Has the reduction of institutional childcare provision in East Germany increased female income inequality?

Abstract:

Since transition, East Germany has experienced decreasing levels of female labour supply, which have frequently been attributed to the reduction in institutional childcare provision. The first aim of this paper is to quantify this effect. Furthermore, household income inequality has increased since 1989. Existing literature explains this trend by referring to changes in the employment structure driven by wage increases. An alternative approach is adopted here by attempting to establish a direct relationship between childcare provision and income inequality *amongst* females in East Germany.

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Introduction

Following transition in 1989, the East German labour market has undergone significant structural changes. Product wages rose, labour demand fell by a third and unemployment rates jumped. This has often been attributed to the imposition of West German institutions such as trade unions. Furthermore, wage setting was politically motivated to promote regional equity, and to ease emigrational pressures. The convergence of the pay structure ensured the competitiveness of West German firms, but combined with the process of monetary union resulted in the loss of East German export markets and employment. In addition to this fall in labour demand, low levels of participation, especially amongst women, have been explained by the reduction of institutional childcare provision in East Germany.

During this period, household income inequality increased. Driven by the question of equity under alternative economic systems, a large body of papers emerged which link this rise to changes in the employment structure, referring in particular to the influence of trade unions and the loss in competitiveness outlined above

This essay has two aims: Firstly, the relationship between the reduction in childcare provision in East Germany and female labour supply decisions is investigated. Secondly, unlike past literature, these results are used to explain the rise in income inequality. A further departure from existing work is that inequality amongst women rather than households is analysed. This is of importance for policy evaluation, given the potentially high social costs of female poverty, and increased dependence on outside income.

The structure is such that **Section I** describes the general rise in inequality in East Germany since transition. By using different inequality measures it is then established whether income disparity amongst females follows this trend. **Section II** outlines past theoretical and empirical literature on childcare and female labour supply, whereas **Section III** illustrates the current childcare regime in Germany and that of the former GDR. **Section IV** describes the estimation procedure of testing the childcare effect on labour supply, and results are discussed in **Section V**. **Section VI** constructs a simulation to quantify the direct relationship between the childcare reduction and rising female income inequality established in **Section I**. Finally, **Section VII** draws policy implications and concludes.

I. The rise in East German inequality and a comparison to sample evidence

Since 1989 overall inequality in East Germany has grown both in terms of income and privately held wealth. Wage rises and the increase in dispersion are well documented, and are especially pronounced during the early years of transition. Using differing measures of inequality, Gang and Yun (2002) obtain estimates that income inequality rose by 25% - 61% between 1990 and 2000. Concerning net wealth there is strong evidence of asymmetric asset accumulation and redistribution, with the most affluent 10% owning 48% and the poorest decile holding a mere 4.5%. Remarkably, within a decade the egalitarian society under the socialist regime in East Germany has become more unequal than the capitalist West.

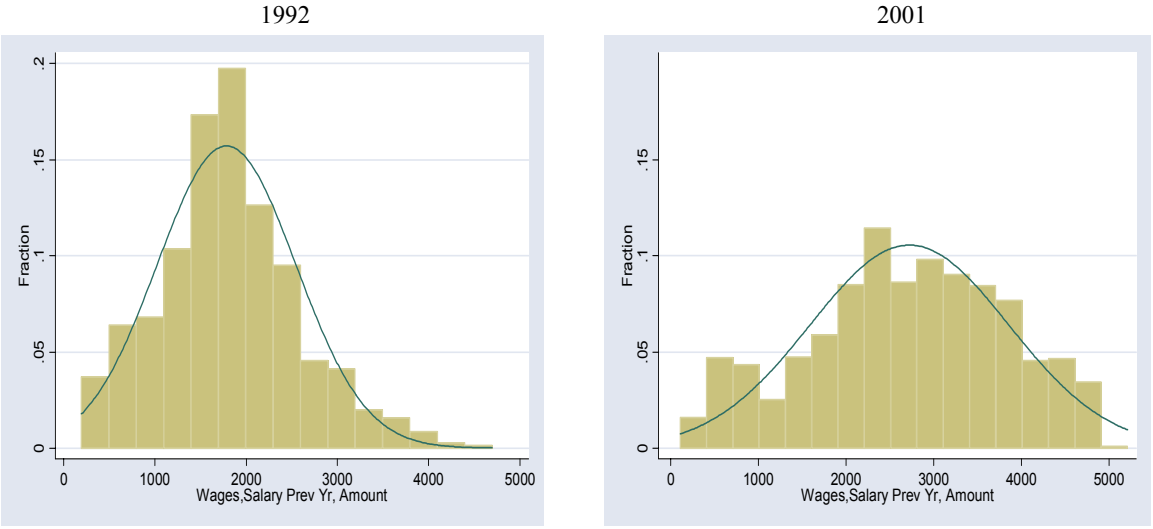
This general trend towards inequality is compared to sample evidence for females in East Germany between 1990 and 2001. Three distinct measures of inequality, namely the second moment of the wage distribution, the Lorenz Curve and the Atkinson index are used. These are evaluated using gross income, as it is a good approximation of social standing and relative valuation by employers.[1] Conceptual issues of measuring inequality especially concern the definition of the income unit. In the literature the nuclear family and an adult equivalence scale are often used. Given likely intra-family transfers, this classification is desirable but is complex due to the need to account for the number of dependants and various forms of non-wage income. Finally, it should be noted that a society may not deem all reasons for differing income as inequality. Given heterogeneous stages in the life cycle, saving rates and levels of dependence, the decision of redistribution will depend on its social judgement.

Female Wage Distribution

Due to insufficient East German wage data before 1992, this wave is used as a proxy for the wage distribution in the former GDR. Referring to Figure 1, the first and second moments of the distribution have changed dramatically over the sample period, of which the latter can be interpreted as a measurement of income inequality.

[1] Any form of non-wage income such as capital gains, interest income and transfer payments is omitted for simplicity. Furthermore, by evaluating inequality solely in terms of income and not accounting for privately held wealth, measurement error due to short term asset price movements is eliminated.

Figure 1
Distribution of female wages in East Germany; 1992 and 2001



Mean wage rose from 1800 DM/month to 3200 DM/month, whereas the variance doubled. This is reflected by the lowering of the peak, around which the distribution is tightly centred in 1992. These estimates are evidence that a substantial part of the overall increase in inequality, as reported by Gang and Yun, is due to rising dispersion of the female wage distribution. A further indication of growing inequality is the increasing skewness and the resulting divergence of mode and mean of the distribution. Whereas in 1992 no female reported a wage above 5000 DM, in 2001 this high earnings bracket makes up 8% of the sample. Finally, individuals with the lowest income seemingly did not benefit from average wage rises as the fraction of women earning less than 1000 DM/month remains high.

These results are supported by Hunt (1999) who reports substantial wage gains for unionised females with high skill levels. Concerning wage dispersion she notes that the largest differences occur across occupations, and are best explained by human capital theory.

Lorenz Curve

The Lorenz curve is a graphical representation of the proportionality of the wage distribution in Figure 1. It is a function of the cumulative proportion of ordered income units mapped onto the corresponding cumulative proportion of their wage. When interpreting Lorenz Curves, the reference point is the perfect equality line, which is a diagonal reflecting zero variance in the wage distribution. Growing levels of inequality are represented by increasingly convex schedules lying below this line. Finally, the Lorenz Curve can quantify the extent of income inequality through the frequently used Gini Coefficient. This is defined as the ratio between the area

enclosed by the line of equality and the Lorenz curve, and the total triangular area under the diagonal.

Figure 2
Lorenz Curve for female wages in East Germany; 1992 and 2001

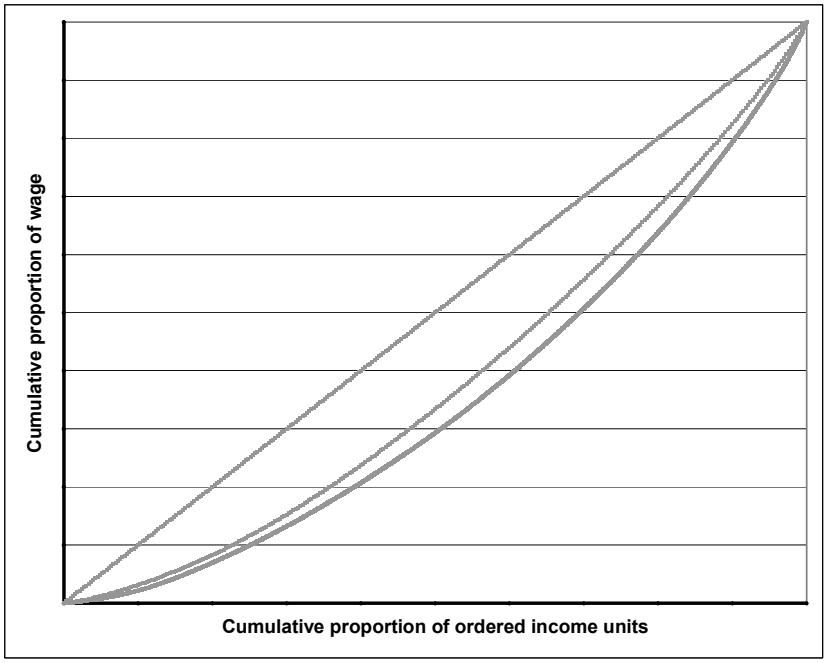


Figure 2 indicates a substantial increase in inequality over the sample period. This is reflected by the wage distribution for 2001 being dominated, as the Lorenz Curve for 1992 lies entirely within the other. As stated by Atkinson (1978), this implies that all measures of inequality will be unambiguous. If the curves had intersected, it would have not been possible to evaluate the states of inequality without introducing social value judgements.

Atkinson Index

Finally, an attempt is made to quantify the change in female wage inequality during the transition period. This is achieved by using the Atkinson index as a summary measure of income concentration, where the following analysis is based on Donaldson (1995). The index is defined as estimating the proportion of total income which is required to obtain the identical level of social welfare if it were equally distributed. Its derivation relies on the choice of a social welfare function (SWF) in terms of income, which reflects the value judgements of society and from which the index inherits its welfarist ethics. The necessary common assumptions are those of symmetry, increasingness, concavity and additive separability.

The limiting cases of this choice are the linear and the maximin welfare functions, respectively.[2] The former measures social welfare in terms of the sum of income and embodies utilitarian ethics. It does not exhibit any degree of inequality aversion and is thus not applicable to inequality indices, as any such measurement is zero by construction. Alternatively, the maximin SWF, as proposed by Rawls (1972), defines social welfare by the income of the worst off individual in society. This paper chooses the SWF of *Mean of Order r*, as proposed by Atkinson (1970). The corresponding inequality index may take on different forms, and it gives increasing weight to the lower deciles of the income distribution as the inequality aversion parameter of society rises. Furthermore, evaluating positive income vectors only, restricts the range of the index to zero and unity.

Table 1
Atkinson index for female wages in East Germany; Aversion parameters: 0.5; 0; -0.5

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
r = 0.5	0,0977	0,1127	0,1245	0,1287	0,1322	0,1315	0,1368	0,1372	0,1530	0,1486
r = 0	0,1646	0,1861	0,2062	0,2146	0,2225	0,2233	0,2420	0,2355	0,2610	0,2510
r = -0.5	0,2315	0,2577	0,2865	0,3002	0,3145	0,3216	0,3668	0,3411	0,3768	0,3549

Table 1 reports the estimates of the Atkinson index for females since transition, which support the findings of dramatically increasing inequality stated above. Interpretation is such that for an aversion parameter of zero, if 75% of total income were equally distributed, social welfare would remain unchanged. Lydall (1968) finds that values of inequality indices for countries such as Czechoslovakia and Hungary are significantly smaller than for Western Europe. Thus it is to be expected that the figures in the 1992 column, which act as a proxy for conditions under the socialist regime, are lower than for West Germany.

The conclusion of Section I is that based on the GSOEP sample all three inequality measures yield strong evidence for an increase in wage dispersion amongst females in East Germany. This is consistent with the trend towards household inequality, as outlined in the literature. It should be noted though that any direct quantitative comparison with past work is not possible, given the alternative definition of the income unit.

[2] It is theoretically possible that the SWF is bowed out from the origin, although this case is difficult to justify in inequality analysis.

II. Past theoretical and empirical studies on childcare and female labour supply.

An early theoretical framework for the relationship between childcare and female labour supply is provided by Heckman (1974), and Blau and Robins (1988). Their aim is to evaluate childcare policy in the US where under the childcare tax credit system the government gives out cash subsidies. Using neoclassical labour supply models they show how childcare costs affect decision making of mothers and families, such as the demand for care, fertility and labour supply. It is argued that a rise in cost is analogous to a reduction in real wage and this in turn results in a flatter budget constraint. By decreasing the propensity to work, female labour supply falls.[3] In his study Heckman assumes that there is a competitive market in childcare through which the cost and the quality of care jointly determine its demand and female labour supply. In addition, the secondary market for custodial care at zero cost is of importance when modelling participation.

Other theoretical work investigates the related question of how children affect female labour supply decisions. When analysing the dynamics of the German labour market, Voicu and Buddelmeyer (2003) identify two distinct channels of influence on after-birth labour force participation. Firstly, hours worked decrease in childcare time due to a substitution effect towards home care. Secondly, they assume that time out of the labour market has an adverse impact on experience. This may decrease the prospects of future employment if labour demand is based on seniority.

The main empirical studies for these theoretical models are Blau and Robins (1988), Ribar (1992, 1995) and Kimmel (1995). Using US data, estimates of labour supply elasticity with respect to childcare are obtained, ranging from -0.07 to -0.74. This implies that participation is indeed positively related to the magnitude of the childcare subsidies.
In analysing the effect of childcare policy on female labour supply, this paper will follow a different approach and is thus not directly comparable to the classical literature. Unlike the US, in Germany the cost of childcare does not play a pivotal role in fertility and employment decisions. As Hank and Kreyenfeld (2000) point out, high levels of regulation, barriers to entry, and subsidies resulted in the non-existence of a competitive market for private childcare. Provision is rather guaranteed by local authorities and non-profit organisations through the Subsidiaritätsprinzip or “subsidiarity principle”.

[3] This is supported by empirical work, although theoretically both the income or the substitution effect may dominate

Most importantly, price is not determined by excess supply and demand, as implicitly assumed by Heckman. Grants are paid to parents with children (*Kindergeld*), but they do not implicitly encourage out-of-house care. Furthermore, the charge for childcare is approximately 150 DM/month in Germany, compared to $240 in the US (Anderson / Levine (1999)). This implies that the impact of the cost on female labour supply may be smaller, as supported by Merkle (1994) who finds no significant elasticity effect for Germany. As a result, childcare is rather an issue of availability in the German context.

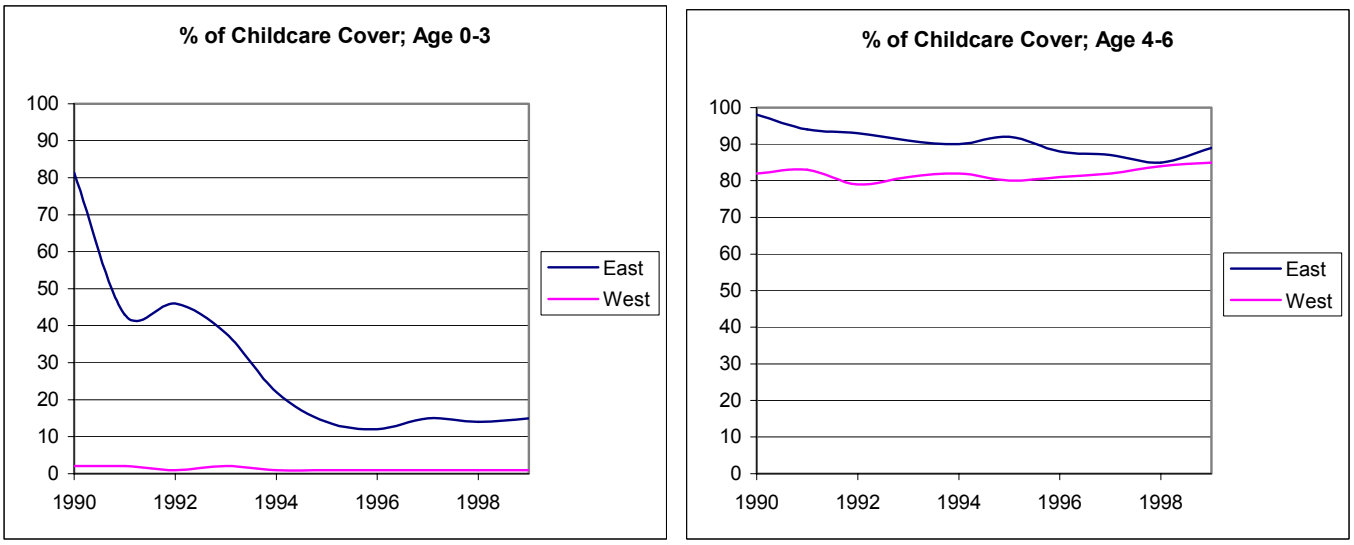
III. Institutional Background: The childcare regime Germany

Childcare provision in West Germany is strongly shaped by the social standing of females within society. Especially the Catholic Church exhibits strong influence by preaching conservative values such as family tradition and cohesiveness. The husband is regarded as the breadwinner, whereas the wife is often confined to raising the children. Participation rates of females are a mere 58%, resulting in low levels of demand for out-of-house childcare. Furthermore, care centres exhibit restrictive opening hours, making return to the labour market following maternity leave difficult. Institutional background may also help to explain why no private market has evolved. Engelbrech and Jungkunst (1998) report a general unwillingness of Germans to pay for childcare provision and additionally observe a substitution effect towards custodial care by relatives.

This is in stark contrast to the childcare regime operated in the former GDR, as outlined in Baske (1991), Hildebrandt (1994) and Mittelbach (1994). By the early 1980s there was a comprehensive state-run childcare system in order to facilitate female labour supply and to convey ideological values to young children. Care levels reached approximately 80% for 0-3 year olds, compared to the virtual non-existence in the West. Furthermore, Wagner, Hank and Tillmann (1995) point out that care centres operated from 6am to 6pm, and that the cost of 1.40 Ostmark/day was less than comparable feeding costs at home. The result of this policy was a female participation rate of 91% and shorter maternity leaves than in the West.

In 1990, East Germany was integrated into the federal system. Responsibility of childcare provision was handed to local authorities, which increasingly faced financial difficulties due to rising levels of unemployment. As German law only requires state care for 4-6 year olds in form of kindergartens, the whole-day centres for infants were mostly closed.

Figure 3
Percentage of childcare cover for infants and kindergartens [4]



These results are supported by Hoeckner (1995), and Joos and Nauck (1996). They observe that for infants the level of care has not entirely converged to Western patterns, and explain this by institutional differences between the two parts of Germany.

IV. Econometric Method

In attempting to estimate the impact of the reduction in childcare on female labour supply in East Germany, this paper will focus on the provision for 0-3 year olds only. As illustrated in Figure 3, the institutional change is most significant for this age group. Furthermore, one can assume that labour supply of mothers with infants is the most elastic with respect to care.

Early literature seemingly assumes a competitive labour market by solely focusing on actual hours worked as the dependent variable. Büchel and Spiess (2002) suggest that regional unemployment rates of 20% in East Germany imply labour market decisions not being a pure reflection of preferences but also of financial necessity and labour market tightness. This paper adopts their reasoning, and will test for the effect of childcare provision on both labour supply and on the willingness to work. Also, regarding policy implications this model specification is important, as a definition of social welfare may include both of these aspects.

[4] The value for 1990 in the left panel is the official figure by the former East German government. Estimates of the level of childcare provision reported in academic research are often lower in comparison.

All estimations are based on data from the German Socio-Economic Panel (GSOEP). This is a longitudinal study of private households with questions ranging from household composition, occupational biographies, employment, earnings, health and satisfaction indicators. Many empirical studies such as Ribar (1992) and Kimmel (1995) are based on cross-sectional data. This is regarded as inappropriate and a panel is used in order to capture the effect of policy changes, which operate with a lag. The sample period spans form 1990 to 2001, where the first cross-Germany wave is used as a proxy for East German institutional characteristics and labour market conditions.[5]

Concerning econometric methods, a brief outline of the statistical problems encountered and the techniques employed, is given below.[6] As in most labour supply studies, income is treated endogenously and is estimated by using instrumental variables in a separate wage equation. Furthermore, this wage will be non-randomly reported by a subset of the sample only, implying a possible sample selection bias. It is to be expected that especially individuals with characteristics leading to low earnings, will fail to report a wage. This is overcome by using the Heckman (1979) two-step procedure and by predicting wages for the entire sample, as suggested by Mroz (1987). The truncation of the distribution of the labour supply variable is taken into account by using a structural tobit model, where income is replaced by the fitted values from the wage equation. The dependent variable *desire to work* exhibits multiple responses and is thus estimated by an ordered probit model. In addition, it is only recorded for individuals out of work. In order to compensate for a further possible selection bias, the response of actually working is added as the highest ordinal category. The issue which is not addressed is that of incorrect standard errors when using fitted values, as outlined by Pagan (1984).

An important issue of concern is the satisfaction of the rank condition of identification, as set out by Wooldridge (2002). In earlier work (e.g. Blau and Robins (1988); Anderson and Levine (1999)) variables are simply excluded to achieve identification. Rather than following this ex post empirical justification, this paper shall attempt to provide a causal rationalisation for exclusion. Furthermore, it will not rely on the non-linearity of the Heckman selection equation, but will introduce a separate identifying variable in order to avoid possible colinearity.

[5] It should be noted that for certain variables, such as wage, no data is available for East Germany in 1990.

[6] Due to the constraints on the scope of this paper, additional notes on the econometric techniques are provided in Appendix 2. Furthermore, the following should be noted. The need for a sufficient statistic for the individual specific term, α, restricts the choice of model to a fixed effects logit or a random effects probit. A formal procedure is given by Hausman (1978). This paper chooses the latter model, as in the fixed effects case important time-invariant variables are eliminated by the within transformation. Furthermore, the model is easily extended to a random effects tobit and a random effects ordered probit. Given this choice, it is assumed that α and ε are mutually independent and independent of all x over the entire sample period.

Identification of the labour supply equation is achieved by the variable *Years in House*. It acts as a proxy for the social family network and in turn as a proxy for access to informal childcare. The number of relatives is regarded as the ideal choice for this purpose, but is not used due to insufficient observation numbers. Concerning the wage equation, the identifying variable is *Years in the Firm*. Here it is assumed that seniority affects the wage structure, but will have no impact on actual hours worked. Finally, identification of the Heckman selection equation occurs through *Car Ownership*. This variable captures the access to the workplace, but once employment is taken up, it will have no further effect on either wage or labour supply.

The estimated equations are a function of standard human capital variables and labour market characteristics, which are not explained further. The following description is to motivate the choice of key variables which are important to this paper and the German context.

Work experience: A proxy for potential work experience is often included in the form of age-schooling-6, but this is regarded as unnecessarily restricting the coefficients of these variables.

Household income: The expected sign of this variable is ambiguous. Affiliation may dominate in that high wage earners who work long hours also live together. Alternatively, higher wages by the spouse may reduce the wife's need to work.

Education dummies: Possible effect on wage due to higher skill level or signalling mechanism, where basic schooling is the comparative category. Accounting for vocational degrees is important as they are completed by a high percentage of Germans.

The Married dummy: As suggested by Verbeek (2003), there is no causal relationship between this variable and wage. Rather, it is picking up cross-individual differences in unobservable characteristics of married and unmarried people.

Single Mother: Its effect on labour supply is ambiguous. Single mothers may either work more due to financial constraints, or alternatively work less in order to look after their children.

Childcare: The variable is defined as regional childcare provision / 1000 children and is assumed to be exogenously determined. Alternatively, access to childcare could be used but it may suffer from endogeneity being possibly a function of family income.

Regional unemployment: This variable is important in explaining labour supply decisions. As data at the regional level is not sufficient, it is excluded from estimation.

V. Interpretation of Results

In the following section, Table 2 reports the estimates of the wage equation, Table 3 those of the labour supply regression and Table 4 presents the results of the willingness to work equation. Only key variables are included, whereas the full output can be found in Appendix 3.[7] Estimates for West Germany are reported to ensure coefficient consistency, and are referred to if they significantly aid interpretation. As motivated above, comparison with work on the US is not appropriate. Büchel and Spiess (2002) (BS hereafter), and Hank and Kreyenfeld (2000) are two empirical studies for Germany which are used for reference. As they both employ cross-sectional data from the GSOEP and alternative model specifications, general conclusions rather than specific coefficients are reproduced. Finally, the Heckman selection equation is not presented in the main text as it is of reduced rather than structural form.

Table 2
Wage Equation; *p-values* in parentheses

	West	**East**
	Wage	**Wage**
University Education	912.48800 (0.000)	432.64300 (0.007)
Vocational Training	298.44570 (0.000)	322.00310 (0.011)
Secondary Schooling	33.27454 (0.667)	241.48350 (0.056)
HH Income / DM 1000s	155.6209 (0.000)	274.0805 (0.000)
Jobprestige	24.56894 (0.000)	22.82550 (0.000)
Married	-337.64570 (0.000)	-354.58650 (0.007)
German	-482.50270 (0.000)	
Years in Firm	30.21509 (0.000)	26.59044 (0.000)
Single Parent	97.53820 (0.248)	335.36090 (0.048)
Number of Children (u3)	-460.89550 (0.000)	-36.21713 (0.497)
Childcare Provision (Vacancies/1000 Children)	0.73716 (0.000)	2.95924 (0.009)

[7] Failure to report values for R^2 is intentional. The reason is that OLS maximises this goodness of fit measure by construction by minimising the sum of squared residuals. Instrumental variable estimation is not chosen using this criterion, but rather to ensure parameter consistency and unbiasedness.

Most importantly, the variable *Years in Firm* is highly significant and of correct sign and magnitude for both East and West Germany. This is evidence that the instrument is valid.[8] As expected education has a positive effect on wage, either by increasing human capital or through some signalling mechanism. Household income is positively correlated with female earnings implying the presence of affiliation amongst couples. Not surprisingly more prestigious employment and increased seniority result in higher wages, whereas the sign of the ethnicity dummy cannot be explained. Relative to cohabitation, married women exhibit characteristics leading to significantly lower wages. These may include greater importance of family and willingness to sacrifice own career. Furthermore, there is evidence for a higher degree of income sharing amongst married couples. Importantly, the negative impact of an additional child below the age of 3 is approximately 13 times greater in the West. In East Germany this effect is highly insignificant (p-value of 0.497). Thus the lack of sufficient childcare provision in West Germany, as illustrated in Figure 3, results in children significantly reducing women's earnings potential. Finally, childcare has a significant positive effect on female wage. For every additional vacancy/1000 children, earnings increase by 0.74 and 2.96 DM/month, respectively. It can be argued that highly paid employment requires long working hours, and that comprehensive childcare provision facilitates access to such occupations. These results support those by BS who also establish a significantly positive effect of childcare on female wages.

[8] It should be noted that a poor instrument may have severe consequences. If the correlation is weak, the standard errors of the IV estimates become increasingly large. Most importantly, a sizeable asymptotic bias can arise. This follows from the fact that the correlation between the instrument and the endogenous variable inversely enters the probability limit of the IV estimator.

Table 3

Labour Supply Equation; Tobit estimates; *p-values* in parentheses, values = $\partial E\{y_i\}/\partial x_{ik}$
(As illustrated in Appendix 2)

	West	East
	Hours Worked	**Hours Worked**
Wage / DM 1000s	3.3528 0.000	2.9816 0.000
University Education	-1.93945 0.000	-0.23716 0.615
Vocational Training	-1.77801 0.142	0.12620 0.730
Secondary Schooling	-1.66626 0.000	-0.07665 0.836
HH Income / DM 1000s	-0.6274 0.000	-0.5821 0.000
Married	-2.29499 0.000	-1.54620 0.000
German	-1.28962 0.000	-5.37136 0.057
Years in House	-0.03535 0.000	-0.15515 0.000
Single Parent	-2.34805 0.000	-3.10303 0.000
Number of Children (u3)	-0.65160 0.000	-0.40512 0.022
Childcare Provision (Vacancies/1000 Children)	0.02213 0.071	-0.00426 0.109

The instrument which acts as a proxy for informal care in the labour supply equation is significant but of the wrong sign. This casts doubt on the quality of its selection and of the estimates. Earnings have a positive effect on labour supply, implying an upward sloping labour supply curve. Surprisingly, education has a negative impact on hours worked in West Germany, whereas it is insignificant in the East. Although the coefficient on household income is significant, its effect is small. In past literature it has been suggested that household income would reduce the necessity of female labour supply, but this paper finds little support for this proposition. Relative to cohabitating females, married women and single mothers work less hours, just as Germans do in comparison to foreign nationals. Referring to the model by Voicu and Buddelmeyer (2003) from above, the number of children had been expected to be significant in explaining labour supply, and in illustrating the impact of differing care levels in East and West Germany. In contrast with this prediction, the coefficients indicate a negligible reduction of less than one hour for each additional child. Finally, the level of childcare provision enters the estimation with opposite signs. In West Germany, labour supply increases in childcare (although not significantly at the 5% level), whereas in the East this relationship is reversed and is statistically insignificant at 10%. Given the high degree of unemployment in East Germany,

binding financial constraints possibly make female labour supply inelastic with respect to childcare provision. Alternatively, it has been suggested by Hank and Kreyenfeld (2000) that such insignificance is evidence for the ineffectiveness of the current childcare regime, as it does not facilitate an expansion of female participation. These estimates are in contrast to BS who estimate a significant childcare effect.

Table 4
Desire to Work equation; Coefficients are Marginal Effects; *p-values* in parentheses

	West		East	
	Strong Desire	No Desire	Strong Desire	No Desire
Predicted Wage / DM 1000s	0,006005314 0,000	-0,00087768 0,000	0,009732917 0,174	-0,000982376 0,174
University Education	0,009067095 0,467	-0,00132515 0,467	-0,04216123 0,346	0,00425547 0,346
Vocational Training	-0,002710316 0,623	0,000396112 0,623	0,04595442 0,390	-0,00463833 0,390
Secondary Schooling	-0,007291468 0,426	0,001065647 0,426	0,03438770 0,344	-0,00347087 0,344
HH Income / DM 1000s	-0,005819582 0,000	0,000850531 0,000	0,005583621 0,230	-0,000563574 0,230
Married	-0,076001923 0,000	0,011107666 0,000	-0,02333751 0,284	0,00235553 0,284
German	-0,006282053 0,296	0,000918121 0,296	-0,02846629 0,790	0,00287320 0,790
Single Parent	-0,055813199 0,000	0,008157088 0,000	0,02447602 0,448	-0,00247045 0,448
Number of Children (u3)	-0,006317316 0,016	0,000923274 0,016	-0,03254659 0,005	0,00328504 0,005
Amount of Childcare Allowance	0,00004686 0,008	-0,00000685 0,008	-0,00008766 0,047	0,00000885 0,047
Length of Maternity Leave	-0,006172065 0,000	0,000902046 0,000	-0,00627076 0,057	0,00063293 0,057
Childcare Provision (Vacancies/1000 Children)	0,00162178 0,029	-0,00023702 0,029	0,00013499 0,063	-0,00001363 0,063

The dependent variable *Willingness to Work* is also recorded for females who do not participate in the labour market, in which case no actual wage is observed. Using predicted wages instead allows for the interpretation of potential earnings corresponding to individual characteristics, which is significant in determining the desire to work in West Germany. Education has seemingly no effect as the coefficients have opposing signs and are highly insignificant. Length of maternity leave is included in this specification and has a negative impact on the willingness to work in that an additional month decreases strong desire by approximately 0.6%. Wagner, Hank and Tillman (2001) report that the East German childcare regime ensured short maternity leaves, implying that current policy has indirectly decreased the desire to work. Most importantly, an additional infant reduces the willingness in East Germany by 3.2%, compared to

the negligible impact on actual hours worked. Thus labour market decisions are not solely driven by preference, but rather by financial needs. This is supported by the fact that also childcare provision has a more significant influence on the desire to work in East Germany (a 10% fall implies a decrease in strong desire by 1.3%), than on actual labour supply. Regarding earlier reference to past empirical studies, these observations highlight their limitations. By not accounting for preferences, any policy implications drawn from them solely on the basis actual labour supply do not capture the true social cost of their implementation.

VI. Measurement of the effect of childcare policy on rising female inequality

Finally, this paper will attempt to estimate in how far the reduction of institutional childcare in East Germany has affected female participation decisions, and whether this in turn can explain the rise in income dispersion. Regarding the theoretical and empirical relationship of participation rates and inequality, contrasting views have been proposed. Solow (1960) argues that the long term trend towards equality has been driven by increasing labour supply of lower class women. This is supported by Danziger (1980) who estimates that the equalising impact of females joining the labour market on the Gini coefficient is as great as 5%. On the other hand, Thurow (1975) points out that the increase in participation has occurred amongst potentially high wage earners and thus increased overall inequality. Finally, Juhn and Kim (1995) use a cross-substitution effect to link female labour supply to declining real wages and rising inequality amongst less skilled men.

Past literature has frequently quantified the effect of female participation on *household* income dispersion, such as Shorrocks (1983) and Betson and van der Gaag (1984). By decomposing the Theil index, they are able to estimate between and within gender inequality. Bergman (1980) and Winegarden (1987) employ a simulation to map the relationship of female labour supply and household inequality. They conclude that at participation rates above 50%, any further increase has an equilibrating effect.

This paper will take an alternative approach as its aim is to explain the rising income inequality *amongst* females, as illustrated by the Atkinson index values in Table 1. Firstly, it will be simulated whether this trend can be attributed to individuals dropping out of the labour force. Then the significance of childcare provision in explaining the drop-out rate will be tested. Finally, estimates of the reduction in childcare provision in East Germany are used to predict its impact on income inequality. The simulation is constructed such that the Atkinson index for female earnings is calculated for 1991. Given its homogeneity of degree zero, adjusting this

distribution by average annual inflation leaves the index unchanged. For all consecutive years, women who actually drop out or join the labour market are identified. These are then eliminated and added to the initial wage distribution, respectively. As no changes to relative wages are made, it is possible to desegregate the direct effect of female labour market dynamics on income inequality. Table 5 reproduces the results from Section I for convenience, and reports the estimates of the simulation.

Table 5
Atkinson index with aversion parameter: 0.5; Simulated effect of labour market dropouts

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Actual	0,0853	0,0977	0,1127	0,1245	0,1287	0,1322	0,1315	0,1368	0,1372	0,1530	0,1486
Simulation	0,0853	0,0896	0,0909	0,0926	0,0935	0,0948	0,0951	0,0972	0,0961	0,0952	0,0942

Over the sample period the Atkinson index of inequality increases by 74%. After the elimination of relative wage changes, a rise in income dispersion of 10.4% remains. Thus, female labour market attrition may account for 14% of the rise in inequality.

As a second step, the significance of childcare provision in explaining drop-outs in East Germany is estimated.

Table 6
Probit Model of labour market drop-outs; Marginal effects; *p-values* in parentheses

	East Dropout
Wage / DM 1000s	-0,025307906 0,000
HH Income / DM 1000s	-0,022741937 0,000
Married	-0,00319942 0,641
German	-0,04285144 0,380
Single Parent	-0,00995826 0,280
Number of Children (u3)	0,01505407 0,000
Amount of Childcare Allowance	0,00002781 0,043
Length of Maternity Allowance	0,01893514 0,000
Childcare Provision (Vacancies/1000 Children)	-0,00004956 0,274

The marginal effect of -0.00004956 from the probit model implies that an increase in childcare provision by 1% (10 places /1000 children) deceases the probability of labour market exit by -0.04956%. Wagner, Hank and Tillman (2001) report a post-transition reduction of care for infants in East Germany of 65%, which corresponds to a fall in this probability of 3.2%. In the simulation it is established that 14% of inequality may be explained by labour market dynamics. From this it follows that the direct effect of childcare on inequality is approximately 0.5%.

Before drawing final conclusions, the limitations of the estimation procedure should be noted. Foremost, the childcare coefficient in the probit model is insignificant (p-value: 0.274), which casts doubt on the robustness of the participation effect. Furthermore, the model is of simple nature as it assumes that females joining the labour market experience no relative wage gains. Measurement errors may occur as the reduction of childcare provision by 65% is no marginal effect, and parameter stability can no longer be assumed.

VII. Policy Implications and Concluding remarks

The first aim of this paper is to estimate the impact of childcare provision on female labour market decisions, which gives rise to some direct policy implications. The significant relationship between care and willingness to work means that a policy reversal may increase female human capital with regards to the labour market rather than just child rearing. Furthermore, the results from the wage equation imply that greater childcare levels would allow women access to higher paid occupations and help reduce the gender wage gap. Büchel and Spiess (2002) observe that children in whole-day care often have single mothers. As this population group is statistically more likely to suffer poverty, an increase in childcare may reduce the dependence on social benefits. They also state that mothers working part-time expressed the desire to increase their hours, but were unable to, given the constraint of looking after their children. Thus there is potential for skilled women to increase their labour force participation. Additionally, a policy change may yield benefits regarding education. In 2000 the PISA study established that on average German children exhibit low levels of basic academic skills. It can be argued that early education in the form of whole-day nurseries and kindergartens may decrease these deficiencies. The two main aims of childcare, namely the compatibility of employment and family, and the educational aspect are directly linked as demand for care will depend on pedagogical quality. Furthermore, childcare provision can only be part of broader policy instruments, and its effectiveness is raised by complimentary measures such as increased labour market flexibility. Finally, general implications for society are considered. It is pointed out above that the structure of the childcare regime in West Germany is influenced by institutional factors. Alternatively, the causality may be reversed in that it further facilitates the status of women within the family. As an explanation for why the policy of reducing childcare provision was implemented following unification, perceived superiority of Western institutions and federalisation have been suggested. Given the large scale closure of state enterprises and resulting unemployment amongst men, it may have also been guided towards removing females from the labour market.

The second objective of this study is to quantify the direct relationship between childcare provision and income inequality. As a first step, rising female wage dispersion is established by using different inequality measures. This trend is then explained in part by labour market dynamics, but no statistically significant impact of childcare on inequality is found. Despite the insignificance and the limitations of the method outlined above, testing for this relationship can be justified though, as it may operate through other channels. For example, a fall in provision may facilitate labour supply reduction from full to part time, rather than entire labour market

exit. Furthermore, as illustrated in Table 2, there is a strong effect on female income and thus on the wage distribution. Finally, the level of care influences the length of maternity leaves, which in turn affects labour market re-entry. As a result it is possible that the true impact of childcare provision on female income inequality is significantly greater than the 0.5% estimated in this paper. Given its relevance for policy evaluation, this question may be subject to future research. By employing more sophisticated models and decompositions, the alternative channels of the relationship between childcare provision and income inequality could be quantified.

Finally it should be noted that, although beyond the scope of this paper, any complete normative policy analysis should additionally take demand for childcare into account. This is of special importance in East Germany where high unemployment and legislation allowing longer maternity leaves have caused a substitution effect towards home care. Furthermore, since 1989 fertility has halved, giving rise to the interesting question of cause and effect in the relationship with childcare provision.

5434 words

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Appendix 1 – Data Description

The following data description is based on the Desktop Companion of the German Socio Economic Panel (2002).

The GSOEP survey is a longitudinal study of private households and is of economic and political nature, whereby many social indicators are included. The core questions are asked on a yearly basis and topics range from household composition, occupational biographies and employment to earnings, health and satisfaction indicators. An additional topic is included which changes from year to year.

The initial sample is taken for the Federal Republic of Germany in 1984, in which 12,290 people in 5,921 households participated. This sample is defined as "SOEP West". In 1990, a first wave is obtained for the former GDR consisting of 4,453 individuals from amongst 2,179 households, after which the sample size of the "SOEP East" has steadily grown. Apart from this regional desegregation, the data is split into further subgroups such as German residents, foreigners and immigrants.

Concerning the survey design, it is a regionally clustered random sample. Responses are gathered both through face-to-face interviews and by completion of a questionnaire. Individuals are closely monitored and are repeatedly surveyed, even if their ordinary residence within Germany changes. Attrition occurs if no interview can be conducted for two consecutive years, either due to refusal, temporary absence or death.

Possible non-response is divided into two groups, of which the first incorporates refusal to reply to a question. If a question is not applicable an alternative coding is used. Outliers, (non-feasible answers) are eliminated from the sample and are reported in the former group. Finally, the refresh rate is such that new respondents are included annually, and children join the sample at the age of 16.

For the estimation purposes of this paper, a panel data set is constructed from raw GSOEP data using the econometric package Stata. The aim is to use the first cross-Germany wave in 1990 as a proxy for East German institutional characteristics and labour market conditions. Thus the two separate samples "SOEP East" and "SOEP West" are combined to create a panel with a sample period from 1990 to 2001. This dataset consists of 383652 observations, including 31971 adult respondents over 12 years. Finally, as not all questions are asked in all years, and due to attrition, it is an unbalanced panel.

(Variable list)

Definition of the variables:

(Source of all variables: GSOEP)

Person Identifier

This is a unique label which is used to identify the individuals in the panel. As the number does not change over the years, it is possible to track each respondent over the sample period. In the data there are 383652 observations resulting from interviewing 31971 people.

Year

This variable is used as the time dimension of the panel. It is not specifically included in the estimation. The sample period spans from 1990 to 2001, thus over 12 years.

Household Number

Similar to the person identifier, this variable labels the household. If a family breaks up, individuals can join another household. In this case, their person identifier is re-matched.

Male

This is a dummy which takes on 1 if the respondent is male, and 0 otherwise. It does not directly enter the estimation as a variable, but rather it is used to separate the sample which is regressed for females only. In further work it may be included in a wage equation in order to measure the gender wage gap.

Actual hours worked

In the labour supply equation, this is the dependent variable. As in many past studies, its distribution is assumed to be truncated from below at zero. This occurs because negative hours worked cannot be realised. As a matter of fact, 45% of the GSOEP sample are situated in the spike at 0.

Willingness to Work

This is the second dependent variable and is used to account for the preferences of the respondents regarding labour market decisions. The question is answered by individuals who are currently not in the labour market, and there are multiple responses: “Strong desire to work”, “Medium desire to work” and “No desire to work”. In order to account for a possible sample selection bias, a fourth ordinal category “Actually working” is added, so that the sample is extended to cover individuals in and out of the labour market. It should be noted that when using a model of ordered response, the newly included category is causally viewed to be the “highest” in the ordinal ranking.

Wage

Income is measured by gross wage in units of DM 1000s / month. The reason that it is included in gross terms is that it is a good measure of earnings potential, social standing and evaluation by the employer. Furthermore, observation numbers of net wage were insufficient for estimation. Finally, this variable is scaled in order to ease interpretation of the coefficients.

Car Ownership

This is a dummy variable which takes on 1 if a car is owned by the individual and 0 otherwise. In the questionnaire, it is asked whether the respondent has access to a car. There were three possible answers, namely "Yes constantly", "Yes occasionally" and "No". In order to create the dummy variable, the simplifying definition is made such that the dummy takes on 1 if either of the first two categories is present.

This variable has the drawback of relatively few observations (75492) as the question is only answered in 5 years over the sample period.

There are three education dummies: *university education*, *vocational training* and *secondary schooling*. The base category that is omitted to avoid colinearity is basic schooling.

University Education

This variable is a dummy which takes on 1 if the individual has a university degree and 0 otherwise.

Vocational Training

This variable is a dummy which takes on 1 if the individual has a vocational degree and 0 otherwise. It is important in the German context, as a high percentage of school leavers choose this form of training.

Secondary Schooling

This variable is a dummy which takes on 1 if the individual has secondary schooling and 0 otherwise.

South

The dummy variable *South* takes on 1 if the individual is resident in the two southern states of Baden-Wütternberg or Bayern, and 0 otherwise. For obvious reasons it is dropped from the model specification for the East.

Household Income / DM 1000s

This variable is defined as income of the entire household, minus the wage of the individual, and is measured in gross terms for the same reasons as personal income. Furthermore, it is scaled in the same way (measured in DM 1000s / per month)

Job prestige

The measure of job prestige occurs on a scale of 0 to 100, where more prestigious jobs obtain higher rankings.

Married

This is a dummy variable which takes on 1 if the individual is married an 0 otherwise

German

This is a dummy variable which takes the value 1 if the individual is a German national and zero otherwise.

Years in Firm

This variable measures the years which the respondent has worked continuously in a firm.

Years in House

This variable measures the years which the respondent has lived continuously in his house. It is calculated as the current year minus the year in which the individual last moved.

Age

The GSOEP raw data does not included this variable. It is obtained by taking the current year and subtracting the year of birth.

Single Parent

This is a dummy variable which takes on 1 if the individual is a single parent and 0 otherwise. It is generated by using the "Household Typology" data.

Number of Children (u3)

This is a discrete measure of the number of children below the age of 3 years which are associated with a given household(number).

Length of Maternity Leave

The length of maternity leave is defined in terms of months which a female respondent is out of the labour market to look after her children.

Amount of Childcare Allowance

This variable is defined in gross terms and, like all other monetary measures, is rescaled such that it is measured in units of DM 1000s / month.

Childcare Provision

This variable is defined as regional childcare provision measured in vacancies / 1000 children. Alternatively, access to childcare could have been used, but this may be endogenous, as it is a function of household income.

Labour market exit

This is a dummy variable that takes on 1 if the respondent drops out of the labour force during the sample period, and 0 otherwise.

Outlier Correction

Despite the fact that the GSOEP has conducted outlier correction, the data is inspected for implausible results. The result is that only gross wage has values lying extremely far from the mode of the distribution. Nevertheless no outlier correction will be undertaken. The reason is that in the 88227 observations, a mere 5 are reported to be greater than 50000 DM month.

Wage	Frequency
56000	3
65000	1
99999	1

Given the large sample size, such high levels of income were to be expected.

Appendix 2 - Notes on Econometric Techniques

In this appendix, some brief explanatory notes concerning the econometric techniques used in the paper are given. The notation is based on Greene (2003), Verbeek (2003), Wooldridge (2002), and Wooldridge (2003);

1.) Issue of endogeneity

In labour supply studies wage is often regarded to enter the labour supply equation endogenously. It is assumed that there is a correlation between this explanatory variable and the unobservables which determine hours worked. To illustrate the impact on the estimation procedure, assume a labour supply equation:

$$y_i = x_i'\beta + \varepsilon_i$$

where the vector x_i' includes human capital variables, possibly regional dummies and wage. The error term is comprised of unobservable labour supply shifters. The unbiased and consistent OLS estimators are derived from the k moment conditions:

$$E\{\varepsilon_i x_i\} = E\{(y_i - x_i'\beta)x_i\} = 0$$

When a regressor is endogenous, the covariance between it and the error term is no longer zero, or $E\{\varepsilon_i x_i\} \neq 0$. This then violates one of the moment conditions and the parameters are no longer identified, which implies that the estimators are biased and inconsistent. The missing information for estimation is obtained from an instrumental variable, which is assumed to be correlated with the endogenous variable, but uncorrelated with the error term ε_i. This then gives rise to the following moment condition

$$E\{\varepsilon_i z_i\} = E\{(y_i - x_i'\beta)z_i\} = 0$$

As identification is now ensured, the instrumental variable estimator can be derived. The assumption that $E\{\varepsilon_i z_i\} = 0$ cannot be tested directly as this would only be possible if consistent estimators for β exist. But these can only be obtained given the assumption of the validity of the instruments.

The rule for identification of the equations is given by the *order condition for identification*. This states that for each potentially endogenous variable, an instrument has to be included in the system. If more than the required instruments are present, these overidentifying restrictions may be tested. An example is Mroz (1987) who excludes experience and experience² from the labour supply equation. As outlined in main text of the paper, only one instrument is available for wage, and thus the system of equations is just identified and not testable. Finally, reference is also made to the fact that in the context of instrumental variable estimation the measure of R² is of no

importance and is not reported. This is because OLS maximises the goodness of fit measure by construction by minimising the sum of squared residuals. Instrumental variable estimation is not chosen using this criterion, but rather to ensure parameter consistency and unbiasedness.

2.) Multi-Response Data

When estimating a model with the dependent variable *Willingness to Work*, standard estimation techniques are not appropriate. This arises as the variable allows for multiple responses which follow the ordinal ranking of Strong/Medium or Weak Desire to work, where the magnitude of the values has no economic meaning other than an ordering purpose. A possible selection bias may occur, as respondents do not participate in the labour force. To overcome this, a fourth category of *actually working* is added as the highest ordinal category.

The analysis is based on an underlying latent variable model which drives the choice between the alternatives:

$$y_i^* = x_i'\beta + \varepsilon_i$$

where y_i^* is unobserved and ε_i is assumed to exhibit a normal distribution

In the example estimated in the main text, the latent variable is to be interpreted as the individual's willingness to work measured in a continuous fashion. If it lies above a certain threshold, the appropriate response is made. From this is follows that the general observation rule is such that:

$$y = 0 \text{ if } y_i^* \le 0$$

$$y = 1 \text{ if } 0 \le y_i^* \le \mu_1$$

$$y = 2 \text{ if } \mu_1 \le y_i^* \le \mu_2$$

$$\vdots$$

$$y = J \text{ if } \mu_{J-1} \le y_i^*$$

where the cut-off point μ is to be estimated. Thus the probability of a certain outcome equals the probability of the latent variable lying between the respective boundaries. As in the standard probit model, the variance is normalised to unity and the error mean to zero. This due to the identification problem of the probit, as without normalisation the maximum likelihood function has no unique maximum, and the same likelihood values may be obtained with different combinations of parameters.

The probabilities of the outcome are:

$$\Pr[y = 0] = \Phi(-x_i'\beta)$$

$$\Pr[y=1] = \Phi(\mu_1 - x_i'\beta) - \Phi(-x_i'\beta)$$
$$\Pr[y=2] = \Phi(\mu_2 - x_i'\beta) - \Phi(\mu_1 - x_i'\beta)$$
$$\vdots$$
$$\Pr[y=J] = 1 - \Phi(\mu_{J-1} - x_i'\beta)$$

The interpretation of the coefficients is analogous to the binary probit model (of which the ordered case is just a generalisation). The marginal effects are obtained as the first derivatives of the probabilities above, and are evaluated at the regressor means. Alternatively they can be calculated empirically. It should be noted though, that any interpretation of the coefficients is conditional on the normalisation constraint of the model. Most importantly, the derivation implies that only the lowest and the highest ordinal responses are unambiguous in their sign, whereas the other cases depend on the relative magnitudes of the normal densities of the first derivatives. Finally, it should be noted that this method of interpretation is inappropriate for dummy variables. Rather, is their effect to be evaluated empirically in that the probabilities of the responses are compared at the different values which the dummies can take on.

3.) Sample Selection Bias

Sample selection bias is common in labour supply estimation. It arises as wage is not observed for the entire sample, but rather only for those individuals who work. Furthermore, this sample is self-selected and non-random. It is to be expected that individuals with characteristics resulting in low income, are more likely to fail to report a wage. Thus it is possible that by not taking this bias into account, average population wages are overestimated. In the context in which the paper is set, this issue is of special importance, as the German welfare state provides generous unemployment benefits, such that there is a strong incentive not to work if low earnings would otherwise be realised.

Underlying the correction mechanism of the selection bias is a latent variable model

$$w_i^* = z_i'\gamma + u_i$$

In the case of labour supply estimations, w_i^* is best interpreted as the unobserved difference in utility of working and not working. Thus, intuitively, if the utility from income minus that of the time foregone is greater than the utility of not working, the individual will chose employment. The wage equation is given as:

$$w_i = x_i'\beta + \varepsilon_i$$

where u_i and ε_i follow a bivariate normal distribution with zero mean, the variance u_i normalised to unity and a correlation coefficient of ρ. As the magnitude of w_i^* is not observed, but only its sign is recorded, the selection into the sample (employment) is based on the following rule:

$$(s_i = 1) \text{ if } w_i^* > 0.$$

whereas s_i and z_i are observed randomly.

The model can now be expressed as:

$$E[w_i | w_i^* > 0] = E[w_i | u_i > -z_i'\gamma]$$

$$= x_i'\beta + E[\varepsilon | u_i > -z_i'\gamma]$$

$$= x_i'\beta + \rho\sigma_\varepsilon \lambda_i(z_i'\gamma / \sigma_u) \text{ where } \lambda = \phi(z_i'\gamma / \sigma_u) / \Phi(z_i'\gamma / \sigma_u)$$

The probability of selection is $P(s_i = 1 | z_i) = \Phi(z_i'\gamma)$, and thus $P(s_i = 0 | z_i) = 1 - \Phi(z_i'\gamma)$. OLS estimation of β is inconsistent as it omits the λ term. To overcome the consequences of the sample selection bias, Heckman (1979) proposes a two-step estimation technique.

1st step: Construct a probit model to obtain estimates of γ. Using this, attain $\hat{\lambda}_i = \phi(z_i'\hat{\gamma}) / \Phi(z_i'\hat{\gamma})$

2nd step: Consistent estimates of β and $\rho\sigma_\varepsilon$ can be obtained by regressing w on x and $\hat{\lambda}$.

4.) Tobit Model

The dependent variable for labour supply is measured continuously, but its distribution is truncated as hours of work cannot fall below zero. It is assumed that the distribution is normal, with all negative values mapped into a spike at 0. In the GSOEP sample this makes up 45% of the observations. For this reason, standard estimation techniques cannot be used, but rather a tobit model is employed.

As in the case of the probit model, there is a latent variable framework underlying the tobit, but the observation rule differs.

$$y_i^* = x_i'\beta + \varepsilon_i$$

where y_i^* is interpreted as the willingness to work. If it is positive, it is assumed that the individual works the corresponding hours. On the other hand, negative labour supply cannot be realised, so desire to work negative hours is mapped to zero.

$$y = y^* \text{ if } y^* > 0$$

$$y = 0 \text{ if } y^* \leq 0$$

where y is actual labour supply. A further difference in comparison with the probit model should be noted. As the dependent variable is measured continuously, no normalisation of the variance is required.

From the observation rule above, it follows that the tobit model has two distinct parts. Firstly it describes the probability of an observation being zero, and secondly the distribution of the dependent variable conditional on that it is positive. The former is given by the following:

$$\Pr\{y_i = 0\} = \Pr\{y_i^* \leq 0\} = 1 - \Phi(x_i'\beta / \sigma)$$

whereas the expectation of the latter is:

$$E\{y_i | y_i > 0\} = x_i'\beta + E\{\varepsilon_i | \varepsilon_i > -x_i'\beta\} = x_i'\beta + \sigma\phi(x_i'\beta / \sigma) / \Phi(x_i'\beta / \sigma)$$

The inclusion of the sigma term reflects the absence of normalisation, and it is estimated jointly with the remaining parameters

Concerning the interpretation of the coefficients, it has to be realised there are marginal effects on both parts of the model. Firstly, the impact on the probability of a zero outcome is given as in the a standard probit model (except for the inclusion of the sigma term):

$$\frac{\partial P\{y_i = 0\}}{\partial x_{ik}} = -\phi(x_i'\beta / \sigma)\frac{\beta_k}{\sigma}$$

The marginal effect on the expected value of y follows from:

$$E\{y_i | y_i > 0\} = x_i'\beta + E\{\varepsilon_i | \varepsilon_i > -x_i'\beta\} = x_i'\beta + \sigma\phi(x_i'\beta / \sigma) / \Phi(x_i'\beta / \sigma)$$

using:

$$E\{y\} = E\{y | y > 0\}P\{y > 0\} + 0$$

results in:

$$E\{y_i\} = x_i'\beta\Phi(x_i'\beta / \sigma) + \sigma\phi(x_i'\beta / \sigma)$$

from which it can be shown that:

$$\frac{\partial E\{y_i\}}{\partial x_{ik}} = \beta_k \Phi(x_i'\beta / \sigma)$$

where not all separate steps and the cancellations are shown

Importantly, it should be noted that there are limitations of using a tobit model in the labour supply context. Foremost, the specification assumes that the same variables which determine the probability a non-zero observation, also determine the level of a positive outcome, as stated in Verbeek (2003). Furthermore, both of these effects have the same sign.

Also does the tobit model assume that the participation decision is based on a corner solution and thus driven solely by preference. It does not account for the fact that possible labour market

abstention is determined by factors such as labour market tightness and certain characteristics, which do not allow the individual to join the labour market.

Appendix 3 – Complete Output of Estimations

Table A1

(Female) Labour Supply Equation, (Female) Wage Equation, Heckman Selection Equation; The values for labour supply are given as $\partial E\{y_i\}/\partial x_{ik} = \beta_k \Phi(x_i'\beta/\sigma)$

	West			East		
	Hours Worked	**Wage**	**Selection**	**Hours Worked**	**Wage**	**Selection**
Intercept	27.26538 0.018	-3901.18100 0.000	-3.51452 0.000	53.67143 0.000	-6793.82800 0.000	-4.69352 0.000
Wage / DM 1000s	3.3528 0.000			2.9816 0.000		
Car Ownership			-0.03440 0.280			0.11013 0.168
University Education	-1.93945 0.000	912.48800 0.000	0.10871 0.203	-0.23716 0.615	432.64300 0.007	-0.05233 0.778
Vocational Training	-1.77801 0.142	298.44570 0.000	0.09647 0.036	0.12620 0.730	322.00310 0.011	0.39940 0.007
Secondary Schooling	-1.66626 0.000	33.27454 0.667	-0.04673 0.499	-0.07665 0.836	241.48350 0.056	0.01405 0.929
South	-0.40479 0.000	-35.82642 0.426	-0.16434 0.000			
HH Income / DM 1000s	-0.6274 0.000	155.6209 0.000	0.0737 0.000	-0.5821 0.000	274.0805 0.000	0.1977
Jobprestige	-0.02354 0.000	24.56894 0.000	0.00521 0.000	-0.06388 0.000	22.82550 0.000	-0.00245 0.471
Married	-2.29499 0.000	-337.64570 0.000	-0.04027 0.506	-1.54620 0.000	-354.58650 0.007	-0.13225 0.379
German	-1.28962 0.000	-482.50270 0.000	0.02495 0.660	-5.37136 0.057		
Years in Firm		30.21509 0.000			26.59044 0.000	
Years in House	-0.03535 0.000			-0.15515 0.000		
Age	-0.58733 0.000	224.89660 0.000	0.04728 0.000	-0.21490 0.007	224.33740 0.000	-0.03057 0.339
Age²	0.00546 0.000	-2.88074 0.000	-0.00071 0.000	0.00237 0.150	-2.47927 0.000	0.00040 0.313
Single Parent	-2.34805 0.000	97.53820 0.248	-0.06960 0.375	-3.10303 0.000	335.36090 0.048	0.07747 0.677
Number of Children (u3)	-0.65160 0.000	-460.89550 0.000	-0.34891 0.000	-0.40512 0.022	-36.21713 0.497	-0.31867 0.000
Amount of Childcare Allowance	-0.00120 0.001		0.00066 0.000	0.00143 0.045		0.00181 0.000
Childcare Provision (Vacancies/1000 Children)	0.02213 0.071	0.73716 0.000	0.00380 0.000	-0.00426 0.109	2.95924 0.009	0.00694 0.000

Table A2
Willingness to Work (Females West), Values are Marginal Effects of Ordered Probit

West

	Working	Strong Desire	Medium Desire	No Desire
Intercept				
Wage / DM 1000s	0.008695593 0.000	0.006005314 0.000	-0.001812597 0.000	-0.00087768 0.000
Car Ownership				
University Education	0.013129001 0.467	0.009067095 0.467	-0.002736742 0.467	-0.00132515 0.467
Vocational Training	-0.003924492 0.623	-0.002710316 0.623	0.000818061 0.623	0.000396112 0.623
Secondary Schooling	-0.010557923 0.426	-0.007291468 0.426	0.0022008 0.426	0.001065647 0.426
South	0.006292446 0.386	0.004345663 0.386	-0.001311661 0.386	-0.00063512 0.386
HH Income / DM 1000s	-0.008426657 0.000	-0.005819582 0.000	0.001756538 0.000	0.000850531 0.000
Jobprestige				
Married	-0.110049506 0.000	-0.076001923 0.000	0.022939831 0.000	0.011107666 0.000
German	-0.009096308 0.296	-0.006282053 0.296	0.001896126 0.296	0.000918121 0.296
Years in Firm				
Years in House				
Age	0.02725213 0.000	0.01882075 0.000	-0.005680709 0.000	-0.00275065 0.000
Age²	-0.000422076 0.000	-0.000291492 0.000	0.00008798 0.000	0.00004260 0.000
Single Parent	-0.080816574 0.000	-0.055813199 0.000	0.016846223 0.000	0.008157088 0.000
Number of Children (u3)	-0.009147367 0.016	-0.006317316 0.016	0.00190677 0.016	0.000923274 0.016
Amount of Childcare Allowance	0.00006785 0.008	0.00004686 0.008	-0.00001414 0.008	-0.00000685 0.008
Length of Maternity Allowance	-0.008937046 0.000	-0.006172065 0.000	0.001862928 0.000	0.000902046 0.000
Childcare Provision (Vacancies/1000 Children)	0.00234831 0.029	0.00162178 0.029	-0.000489505 0.029	-0.00023702 0.029

Table A3
Willingness to Work (Females East), Values are Marginal Effects of Ordered Probit

East

	Working	Strong Desire	Medium Desire	No Desire
Intercept				
Wage / DM 1000s	0.009732917 0.174	0.006721706 0.174	-0.002028828 0.174	-0.000982376 0.174
Car Ownership				
University Education	-0.04216123 0.346	-0.02911721 0.346	0.00878851 0.346	0.00425547 0.346
Vocational Training	0.04595442 0.390	0.03173684 0.390	-0.00957920 0.390	-0.00463833 0.390
Secondary Schooling	0.03438770 0.344	0.02374869 0.344	-0.00716812 0.344	-0.00347087 0.344
South				
HH Income / DM 1000s	0.005583621 0.230	0.003856137 0.230	-0.001163906 0.230	-0.000563574 0.230
Jobprestige				
Married	-0.02333751 0.284	-0.01611725 0.284	0.00486471 0.284	0.00235553 0.284
German	-0.02846629 0.790	-0.01965927 0.790	0.00593380 0.790	0.00287320 0.790
Years in Firm				
Years in House				
Age	0.03843567 0.000	0.02654428 0.000	-0.00801192 0.000	-0.00387944 0.000
Age²	-0.00059448 0.000	-0.00041055 0.000	0.00012392 0.000	0.00006000 0.000
Single Parent	0.02447602 0.448	0.01690353 0.448	-0.00510203 0.448	-0.00247045 0.448
Number of Children (u3)	-0.03254659 0.005	-0.02247719 0.005	0.00678434 0.005	0.00328504 0.005
Amount of Childcare Allowance	-0.00008766 0.047	-0.00006054 0.047	0.00001827 0.047	0.00000885 0.047
Length of Maternity Allowance	-0.00627076 0.057	-0.00433069 0.057	0.00130714 0.057	0.00063293 0.057
Childcare Provision (Vacancies/1000 Children)	0.00013499 0.063	0.00009323 0.063	-0.00002814 0.063	-0.00001363 0.063

Table A4
Probit estimation of probability of labour market exit. (Values are Marginal Effects)

	West	East
	Dropout	**Dropout**
Intercept		
Wage / DM 1000s	0.00113813 0.279	-0.025307906 0.000
Car Ownership		
University Education	-0.00292158 0.648	0.02486769 0.007
Vocational Training	0.00745532 0.020	0.02841955 0.000
Secondary Schooling	0.02601643 0.000	0.01635040 0.028
South	0.00294646 0.295	
HH Income / DM 1000s	-0.01410248 0.000	-0.022741937 0.000
Jobprestige		
Married	0.03399960 0.000	-0.00319942 0.641
German	-0.00412511 0.262	-0.04285144 0.380
Years in Firm		
Years in House		
Age	-0.01524391 0.000	-0.00897496 0.000
Age²	0.00018900 0.000	0.00014857 0.000
Single Parent	-0.00929131 0.128	-0.00995826 0.280
Number of Children (u3)	0.02015729 0.000	0.01505407 0.000
Amount of Childcare Allowance	-0.00003191 0.001	0.00002781 0.043
Length of Maternity Allowance	0.01708812 0.000	0.01893514 0.000
Childcare Provision (Vacancies/1000 Children)	0.00005173 0.109	-0.00004956 0.274