Title: Effects of maternal socio-demographic characteristics on the birth weight distribution in Greece: a quantile regression analysis.

Authors:
Georgia Verropoulou and Cleon Tsimbos

Georgia Verropoulou
Dept of Statistics & Insurance Science
University of Piraeus
80, Karaoli & Dimitriou str.
Greece
&
Centre for Longitudinal Studies
Institute of Education
University of London
gverrop@unipi.gr

Corresponding Author:
Georgia Verropoulou
gverrop@unipi.gr; gverrop@webmail.unipi.gr

Cleon Tsimbos
Dept of Statistics & Insurance Science
University of Piraeus
80, Karaoli & Dimitriou str.
Greece
cleon@unipi.gr

Extended abstract/draft for submission at the 2011 EPC Conference

Abstract

The present study aims at exploring and quantifying effects of the socio-demographic characteristics of the mother across the distribution of birth weight in Greece. For the purposes of the analysis nationwide vital registration data at individual level, provided by the Hellenic Statistical Authority upon request, are used. The data include 103,266 single live births registered in 2006 to women aged 20 or higher. The response variable is birth weight, recorded in grams. The method involves application of quantile regression models. Births occurring before the 37^{th} week of gestation (preterm) are examined separately from those occurring at term as they form distinct and independent distributions while they are also influenced by different risk factors. The effects of the explanatory variables are estimated at 6 different quantiles of the response variable (0.05, 0.10, 0.25, 0.50, 0.75 and 0.90). Estimates are then compared with results based on OLS models. The results reconfirm that preterm and term births form distinct birth weight distributions. Moreover, effects of most factors differentiate across the distributions in both instances. More specifically, for most predictors the effect is greater at the lower tail, i.e. among low birth weight babies. For instance, illegitimate live births at full term have lower weight by 130 grams at the 0.05 quantile compared to legitimate babies while the difference is only 60 grams at the 0.90 quantile. By contrast, the OLS indicates a difference of 82 grams. Hence, the method has an advantage over OLS, which assumes a constant effect. The findings indicate that female sex, primiparity, illegitimacy status, age of the mother over 35, past history of stillbirths and deceased children, living in big metropolitan areas, and being a Greek citizen are associated with a lower birth weight while tertiary education has a protective effect. Among preterm births usual place of residence, citizenship and legitimacy are not very significant but parity, prior stillbirth and deceased child and education have a more pronounced effect.

Keywords

Birth weight distribution, preterm, full term, quantile regression

Extended abstract

Background

Low birth weight (LBW), a term referring to births weighting less than 2,500 grams, has been a major concern for public health policy since there is an extensive body of research showing strong links with neonatal and post neonatal mortality in addition to morbidity in infancy, childhood and adulthood (McCormick, 1985; Kramer, 1987; WHO, 2004; Barker, 1994; 1998; Strauss, 2000; Huxley et al., 2000). A significant correlate of birth weight is gestational age; births occurring before the 37th week of gestation, termed preterm, have a higher chance of being LBW than births occurring later (full term). LBW preterm babies in particular represent the most compromised pregnancy outcome facing the highest mortality risks, especially if birth weight is very low (i.e. below 1500 grams) or extremely low (i.e. below 1000 grams). There is ample evidence indicating different risks of mortality and morbidity for preterm and term LBW babies in addition to different aetiology; hence, a vast amount of research has been carried out considering these adverse pregnancy outcomes separately (Kramer, 1987; 1990; Kramer et al., 2000; Kramer, 2003; Meggiolaro, 2009; Tsimbos & Verropoulou, 2011). In addition, it has been suggested that term and preterm births constitute different birth weight distributions (Wilcox, 2001)

Regarding maternal characteristics, teenage mothers and those aged 35 or more have higher chances of giving birth to a LBW baby (Astolfi & Zonta, 1999; Machado, 2006). Maternal lifestyle during pregnancy is an important factor; unhealthy habits such as excessive alcohol consumption, smoking, drug abuse and poor nutritional intake have been linked to adverse pregnancy outcomes (Rodriguez et al., 1995; Windham et al. 2000; Kesmodel et al., 2002). Socio-economic status of the mother also plays a part, acting as mediator; material deprivation, lone motherhood, housewife status, unemployment, low educational attainment and psychosocial stress seem to affect unfavourably birth weight (Rodriguez et al., 1995; Pattenden et al., 1999; Reime et al., 2006; Cheung & Yip, 2001; Meggiolaro, 2009; Mulder et al., 2002).

Research attempting to quantify effects of these factors on the birth weight distribution usually is based on two approaches: either OLS regression models are employed or adverse outcomes are considered in comparison to normal weight births occurring after the 36th week of gestation in a logistic or multinomial logistic regression context (Abrevaya, 2001). The first approach, OLS regression, has the disadvantage that effects are estimated on the mean of the birth weight distribution while, in the second case, the outcome variable is categorical and information related to the rest of the distribution is lost. Some more recent analysis, however, has been based on a different approach which allows for the effects of the various factors to differentiate across the quantiles of the birth weight distribution. Nevertheless, such analysis is scarce and does not make any distinction for gestational age. It is in that aspect of the birth weight analysis that this paper attempts to fill in a gap, quantifying effects of factors associated with adverse pregnancy outcomes using quantile regression techniques while considering preterm and normal term deliveries separately since they are related to different risk factors and exhibit different birth weight distributions.

Data and methods

Data

This study makes use of information collected by the vital registration system of Greece. The analysis is based on nationwide micro data on single livebirths recorded in 2006 to mothers aged 20 or higher. Thus, the analysis focuses on 103,266 records of single live births to native and foreign origin women aged 20 or higher living in Greece. Birth registration in Greece is complete and since practically all births (99.9%) occur in maternity wards and hospitals the information collected is considered reliable.

Measures

In the analysis the response variable is represented by the birth weight measured in grams; all the predictors are indicators introduced in binary form. Female births (=1) are compared to male births (=0). The variable expressing parity distinguishes between first births (=1) and those of birth order 2 or higher (=0), while illegitimate

(extra marital) births (=1) are distinguished from legitimate births (=0). With respect to maternal age, women are categorized in two broad age groups; women aged 35 or higher (=1) are compared to those under age 35 (=0). A dichotomous variable is introduced as proxy of past adverse maternity and birth history, denoting whether a woman reported that she has had at least one prior stillbirth or deceased child (=1) or she has had no such past experience (=0). Maternal socioeconomic status is represented by education; the dichotomous variable used denotes whether the mother has obtained tertiary educational qualifications (=1) or she has completed at the most upper secondary education (=0). A dummy is also used indicating whether a woman lives in big metropolitan areas, i.e. the capital of Greece, Athens, or the second largest city, Salonica (=1) or she lives in other less urbanized areas (=0). Finally, an indicator of whether the mother is a Greek citizen (=1) or an immigrant (=0) is included in the models.

Models

As already stated the aim of this work is to estimate the impact of a number of maternal socio-demographic characteristics on the birth weight of newborn infants in Greece. This research task is fulfilled by the application of two models, the standard OLS regression and the Quantile regression model (Koenker & Basset, 1978; Koenker & Hallock, 2001). Application of the latter method is justified on the basis that the different factors' effects differ in magnitude and nature across the quantiles (or percentiles) of birth weight. In other words, it is likely that the OLS estimates do not portray adequately the impact of the regressors throughout the distribution of the response variable, particularly at the tails of it. Quantile regressions have been estimated at seven different percentiles (0.05, 0.10, 0.25, 0.50, 0.75, 0.90 and 0.95). The models were estimated separately for two subsets of the sample, preterm and full term babies on the basis that they constitute distinct birth weight distributions (Wilcox, 2001).

Results

Most births in the sample, 94.6 per cent, occurred at full-term (the 37^{th} week of gestation or later); the proportion of preterm births is quite low, only 5.4%. Mean weight for the babies in the sample is 3210 grams; it is somewhat higher among births occurring at term but substantially lower (2487 grams) among preterm births.

Apart from mother's citizenship, which seems to have a constant effect across the birth weight distribution, for all other predictors effects differentiate. For most variables, associations are more pronounced at the lower tail of the distribution; the only exceptions are sex of the baby and usual place of residence of the mother, for which the effect is greater at the upper tail. Associations for most predictors are significant at the 1% level. Females are born lighter than males; the difference is about 100 grams at the 0.05 quantile (which corresponds to LBW births) while it reaches 160 grams at the 0.90 quantile. First born children are lighter by about 50 grams at the 0.05 quantile; the difference decreases to 17 grams at the 0.75 quantile. Births occurring to mothers outside marriage are significantly lighter than those occurring within marriage, the difference ranging from 130 for LBW babies to 60 grams. Age of mother over 35 have a negative association though rather small while prior history of stillbirths and infant death has a more substantial negative impact. Tertiary education seems to have a protective effect, especially among LBW infants. Living in big metropolitan areas for the mother has a slight, negative association. Greek mothers have on average lighter babies by about 100 grams.

(Table 1 about here)

Regarding preterm babies, usual place of residence, extra marital status of a birth and citizenship of the mother are not significant predictors of birth weight in this instance. All other variables show significant associations which differentiate across the birth weight distribution. Female sex, births of first order, age of mother over 35 and prior history of stillbirths and deceased children have negative associations with birth weight; the coefficients indicate, for all variables except sex, a greater impact among preterm than among full term babies. Prior history of adverse pregnancy outcomes seems the most significant predictor in this instance and has a particularly pronounced effect at the lower tail of the distribution.

(Table 2 about here)

Conclusion

The findings indicate that female sex of the baby, primiparity, illegitimacy status, age of the mother over 35, past history of stillbirths and deceased children, living in big metropolitan areas, and being a Greek citizen are all factors that tend to reduce birth weight of term babies while education has a protective effect. Among preterm births, on the other hand, usual place of residence of the mother, citizenship and legitimacy are not very significant while effects of parity, prior stillbirth and deceased child and education are more pronounced than among term newborns. These findings are more or less in line with previous analyses carried out on the same dataset based on multinomial regression models, though citizenship there had come up as significant only among LBW preterm births and illegitimacy status was important for all LBW babies (Tsimbos & Verropoulou, 2011). The very pronounced effect of past adverse maternity history among preterm births is in accordance with other relevant research (Kramer, 1987; Reime et al., 2006; Tsimbos & Verropoulou, 2011).

The results of the study reconfirm that the birth weight distribution of term and preterm babies differ and that they should be analysed separately. The analysis provides evidence that effects of most factors differentiate across the birth weight distribution and coefficients based on OLS regression are a poor representation of these variations. Finally since this is one of the very few quantile regression analysis of birth weight considering socio-demographic characteristics, it provides a guide regarding factors which seem to differentiate across the outcome distribution and whether impact seems more pronounced in the lower or upper tail.

References

Abrevaya, J. (2001) The effects of demographics and maternal behavior on the distribution of birth outcomes. *Empirical Economics* **26**, 247-257.

Astolfi, P. & Zonta, L. A. (1999) Risks of preterm delivery and association with maternal age, birth order and fetal gender. *Human Reproduction* **14(11)**, 2891-2894.

Barker, D. J. P. (1994) The fetal origins of adult disease. *Fetal and Maternal Medicine Review* **6**, 71-80.

Barker, D. J. P. (1998) In utero programming of chronic disease. *Clinical Science* **95**, 115-128.

Huxley, R. R., Shiell, A. W. & Law, C. M. (2000) The role of size at birth and postnatal catch-up growth in determining systolic blood pressure: a systematic review of the literature. *Journal of Hypertension* **18**, 815-831.

Kesmodel, U., Wisborg, K., Olsen, S. F., Henriksen, T. B. & Secher, N. J. (2002) Moderate alcohol intake during pregnancy and the risk of stillbirth and death in the first year of life. *American Journal of Epidemiology* **155**, 305-312.

Koenker, R. & Bassett, G, (1978). Regression Quantiles. Econometrica **46**, 33-50.

Koenker, R. & Hallock, K. F. (2001). Quantile Regression. Journal of Economic Perspectives **15(4)**, 143-156

Kramer, M. S. (1987) Determinants of Low Birth Weight: Methodological assessment and meta-analysis. *Bulletin of the World Health Organization* **65(5)**, 663–737.

Kramer, M. S. (1990) Birth weight and infant mortality: perceptions and pitfalls. *Paediatric & Perinatal Epidemiology* **4**, 381-390.

Kramer, M. S., Séguin, L. Lydon, J. & Goulet, L. (2000) Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly? *Paediatric & Perinatal Epidemiology* 1**4**, 194-210.

Kramer, M. S. (2003) The epidemiology of adverse pregnancy outcomes: An overview. *The Journal of Nutrition* **133**, 1592S-1596S.

Machado, C. J. (2006) Impact of maternal age on birth outcomes: a population-based study of primiparous Brazilian women in the city of Sao Paulo. *Journal of Biosocial Science* **38**, 523-535.

McCormick, M. C. (1985) The contribution of low birth weight to infant mortality and childhood morbidity. *New England Journal of Medicine* **312(2)**, 82-90.

Meggiolaro, S. (2009) Low birth weight and parental resources in Italy. *Genus* **65(1)**, 103-121.

Mulder, E. J., Robles de Medina, P. G. Huizink, A. C., Van de Bergh, B. R., Buitelaar, J. K. & Visser, G. H. (2002) Prenatal maternal stress: Effects on pregnancy and the (unborn) child. *Early Human Development* **70(1-2)**, 3-14.

Pattenden, S., Dolk, H. & Vrijheid, M. (1999) Inequalities in low birth weight: Parental social class, area deprivation, and "lone mother" status. *Journal of Epidemiology and Community Health* **53**, 355-358.

Reime, B., Ratner, P. A., Tomaselli-Reime, S. N., Kelly, A. Schuecking, B. A. & Wenzlaff, P. (2006) The role of mediating factors in the associations between social deprivation and low birth weight in Germany. *Social Science & Medicine* **62**, 1731-1744.

Rodriguez, C., Regidor, E. & Gutierrez-Fisac, J. L. (1995) Low birth weight in Spain associated with sociodemographic factors. *Journal of Epidemiology and Community Health* **49**, 38-42.

Strauss, R. S. (2000) Adult Functional Outcome of Those Born Small for Gestational Age: Twenty-six–Year Follow-up of the 1970 British Birth Cohort. *Journal of the American Medical Association (JAMA)* **283**, 625-632.
Tsimbos, C. & Verropoulou, G. (2011) Demographic and socioeconomic determinants of low birth weight and preterm births among natives and immigrants in Greece: an analysis using nationwide vital registration micro-data. *Journal of Biosocial Science,* **43**: 271-283.
WHO [Wardlaw, T., Blanc, A., Zupan, J. & Ahman, A.] (2004) *Low Birthweight: Country, regional and global estimates*. United Nations Children's Fund and World Health Organization, UNICEF, New York.
Wilcox, A. J. (2001) On the importance – and the unimportance – of birthweight. *International Journal of Epidemiology* **30,** 1233-1241.
Windham, G., Hopkins, B., Fenster, L., Swan, S. (2000) Prenatal Active or Passive Tobacco Smoke Exposure and the Risk of Preterm Delivery or Low Birth Weight. *Epidemiology* **11(4),** 427-433

Table 1 Coefficients based on Quantile Regression (births occurring at the 37th week of gestation or later)

Explanatory Variables	Coefficients						
	5%	10%	25%	50%	75%	90%	OLS
Sex							
Male (ref cat)							
Female	-100***	-115***	-125***	-145***	-150***	-160***	-137***
Parity							
One	-50***	-40***	-25***	-20***	-17***	-30***	-30***
2nd or higher (ref cat)							
Legitimacy							
Legitimate (ref cat)							
Illegitimate	-130***	-120***	-80***	-80***	-67***	-60***	-82***
Age of mother							
20-34 (ref cat)							
35 or higher	-50***	-50***	-30***	-25***	-17***	n.s.	-26***
Prior stillbirth or deceased child							
At least one	-100***	-130***	-100***	-50**	-63**	-80**	-74***
No such history (ref cat)							
Educational attainment of mother							
Below tertiary (ref cat)							
Tertiary	50***	35***	25***	25***	n.s.	10**	23***
Usual place of residence							
Big metropolitan areas	-20***	-25***	-25***	-25***	-43***	-50***	-35***
Less urbanised areas (ref cat)							
Citizenship							
Greek	-100***	-90***	-95***	-100***	-107***	-110***	-99***
Immigrant (ref cat)							

*** p<0.01, ** p<0.05, *p<0.10

Table 2 Coefficients based on Quantile Regression (preterm births occurring before the 37th week of gestation)

Explanatory Variables	Coefficients					
	10%	25%	50%	75%	90%	OLS
Sex						
Male (ref cat)						
Female	-75*	-110***	-120***	-125***	-126***	-102***
Parity						
One	-260***	-250***	-185***	-125***	-64**	-169***
2nd or higher (ref cat)						
Legitimacy						
Legitimate (ref cat)						
Illegitimate	n.s.	n.s.	-70**	n.s.	n.s.	-68*
Age of mother						
20-34 (ref cat)						
35 or higher	-120**	-150***	-95***	-75***	n.s.	-90***
Prior stillbirth or deceased child						
At least one	-950***	-820***	-355**	-250**	-194**	-468***
No such history (ref cat)						
Educational attainment of mother						
Below tertiary (ref cat)						
Tertiary	135***	130***	70***	n.s.	n.s.	63***
Usual place of residence						
Big metropolitan areas	-100*	n.s.	n.s.	n.s.	n.s.	n.s.
Less urbanised areas (ref cat)						
Citizenship						
Greek	175***	n.s.	n.s.	n.s.	n.s.	n.s.
Immigrant (ref cat)						

*** p<0.01, ** p<0.05, *p<0.10