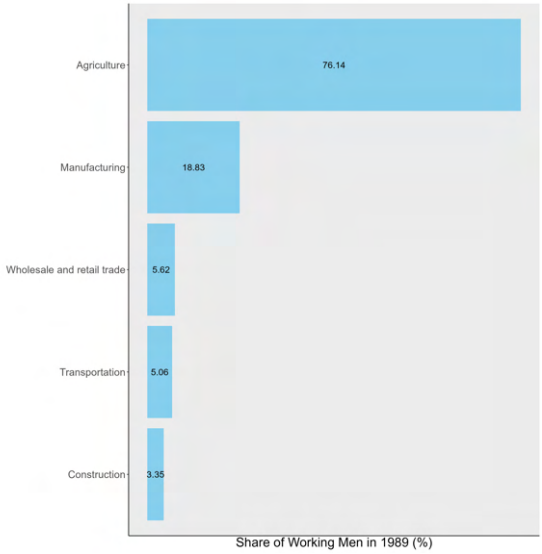


(b) Female

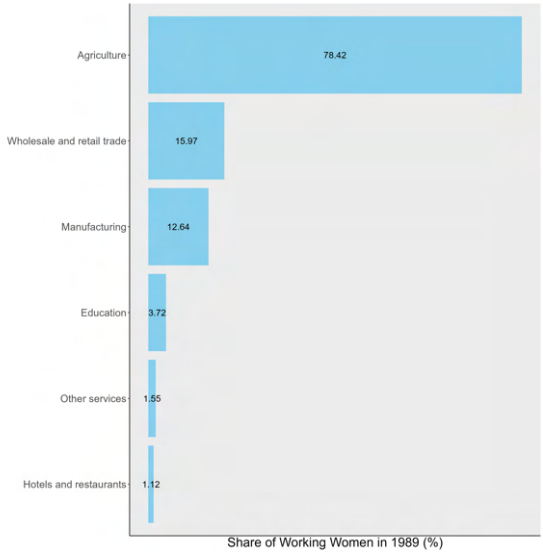


South

(c) Male



(d) Female

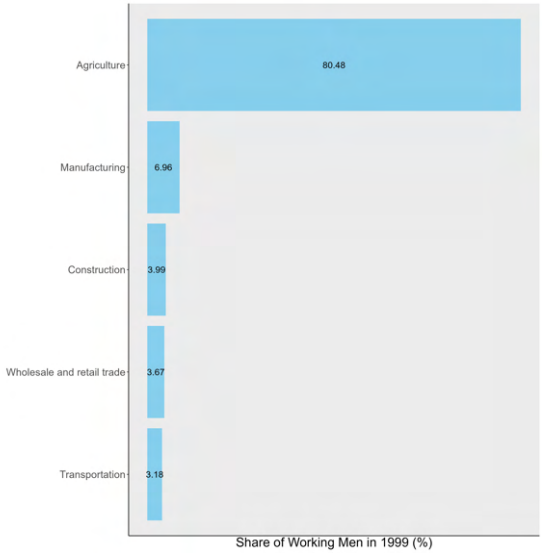


Source: Author's calculations using 1989 PHC.

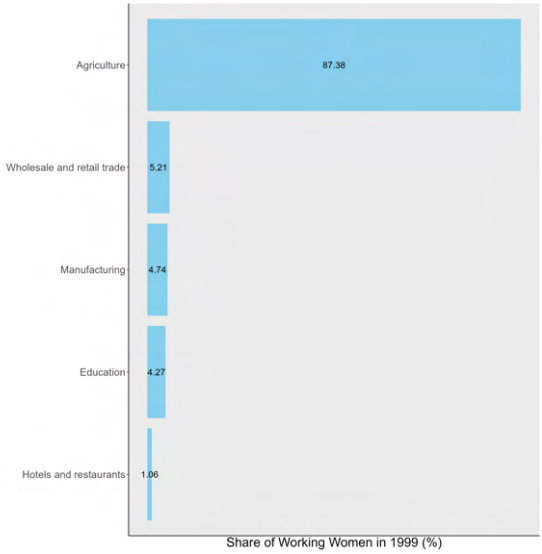
Figure A.8: Industry composition of the male and female workers in 1999

North

(a) Male

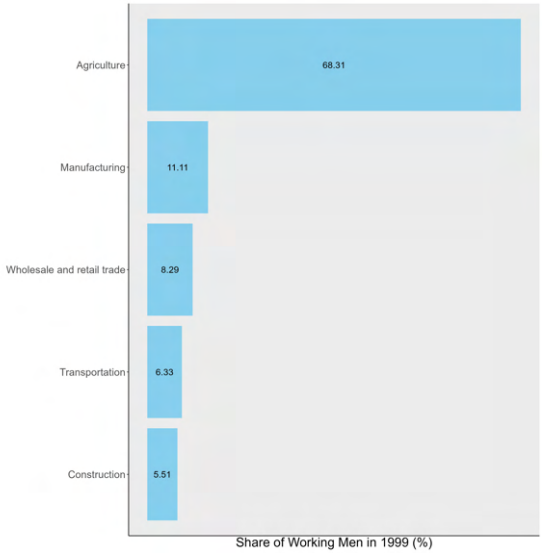


(b) Female

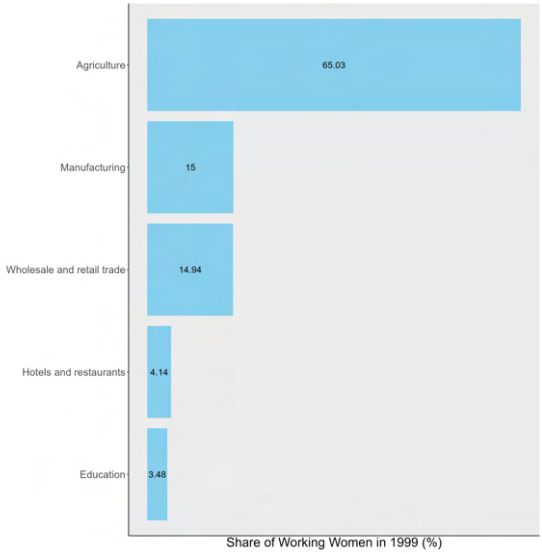


South

(c) Male



(d) Female

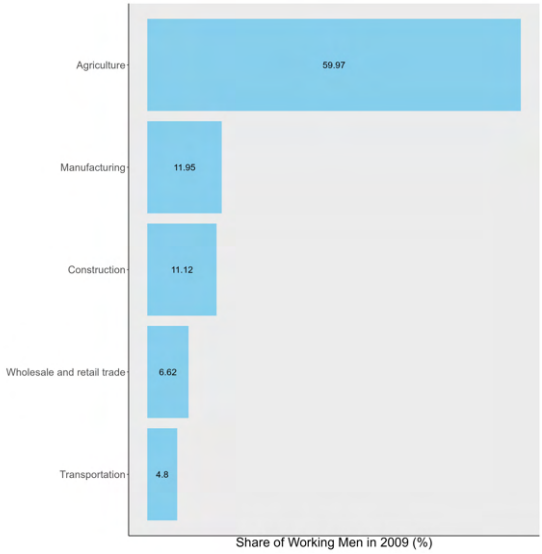


Source: Author's calculations using 1999 PHC.

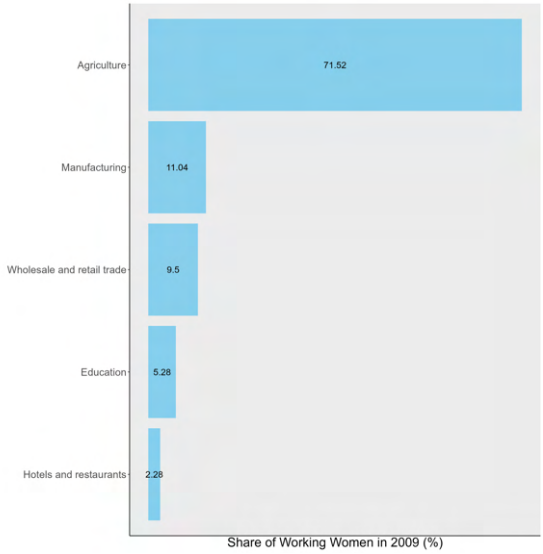
Figure A.9: Industry composition of the male and female workers in 2009

North

(a) Male

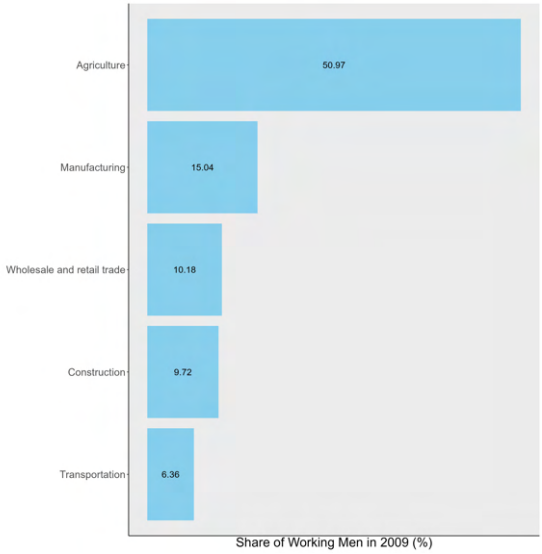


(b) Female

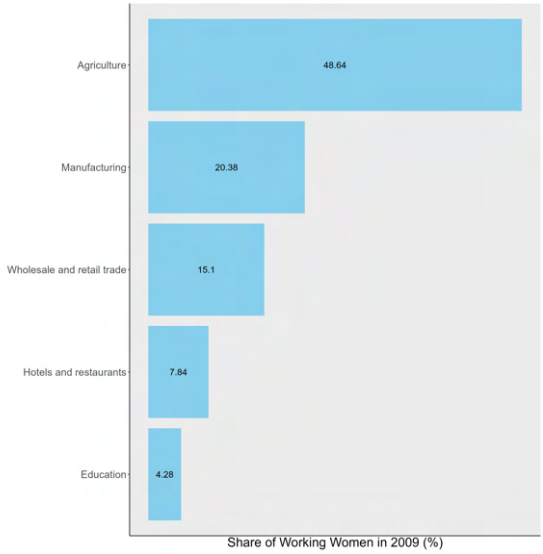


South

(c) Male



(d) Female



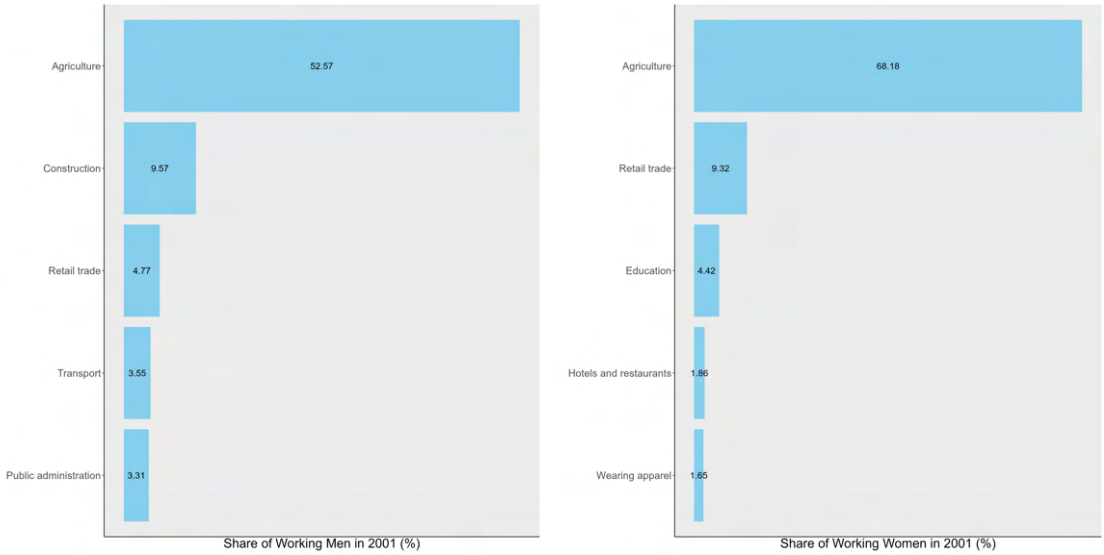
Source: Author's calculations using 2009 PHC.

Figure A.10: Industry composition of the male and female workers in 2001

North

(a) Male

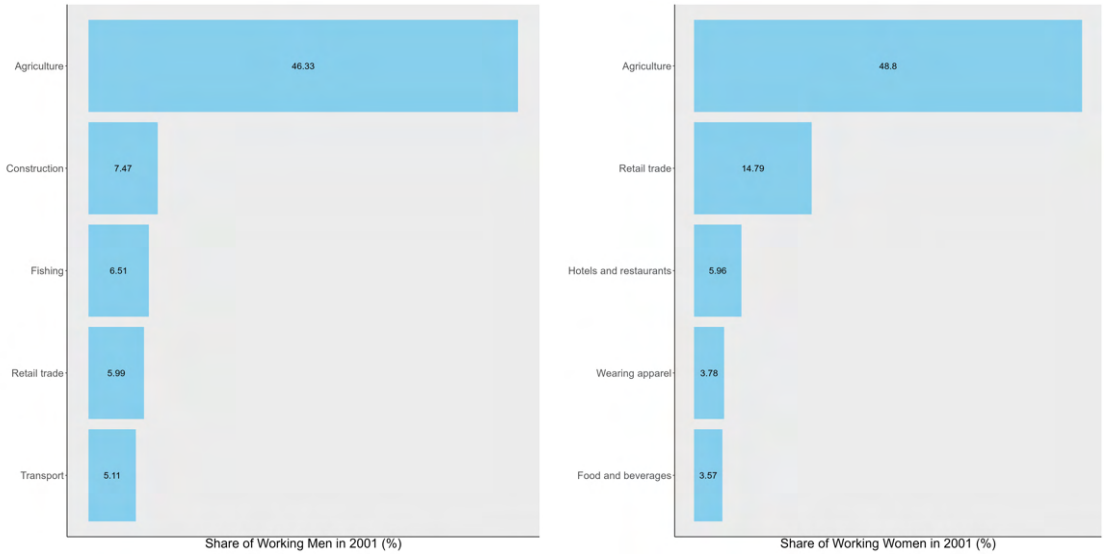
(b) Female



South

(c) Male

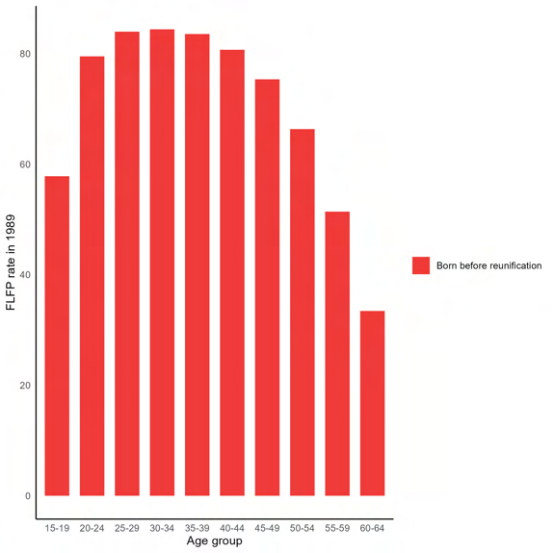
(d) Female



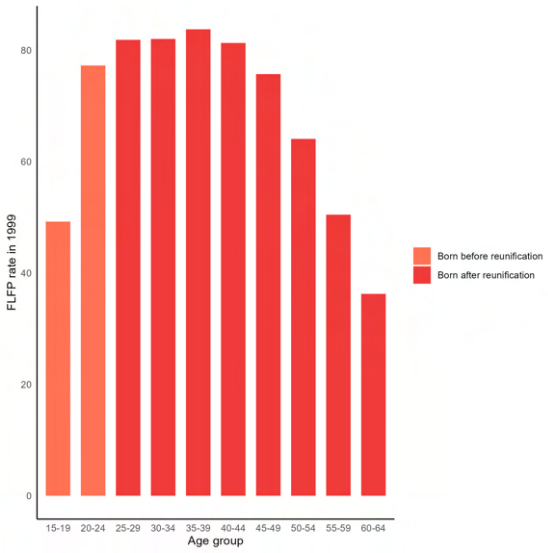
Source: Author's calculations using 2002 VHLSS.

Figure A.11: FLFP rate in Vietnam, by age group

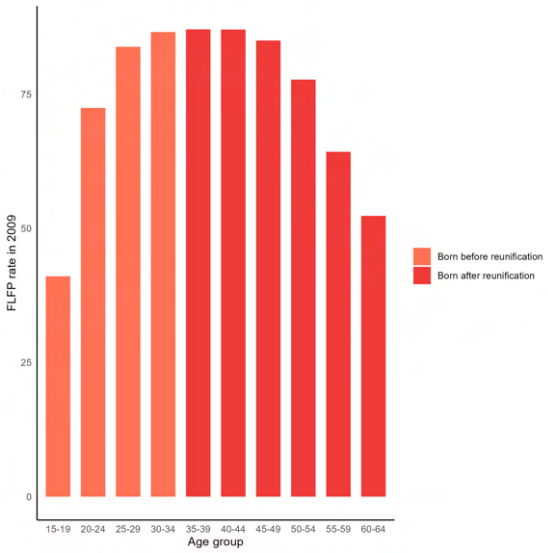
(a) 1989



(b) 1999

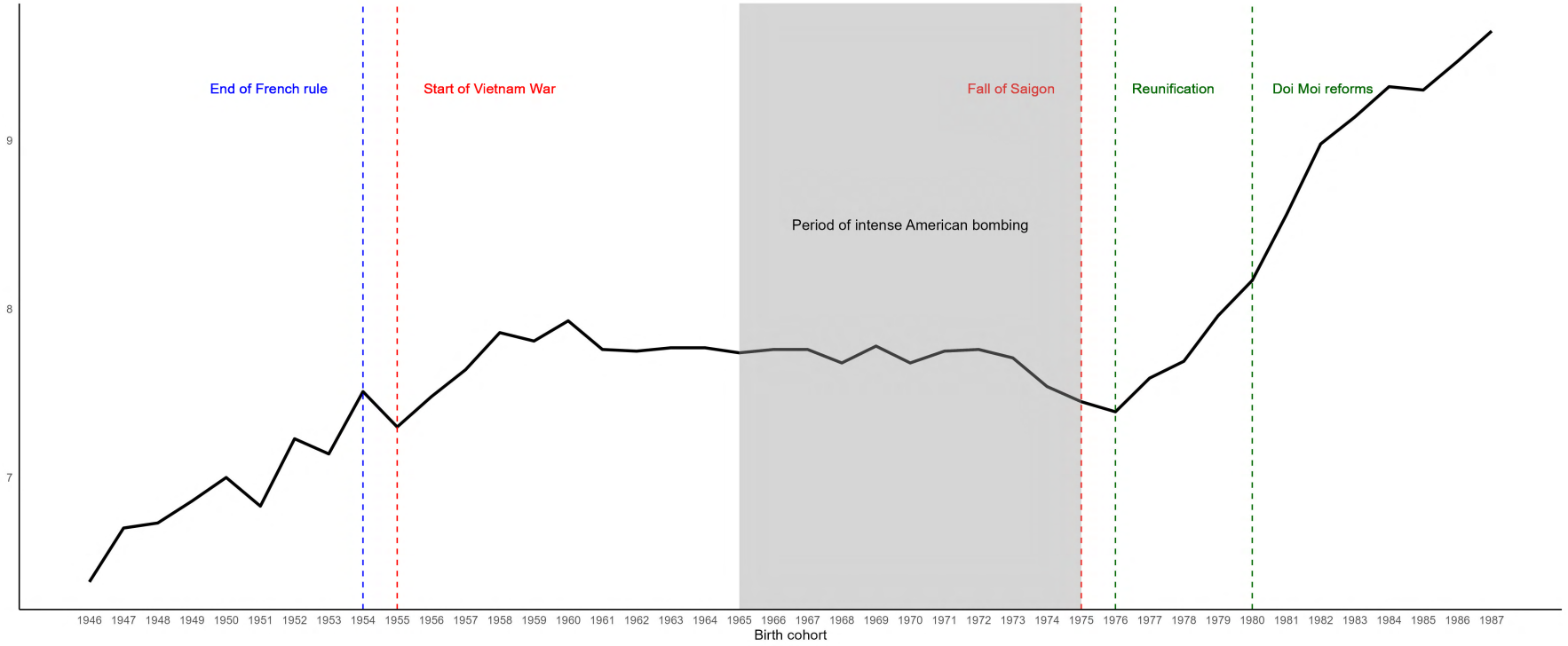


(c) 2009



Source: Author's calculations using 1989, 1999 and 2009 PHC.

Figure A.12: Education level by birth cohort



Source: Author's calculations using the 2002 VHLSS.

A.2 Further analyses

Table A.1: Impact of ordnance on the probability of working

I. North

	2001	2003	2005	2007	2009	2011
ln(BMR)	-0.0028	-0.0012	0.0002	-0.0038	-0.0074***	0.0073***
	(0.0018)	(0.0020)	(0.0005)	(0.0033)	(0.0018)	(0.0024)
× Female	0.0019	-0.0011	-0.0018	0.0042	-0.0007	-0.0024
	(0.0017)	(0.0025)	(0.0025)	(0.0034)	(0.0034)	(0.0025)
$\beta_1 + \beta_2$	-0.0009	-0.0024	-0.0015	0.0004	-0.0081**	0.0049
	(0.0019)	(0.0033)	(0.0022)	(0.0036)	(0.0030)	(0.0038)
Observations	84,060	52,680	52,646	10,487	10,025	9,959
R^2	0.26295	0.25861	0.27887	0.29815	0.29407	0.31039
Within R^2	0.08776	0.07900	0.09363	0.08516	0.08723	0.08618

II. South

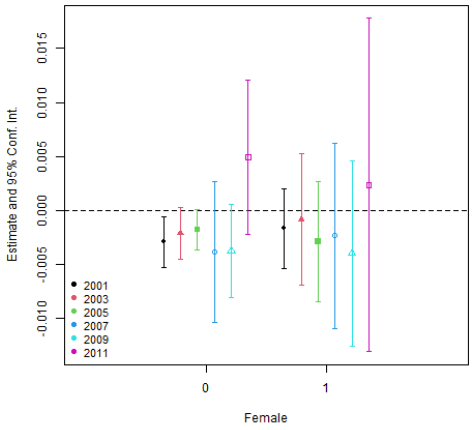
	2001	2003	2005	2007	2009	2011
ln(BMR)	-0.0009	0.0005	-9.51×10^{-5}	0.0001	0.0008	-0.0024
	(0.0022)	(0.0026)	(0.0028)	(0.0017)	(0.0029)	(0.0052)
× Female	0.0153***	0.0138***	0.0149***	0.0084*	0.0132***	0.0164***
	(0.0016)	(0.0020)	(0.0027)	(0.0045)	(0.0030)	(0.0042)
$\beta_1 + \beta_2$	0.0144***	0.0143***	0.0148***	0.0086**	0.0140***	0.0140***
Observations	101,606	63,292	63,269	12,744	12,596	12,604
R^2	0.17690	0.17896	0.19174	0.21655	0.21129	0.20942
Within R^2	0.09954	0.09935	0.10858	0.12258	0.10306	0.10884

Clustered (district) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*
All specifications include province fixed effects. Controls include gender, age and its square, years in education, marital status, a dummy for ethnic minority status and a dummy for urban-dwelling.

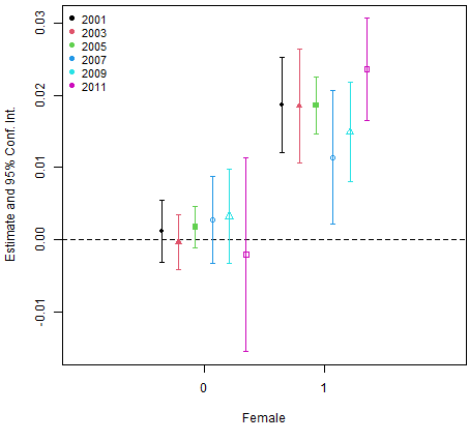
Figure A.13: Effect of ordnance on probability of working, by period of birth

Born before 1975

(a) North

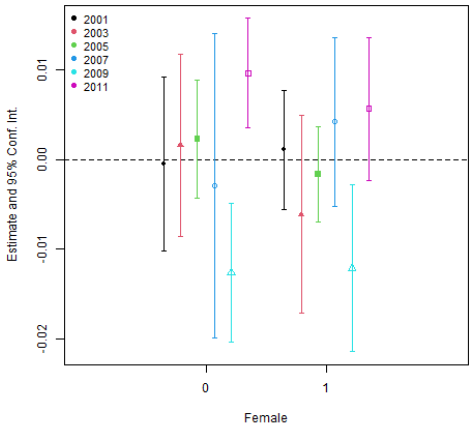


(b) South

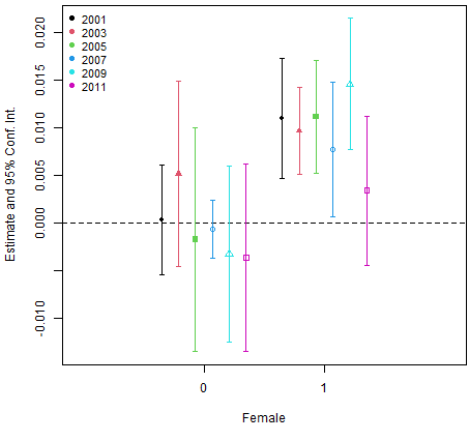


Born during or after 1975

(c) North



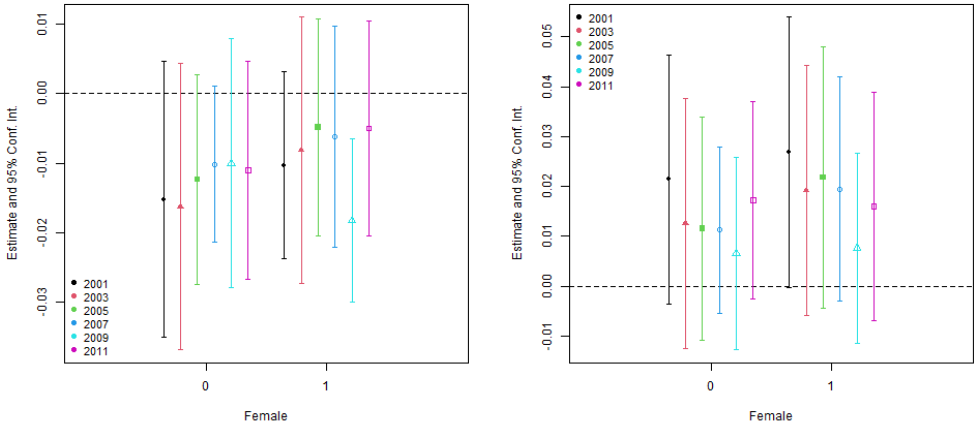
(d) South



Source: Author's calculations using the 2002 to 2012 VHLSS.

Figure A.14: Effect of ordnance on probability of working in agriculture

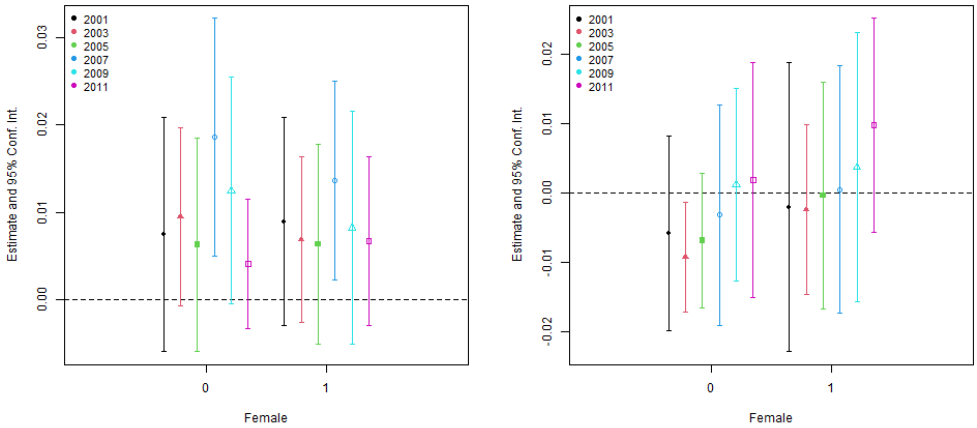
(a) North (b) South



Source: Author's calculations using the 2002 to 2012 VHLSS.

Figure A.15: Effect of ordnance on probability of working in manufacturing

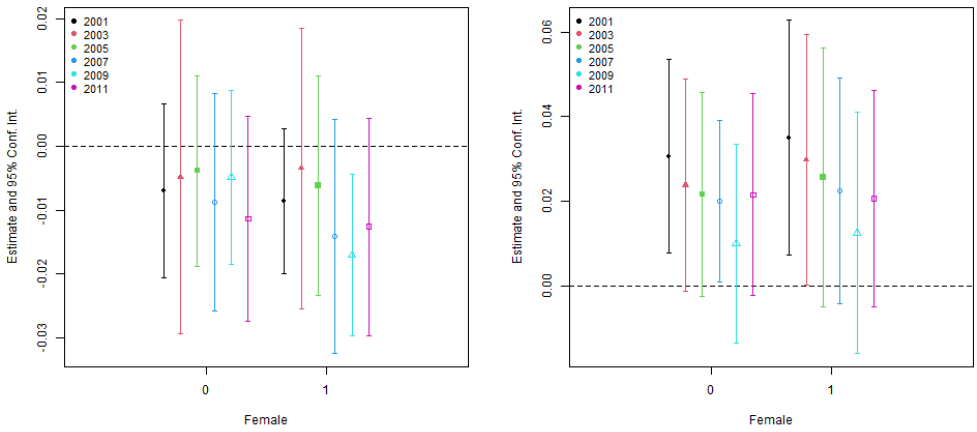
(a) North (b) South



Source: Author's calculations using the 2002 to 2012 VHLSS.

Figure A.16: Effect of ordnance on probability of being self-employed in the agricultural sector

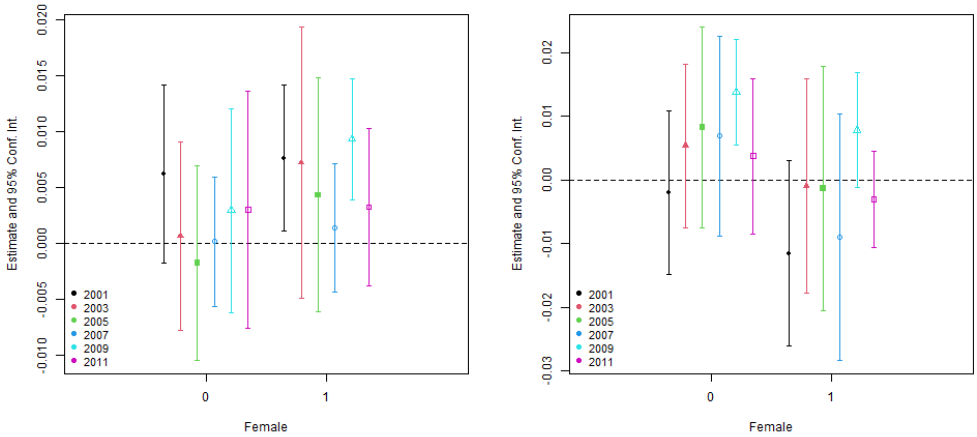
(a) North (b) South



Source: Author's calculations using the 2002 to 2012 VHLSS.

Figure A.17: Effect of ordnance on probability of being self-employed in the non-agricultural sector

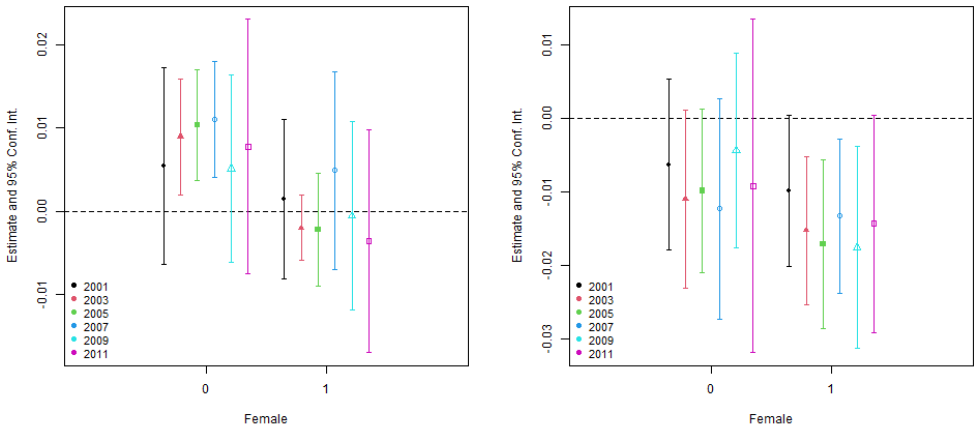
(a) North (b) South



Source: Author's calculations using the 2002 to 2012 VHLSS.

Figure A.18: Effect of ordnance on probability of working for a wage

(a) North (b) South

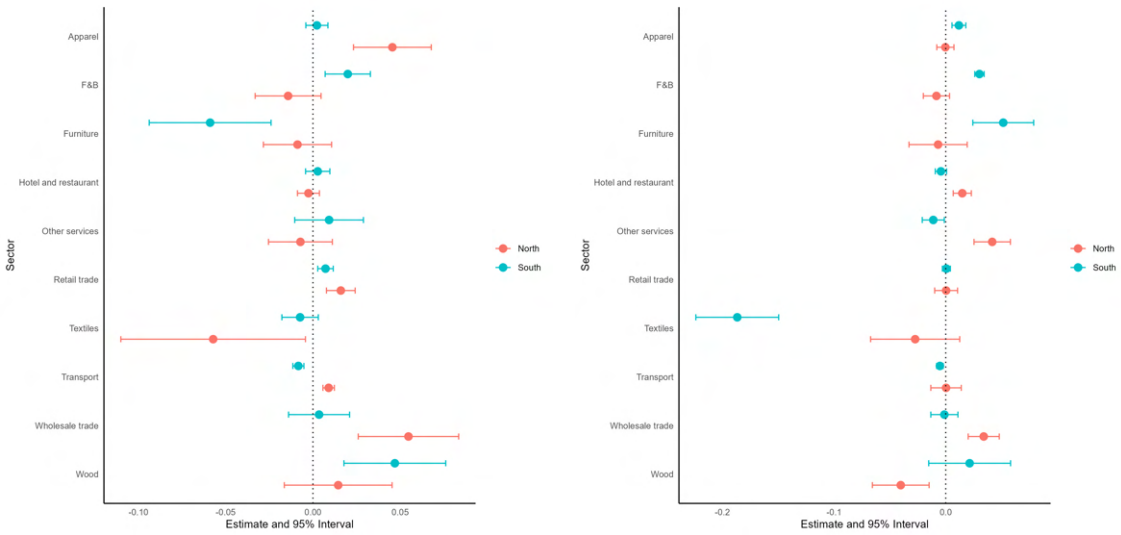


Source: Author's calculations using the 2002 to 2012 VHLSS.

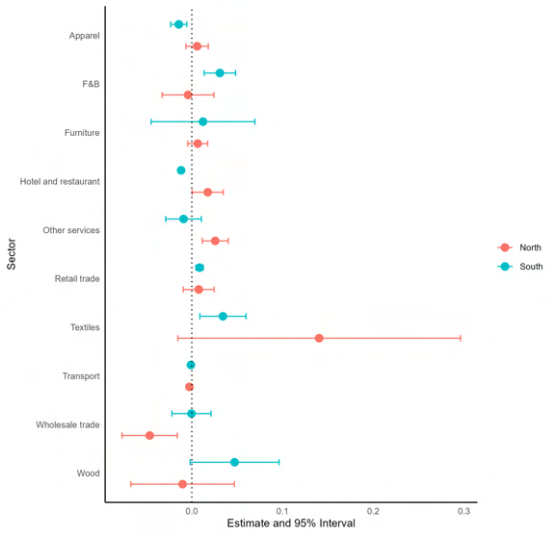
Figure A.19: Impact of ordnance on the probability of businesses being female-managed, by sector

(a) 2001

(b) 2003



(c) 2005



A.3 Robustness check using casualties data

Figure A.20: Impact of casualties on the probability of working

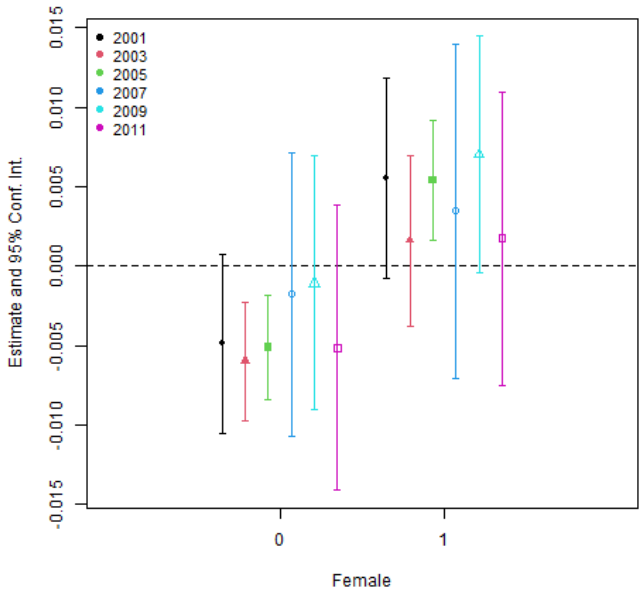


Figure A.21: Impact of casualties on the probability of working, by age

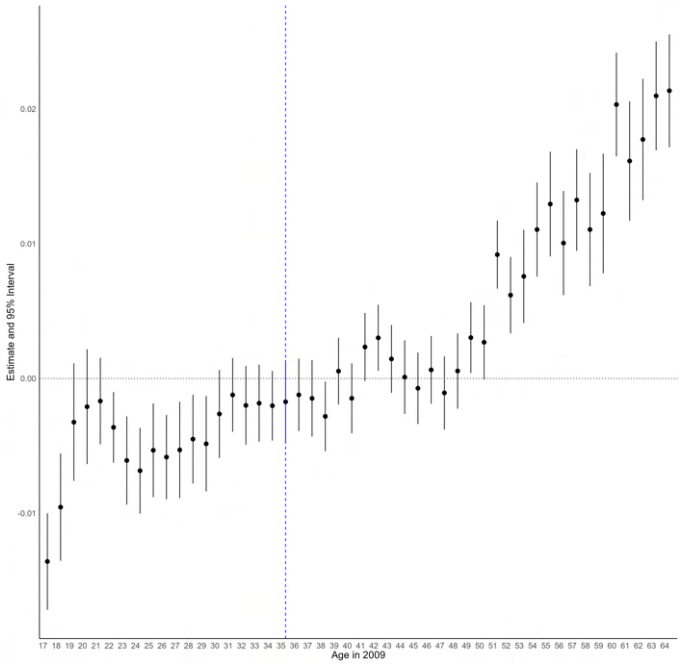


Figure A.22: Impact of casualties on firm-level ratio of male to female workers

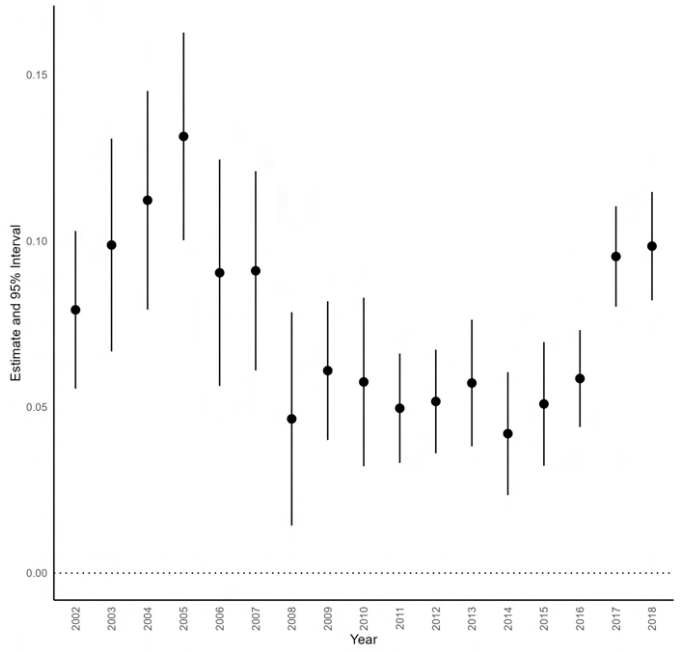


Table A.2: Impact of casualties on the probability of businesses being female-managed

I. Without industry F.E.

	2001	2003	2005
ln(Casualties)	0.0088	0.0020	0.0086**
	(0.0071)	(0.0033)	(0.0038)
Mean	0.62	0.58	0.59
Observations	9,429	10,808	7,867
R^2	0.00583	0.00725	0.00695
Within R^2	0.00063	3.29×10^{-5}	0.00063

II. With industry F.E.

	2001	2003	2005
ln(Casualties)	0.0062	-0.0001	0.0054
	(0.0064)	(0.0027)	(0.0048)
Mean	0.62	0.58	0.59
Observations	9,429	10,808	7,867
R^2	0.33316	0.23903	0.35058
Within R^2	0.00046	1.73×10^{-7}	0.00037

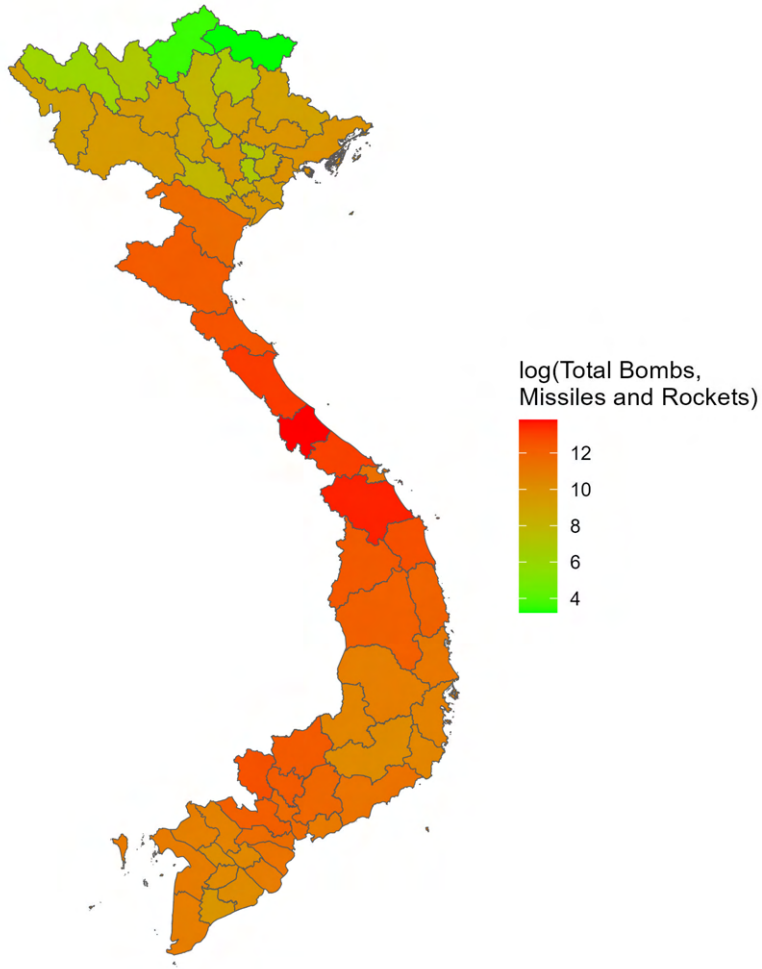
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

All specifications include province fixed effects.

B.1 Province-level analyses

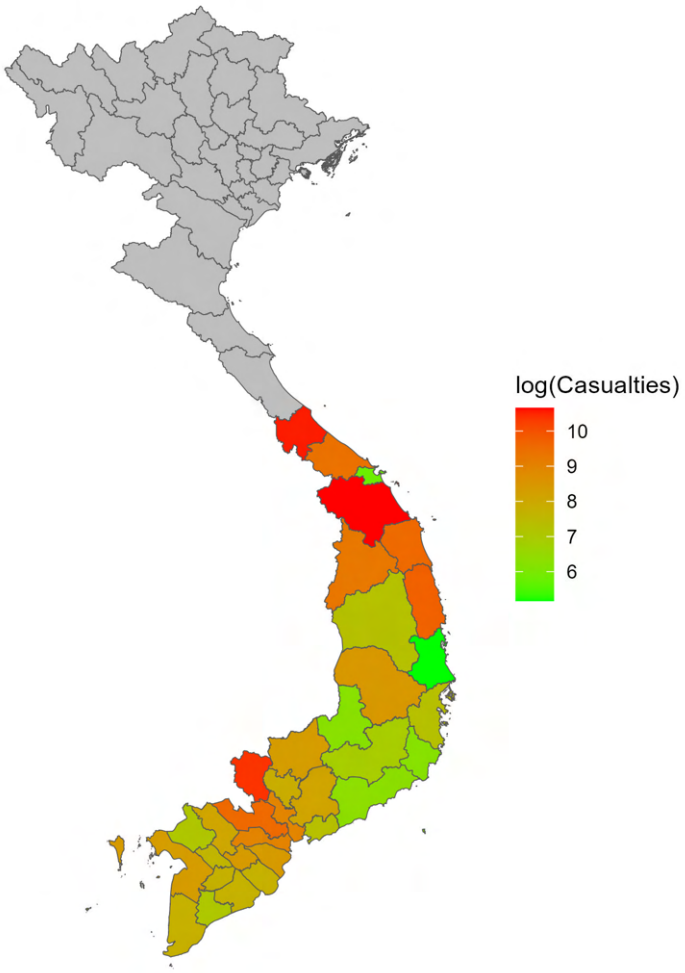
B.1.1 Descriptive statistics

Figure B.1: Map of province-level bombing intensity



Source: Author's calculations using THOR.

Figure B.2: Map of province-level casualties



Source: Author's calculations using SITRA.

Figure B.3: Provincial bombing intensity versus casualties

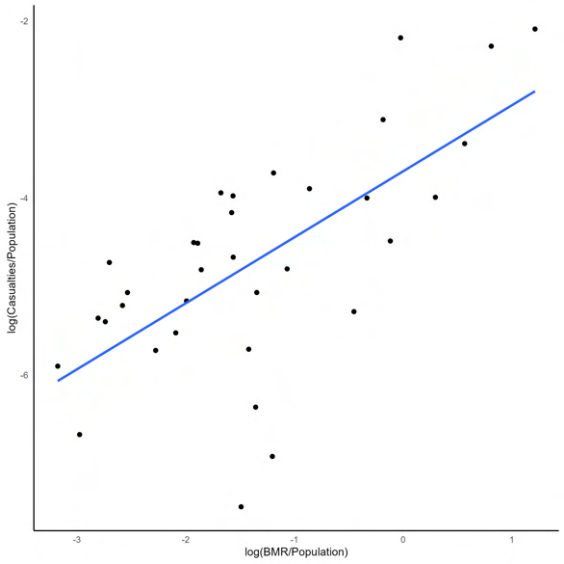
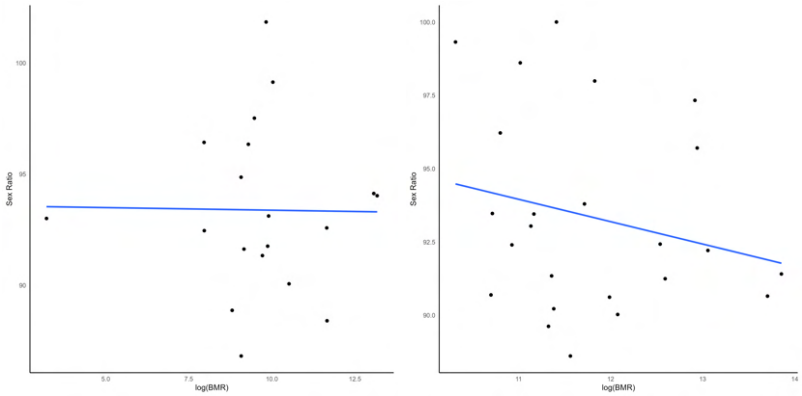


Figure B.4: Provincial bombing intensity versus provincial sex ratio

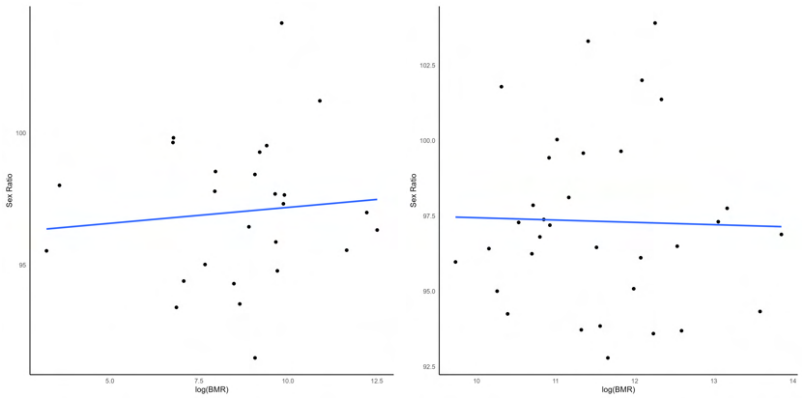
1989

(a) North (b) South



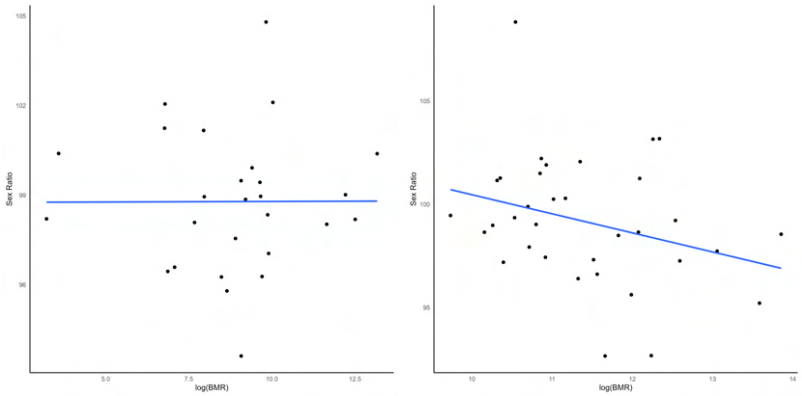
1999

(c) North (d) South



2009

(e) North (f) South

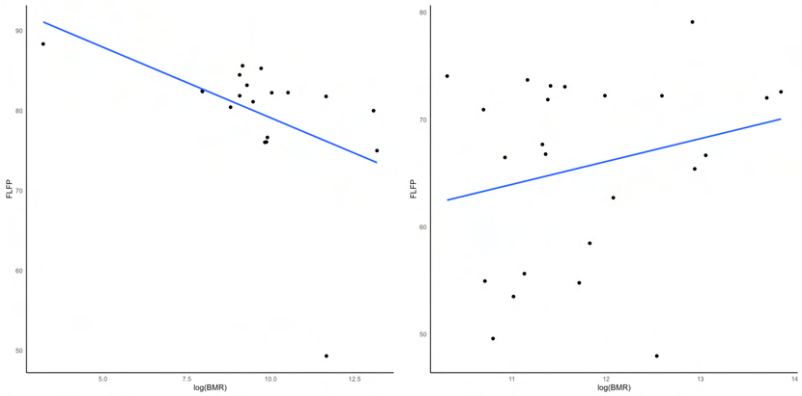


Source: Author's calculations using 1989, 1999 and 2009 PHC.

Figure B.5: Provincial bombing intensity versus FLFP

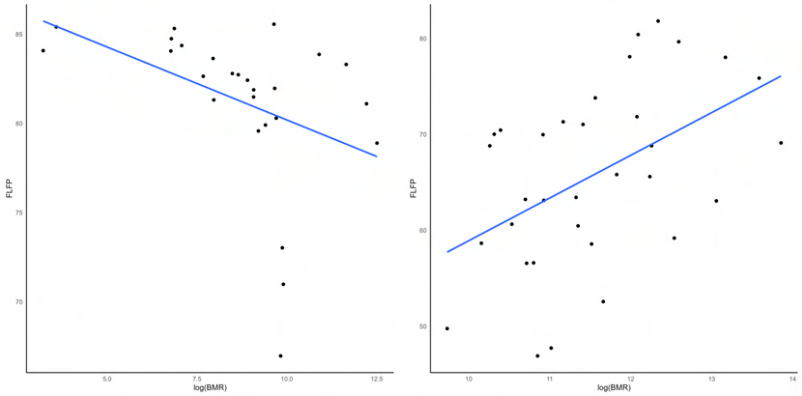
1989

(a) North (b) South



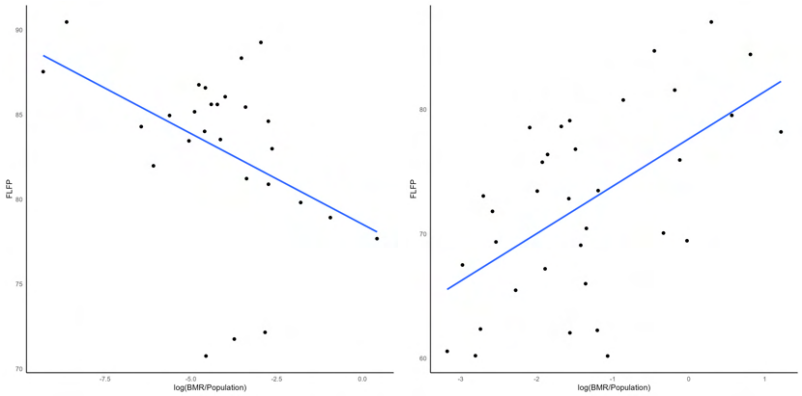
1999

(c) North (d) South



2009

(e) North (f) South

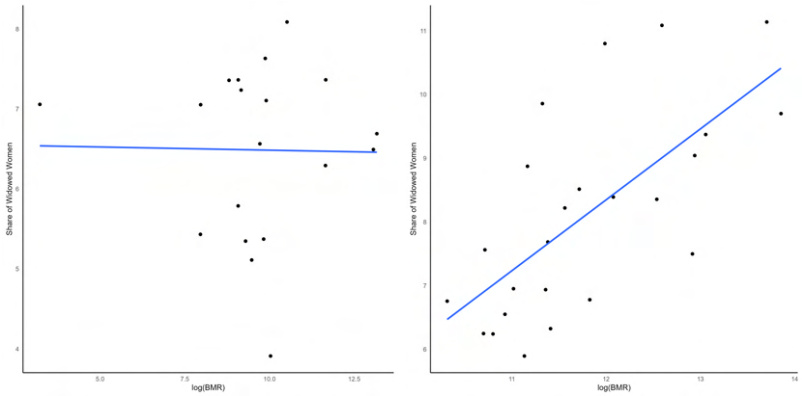


Source: Author's calculations using 1989, 1999 and 2009 PHC.

Figure B.6: Provincial bombing intensity versus share of women widowed

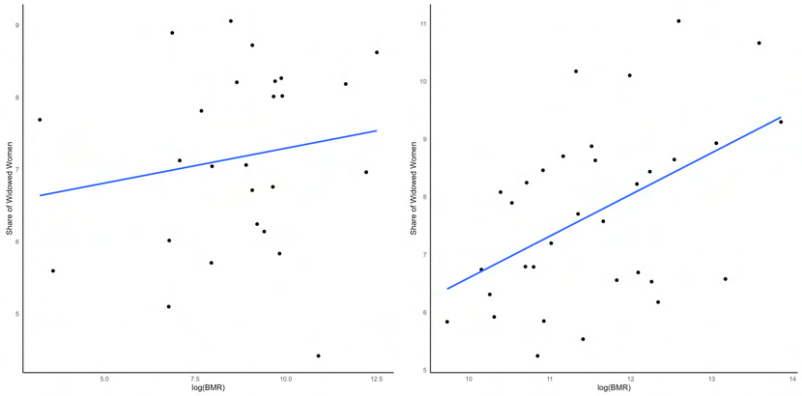
1989

(a) North (b) South



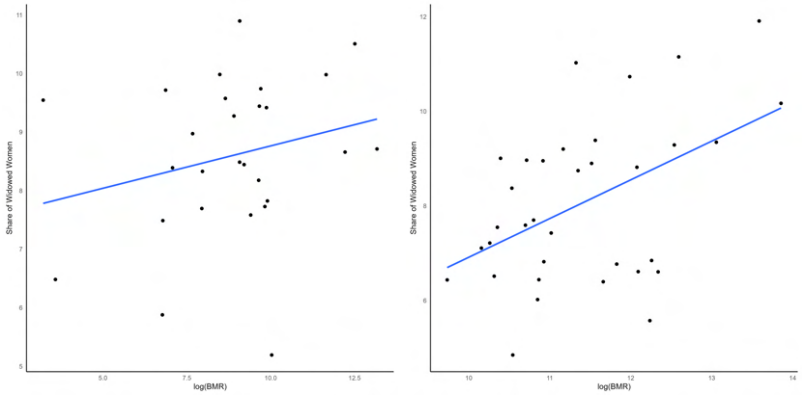
1999

(c) North (d) South



2009

(e) North (f) South



Source: Author's calculations using 1989, 1999 and 2009 PHC.

B.1.2 Province-level regressions

Since intra-provincial migration may bias results, I replace the dependent variable in equations (1) and (2), and (3) with the total number of bombs, missiles and rockets dropped on province p between 1965 and 1975.[11] I also remove the province-fixed effects since these are collinear with the number of ordnance dropped on province p. However, I control for the natural log of the population density alongside the individual-level controls.

Table B.1: Impact of province-level ordnance on the probability of businesses being female-managed

I. Without industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0098	0.0118*	0.0123	0.0033	0.0056	-0.0020
	(0.0086)	(0.0059)	(0.0073)	(0.0084)	(0.0075)	(0.0061)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	7,169	7,833	5,805	11,023	12,649	9,377
R^2	0.00098	0.00139	0.00156	3×10^{-5}	9.08×10^{-5}	1.17×10^{-5}
Adjusted R^2	0.00084	0.00126	0.00139	-6.07×10^{-5}	1.18×10^{-5}	-9.5×10^{-5}

II. With industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0115*	0.0074	0.0093*	0.0041	0.0068	0.0005
	(0.0063)	(0.0064)	(0.0048)	(0.0094)	(0.0071)	(0.0060)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	7,169	7,833	5,805	11,023	12,649	9,377
R^2	0.28199	0.18372	0.29864	0.31883	0.22921	0.34678
Within R^2	0.00182	0.00064	0.00125	6.5×10^{-5}	0.00017	1.01×10^{-6}

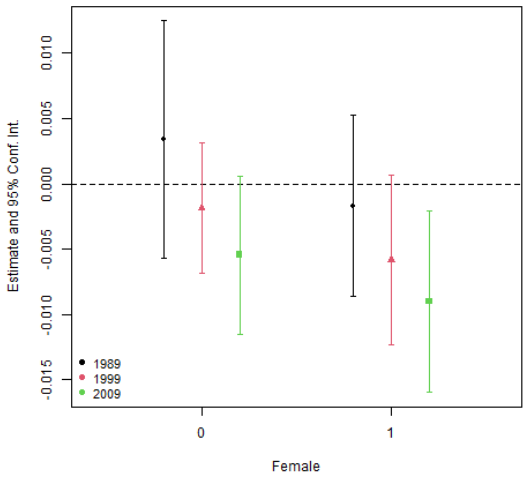
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*
All specifications include province fixed effects.

[11] Provinces are the first subnational unit in Vietnam. In 2001, there were 61 provinces and from 2003 there are 63 provinces.

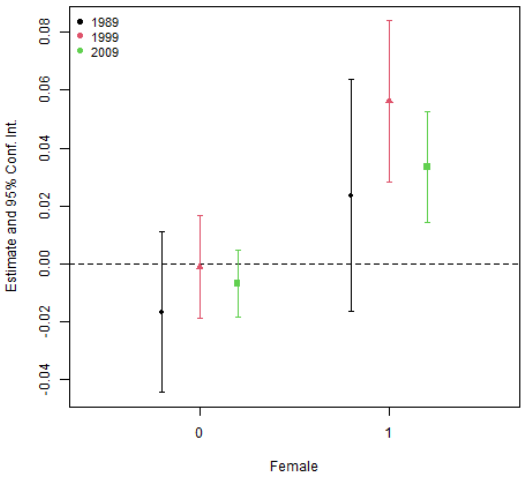
Figure B.7: Impact of province-level ordnance on the probability of working

PHC

(a) North

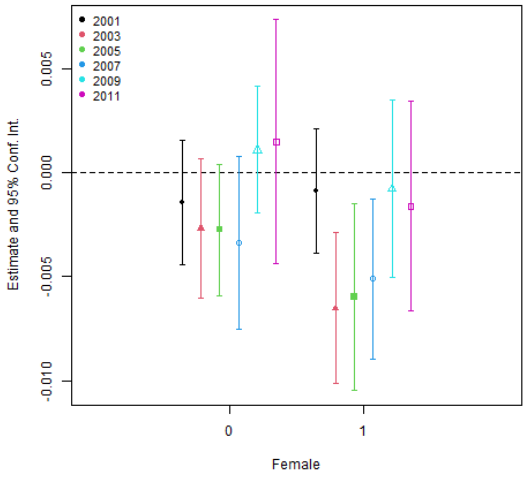


(b) South



VHLSS

(c) North



(d) South

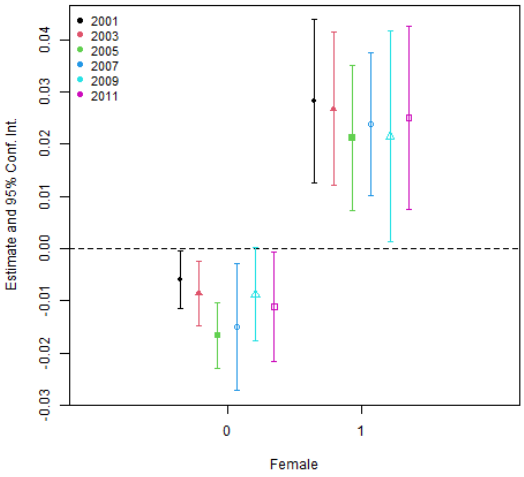


Figure B.8: Impact of province-level ordnance on the probability of working for females, by age

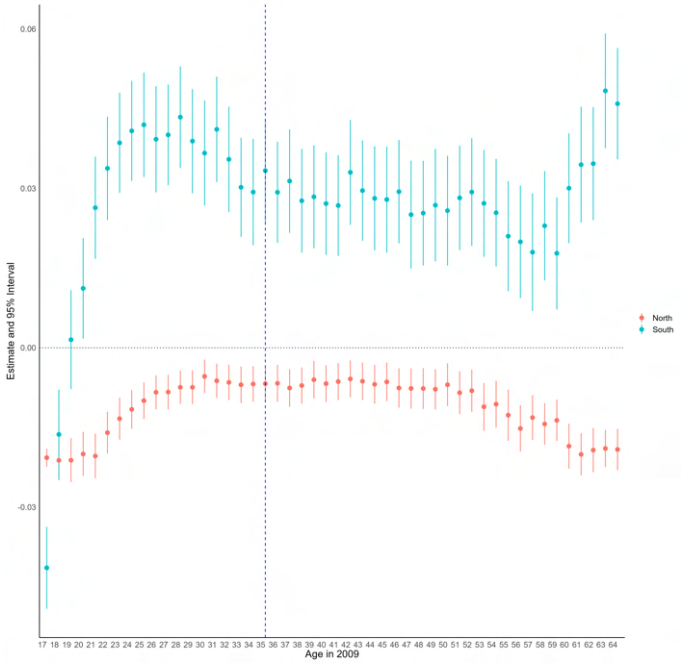
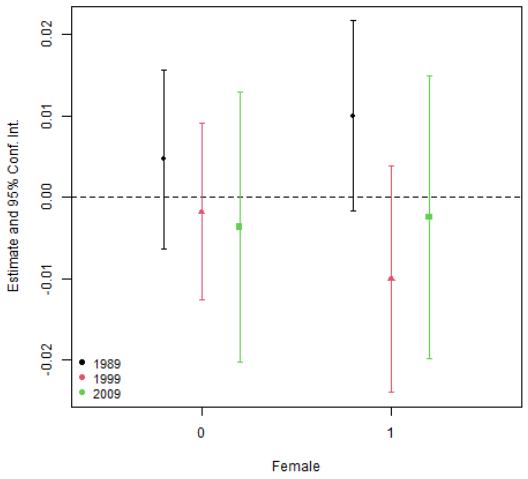


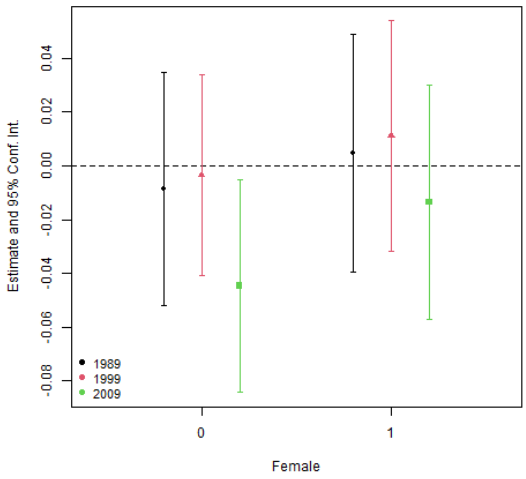
Figure B.9: Impact of province-level ordnance on the probability of working in agriculture

PHC

(a) North

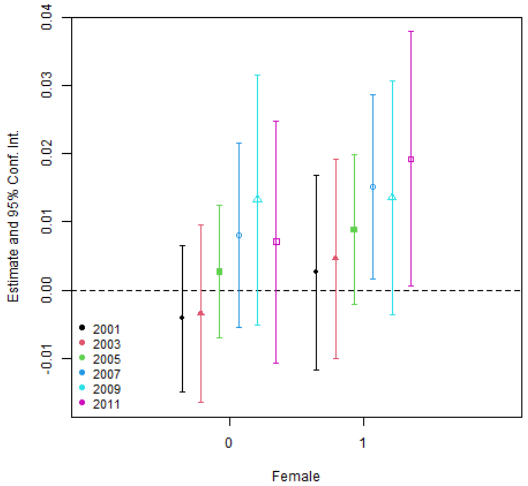


(b) South



VHLSS

(c) North



(d) South

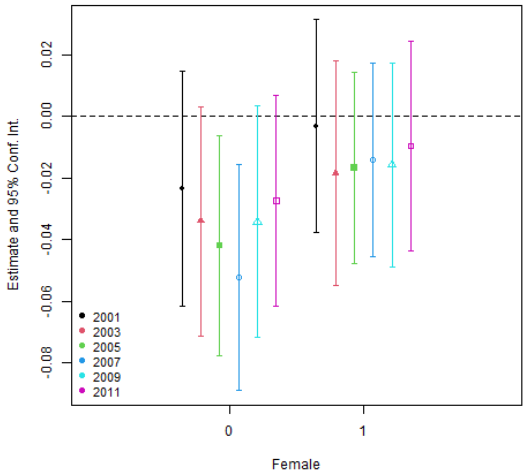
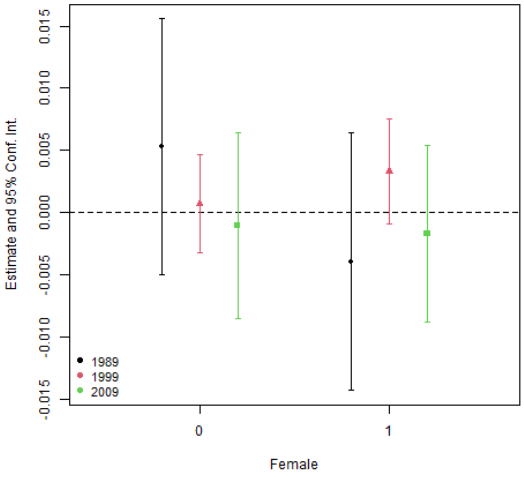


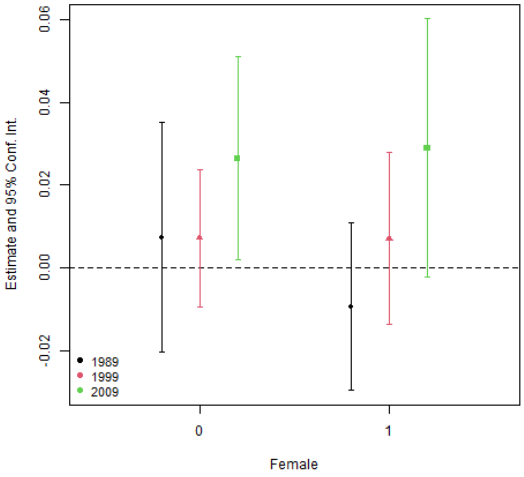
Figure B.10: Impact of province-level ordnance on the probability of working in manufacturing

PHC

(a) North

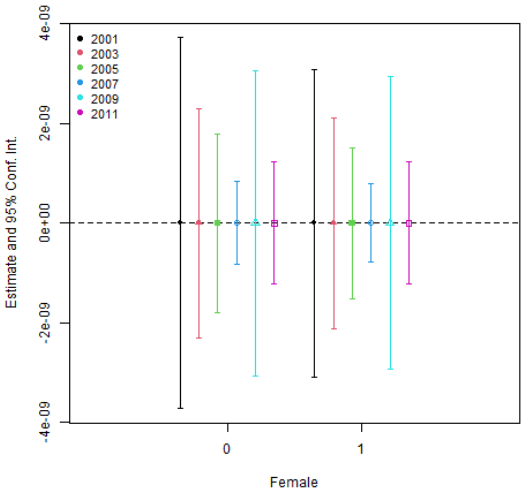


(b) South



VHLSS

(c) North



(d) South

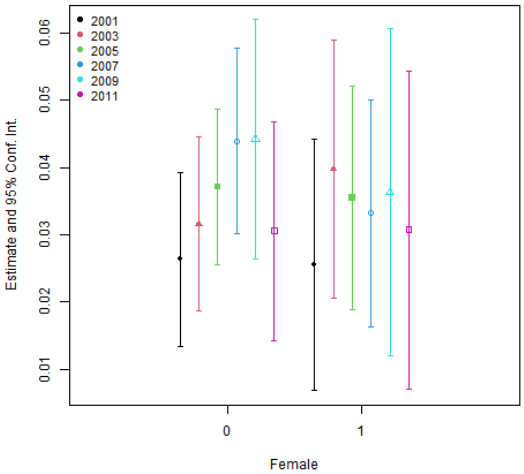


Figure B.11: Impact of province-level ordnance on firm-level ratio of male to female workers

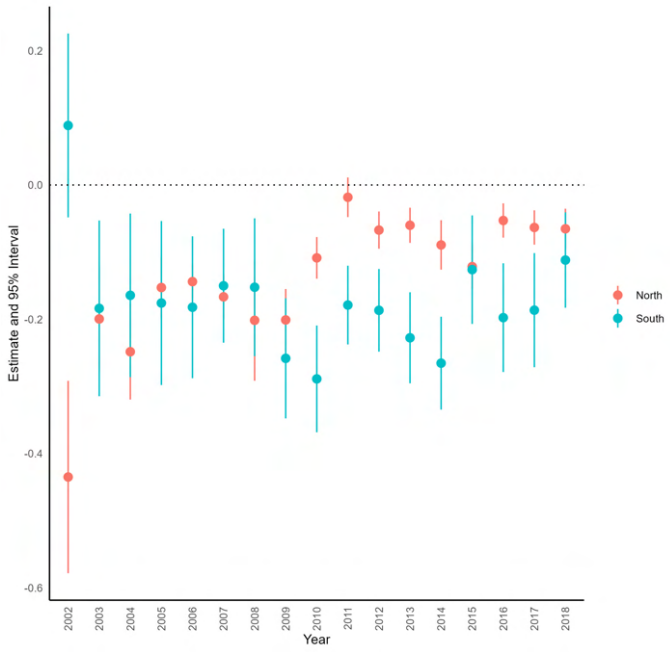
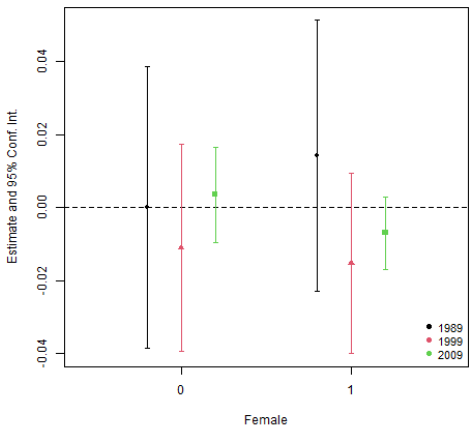


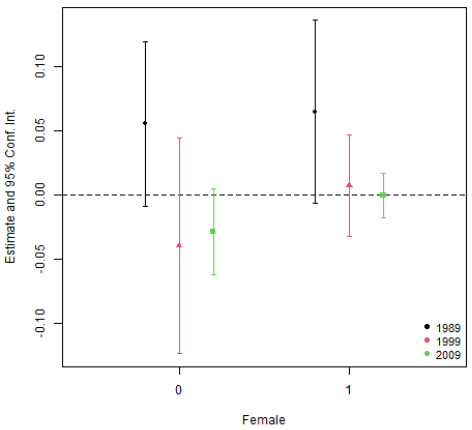
Figure B.12: Effect of ordnance on probability of working for widows

Without children

(a) North

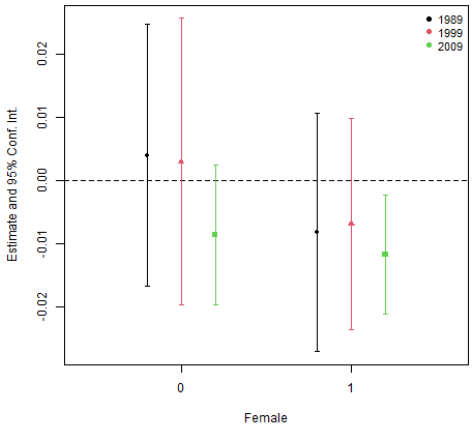


(b) South



With children

(c) North



(d) South

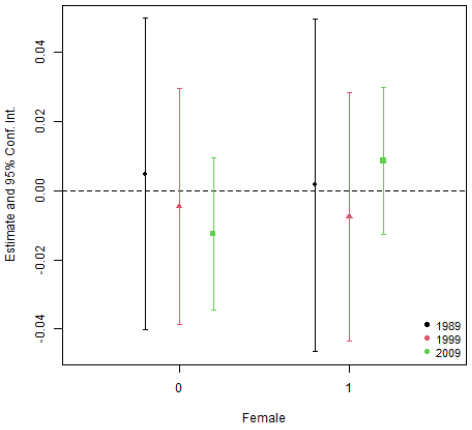
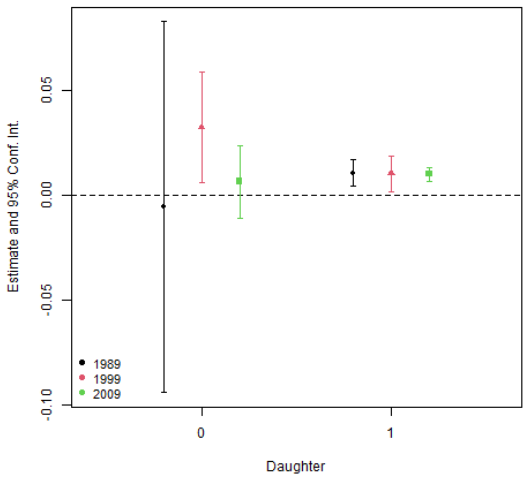
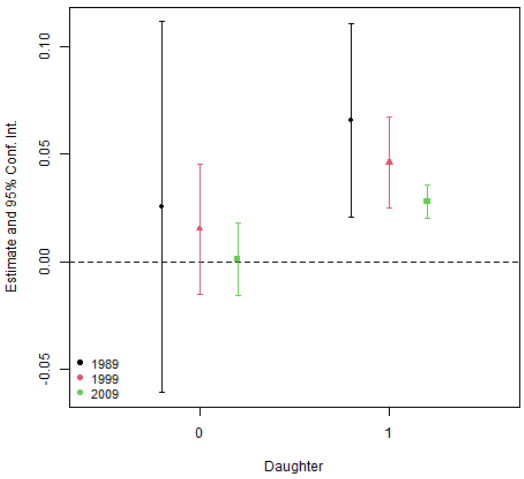


Figure B.13: Impact of widowhood on the probability of working for sons and daughters

(a) North



(b) South



B.1.3 Alternative measures to province-level exposure to the Vietnam War

While district-level population data is not available for pre-war years, the Statistical Yearbook of 1960 and 1969 provides data on the provincial pre-war population for North and South Vietnam respectively. Thus, I am able to match old provincial boundaries with contemporary boundaries to scale provincial exposure to the Vietnam War by its pre-war population. Thus, I amend the analysis in section B.1.2 by dividing the number of bombs, missiles and rockets dropped on province p by its pre-war population.[12] As in section B.1.2, I also control for the population density of province p in cross-sectional year t.

Table B.2: Impact of province-level ordnance on the probability of businesses being female-managed

I. Without industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0092	0.0089	0.0119	0.0106	0.0134	0.0098
	(0.0084)	(0.0065)	(0.0074)	(0.0064)	(0.0084)	(0.0090)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	7,169	7,833	5,805	11,023	12,649	9,377
R^2	0.00075	0.00069	0.00123	0.00050	0.00085	0.00047
Adjusted R^2	0.00061	0.00056	0.00106	0.00041	0.00078	0.00036

II. With industry F.E.

	North			South		
	2001	2003	2005	2001	2003	2005
ln(BMR)	0.0129*	0.0068	0.0096	0.0132**	0.0152**	0.0068
	(0.0066)	(0.0069)	(0.0059)	(0.0055)	(0.0067)	(0.0047)
Mean	0.50	0.60	0.58	0.62	0.58	0.59
Observations	7,169	7,833	5,805	11,023	12,649	9,377
R^2	0.28210	0.18358	0.29855	0.31955	0.23016	0.34700
Within R^2	0.00197	0.00047	0.00111	0.00112	0.00139	0.00034

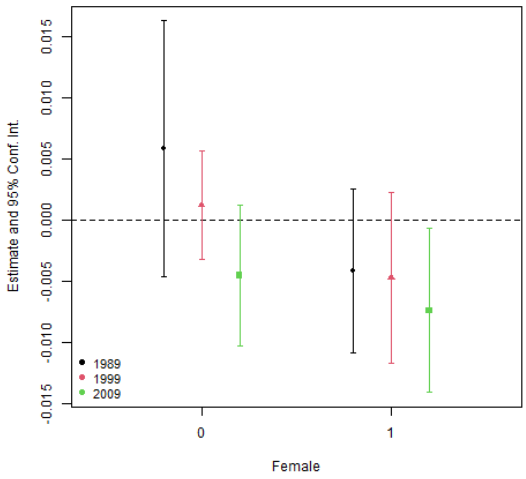
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

[12] For North Vietnam, I divide the total ordnance jettisoned by the 1961 population of province p. For South Vietnam, I divide the total number of ordnance jettisoned by the 1965 population of province p.

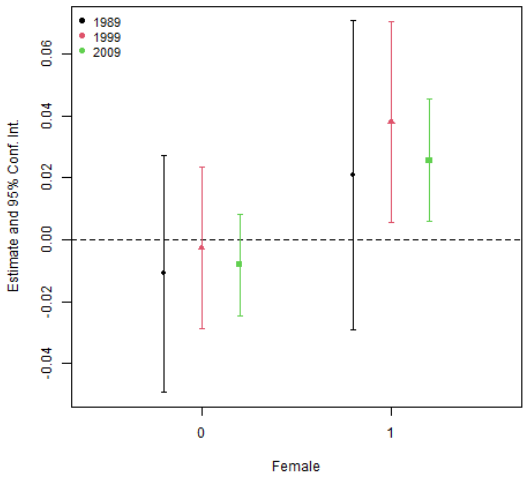
Figure B.14: Impact of province-level ordnance on the probability of working

PHC

(a) North

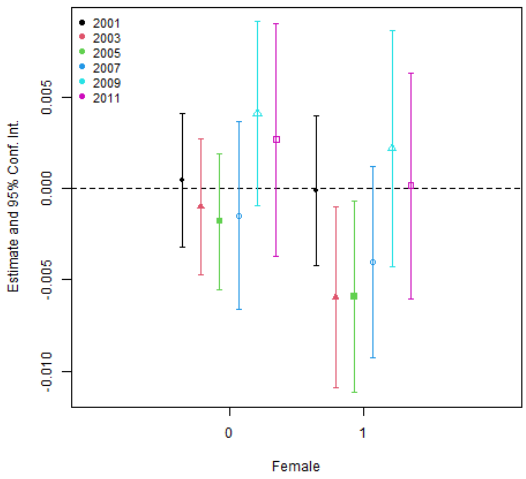


(b) South



VHLSS

(c) North



(d) South

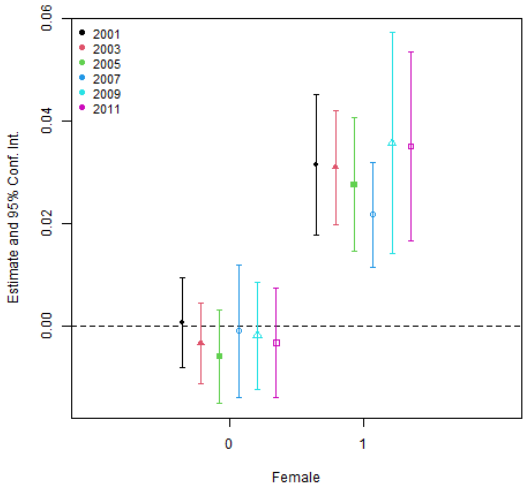


Figure B.15: Impact of province-level ordnance on the probability of working for females, by age

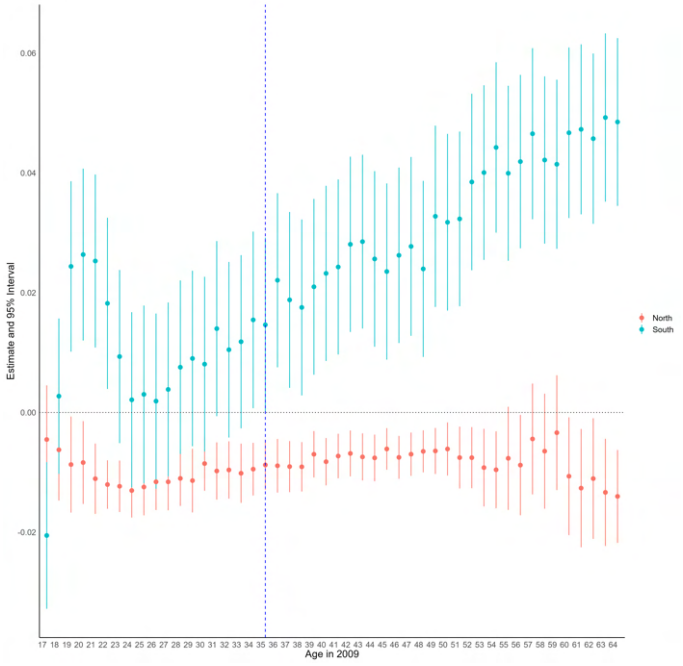
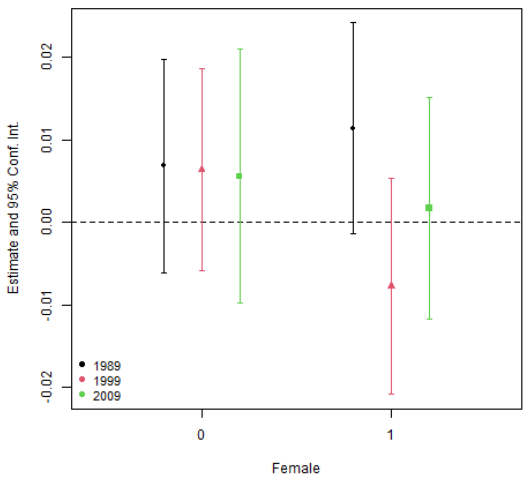


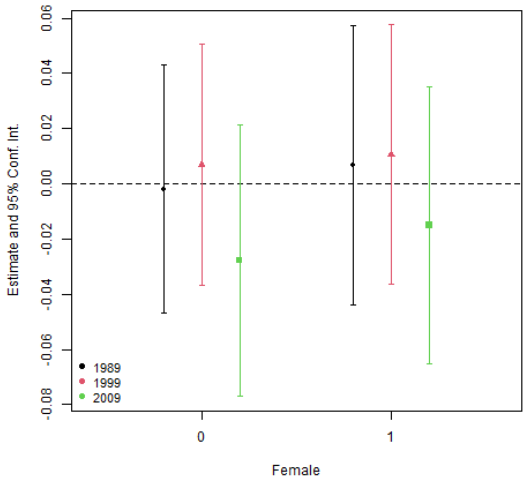
Figure B.16: Impact of province-level ordnance on the probability of working in agriculture

PHC

(a) North

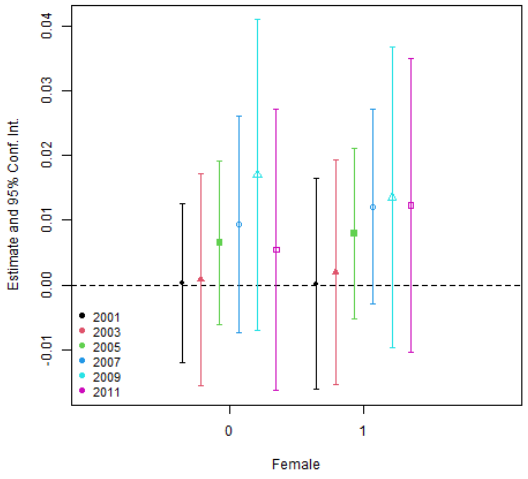


(b) South



VHLSS

(c) North



(d) South

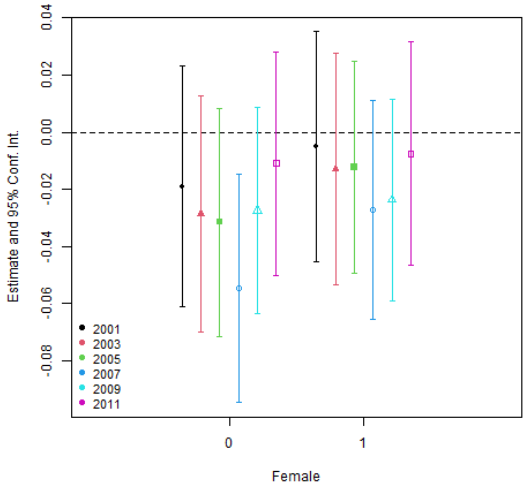
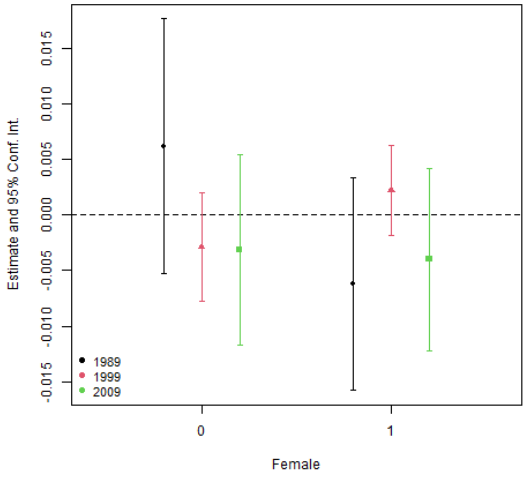


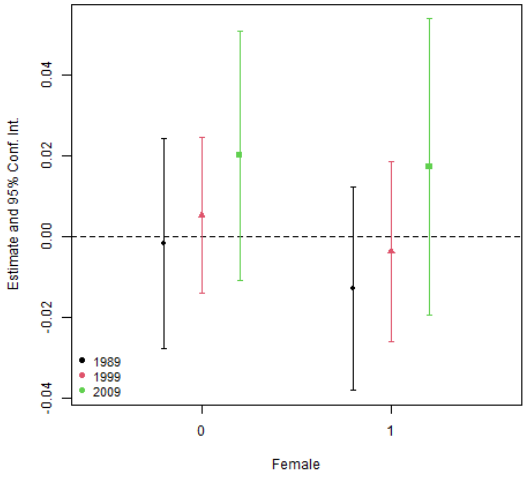
Figure B.17: Impact of province-level ordnance on the probability of working in manufacturing

PHC

(a) North

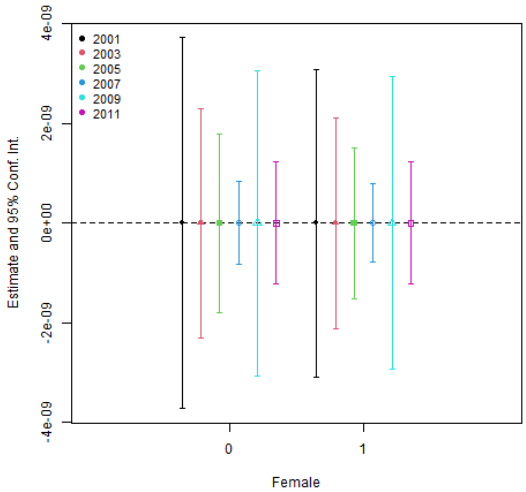


(b) South



VHLSS

(c) North



(d) South

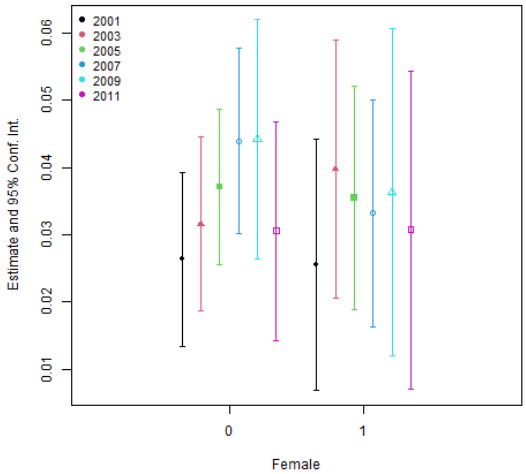


Figure B.18: Impact of province-level ordnance on firm-level ratio of male to female workers