Trade and Employment by Gender – A Canadian Perspective

by Jonas Welisch

(8822713)

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Supervisor: Professor Louis-Philippe Morin

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1. Introduction

Female employment and labour force participation in Canada has seen a dramatic rise in recent decades. Figure 1 shows the consistent growth of male and female employment in Canada over the last 40 years, that was only interrupted by the early 1980s and early 1990s recessions and the 2008 financial crisis. In 1977, the gap between male (6.2 million) and female employment (3.7 million) in Canada was 2.5 million jobs. This gap narrowed considerably to only 800 thousand by 2011 before stabilizing at this level. In fact, Ray, MacLachlan, Lamarche, & Srinath (2017) show that female employment growth in Canada from 2010 to 2012 was slower than male employment growth when correcting for industry mix and regional effects. A common way to measure relative male and female employment is the sex ratio (Juhn, Ujhelyi, & Villegas-Sanchez, 2012), which is defined as male employment divided by female employment. A large sex ratio means that employment is male-dominated, while values less than one indicate a higher relative share of female workers. Figure 2 shows the development of the Canadian sex ratio between 1977 and 2017, based on annual total employment values from the Labour Force Survey (LFS). The sex ratio saw a steep decline from 1.7 to 1.2 between 1977 and 1992, equivalent to a 37% decrease. Following a more gradual decline until 2009, the sex ratio leveled off at around 1.1 in recent years.

There are many factors that have contributed to the rise in female employment. Technological progress, such as the introduction of computers to the workplace (Weinberg, 2000) and the automatization of manufacturing, has reduced the need for physical strength in many occupations and allowed women to gain access to many employment opportunities previously confined to men (Sauré & Zoabi, 2011). While these studies are placed in the U.S., computerization and the automatization of manufacturing are general trends that apply to Canada and most other countries. Another important factor in Canada was changes in the provincial, job-protected maternal leave legislations, especially in the early 1990s and 2000s, that have enabled women to take longer leaves from their job and thus increased female labour force participation (Baker & Milligan, 2008). Finally, a study from Spain found the pursuit of higher education to delay women’s decision to start a family and to increase female labour force attachment, due in part to the larger opportunity cost of forgoing the wage premium associated with higher education (Davia & Legazpe, 2014). This result is likely transferable to Canada and other developed countries. The rise of female employment is important from a macroeconomic perspective as well, since according to Bloom, Canning, Fink, & Finlay (2009) it represented one of the main drivers of economic growth in developed countries. This study contributes to the analysis of drivers of female employment by focusing on the impact of trade.

This study estimates the effects of lagged trade variables on the sex ratio, i.e. relative employment by gender, in Canada for a panel of 88 industries, built from employment data of the 2001 and 2006 Censuses and the 2011 National Household Survey, and trade data from the 1998 to 2008 input-output tables. Measures of trade by industry are trade exposure, export share and import penetration. Export share is defined as the percentage of industry output that is exported, while import share is the percentage of total domestic absorption that is imported. Trade exposure is defined as the sum of imports and exports as a fraction of total output and thus represents a combination of the two other measures. An obvious way in which trade may impact employment is through its effect on industry structure. For example, if the oil and gas sector favors the employment of male over female workers, an uptick in oil and gas exports will increase male employment more than female employment. Though obviously important, this channel of trade impact is not the main subject of this study. Rather, this study tries to estimate the impact of trade on the sex ratio by industry. The motivating hypothesis is that trading industries demand skills such as social skills in which psychological and other studies have found women to have a comparative advantage (Cortes, Jaimovich, & Siu, 2016), so that trade favours female employment. An additional channel through which trade exposure would favour gender-specific employment would be if men or women have a personal preference for working in industries that involve international trade and self-select into these industries.

I find some evidence that an industry's sex ratio is negatively correlated with its lagged export share. Hence, an industry's lagged export share is positively related to relative female employment. The large absolute size of the estimated effect relative to the mean sex ratio indicates that it is economically significant. A 10 percentage point increase in an industry's export share is connected to a 7% decline in its sex ratio. This finding supports the hypothesis that female advantage in social skills results in a preference of exporting industries for female workers or vice versa. There is some evidence that this effect is driven by industries in the services sector. It is not implausible to expect social skills to be even more important in the services trade. Services are more differentiated, so trade in these products may rely more heavily on marketing skills than homogeneous products such as primary resources. In addition, I find that a 10 percentage point increase in trade exposure for the average industry is associated with a decrease in male employment of 2.6%. A possible interpretation of the negative coefficient estimate could be that trade-induced competitive pressure and productivity gains resulted in net employment losses for male employees. I do not find evidence in my preferred specifications that lagged trade exposure or import penetration affect industry sex ratios, or that lagged export share or import penetration affect male employment. There is also no indication that the effect of trade on employment is delayed by more than one year.

Section 2 will present a literature review to identify the contribution to the female employment literature of the present paper. Section 3 explains the data used, while Section 4 describes the econometric model. Section 5 presents the results and Section 6 concludes.

2. Literature Review

The impact of trade on female employment outcomes provides a fascinating research area at the intersection of trade and labour economics. Not surprisingly, economists have applied a wide variety of approaches to tackle questions within this research area. As discussed in the introduction, several factors have contributed to strong female employment growth in Canada and other developed countries, resulting in a decline of the male to female sex ratio in Canada to around 1.1. by 2009, a level where it has since stabilized. A key factor behind this trend has been technological progress, including computerization, which has expanded employment opportunities for women (Juhn et al., 2012). Indeed, one study finds that more than half of female employment growth in the U.S. between 1975 and 1994 can be explained by rising computer use (Weinberg, 2000). Policy changes such as maternal leave legislation and a growing awareness of discrimination (Baker & Milligan, 2008) have also contributed to women achieving a more equal footing in the labor market.

One way that trade affects employment by gender is through its effect on skill and other requirements to the workers. If trade favors tasks in which either men or women have a skills advantage, an increase in trade will result in workers of that sex benefiting more. For example, one study finds that exporting firms exhibit a preference for male employees, as evidenced by a larger gender wage gap in exporting firms (Boler, Javorcik & Ulltveit-Moe, 2018). This preference is related to higher actual or perceived flexibility of male employees to work long hours and travel on short notice. A study focusing on occupational differences finds a 10% higher occupational export share to be associated with a 3.8% higher female wage, while a 10% higher import penetration is associated with a female wage decrease of 1.8% (Ebenstein, Harrison, McMillan, & Phillips, 2014). Another channel through which trade drives employment by gender is by increasing competition, thus forcing domestic firms to improve their efficiency, for instance by upgrading their technology. Hence, trade induces technological upgrading, which as mentioned above tends to benefit female employees (Juhn et al., 2012). Connected to this discussion is the fact that trade can lead to the offshoring of routine tasks. If men or women are overrepresented in physical or cognitive routine occupations, trade may thus displace a disproportionate amount of male or female jobs. The following presents some of the most relevant papers in more detail.

Weinberg (2000) develops a model to analyze the effect of rising computer use between 1975 and 1994 on female labor demand in the U.S. He uses the assumption that females have a comparative advantage in tasks that require cognitive skills over physical skills and introduces these two skill factors into the production function with “a” tasks that favor women. The assumption of comparative advantage is supported by data showing that women were significantly more likely to spend hours worked on the computer than men. Technological development and increasing computer use are thus expected to favor female employment and, through higher aggregate female labour demand, the relative wage of women. The empirical analysis relies on data on employment and computer use from the 1975, 1984 and 1994 Census of Populations for 68 industries and four occupation groups. The study finds that increased computer use can explain more than half of female employment growth over the period, equivalent to a 3.7 percentage point increase in female’s employment share for each of the 10-year periods. In contrast, shifts towards female-intensive industries and occupations accounted for only 1.5 and 1 percentage point increases in female employment, respectively. Growing computer use through effects on work environments and indirect effects on automation in can further increase female labor demand even in non-computer occupations. Finally, analogous to Juhn et al. (2012) this study finds a stronger effect on female blue-collar workers since they benefit most from technological improvements through a reduction in required physical strength.

Cortes et al. (2016) analyze the increase of female employment share in cognitively demanding, non-routine occupations from 1980 to 2000 in the U.S. While total demand for high-skilled labour has been strongly increasing over the period, men and women have not seen the same benefits. Restricting their analysis to college-educated persons and controlling for demographic variables, the authors find that men’s probability of working in a “good job” has decreased while women’s probability has increased. This trend appeared despite demographic changes favoring movements in the opposite direction, such as a growing number of high-skilled women in the labour force and an increasing share of prime-age men. A flexible model of high-skilled labour demand and supply is used to test various hypotheses. The most likely explanation for the diverging male-female trend is an increase in the demand for skills such as social skills, in which psychological and other studies have found women to have a comparative advantage. This rise in female skills demand was based on within-occupation transformations as opposed to between occupation transformations. Female employment share and its growth by occupation were positively related to the occupation’s level and growth of demand for social skills. There was a notable trend reversal for the 2000 to 2014 period, with a reduction in the demand for cognitive skills reducing both female and male employment probability in high-skill occupations. While not trade-related, this paper gives valuable insights on female employment trends and their drivers.

Boler et al. (2018) assess the impact of trade on the gender wage gap in Norwegian manufacturing companies using a rich employer-employee matched dataset for the 1996 to 2010 period. Their main hypothesis is that exporting companies require more flexibility of their employees in terms of long working hours and travel on short notice than comparable non-exporting companies, to ensure smooth cooperation with international partners in various time zones. Thus, if women are less flexible, or there is such a perception among employers, exporting companies should exhibit a preference for male employees, resulting in a wider gender wage gap within these companies. The paper finds support for the main hypothesis, with exporters having a 3 percentage point higher gender wage gap on average than non-exporting companies after controlling for a variety of individual worker and company characteristics. The wage gap is found only for college-educated women, consistent with the idea of advanced employment positions requiring the most flexibility with respect to export activities. Further support to their hypothesis is the finding that a larger time zone differential between Norway and the export destination, and a higher number of export destinations, are also associated with a larger gender wage gap. The effect on the gender gap is large in economic significance when compared to the results of other related studies.

Sauré & Zoabi (2011) build a labour supply model to analyze theoretically the effect of international trade on the wage gap, and in turn on female labour force participation. The model is based on two producing sectors, one of which is capital-intensive and favours female participation, while the other requires physical labour of which men have a larger endowment. Countries trade because they have a comparative advantage in either capital or labour-intensive sectors based on capital and labour endowments. Trade causes labour reallocation towards the advantaged sector. The paper finds that, contrary to expectations, an expansion in the female-intensive sector leads to a decrease in female labour force participation because the inflow of male labour reduces the marginal product of females and increases the gender wage gap. The theory is put to the test empirically with data from U.S.-Mexican trade from 1990 to 2007, a perfect example of trade between a capital-rich and capital-poor economy. Variation in trade exposure by U.S. states, instrumented by distance to Mexico, is exploited to identify the effects of trade on female labor force participation. The authors find support for their theory's prediction that trade with countries short on capital reduces female labour force participation.

Do, Levchenko, & Raddatz (2016) analyze the effect of international trade on fertility outcomes with export data by industry for 146 countries. They build a very simple two-country two-sector model where each sector uses either female or male labour exclusively. Women choose to supply their full labour endowment or to dedicate part of it to child rearing. The model shows that initial comparative advantage in the female-intensive goods sector increases capital flows towards this sector. This further strengthens comparative advantage, leading to an increase in exports of the female-intensive sector and a higher female wage rate. The key insight of the model is that the higher wage induces an increase in female labour supply through the substitution effect and thus reduces fertility. Empirically, a straightforward way to approximate comparative advantage would be the female-intensity of measured exports. However, recognizing a likely reverse causality issue between comparative advantage in female-intensive sectors, trade flows and fertility decision, an instrumental variable approach is used. The instrumental variable is constructed using a gravity specification on exogenous geographical differences to predict trade flows. In addition to the geographical data, U.S. Census data on female employments share, COMTRADE bilateral trade data and fertility data from the World Bank are used. As predicted by the model, female labor intensity of exports has a significant effect on a country’s fertility. This result is robust to various specifications and robustness checks.

Juhn et al. (2012) study the effects of tariff reductions from the implementation of NAFTA on female employment and wages in Mexico. They create a heterogeneous firms model which allows firms to choose different production technologies, with trade inducing exporting firms to upgrade their technology. The new technology reduces the need for physically demanding skills in blue collar occupations. Workers are differentiated by occupation and gender specific skills, with men having a comparative advantage in physical skills. Thus, the model predicts that technology upgrading firms will be more likely to hire female workers in blue collar categories and that their wages should increase given the boost to their marginal product of labour. Female workers in white collar occupations should not see the same benefits, as their occupations require little physically demanding skills to begin with. The authors test their theory using detailed Mexican firm data from 1991 and 2000 that covers 200 manufacturing classes, as well as wage/employment data by gender and four occupational categories. As predicted, they find a significant positive effect of trade on female employment and wages in blue collar occupations, and no significant effect for white collar occupations. Firms experiencing the average reduction in US tariffs in their sector had increased the female employment share in blue-collar occupations 20% more than firms that experienced no tariff change. Import tariff reductions did not result in significant changes of the key variables. More generally, in line with other research, the paper finds that exporters are larger in terms of sales and employment and more capital intensive than non-exporting firms. Firms are more likely to enter the export market in sectors where tariff reductions are higher and new exporters tend to be more active in adopting the new technology.

3. Data Section

Annual import, export and total output data for 112 ‘Input-Output Industry Classification’ (IOIC) industries[1] were collected from Statistics Canada’s input-output tables for the years 1998 to 2008. The purpose of the input-output tables, a part of the Canadian System of Macroeconomic Accounts (CSMA), is to give an in-depth view of the structure of the Canadian economy and show the interconnectedness of industries and regions. To achieve this level of detail, Statistics Canada collects and combines data from a variety of sources. For example, businesses are assigned a North American Industry Classification System (NAICS) code and data from their submitted Canada Revenue Agency income tax filings is used to allocate their revenue and trade to the correct industry (Statistics Canada, 2018). In the context of this study, the information on inter-industry links may have been used to measure indirect effects of trade on connected industries as in Murray (2017). However, the inclusion of indirect effects is beyond the scope of this study. The Link-Public aggregation level[2] was chosen to allow for a detailed breakdown of output, imports and exports by industry. Since the Link-Public aggregation level was introduced only in 1997, the inclusion of earlier data would be tedious and imprecise due to imperfect matching. In the same way, input-output data underwent substantial changes in definitions in 2009 to reflect the economic shift from manufacturing to services. This renders the matching of the 1998-2008 data to year 2009-2011 observations impossible. Following the recommendation outlined in the user guide (Statistics Canada, 2018), this study uses trade and output variables at basic prices. Basic prices, also called factory gate prices, are what the producer of the good ultimately receives and thus excludes any taxes, subsidies, transport and retail margins, which are later added to determine the purchaser price. A potential alternative source for trade data may have been Industry Canada’s Trade Data Online. However, this database covers only the manufacturing sector. Since the emphasis of this study is on gender-based effects of trade, using only data on the manufacturing sector would severely limit the scope of the results, especially given the growing importance of the services sector in general.

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[1] The input-output tables for the year 1998 include 113 industry categories. Starting in 1999, the two categories 513A Pay TV and 51A0 Publishing were combined to form 51B0 Publishing, Pay and Specialty TV, Telecommunications, and Other Information Services. Thus, before merging the trade data, the values of 513A and 51A0 were added for 1998 to form 51B0.

[2] The Link-Public is an aggregation of the standard Link industrial aggregation within the IOIC framework. The non-residential and engineering construction industries have been aggregated into a single industry to avoid suppressions of data related to confidentiality. The fictive industries have also been removed from the tables--their inputs were allocated to industries and final demand categories based on each of the latters' shares in the total consumption of a given fictive commodity.

Employment data for the employed labour force above age 15 by gender and NAICS industry[3] were retrieved through a custom tabulation request from Statistics Canada. The data comes from the 2001 Census, 2006 Census and 2011 National Household Survey (NHS). Thus, the regressions cover up to three points in time depending on the specification of the lag structure, which is explained in the empirical strategy section. Additional years were not available in the custom format and major industry coding changes between 1996 and 2001 would render their use infeasible for this project (Statistics Canada, 2002). Since Canadian census data are used to determine federal transfer payments and voting districts, the census is characterized by a consistent questionnaire and high-quality data. A census is held every five years and covers all households in Canada, 80% of which receive the short form questionnaire. The other 20% of the full population sample receives the long form questionnaire, which contains the question on industry of employment that is relevant to this study. A strong response rate is ensured by extensive promotion of the census and targeting of hard-to-reach groups. While participation in the census is required by law, the 2011 NHS was conducted on a voluntary basis and thus the collected data does have a lower quality and higher non-response rate of 26.1% (Statistics Canada, 2013). Though Labour Force Survey (LFS) employment data would allow for a higher frequency, it only offers 16 industry classifications. Hence, the census data was chosen based on its fine level of detail in industry classifications. One may also ask why this study does not include an analysis of male and female wages. While the census does contain wage data, the question in the census on a person's wage refers to the year preceding the survey, whereas the question on industry of employment refers to the census collection year. Thus, there would be a mismatch between wage and industry for every person who switched industries in the year before survey collection. Other wage data either did not contain the same level of detail on industries (LFS) or a distinction by gender, such as the Survey of Employment, Payrolls and Hours.

The trade and employment data then had to be matched along industry and year dimensions. Though the industry breakdown in the input-output tables (IOIC) is based on NAICS categories, these categories are not identical. The IOIC and NAICS codes were matched on the basis of a concordance file[4] prepared by Statistics Canada. 16 categories from the IOIC had to be combined into 6 larger categories prior to merging with the employment data to ensure the correct alignment of industry categories between the two datasets. 14 IOIC categories were dropped because there was no equivalent category in the NAICS classifications.[5] These two steps reduced the total number of industries from 112 to 88. Overall, the matched data includes 88 total industries, 18 of which are in the primary sector, 36 are in the manufacturing sector and 34 are in the services sector. Some of the service sector industries are part of the non-profit and government sector such as 'universities'. Others, such as the 'social assistance' industry, are a mix between private, public and non-profit categories since the NAICS employment data does not always differentiate between these three sectors. The employment data also had to be adjusted before merging with the trade data. Following the concordance file, 64 NAICS industries were combined into 19 categories to align with the IOIC breakdown. The final 88 categories are drawn from different levels of in the NAICS hierarchical structure. These levels of detail are represented by the number of digits in the NAICS codes. Most of the final industry categories are at the 4-digit, some at the 3-digit and 2-digit levels, or a combination of any of these. Thus, the final industry categories represent either specific NAICS industries or a combination of several NAICS industries.

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[3] The number of 2-, 3- and 4-digit NAICS industries in the data was 420 in 2001 (NAICS 1997 codes), 433 in 2006 (NAICS 2002 codes) and 425 in 2011 (NAICS 2007 codes). Changes between these years were made to subcategories in construction and information technologies at a high level of detail that does not affect the final industry breakdown of my study (Statistics Canada, 2016).

[4] The .pdf concordance file may be accessed online at: www23.statcan.gc.ca/imdb-bmdi/document/1401_D3_T1_V1-eng.pdf

Table 1 shows summary statistics for the final sample, which includes 264 observations for the dependent variables *sex ratio* and *male employment* (88 industries at years, 2001, 2006 and 2011). Summary statistics are weighted by base year male employment, which should capture the size of the industry. Thus, by weighting summary statistics and regression results, I can avoid the issue of very small industries distorting the summary statistics or driving regression results. The base year is 2001 since it represents the first year of available employment data. The explanatory trade variables have a total of 968 observations (88 industries for the 11 years of 1998 to 2008). The total number of observations in each regression varies between 176 and 264 depending on the lag structure applied. There are fewer years of employment data than trade data, but all industries are represented in each year of data used in the empirical analysis.

Overall variation across both time and industries is significant, with values ranging from 0 to nearly 1 for *export share* and *import penetration,* and from 0 to 8.5 for *trade exposure*[6]. Thus, while some industries are barely exposed to trade, others export nearly their full output or import nearly their full domestic absorption[7]. The trade variables' mean value is largest for manufacturing industries, highlighting the stronger trade exposure of the manufacturing sector, followed by the primary sector. On average, services sector industries are the least exposed to trade. The mean sex ratio by industry is 2.8.

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[5] Most of these categories, such as 'Subsidies on production' or 'Supplementary labour income' are irrelevant to this study since they do not represent industries. Others, including 'Other Non-Profit Institutions Serving Households' or government services such as 'Other Federal Government Services' are unlikely to have any trade exposure and can be excluded without harm. Category NP20 'Non-Profit Education Services' could not be precisely matched into the university and non-university education categories and was omitted. This is unlikely to have a strong effect due to NP20's small size in terms of trade and output.

[6] There is only one industry with zero values for most years, NAICS industry 8131 'Religious organizations'.

[7] Domestic absorption is defined as total output minus exports plus imports.

The means of the ‘major sectors’ dummy variables describe the percentage of employment-weighted industries in the primary (10.0%), manufacturing (28.7%) and services sector (61.3%) for the complete sample of 88 industries.

Table 2 shows that the three trade variables are strongly positively correlated, with correlation varying between 0.73 and 0.87. This is not surprising, given that some industries, especially in the services sector, are much less traded overall, while industries such as ‘oil and gas’ are heavily traded. Another factor contributing to the strong correlation is large intra-industry trade flows for international supply chains (Greenaway Hine & Wright., 1999). Greenaway et al. (1999) also find positive correlation between their export shares and import penetration variables.

4. Empirical Strategy

First, I would like to estimate whether trade affects a direct measure of employment, the log of total male employment by industry. If trade influences male employment directly, it is more reasonable to assume that it might affect the sex ratio, or relative employment. The specification is defined as follows:

$$\log male\ employment_{i,t} = \beta_1 + \beta_2\ trade\ variable_{i,t-1} + \mu_t + \tau_i + \varepsilon_{i,t} \tag{1}$$

The dependent variable *log male employment* is simply the natural log of male employment. *Trade variable* represents the three explanatory trade variables: *trade exposure*, *export share* and *import penetration*. Separate regressions are run for each explanatory variable. Time dummies are introduced to control for general trends in female and male employment, such as the observed decline in the sex ratio in Figure 2. Industry fixed effects are included to control for factors specific to an industry category. Subscript *i* represents the industry category, while *t* refers to the year of the observation. The estimation method used is ordinary least squares (OLS). The preferred specification includes both industry and time fixed effects. All regressions are weighted by industry male employment in the base year 2001 to avoid smaller industries driving the regression results. Standard errors are clustered at the industry level.

The main econometric model takes the following form:

$$sex\ ratio_{\ i,t} = \beta_1 + \beta_2\ trade\ variable_{i,t-1} + \mu_t + \tau_i + \varepsilon_{i,t} \tag{2}$$

The dependent variable *sex ratio*, as discussed in the introduction, is the ratio of male employment over female employment. A higher sex ratio is indicative of industries that are more male dominated. Therefore, a positive coefficient estimate for β_2 means that trade is associated with higher relative male employment. Subscripts and fixed effects remain the same as in equation 1.

The next econometric model is specified as follows:

$$sex\ ratio_{\ i,t} = \beta_1 + \textstyle\sum_{j=1}^{3} \beta_{j+1}\, trade\ variable_{i,t-j} + \mu_t + \tau_i + \ \varepsilon_{i,t} \qquad (3)$$

The difference compared to equation 2 is that two-year and three-year lagged values of the trade variable are included as explanatory variables. My base model in equation 2 assumes that the appropriate time lag between changes in the trade variables and their effect on employment is one year. Equation 3 tests this assumption by verifying if two-year and three-year lagged trade values have explanatory power. In other words, I would like to investigate whether employment decisions related to trade are made before the one-year period. This model is motivated by the hypothesis that trade effects on employment could be delayed due to frictions in the labour market.

The next econometric model is specified as follows:

$$sex\ ratio_{\ i,t} = \beta_1 + \beta_2\ trade\ variable_{i,t-3} + \mu_t + \tau_i + \ \varepsilon_{i,t} \qquad (4)$$

This model, like equation 3, is based on the idea that the impact of the trade variables on employment by gender takes time to take effect. For example, rising import penetration may lead to plant closures and restructuring after a transition period in which employment is not adjusted. Though similar to equation 3, this model includes only the 3-year lag value of the trade variables. The model's main advantage over equation 3 is that it uses the complete sex ratio data since the three-year lag values of the trade variables are available at all three employment data points, whereas equation 3 only uses two data points.

The final econometric model is specified as follows:

$$\begin{aligned} sex\ ratio_{\ i,t} &= \beta_1 + \beta_2\ trade\ variable_{i,t-1} + \beta_3\left[trade\ variable_{i,t-1} \times service_i\right] + \\ &\beta_4\left[trade\ variable_{i,t-1} \times primary_i\right] + \mu_t + \tau_i + \ \varepsilon_{i,t} \qquad (5) \end{aligned}$$

This model tests for potential heterogeneity of trade variable effects by major sector (primary, manufacturing and services). The only change compared to equation 2 is the addition of two interaction terms on the trade variable. Both *service* and *primary* are dummy variables that are equal to one if industry *i* is part of the services sector or primary sector, respectively, and zero otherwise. According to the model specification, the reference group consists of industries in the manufacturing sector, which is the largest major sector group in the sample in terms of number of industries. Hence, the coefficient β_2 represents the effect of the trade variables on the sex ratio of manufacturing industries. The effect of trade on the sex ratio of services industries (i.e. where *services*=1) is measured by the sum of β_2 and β_3. Similarly, the effect of trade on the sex ratio of primary industries (i.e. where *primary*=1) is measured by the sum of β_2 and β_4. Thus, the two coefficients β_3 and β_4 represent the difference in effect of the trade variables for services and primary industries, compared to the reference group of manufacturing industries. If these coefficients are insignificant, heterogeneity by major sector can be ruled out.

5. Results

Regression results for equation 1 where I regress *log male employment* on the lagged trade variables are shown in table 3. For simplicity, I will omit the term ‘lagged’ throughout the discussion of results, but unless otherwise indicated, the explanatory trade variable is assumed to be lagged by one year. Columns 1 to 3 present results with *trade exposure* as the explanatory variable. The first specification without any fixed effects produces a large negative estimate for the coefficient of *trade exposure* that is significant at the 1% level. The estimate implies that a 10 percentage point increase in trade exposure for the average industry is associated with a decrease in male employment of 12.3%. The estimate is robust to the inclusion of year fixed effects[8] in specification 2. Once both year and industry fixed effects are included in specification 3, the estimated coefficient is now much smaller, but still significant at the 5% level. Given the estimated coefficient, a 10 percentage point increase in trade exposure for the average industry is associated with a decrease in male employment of 2.6%, providing some evidence that trade does affect male employment. A possible interpretation of the negative coefficient estimate could be that trade-induced competitive pressure and productivity gains resulted in net employment losses for male employees. As discussed in the empirical strategy section, the inclusion of fixed effects is preferable from a theoretical perspective, so specification 3 is preferred. The same is true for all trade variables, thus columns 3, 6 and 9 always present the preferred specifications.

For both *export share* and *import penetration*, the two specifications without industry fixed effects in columns 4, 5, 7 and 8 produce negative and significant coefficient estimates, suggesting that trade has a negative effect on male employment. Again, this is plausible if trade heightens competitive pressures and forces companies to cut labour in efforts to improve their efficiency. However, once industry fixed effects are included in specifications 6 and 9, the estimates for *export share* and *import penetration* become statistically insignificant and both switch to a positive number, suggesting that differences between industries were falsely attributed to the trade variables in the first two specifications. The positive and statistically significant coefficient on the 2006 dummy means that male employment for the average industry grew from 2001 to 2006, in line with the consistent employment growth trend shown in Figure 1.

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[8] In all regressions for equations 1, 2, 3 and 5, year fixed effects boil down to the inclusion of a dummy variable that is one if the observation is from year 2006, zero if the observation is in 2001. This is because 2001 and 2006 are the only available data points. The 2011 employment values could not be included in the regressions for equation 1, 2, 3 and 5 since the 2010 trade data was not available to create the one-year lag value. In equation 4, year fixed effects add a second year dummy variable for 2011. I choose to present these dummy variables in my regression results to give additional context.

Table 4 provides results for the basic regressions of the main variable of interest, the male-to-female sex ratio, on the three trade variables. In the first two specifications, the coefficient estimate for *trade exposure* is positive, but insignificant even at the 10% level. For the preferred specification with industry fixed effects in column 3, the sign of the estimate switches to a negative, but it remains statistically insignificant. Only the year 2006 dummy is statistically significant in the preferred specification. Its negative sign indicates that there was a decline in the sex ratio from 2001 to 2006 for the average industry. In other words, female employment grew faster relative to male employment. This is consistent with the trend shown in Figure 2.

Export share has a positive, but statistically insignificant estimate in specifications 4 and 5. However, the estimate becomes negative and significant at the 10% level once industry fixed effects are included. The sign of the coefficient estimate suggests that the industry sex ratio is negatively correlated with its export share. Hence, an industry's export share is positively related to relative female employment. The large absolute size of the coefficient (-1.97) relative to the mean sex ratio (2.77) indicates that this effect is economically significant. A 10 percentage point increase in export share is associated with a 7% decline in the sex ratio when the mean sex ratio of 2.765 is used as the base. This result gives some support to the hypothesis that exporting industries may prefer female employees for their superior social skills (Cortes et al., 2016). *Import penetration* has insignificant estimates for all three specifications, with the sign on the coefficient estimate switching to negative once industry fixed effects are included. The negative and statistically significant coefficient estimate on the 2006 dummy variable again indicates a declining sex ratio between 2001 and 2006. In fact, this result for the coefficient of the 2006 dummy variable holds for all preferred specifications in columns 3, 6 and 9 across all sex ratio regressions.

Table 5 provides results for equation 3, where two-year and three-year lags of the trade variables are included in the estimation to investigate whether trade-related employment decisions are made in advance of the one-year period assumed in the previous model specifications. For *trade exposure*, all three specifications (no fixed effects, time fixed effects, time and industry fixed effects) produce insignificant coefficient estimates. Consistent with the result shown in Table 4 equation 2, there is a large negative and statistically significant estimate for the one-year lag *export share* coefficient once industry fixed effects are included. The estimate is even larger in absolute value than in equation 2. Nevertheless, given that the two-year and three-year lag variables are both not statistically significant, specification 6 of equation 2 remains preferred. The variable *import penetration* again provides insignificant results. Based on the regression results presented in this table, I can discard the hypothesis that a multi-year lag structure may help explain the relationship between trade and employment.

Table 6 presents results for the model in equation 4, which uses only the three-year lag of the trade variables. As discussed in the empirical strategy section, this model allows for the use of all three employment data points, whereas equation 3 only uses two data points. The coefficient estimates on the trade exposure variable are small and not statistically significant. For *export share*, the coefficient estimate is statistically significant for the first two regressions, but insignificant once industry fixed effects are included. *Import penetration* as the explanatory variable produces only small and statistically insignificant estimates. Across the preferred specifications for the three trade variables (with industry fixed effects), only the 2006 year dummy is statistically significant and negative, replicating the result from the other sex ratio models of equations 2 and 3. Overall, the results of this model combined with those from equation 3 suggest that the potential effect of the three trade variables on the sex ratio is not subject to a delay of more than one year.

Table 7 provides the results for equation 5, which tests for heterogeneity of trade effects by type of major sector (primary sector, manufacturing sector and services sector). As explained in the empirical strategy section, in this model, the coefficient estimate on the trade variable represents the estimated effect of trade on the sex ratio in the manufacturing sector (the reference group), whereas the coefficients on the *services* and *primary* interaction terms describe the differential effect of trade on the sex ratio in these two major sectors, relative to the manufacturing sector. The coefficient of *trade exposure* is statistically insignificant in all specifications. In specification 3, the interaction term with the services dummy is negative and statistically significant at the 5% level, indicating that trade exposure may have a negative effect on the sex ratio in the services industry only. The coefficient on *export share* is statistically significant in specifications 4 and 5, but this significance disappears with the inclusion of industry fixed effects. Again, the interaction term with the services dummy is negative and statistically significant, this time at the 10% level. For *import penetration*, estimated coefficients are insignificant except for the services interaction term in the OLS regressions. However, significance disappears with the inclusion of industry fixed effects, so this is likely due to the services dummy picking up industry-specific variation. It is interesting to observe that the estimated coefficient on the services sector interaction term is negative and statistically significant for two of the preferred specifications. This may indicate that the export of services drives the effect measured for *export share* in equation 2. It is not implausible to expect social skills to be even more important in the services trade. Services are more differentiated, so trade in these products may rely more heavily on marketing skills than homogeneous products such as primary resources.

It is helpful to think about potential threats to the unbiasedness of my estimates. Given the simplicity of my econometric approach, it might appear that there is a strong likelihood for omitted variable bias. However, the use of fixed effects can alleviate this concern. Time fixed effects account for time trends across all industries, such as the general rise in relative female employment observed in Figure 1. Differential time trends across industries, on the other hand, are not covered by the time fixed effects. Industry fixed effects control for industry-specific factors such as capital-intensity or the level of technology, which may be connected to both trade exposure and sex ratio at the industry level. To illustrate this point, industries with a relatively high level of technology that reduces the need for physical strength and favors female employment may produce more easily tradable goods. In this case, there would be endogeneity through the correlation of the trade variable with the error term, and the coefficient on the trade variable would incorrectly capture the impact of the technology level on the sex ratio. Therefore, any coefficient estimates would be biased and inconsistent. The inclusion of industry fixed effects should alleviate these concerns, assuming that industry-specific factors are constant over time. Given the strong potential for omitted variable bias when fixed effects are not included, the preferred specification for equations (1) to (5), at least from a theoretical perspective, includes both industry fixed effects and time fixed effects.

Another common threat to unbiasedness is reverse causality. In this analysis, reverse causality would exist if sex ratios were to determine trade outcomes. This could be plausible if women or men are more likely to support exporting activities. However, the lag structure of my model rules out this issue, since sex ratios are measured at least one period after the trade variable. Thus, it is not plausible to assume that future relative employment by gender affects trade outcomes. The last potential source of endogeneity is measurement error. Classical measurement error causes biased estimates only if it affects the explanatory variables. The input/output tables’ high quality of data means that this problem is less likely to affect my results.

6. Conclusion

This study estimates the effects of trade on the sex ratio, i.e. relative employment by gender, in Canada on a panel of 88 industries built from employment data of the 2001 and 2006 Censuses and the 2011 National Household Survey and trade data from the 1998 to 2008 input-output tables. Measures of trade used are trade exposure, export share and import penetration. I find that an industry’s sex ratio is negatively correlated with its lagged export share. Hence, an industry’s lagged export share is positively related to relative female employment. The large absolute size of the estimated effect relative to the mean sex ratio indicates that it is economically significant. A 10 percentage point increase in export share is associated with a 7% decline in the sex ratio. There is some evidence that this effect is driven by the services sector. A possible explanation for this result is the female advantage in social skills, which may result in a preference of exporting industries for female workers. It is not implausible to expect social skills to be even more important in the services trade. Services are more differentiated, so trade in these products may rely more heavily on marketing skills than homogeneous products such as primary resources. Another channel through which large export shares may favour female employment would be if women have a personal preference for working in industries that involve international trade and self-select into these industries.

Furthermore, I find that a 10 percentage point increase in trade exposure for the average industry is associated with a decrease in male employment of 2.6%. A possible interpretation of the negative coefficient estimate could be that trade-induced competitive pressure and productivity gains resulted in net employment losses for male employees. I do not find evidence in my preferred specifications that lagged trade exposure or import penetration affect industry sex ratios, or that lagged export share or import penetration affect male employment. There is also no evidence that the effect of trade on employment is delayed by more than one year.

Further research may use firm level data as in Juhn et al. (2012). This may be a more appropriate way to analyze export share effects on employment, since export decisions are made at the firm level and not by industry. This study could also be replicated with a focus on the strong growth period of relative female employment in Canada between 1977 and 1992 to ensure more variation in the sex ratio. A potential issue with this approach, however, is the lack of consistent industry definitions due to transformational changes in industry structure.

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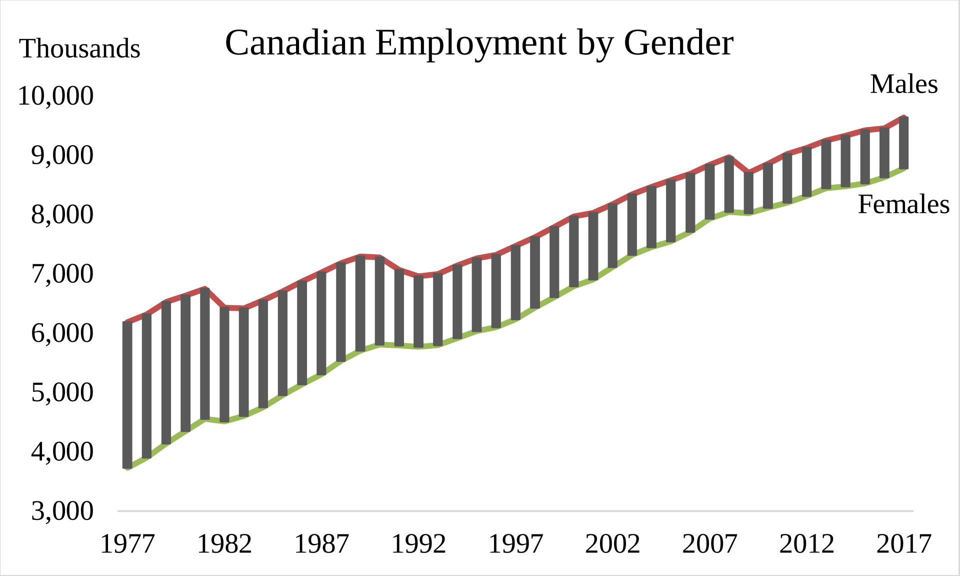
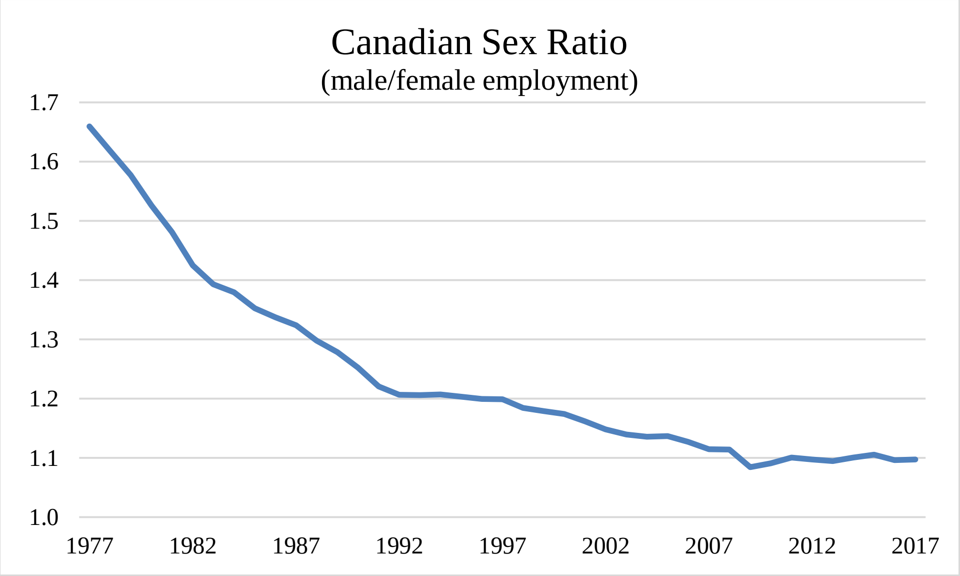
Figure 1. Canadian Employment by Gender



Source: Statistics Canada. Table 282-0008 - Labour Force Survey estimates (LFS)

Figure 2. Canadian Sex Ratio



Source: Statistics Canada. Table 282-0008 - Labour Force Survey estimates (LFS)

Table 1. Summary Statistics

	Mean	SD	Min	Max	Observations
A. Trade variables					
I. Trade exposure	0.377	(0.522)	0.000	8.489	N = 968
Primary	0.392	(0.273)	0.005	1.762	N = 216
Manufacturing	0.795	(0.788)	0.000	8.489	N = 432
Services	0.178	(0.144)	0.000	0.729	N = 408
II. Export share	0.182	(0.207)	0.000	0.977	N = 968
Primary	0.240	(0.176)	0.002	0.858	N = 216
Manufacturing	0.333	(0.285)	0.000	0.977	N = 432
Services	0.102	(0.094)	0.000	0.556	N = 408
III. Import penetration	0.163	(0.214)	0.000	0.990	N = 968
Primary	0.175	(0.133)	0.003	0.823	N = 216
Manufacturing	0.342	(0.309)	0.000	0.990	N = 432
Services	0.077	(0.069)	0.000	0.351	N = 408
B. Employment variables					
IV. Male employment	316,911	(295,158)	1,220	964,905	N = 264
Primary	113,409	(99,100)	5,325	260,765	N = 54
Manufacturing	334,736	(380,198)	1,220	964,905	N = 108
Services	341,806	(257,025)	2,965	879,815	N = 102
V. Sex ratio	2.765	(2.349)	0.208	10.281	N = 264
Primary	3.045	(1.866)	0.989	10.281	N = 54
Manufacturing	5.057	(2.214)	0.317	8.242	N = 108
Services	1.644	(1.560)	0.208	8.489	N = 102
C. Major sectors					
Primary	0.100	(0.300)	0.000	1.000	N = 1056
Manufacturing	0.287	(0.453)	0.000	1.000	N = 1056
Services	0.613	(0.487)	0.000	1.000	N = 1056

Note: All summary statistics are weighted by 2001 male employment.

Table 2. Correlation

	Trade exposure	Export share	Import penetration
Trade exposure	1	0.734	0.866
Export share	0.734	1	0.860
Import penetration	0.866	0.860	1

Table 3. Regression results, equation (1), dependent variable: log male employment

Trade variable:	Trade exposure			Export share			Import penetration		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
Trade variable (1-year lag)	-1.231***	-1.231***	-0.256**	-3.094***	-3.091***	0.585	-3.051***	-3.049***	-0.674
	(0.196)	(0.197)	(0.121)	(0.475)	(0.475)	(0.494)	(0.471)	(0.472)	(0.469)
2006 (time dummy)		0.064	0.076***		0.029	0.088***		0.062	0.075***
		(0.259)	(0.021)		(0.247)	(0.024)		(0.254)	(0.021)
Constant	12.535***	12.503***	12.135***	12.643***	12.628***	11.926***	12.567***	12.536***	12.148***
	(0.186)	(0.223)	(0.047)	(0.196)	(0.228)	(0.098)	(0.186)	(0.220)	(0.078)
R-squared	0.274	0.274	0.249	0.285	0.285	0.218	0.290	0.291	0.224
Industry fixed effects	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Industry-clustered standard errors in brackets. Weighted by 2001 male employment. N=176 observations.

Level of significance 10%*, 5%**, 1%***

Table 4. Regression results, equation (2), dependent variable: sex ratio

Trade variable:	Trade exposure			Export share			Import penetration		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
Trade variable (1-year lag)	0.458	0.457	-0.111	2.687	2.684	-1.971*	0.777	0.775	-1.430
	(0.558)	(0.559)	(0.140)	(1.704)	(1.713)	(1.097)	(1.390)	(1.394)	(0.989)
2006 (time dummy)		-0.061	-0.068**		-0.023	-0.098***		-0.062	-0.074**
		(0.786)	(0.031)		(0.802)	(0.030)		(0.785)	(0.030)
Constant	2.589***	2.620***	2.835***	2.268***	2.280***	3.169***	2.634***	2.666***	3.026***
	(0.574)	(0.705)	(0.053)	(0.680)	(0.814)	(0.206)	(0.588)	(0.717)	(0.160)
R-squared	0.010	0.010	0.045	0.055	0.055	0.077	0.005	0.005	0.064
Industry fixed effects	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Industry-clustered standard errors in brackets. Weighted by 2001 male employment. N=176 observations.
Level of significance 10%*, 5%**, 1%***

Table 5. Regression results, equation (3), dependent variable: sex ratio

Trade variable:	Trade exposure			Export share			Import penetration		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
Trade variable (1-year lag)	-0.426	-0.371	-0.057	-0.390	-0.384	-3.590**	4.511	5.012	-1.975
	(2.122)	(2.422)	(0.265)	(7.033)	(7.095)	(1.446)	(7.667)	(8.854)	(1.297)
Trade variable (2-year lag)	0.883	0.822	-0.116	5.403	5.402	2.725	-5.617	-6.130	0.134
	(3.432)	(3.693)	(0.622)	(8.048)	(8.085)	(1.978)	(8.713)	(9.878)	(1.328)
Trade variable (3-year lag)	0.006	0.011	0.034	-2.322	-2.329	-0.228	1.894	1.907	0.896
	(2.030)	(2.044)	(0.298)	(3.336)	(3.351)	(0.696)	(4.655)	(4.686)	(0.945)
2006 (time dummy)		-0.042	-0.070**		-0.024	-0.082***		-0.097	-0.062**
		(0.815)	(0.032)		(0.808)	(0.030)		(0.823)	(0.028)
Constant	2.582***	2.603***	2.847***	2.260***	2.273***	2.993***	2.638***	2.688***	2.938***
	(0.583)	(0.733)	(0.072)	(0.687)	(0.823)	(0.233)	(0.593)	(0.740)	(0.130)
R-squared	0.010	0.010	0.046	0.057	0.057	0.140	0.006	0.007	0.077
Industry fixed effects	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Industry-clustered standard errors in brackets. Weighted by 2001 male employment. N=176 observations.

Level of significance 10%*, 5%**, 1%***

Table 6. Regression results, equation (4), dependent variable: sex ratio

Trade variable:	Trade exposure			Export share			Import penetration		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
Trade variable (3-year lag)	0.368	0.367	0.007	2.525*	2.527*	0.386	0.750	0.747	-0.081
	(0.403)	(0.405)	(0.056)	(1.344)	(1.354)	(0.428)	(1.079)	(1.085)	(0.488)
2006 (time dummy)		-0.052	-0.066**		-0.021	-0.060**		-0.056	-0.068**
		(0.784)	(0.030)		(0.800)	(0.027)		(0.785)	(0.029)
2011 (time dummy)		-0.014	-0.017		0.040	-0.009		-0.012	-0.018
		(0.786)	(0.043)		(0.803)	(0.038)		(0.787)	(0.041)
Constant	2.623***	2.646***	2.790***	2.306***	2.299***	2.717***	2.640***	2.663***	2.807***
	(0.453)	(0.654)	(0.022)	(0.543)	(0.742)	(0.072)	(0.476)	(0.672)	(0.076)
R-squared	0.007	0.007	0.022	0.050	0.050	0.027	0.005	0.005	0.022
Industry fixed effects	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Industry-clustered standard errors in brackets. Weighted by 2001 male employment. N=264 observations.

Level of significance 10%*, 5%**, 1%***

Table 7. Regression results, equation (5), dependent variable: sex ratio

Trade variable:	Trade exposure			Export share			Import penetration		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Estimation method	OLS	OLS	FE	OLS	OLS	FE	OLS	OLS	FE
Trade variable (1-year lag)	0.336	0.335	-0.037	2.789*	2.785*	-1.036	0.462	0.458	-1.351
	(0.584)	(0.586)	(0.101)	(1.576)	(1.586)	(1.204)	(1.361)	(1.366)	(1.066)
Trade variable (1-year lag) x services	-3.818	-3.832	-2.876**	-2.835	-2.847	-3.560*	-13.433***	-13.448***	-1.806
	(2.721)	(2.733)	(1.336)	(3.867)	(3.898)	(1.948)	(4.621)	(4.637)	(2.375)
Trade variable (1-year lag) x primary	-0.282	-0.285	0.921	-0.598	-0.599	0.438	-1.746	-1.745	2.204
	(1.291)	(1.296)	(3.293)	(1.675)	(1.681)	(4.746)	(2.541)	(2.547)	(5.379)
2006 (time dummy)		-0.101	-0.095***		-0.047	-0.113***		-0.096	-0.079**
		(0.752)	(0.032)		(0.792)	(0.034)		(0.724)	(0.031)
Constant	3.062***	3.115***	3.100***	2.443***	2.468**	3.221***	3.342***	3.392***	3.063***
	(0.841)	(0.946)	(0.200)	(0.844)	(0.972)	(0.209)	(0.786)	(0.884)	(0.174)
R-squared	0.060	0.061	0.100	0.066	0.067	0.108	0.131	0.132	0.080
Industry fixed effects	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Industry-clustered standard errors in brackets. Weighted by 2001 male employment. N=176 observations.

Level of significance 10%*, 5%**, 1%***