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Vierteljahrshefte zur Wirtschaftsforschung

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*Suggested Citation:* Strand, Alexander (1997) : The Effect of Occupational Segregation by Gender on Wages: a Comparison of the United States and Germany, Vierteljahrshefte zur Wirtschaftsforschung, ISSN 0340-1707, Duncker & Humblot, Berlin, Vol. 66, Iss. 1, pp. 47-54

This Version is available at:

<https://hdl.handle.net/10419/141160>

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# Labor Market Participation

## The Effect of Occupational Segregation by Gender on Wages: A Comparison of the United States and Germany

By Alexander Strand\*

### Summary

*Men and women tend to work in different occupations in both the United States and Germany. This occupational segregation is correlated with wages: people in occupations with proportionally more women earn less. The correlation could be the result of discrimination or the result of women voluntarily choosing lower paying occupations. The empirical evidence for the United States is mixed between support of these two explanations. This paper extends the analysis to Germany. It compares the distribution of people across occupations and the corresponding distribution of wages for the two countries. It also looks for differences in the way occupational segregation and wages are related in the United States and Germany.*

### 1. Introduction

The United States and Germany both have a substantial degree of occupational segregation by gender. Also, both countries have a persistent gap between the earnings of men and women. This study examines the relationship between these phenomena by testing whether occupational segregation has an independent effect on wages. This section reviews two proposed theoretical explanations of this effect. The following sections review measurement issues and conduct empirical analysis. Ordinary least squares and fixed effects regression models are estimated for both countries.

The starting point of the theoretical debate on this issue is Bergmann's (1974) seminal paper that asserts the "crowding hypothesis." According to this, women are pushed into certain occupations by noneconomic factors at a higher rate than is warranted by the incentives of each occupation. Thus, equilibrium wages for women are lower than they would be in the absence of these noneconomic

factors. For men, the decreased supply of labor in the remaining occupations drives the wage up.

England et al. (1988) refer to this as the "sociological hypothesis." It explains the wage gap by market failure due to allocative inefficiency. Human capital is inefficiently allocated if its distribution is based on factors not related to productivity (Bergmann 1989). In this case, productivity and total output could be increased by reassigning some workers among occupations a sure sign of allocative inefficiency and an indication of Pareto nonoptimality.

This remained the only theory explaining the empirical observations until Polachek (1981) extended the choice model into the realm of occupational segregation. For the sake of comparison, call this the "economic hypothesis." In the economic hypothesis, an individual chooses an occupation based on the costs of entering the occupation and the expected lifetime returns. If women have greater desire to devote time to child raising, it is rational to seek occupations with a low penalty to temporary labor market withdrawal. According to Polachek, occupations do differ in this respect and women seek these occupations because they offer maximal lifetime returns when intermittent labor force participation is expected. Thus, the gross correlation of female concentration and wages is spurious. Female concentration could be acting merely as a proxy for the degree of commitment to the labor market.

This paper employs a model that tests the relative strengths of these competing hypotheses. Previous research on Germany has not done this, but rather has focused on the economic hypothesis (see Bellman and Kohaut 1995). In the United States, research has frequently focused on one or the other. Exceptions to this include England et al. (1988) and Gerhart and El Cheikh (1991). However, these papers reach opposing conclusions. The empirical techniques are very similar, but the choice and handling of the data produce different results. Thus, it is warranted to extend this technique to other data sets and to expand the debate to include another advanced industrialized economies.

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The developing consensus technique in the literature involves testing both hypotheses by examining the correlation between the percent female in an occupation and wages while controlling for other factors that might influence the choice of occupation. One could divide these into 1) the nonpecuniary benefits to working in that occupation and 2) the prerequisites of employment in that occupation. The former will be approximately measured by working conditions and the latter by educational and training requirements for employment. Both of these factors will be included in a least squares regression model to obtain a measure of correlation after accounting for the choice of occupation. In addition, individual characteristics may influence the choice of occupation; these are accounted for with a fixed effects model.

## 2. Data Issues

This study uses the German Socioeconomic Panel (GSOEP) and the Panel Study of Income Dynamics (PSID) with supplemental data from census sources. Data on occupational conditions and prerequisites have been made available by Miller et al. (1980) for the United States. This data set uses the census classification of 1970 (also used by the PSID) and is based on the *Dictionary of Occupational Titles* research. It provides multifactor scales that have become standard control variables in the American literature on this subject. The scales for physical work demands, environmental working conditions, required educational development, and required vocational training will be used here.

There are no equivalent data for Germany, but supplement data on job characteristics are available in the 1985, 1987, and 1989 waves of the GSOEP<sup>1</sup>. Job characteristics are constructed from the individual's responses to the following questions.

- Is your work physically demanding? [P3902]
- Are you exposed to undesirable working conditions? [P3912]
- What type of training is usually necessary for the job that you do?  
 [ P3201] no particular training,  
 [ P3202] just a quick introduction in the work place,

- [ P3203] fairly lengthy training at the work place,
- [ P3205] completed career training,
- [ P3206] completed higher education.

There are several possible sources for the central variable of this study, the proportion of women in an occupation. It could either be gathered from the decennial censuses conducted by both countries or it could be calculated from the GSOEP and PSID directly. The census sources provide data for only one year relevant to this study, whereas calculations from the longitudinal data sets provide an observation for every year. However, as is demonstrated below, the figures from the GSOEP and PSID are not nearly as accurate as the census sources.

Table 1 shows the two alternative estimates of the working populations of men and women and the percent female in their occupations for each country. Both estimates of the percent female are based on the workers observed in the GSOEP and PSID and the cross-sectional sample weights, but the gender composition of these workers' occupations come from different sources. In the census alternative for each country, the gender composition of each worker's occupation is derived from national statistics. In the GSOEP/PSID alternative, the gender composition is calculated as the sum of the women's sample weights divided by the sum of all sample weights for each occupation. The differences between the two measures are significant for both countries at the 1 percent level of significance. This reflects the inaccuracy of the GSOEP/PSID alternatives, which exaggerate the degree of gender segregation across occupations in both countries. Each gives a higher estimate of the degree to which women are segregated with other women and a lower estimate of the number of women in male-dominated occupations. The large differences indicate that the estimates of percent female in each occupation should be taken from the census sources.

<sup>1</sup> These provide roughly the same information, although it is presumably less accurate than the Miller et al. controls. The GSOEP respondents report about their particular jobs whereas the *Dictionary of Occupational Titles* data are based on nationally representative samples.

Table 1

**Comparison of Census and GSOEP/PSID Estimates of Male and Female Employment<sup>1)</sup>**

	German Census, 1987	GSOEP, 1987	U.S. Census, 1990	PSID, 1990
Number of men employed (millions)	16.65	15.68	66.97	79.01
Percent female in men's occupations	20.60	16.50	27.50	25.90
Number of women employed (millions)	10.25	10.39	56.49	70.47
Percent female in women's occupations	58.70	71.20	65.80	73.10

<sup>1)</sup> GSOEP and PSID data are weighted.

Source: Author's calculations using German Census, U.S. Census, GSOEP, and PSID.

Table 2

## Average Wages and Occupational Concentration of Women

	1985		1991	
	Men	Women	Men	Women
Germany				
Percent female in occupation	21.3 (23.3)	58.7 (22.3)	20.3 (23.03)	58.5 (23.3)
Wage	19.21 (9.41)	14.47 (8.02)	23.27 (10.02)	17.79 (9.07)
United States				
Percent female in occupation	28.5 (22.5)	65.9 (24.8)	29.1 (22.7)	65.6 (25.2)
Wage	11.78 (6.64)	7.97 (4.58)	13.92 (8.00)	10.57 (6.31)

Note: Standard deviations are in parentheses. GSOEP wages are measured on an hourly basis (monthly earnings divided by monthly work hours) and are not deflated. PSID wages are measured on an hourly basis (annual earnings divided by annual work hours) and are not deflated.

Source: Author's calculations using GSOEP and PSID and measures of female concentration rates in occupations from 1987 German Census and 1990 U.S. Census.

It was necessary to convert both sets of census data to different occupational classification systems before they could be used in conjunction with individual-level data from the GSOEP and PSID. The PSID uses the 1970 census classification, not the 1990 census system. The GSOEP uses the international standard of 1968 (ISCO), but the German census uses the Statistisches Bundesamt Classification of 1975. The reclassifications were largely successful, but there are certainly some errors in matching between sources and some observations could not be reclassified.

The remaining variables used in this study come from the PSID and the GSOEP. Directly comparable control variables for work experience, school enrollment status, and marital status can be constructed. Comparable measures of education and vocational training are not directly available in the two data sets. I reclassify workers into high education and low education groups, based on years of education in the American sample and on educational and vocational certificates in the German sample<sup>2</sup>. The hourly wage for Germans is constructed as monthly income (from wage and salary on primary and second jobs plus bonuses) divided by monthly work hours (average weekly work hours times 4.35). For Americans, the average hourly earnings variable available in the PSID (computed as annual labor earnings divided by annual work hours) is used<sup>3</sup>.

### 3. Empirical Analysis

In the empirical work that follows, the measures of female concentration rates by occupation from the censuses are

matched onto the individual data records from the PSID and GSOEP. Table 2 shows that men and women tend to work in different occupations in both countries. In Germany, the average woman works in an occupation with 59 percent women, and the average man works in an occupation with only 21 percent women. The situation is similar in the United States although proportionally many more American women work. The average female works in an occupation with 66 percent women, while men on average work in occupations with 29 percent women. This illustrates a very similar degree of occupational segregation as Germany, although the overall means are substantially higher.

<sup>2</sup> PSID samples members with less than 12 years of schooling were classified as "low" education (17.6 percent of individuals); those with between 12 and 15 years are "middle" education (58.8 percent); and those with 16 or more years of education are in the "high" education category (23.6 percent). The low education category in the GSOEP includes persons with no school degree or with a *Hauptschule* degree and no vocational training (19.0 percent of individuals); high education is defined as a university degree (including technical college), or any school-leaving degree plus civil service training or technical school training, or the highest school-leaving degree (*Abitur*) and any completed training (22.9 percent of individuals). "Middle" education incorporates all other degree and training combinations. All percentages are based on weighted data.

<sup>3</sup> Neither wage is deflated, but the regressions include a time trend. The regression samples include all observations where the wage is greater than one-fourth but less than five times the median wage.

Table 3

## Female Concentration and Wages by Quintiles

Female Concentration Quintile	Men					Women					Percent Women in this Quintile	
	Wage Quintile					Percent Men in this Quintile	Wage Quintile					
	1	2	3	4	5		1	2	3	4		5
Germany												
1	13.07	15.58	21.24	26.74	23.36	29.08	19.86	39.29	31.49	7.91	1.46	0.61
2	12.11	14.06	22.46	23.15	28.21	28.56	47.58	21.46	18.52	8.13	4.31	5.01
3	10.41	13.99	16.29	17.17	42.15	21.68	33.13	19.35	10.02	17.57	19.93	18.77
4	12.30	15.13	10.23	25.44	36.90	13.59	20.72	17.39	19.30	25.31	17.28	30.44
5	14.87	12.95	16.30	29.90	25.98	7.08	35.93	30.85	15.16	11.11	6.95	45.17
Total	12.24	14.55	18.67	23.69	30.84	100.00	31.26	24.17	15.72	16.48	12.36	100.00
United States												
1	8.62	13.36	16.88	25.69	35.44	32.47	18.16	6.05	28.86	26.64	20.28	1.69
2	13.32	11.57	15.68	22.26	37.18	35.02	25.76	23.14	14.44	21.37	15.29	12.25
3	9.42	9.81	17.20	21.67	41.90	15.28	25.02	22.68	20.03	20.06	12.21	19.39
4	8.16	12.58	19.60	3.19	36.47	14.76	25.22	22.11	19.81	17.56	15.30	29.22
5	22.29	17.67	23.34	14.78	21.92	2.47	26.34	26.67	23.14	16.44	7.41	37.44
Total	10.66	12.18	17.07	23.24	36.86	100.00	25.55	23.78	20.60	18.24	11.83	100.00
Note: Female concentration quintiles and wage quintiles are based on combined male and female workers. Female concentration rates are calculated using census data.												
Source: Author's calculations using GSOEP, PSID, and census data.												

The difference in women's labor force participation rates exaggerates the apparent difference in segregation between the countries. For example, 62 percent of German men work in highly segregated occupations, defined as those that contain less than 20 percent women. In the United States, this figure is only 41 percent. Similarly, only 16 percent of German women work in female-dominated occupations, defined as those with more than 80 percent women, while 40 percent of American women are in this category. Figures such as these are often cited in the United States context (see Beller 1982), but they are generally unsuited for international comparisons, since they conflate the effect of the fraction of women relative to men in the labor force with the degree of segregation. That is, the fraction of women working in highly male-concentrated occupations may be low either because of the high degree of segregation or because female labor force participation rates are low overall.

This problem is removed in Table 3, which defines quintiles of the percent female in occupation variable based on the entire working population. It shows the distributions of the men and women in these quintiles by wage quintiles, also constructed using the entire working population. This allows a direct comparison of the wage distribution of the

most segregated fifth of the work force in both countries, for example. The table shows that German women are more concentrated in the upper female concentration quintiles than American women. In general, the distributions for men and women are very similar for the two countries.

Table 3 also illustrates the gross correlation between wages and female concentration. The bottom row in each panel shows the distribution of workers across wage quintiles. Women are much more concentrated in the lower wage quintiles than men. In Germany, for example, 31 percent of women are in the lowest wage quintile while only 12 percent of men are. In the United States the figures are 26 percent and 11 percent, respectively. However, the distribution for women in the most segregated occupations (the fifth female concentration quintile one row up) is even more skewed toward the lower wage quintiles. This indicates an independent effect of female concentration on wages in both countries.

## Regression Analysis

The central empirical question is whether the gross correlation between percent female and wages holds when individual and job characteristics are controlled. Initially,

Table 4

## OLS and Fixed Effects Wage Regressions for Germany

Log(wage)	OLS				Fixed Effects			
	Men(1)	t-statistic	Women(2)	t-statistic	Men(3)	t-statistic	Women(4)	t-statistic
Experience	-0.0006	-0.525	0.0088	0.466	0.0013	1.326	0.0005	0.386
Experience Squared	0.0000	0.527	0.0000	-0.141	-0.0000	-0.411	-0.0000	-0.548
Low Education	-0.1571	-9.469	-0.1086	-5.363	—	—	—	—
High Education	0.2183	17.222	0.3091	14.528	—	—	—	—
Married	0.2091	19.722	0.0463	3.131	0.0400	2.214	0.0348	1.268
Enrolled	-0.4163	-20.526	-0.4442	-13.637	-0.2875	-13.579	-0.3535	-10.699
Percent female	0.0003	1.212	-0.0014	-4.423	-0.0011	-2.567	-0.0005	-0.953
Wave	0.0251	12.429	0.0195	7.175	0.0525	37.502	0.0545	25.173
Heavy	-0.0606	-5.977	-0.0620	-4.170	—	—	—	—
Dirty	-0.0265	-2.964	-0.7686	-5.250	—	—	—	—
OJT required	-0.0030	-0.158	0.0524	2.001	0.0296	1.527	-0.0106	-0.336
College required	0.1817	8.500	0.2286	6.103	-0.0075	-0.323	-0.0410	-0.997
Vocational training	0.0117	0.860	0.1055	5.603	0.0075	0.397	-0.0150	-0.478
Courses required	0.0044	0.209	0.1374	4.152	0.0280	1.175	-0.0140	-0.272
Constant	0.6105	3.305	0.9689	3.924	-0.0066	-4.846	-0.0013	-0.296
R <sup>2</sup>	.32		.25		.33		.30	
N	5,880		3,371		4,086		2,079	

Note: The sample includes observations from 1985, 1987, 1989, 1991, and 1993. Also, wages less than one-quarter of the median or more than five times the median were discarded. "Percent female in occupation" is constructed using the 1987 census.  
Source: Author's calculations using GSOEP data with 1987 German census.

human capital investments will be accounted for in a standard Mincerian wage function. Then, the implications of Polachek's economic hypothesis will be tested. First, the theory predicts that women's choices of occupation produce the observed wage differential. It is possible to control for the choice of occupation by including occupational characteristics in the regression. For example, if workers are paid a premium for exposure to environmental hazards, then those who are averse to that risk will be observed in safer, lower-paying occupations. In other words, there should be observed compensating differentials for occupational characteristics. Second, Polachek asserts that the individuals in various occupations differ as well. Different preferences and unobservable characteristics can be accounted for using a fixed effect in the regression.

Including these variables provides a way to distinguish between the economic hypothesis and the sociological hypothesis. The coefficients on the occupational characteristics variables will test for compensating wage differentials. Also, the difference between the OLS and fixed effects coefficients on percent female will give an indication of the role preferences play in sorting women across occupations.

Tables 4 and 5 show the results of these regressions. There are notable differences across countries in the magnitudes of the human capital coefficients. For example,

the pecuniary return to experience is larger in the United States for both men and women whereas the return to education is larger in Germany. The coefficient on "percent female" shows the magnitude of the effect of occupational segregation on wages when controlling for measurable occupational characteristics. For a German woman, switching to an occupation with 1 percent fewer women results in a wage increase of 0.14 percent, *ceteris paribus*. Switching from the most female-dominated occupation to the most male-dominated one is associated with a wage increase of about 14 percent. In the United States, this change yields a 19 percent increase.

The assertion that choice of occupation based on working conditions affects wages is strongly rejected. This assertion would be supported by a positive coefficient showing a compensating differential for poor working conditions. However, the variables indicating manually difficult work ("heavy" in Germany and "physical demands" in the United States) and dangerous working conditions ("dirty" in Germany and "environment" in the United States) generally have negative and statistically significant coefficients.

The one occupational characteristic for which both countries do show a significant compensating differential is the education level required for that occupation. In Germany, occupations requiring a college education pay premiums of

Table 5

## OLS and Fixed Effects Wage Regressions for the United States

Log(wage)	OLS				Fixed Effects			
	Men(1)	t-statistic	Women(2)	t-statistic	Men(3)	t-statistic	Women(4)	t-statistic
Experience	0.0279	27.821	0.0228	25.215	0.0506	10.952	0.0266	6.812
Experience Squared	-0.0005	-24.028	-0.0003	-14.421	-0.0010	-8.287	-0.0011	-8.703
Low Education	-0.1972	-14.260	-0.1744	-11.673	—	—	—	—
High Education	0.1333	12.545	0.2103	20.219	—	—	—	—
Married	0.0997	9.551	-0.1585	-1.870	0.0582	4.789	-0.0116	-0.861
Enrolled	-0.0903	-0.786	-0.6864	-0.596	—	—	—	—
Percent female	-0.0024	-9.720	-0.0019	-10.087	-0.0010	-3.776	-0.0004	-1.614
Wave	0.0274	14.626	0.0413	22.793	0.0428	34.238	0.0629	46.453
GED	0.1484	13.223	0.2270	19.541	0.0399	3.079	0.0302	2.337
SVP	0.0074	1.306	-0.0006	-0.098	-0.0071	-1.144	-0.0042	-0.668
Physical demands	-0.0445	-7.516	0.2314	3.544	-0.0300	-4.940	-0.0170	-2.355
Environment	-0.0261	-3.160	-0.0445	-4.159	0.0281	3.429	-0.0050	-0.426
Constant	-0.8188	-4.846	-2.5397	-15.598	0.0053	2.272	0.0199	8.111
R <sup>2</sup>	.24		.31		.13		.19	
N	15,803		13,811		13,902		12,011	

Note: The sample includes observations from 1985, 1987, 1989, and 1991. Wages less than one-quarter of the median or more than five times the median were discarded. "Percent female in occupation" is constructed using the 1987 census.

Source: Author's calculations using PSID and 1990 U.S. Census.

18 and 23 percent for men and women, respectively. In the United States, a difference of one point on the 6 point general educational development (GED) scale is associated with 15 and 23 percent differentials for men and women, respectively. It is not surprising that educational requirements are influential. Szydlík (1990) has shown that they are important in distinguishing primary segment jobs from others when labor markets are segmented.

The fixed effects regressions show a diminished and statistically insignificant influence of female concentration on women's wages. See column 4 of Tables 4 and 5. The coefficient on percent female in the regressions for men (column 3) has a negative sign and is statistically significant. Previous studies for the United States, including England et al. (1988) and Gerhart and El Cheikh (1991), have also found this result for men.

Variables that do not change over time for the individual or that have very little variation over time cannot be included in the fixed effects regressions. This is the case for the education categories that were created for both countries as well as for enrollment status for the United States. Of the people in the samples, only a few changed categories during the period of the panel. The limited availability of reported job characteristics for Germans required that some of these variables be dropped.

In these specifications, the "percent female" variable is constant for an individual unless the person changes occupation. This is the result of using census figures from one year for the entire length of the panels. In the section on data issues, the alternative of retrieving these figures directly from the PSID and GSOEP was discussed. This alternative allows a figure to be computed for every year and provides time variation in percent female because the demographic composition of occupations changes from year to year. However, this alternative was rejected due to lower accuracy. Nevertheless, a fixed effects regression was executed as an experiment using this alternative data. This did not change the coefficient on percent female significantly. It is not possible, however, to determine whether the year to year variation is negligible or whether it is counteracted by the loss of measurement accuracy with this alternative.

The percent female variable in columns 3 and 4 of Tables 4 and 5 are based on the census sources. Therefore, the coefficients are identified by change in wages associated with a change in percent female only for those who changed occupations. There is a potential for bias if those who changed occupations are a vastly different group from those who did not.

In Germany, the group of occupational movers is clearly not representative of the entire labor force. This is illustrated

Table 6

## Characteristics of Occupational Movers and Stayers

	Germany		United States	
	Movers	Stayers	Movers	Stayers
Female	0.34 (0.48)	0.36 (0.48)	0.47 (0.50)	0.46 (0.50)
Birth Year	1949.20** (10.80)**	1947.60 (11.40)	1948.10** (11.70)	1944.30 (11.80)
Hours	41.00** (9.40)	40.20 (9.60)	1963.00* (691.00)*	1987.00 (704.00)
Wage	22.30** (11.02)**	20.74 (9.39)	10.91** (6.66)**	12.51 (7.30)
Full-Time Experience	16.00 (13.80)	16.30 (13.50)	13.40** (10.90)**	15.80 (11.40)
Low Education	0.13 (0.34)	0.13 (0.34)	0.09* (0.29)**	0.10 (0.30)
High Education	0.30** (0.46)*	0.26 (0.44)	0.26** (0.44)**	0.35 (0.48)
Percent female in occupation	33.60 (29.30)	34.80 (29.10)	45.10** (29.00)**	47.50 (31.80)
N	2,052	4,528	17,527	8,595

Notes: Standard deviations are in parentheses. Hours are measured per week for Germany and per year for the United States. — \* Means are different between two columns at 5 percent significance level. — \*\* Means are different between the two columns at 1 percent significance level.

Source: Author's calculations using GSOEP and PSID and census data.

in Table 6, which shows the means of key variables for occupational movers and stayers. Occupational movers are those who reported different occupations in any two waves of data that were used. In Germany, this is only 29 percent of the sample. This subset is younger and appears to be more ambitious in terms of labor market achievement. They work more hours, earn more per hour, and are more likely to be in the high education category. Despite being almost two years younger, they have accumulated nearly the same amount of full-time labor market experience as "stayers."

Movers are also different from stayers in the United States, but in a different way. First of all, 66 percent of the population changed occupations during the sample period. This is substantially higher than in Germany, even though the United States sample period was two years shorter. Occupational mobility is simply more prevalent in the United States. Like Germany, movers are younger than stayers, but they appear to be a less accomplished group than stayers. They work fewer hours, earn less per hour, and are less likely to be in the high education category.

#### 4. Conclusion

There is a strong cross-sectional correlation between the occupational female concentration rate and wages in both Germany and the United States. When the longitudinal aspect is examined with a fixed effects model, the relationship between female concentration and wages loses its statistical significance. This offers nominal support for the economic hypothesis that occupational segregation is freely chosen and not the result of discrimination. The support is merely nominal because the result applies only to a subset of the labor force. Furthermore, these subsets are very different in the two countries. The German subset is a small group with greater than average labor market commitment and success. The United States subset is a larger group with traits characteristic of the younger part of the labor force. The comparison of the effects of occupational segregation on wages is still inconclusive. Further research is required to examine the behavior of the different subsets of the labor force and the endogeneity of the decision to change occupations.



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