The Interrelationships Between Births and Deaths

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ABSTRACT. This paper provides a preliminary study of the way in which the births and deaths of firms interact *over time*. It uses the retailing sector as a case study, although the results also have relevance for other sectors. Section I of the paper introduces the background to the paper. Section II provides a non mathematical theoretical framework for analysing the births/deaths interrelationship. It identifies three separate types of effect operative in these interrelationships: the "competition", "multiplier" and Marshall ("life cycle") effects. The data used in this study (Value Added Tax registrations and deregistrations) and their limitations are considered in Section III. Section IV presents the preliminary empirical results. This section utilises panel data vector autoregression techniques to identify the salient birth-death relationships. The final section concludes the paper and draws out possible policy conclusions. It also suggests avenues for further work.

I. Introduction

Recent years have seen a significant growth in research interest in the determinants and effects of business births (e.g. Acs and Audretsch, 1989; Johnson, 1986; Robson, 1991; Storey and Jones, 1987). Research has also been conducted, though to a lesser extent, into business deaths (e.g. Bowden *et al.*, 1992; Pratten, 1991; Storey *et al.*, 1987; Turner *et al.*, 1992). In addition to this work on births and deaths, studies have been made of business turbulence — usually measured as the *sum* of the birth and death rates — across industries (Audretsch and Acs, 1990; Beesley and Hamilton, 1984) and geographical areas (Batstone and Mansfield, 1990). So far however relatively little attention has been paid to the way in which births and deaths *interact over time*.[1] This paper provides a preliminary study of the relevant interrelationships, using the UK retailing sector in the 1980s as a case study. Attention is focused on one sector only in order to abstract from possible industry effects. The analysis is conducted within a regional framework, thereby also permitting some consideration of regional interdependencies. It utilises VAT registration data.

The plan of the paper is as follows. In Section II a theoretical framework for the analysis is provided. Section III briefly outlines the data sources and their limitations. In Section IV the empirical results are presented. The final Section offers some concluding remarks on the study and its relevance for policy.

II. The theoretical framework

The analysis in this paper recognises the existence of two opposing forces in the relationship between the birth or death of one business and the subsequent birth or death of another. The first is the "multiplier effect". This effect serves to perpetuate a trend of births or deaths over time. The second is called the "competition effect" which has the stabilising property of encouraging births to follow deaths and deaths to follow births. Each effect is considered in turn below.

The multiplier effect occurs when births cause future births (and retard future deaths), or when deaths cause future deaths (and retard future births). In the retailing sector, the effect may be generated in a number of ways. For example, the opening of a new outlet may enhance the overall attractiveness of a shopping area to customers,[2] and thereby act both as a magnet for other retailing ventures, and as a means of reducing the likelihood that other shops in the area will close. A retail death on the other hand may make the

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business of other shops in the area less viable and thus stimulate further deaths. There may also be a "demonstration" effect at work: for example the opening of a corner shop or a take-away may lead others to consider a similar venture. This stimulus may be particularly strong for employees of the new venture, since such employees are likely to be particularly aware of the available market and of any shortcomings of their employer in meeting the needs of that market. A birth (death) may also lead to an increase (decrease) in incomes in the area, and hence to higher (lower) demand for retailing services, which in turn may be expressed in additional births (deaths).

The competition effect occurs when births cause future deaths (and retard future births) or when deaths cause future births (and retard future deaths). The most obvious example of the competition effect at work in retailing is the demise of a shop or shops as the result of the arrival of a competing (and more efficient and/or innovative) shop in the locality: there may simply be insufficient demand for all the outlets to remain viable. It is of course the displacement effect of new innovative businesses on existing ones that lies at the heart of the Schumpeterian creative destruction process (Schumpeter, 1952, chap. VII). A new shop may also discourage others from setting up, because other potential founders perceive that the market is now too small to cater for them.

The death of a retailing outlet may encourage births in at least two ways. Firstly, a death may lower the price of the equipment and other resources required by a potential new retailer, an argument that has been utilised by Storey and Jones (1987) in the context of manufacturing. Secondly, the prospect of unemployment among employees of a closing outlet may stimulate a move into retailing on an "own account" basis. The positive impact on new business formation from the "push" effect of actual or threatened unemployment is well documented for a number of industries (for a survey see Johnson, 1986, pp. 120—135).

It is to be expected that the various components of both the multiplier and competition effects will not manifest themselves instantly, but will evolve over time. For example, an individual contemplating setting up in retailing may be responding to previous births stretching back over several years. One reason for such delay may be that the potential new retailer is using the experience of recently established retailers as an indicator of his (her) own likely success. (S)he may require the evidence of several periods before launching out. Again, the displacement effects of a birth may take several periods to work through. At any rate, time lags are an integral characteristic of the interdependence between births and deaths. One objective of the empirical analysis of Section IV is to discover how long these lags might be in practice.

So far only the implications of a business birth or death on the birth or death of *other* businesses have been considered. However it is important to recognise that the birth of a firm must necessarily be followed at some stage by its own death unless it is taken over. The evidence for the UK (Ganguly, 1985, p. 140) suggests that the majority of new firms do not last more than a few years. It is unlikely that such a short life span reflects the initial aspirations of the founders. Rather, most founders probably overestimate their viability at the time of formation, a mistake which they only find out by actually setting up. Even for those firms which are successful, death is ultimately inevitable, barring take-over. As Marshall points out (1920, p. 263) in his graphic "trees of the forest" analogy, "sooner or later age tells on them all".[3] The simple fact therefore that for most businesses, life is finite, means that births will inevitably generate subsequent deaths. The immediate cause of the death of a business that is running out of steam — for example because the founder's energies are beginning to flag — may of course be the birth, or indeed the death of another business. However the point of the "Marshall effect" — the positive influence of births on subsequent deaths generated by finite business life spans — is that death will ultimately occur because of age even if there is no change in the competitive environment in which the firm operates. As we shall see, the existence of the Marshall effect makes for some difficulties in the precise interpretation of some of our results.

It should be noted that only retailing is considered here. A birth or a death in retailing may however have an impact on a birth or a death in another industrial sector, and vice-versa. Two out of many possible examples of this inter-industry effect are: a new retail outlet raising demand in manufacturing, and thus encouraging births in that sector; and the birth of a new innovatory firm in manufacturing opening up new retailing possibilities. Such inter-industry relationships are not explored here, because of data limitations. However they should be borne in mind in the interpretation of the empirical results.

Table I summarises the various birth-death causality relationships generated by the multiplier, competition and Marshall effects. The table categorises the marginal changes at time t of births (B_t) and deaths (D_t) caused by marginal changes in births and deaths after a lag of 1 year. We are *a priori* agnostic about the relative strengths of the different effects: the principal task of the empirical section will be to provide evidence on this issue using data on both births and deaths.

TABLE I
The multiplier, competition and Marshall effects: a summary

	Expected sign of each effect		
	Multiplier	Competition	Marshall
$\partial B_t/\partial B_{t-1}$	+	−	n.a.
$\partial D_t/\partial D_{t-1}$	+	−	n.a.
$\partial B_t/\partial D_{t-1}$	−	+	n.a.
$\partial D_t/\partial B_{t-1}$	−	+	+

n.a. = not applicable

In the empirical study reported in Section IV the results relate only to the *net* impact of the different effects of births or deaths on subsequent births or deaths; it is not possible to identify the part played by each effect separately. This inevitably imposes some restrictions on interpretation, particularly in respect of the last row in Table I where any positive net effects of births on subsequent deaths could be due to the competition and/or Marshall effects.

III. The data

As Johnson (1986, pp. 8—14) has pointed out, a business "birth" is not straightforward to define. Definitional problems also arise over the concept of business "death". It is not however necessary to become embroiled in a debate over definitions, as the data used here are annual VAT registrations and deregistrations. These data, which are produced by the Department of Employment from statistics collected by HM Customs and Excise, have a number of limitations when used as proxies for births and deaths respectively. Some of these limitations have been recognised in the literature (Daly, 1990). The figures are generated by taxation requirements rather than by the needs of applied economic research. Firms do not have to register, although some do, until their turnover reaches the VAT threshold (£36,600 in August 1991); firms may deregister when their turnover falls below this threshold, but continue trading; and some trades are exempt.

It should also be recognised that the registration/deregistration data will be affected by business reorganisation and changes in ownership. It is known for example that 28 per cent of all UK deregistrations results from take-over by other businesses: see Daly (1990). (The percentage for retailing alone is unknown.) A take-over does of course result in the removal of an independent business, and in this sense may be regarded as a 'death'.[4] Some registrations may occur because part of an existing business is sold off — for example via a management buy-out — and then operated by its new owners as a free-standing business.

Despite these difficulties over interpretation, the VAT data probably represent the best time-series data available. In this paper therefore a registration is treated as a "birth" and a deregistration as a "death".

The study utilises birth and death data for each year, 1980 to 1990, for each UK county and region. It should be noted that the VAT threshold which is adjusted annually has remained fairly constant in terms of the employment it implies.[5]

Over the whole period there were 375570 registrations and 383556 deregistrations in UK retailing. The net loss in the number of registered businesses of 7986 represented 2.9 per cent of the stock at the beginning of the period.

Throughout this paper annual birth and death *rates* are used. These rates are defined as the number of births/deaths in the year as a percentage of the stock of businesses in existence at the beginning of the year.

IV. Empirical analysis and results

In the model that follows, births and deaths in each county at time t are denoted B^s_t and D^s_t respectively. Apart from depending on each other via some (*a priori* unknown) lag structures, B^s_t and D^s_t may also depend on the lagged *mean* birth and death rates calculated over the rest of the region less the county in question. These latter variables, which are useful for assessing intra-regional spill-overs (though their complicated construction ensures that they are of no intrinsic interest as dependent variables), are denoted B^r and D^r. There may also be county-specific effects.

The fact that an unrestricted set of interdependencies is being studied using a longitudinal data-set suggests that the most appropriate vehicle for empirical analysis is Holtz-Eakin *et al.*'s (1988) method for estimating vector autoregressions (VARs) with panel data. This method is very general, allowing not only for unrestricted inter-dependencies, but also for case specific ('county') effects; heteroskedasticity; non-stationary regression coefficients; and error in measuring the variables. The general model is described by the equations:

$$B^s_t = \alpha_{OBt} + \sum_{k=1}^{m} \alpha_{Bkt} B^s_{t-k} + \sum_{k=1}^{m} \beta_{Bkt} D^s_{t-k} + \sum_{k=1}^{m} \gamma_{Bkt} B^r_{t-k} + \sum_{k=1}^{m} \delta_{Bkt} D^r_{t-k} + \Psi_{Bt} f^s_B + v^s_{Bt} \qquad (1a)$$

$$D^s_t = \alpha_{ODt} + \sum_{k=1}^{m} \alpha_{Dkt} B^s_{t-k} + \sum_{k=1}^{m} \beta_{Dkt} D^s_{t-k} + \sum_{k=1}^{m} \gamma_{Dkt} B^r_{t-k} + \sum_{k=1}^{m} \delta_{Dkt} D^r_{t-k} + \Psi_{Dt} f^s_D + v^s_{Dt} \qquad (1b)$$

where the fs are unobserved individual (i.e. county-specific) effects; and subscripts B and D denote coefficients relating to the birth and death equations respectively. These coefficients are the αs, βs, γs, δs and Ψs; the symbol k denotes a lag, the maximum lag being imposed as m. (Potential time-variation of these coefficients accounts for the presence of t as an additional subscript). The equations are estimated at time t; the vs are white noise error terms.

Another two equations — for B^r_t and D^r_t — complete the 4-equation VAR, but these are irrelevant to us. In the following, only the B^s_t and D^s_t equations are reported. To simplify matters, we assume parameter stationarity, accurate measurement and white noise errors; heteroskedasticity was tested for after the regression equations were run. The individual effects were however felt to be potentially important so we kept them in. Transforming (1a) and (1b) for estimation purposes, the appropriate model[6] (Holtz-Eakin *et al.*, 1988, p. 1376) is:

$$\Delta B^s_t = \alpha_{Bt} + \sum_{k=1}^{m} \alpha_{Bk} \Delta B^s_{t-k} + \sum_{k=1}^{m} \beta_{Bk} \Delta D^s_{t-k} + \sum_{k=1}^{m} \gamma_{Bk} \Delta B^r_{t-k} + \sum_{k=1}^{m} \delta_{Bk} \Delta D^r_{t-k} + \nu^s_{Bt} \qquad (2a)$$

$$\Delta D^s_t = \alpha_{Dt} + \sum_{k=1}^{m} \alpha_{Dk} \Delta B^s_{t-k} + \sum_{k=1}^{m} \beta_{Dk} \Delta D^s_{t-k} + \sum_{k=1}^{m} \gamma_{Dk} \Delta B^r_{t-k} + \sum_{k=1}^{m} \delta_{Dk} \Delta D^r_{t-k} + \nu^s_{Dt} \qquad (2b)$$

where the Δ symbol indicates temporal first differencing (the ν_t terms are transformed white noise errors).

Equations (2a) and (2b) were both estimated using data from 1990. Since only observations back to 1980 are available, the maximum lag length was initially set as $m = 9$. The first task was to ascertain whether this could be cut down to obtain more parsimonious equations. 'Zero restriction' F tests were run for both equations (2a) and (2b), to test the null hypothesis that the lag length is less than some number. The results for potential lag lengths up to 7 years are presented in Table II. (The results for the longer lags are not significant and are not reported here). We may then work down the table accepting progressively shorter lags until the null hypothesis is rejected. It is readily seen that the maximum lag for births is 6 years, whereas that for deaths is 2 years. These preliminary results suggest that factors causing births gestate over a longer time span than those causing deaths.

TABLE II
Optimal lag lengths for the VARS: 1990

Null hypothesis lag length	Equation (2a) $F(4,63-4m)$	Equation (2b) $F(4,63-4m)$
$m < 7$	1.42	0.69
$m < 6$	3.20*	1.17
$m < 5$		1.72
$m < 4$		0.17
$m < 3$		0.68
$m < 2$		4.45*

Notes:
* Signifies rejection of the null hypothesis of the lag length in question: Type 1 error = 5%.

The next task was to run Granger causality tests to determine whether births cause deaths, or vice versa, or both.[7] We first consider whether births cause deaths. The null hypothesis that all 'birth' variables in the 'deaths' equation (2b) are jointly zero (for $m = 2$) was clearly rejected, since the F-statistic for exclusion was $F(4,55) = 2.88$ (the 5% critical value is 2.54). Hence we infer that births *do* affect future deaths. Turning to the question of whether deaths affect births, the null hypothesis that all 'death' variables in the 'births' equation (2a) are jointly zero (for $m = 6$) is not clearly rejected, since $F(12,39) = 1.12$ (the 5% critical value is 2.01). This F-value falls in the upper tail, but not far enough to reject the null. In summary so far, then, the results suggest that the causal chain of births → deaths is considerably stronger than that of deaths → births.

We next ran a general-to-specific exercise in order to discover efficient estimates of the signs and magnitudes of the regression coefficients. This involved starting from an initially over-parameterised model, and 'testing down' using F-tests (on sets of coefficients) and t-tests (on individual coefficients). By imposing acceptable restrictions on the coefficients (i.e. restrictions which, when tested, did not reject the null hypothesis of acceptability) we obtained the parsimonious regression equations presented in Table III.

What is the interpretation of these results? A surprising feature of the 'deaths' regression is its relative simplicity: it parsimoniously explains over a third of the variation in ΔD_t^s. The 'births' regression is less compact but it explains nearly half of the variation in ΔB_t^s. Confirmation of the dual causality of births → deaths and deaths → births is also provided; furthermore as noted earlier, the causes of births drag on over a longer time span than the causes of deaths, which are precipitated fairly rapidly.

The two regressions tell somewhat different stories. The most interesting feature of the 'births' equation in Table III is the dominant role played by the competition effect. In all eight cases where past increases in the birth rate affects current changes in birth rates, they do so negatively. This is so whether the increase in the birth rate occurs within the immediate vicinity (county) or at the broader regional level. Moreover the negative effect of past on current changes in birth rates persists over a long time span: six years in the case of this sample. Reinforcing the dominant competition effect, extra deaths occurring in the previous period encourage births, although the effects five periods ago indicate some evidence of a long delayed multiplier effect.

In contrast, the multiplier effect seems to be the most important factor affecting the death rate. The 'deaths' equation indicates that past increases in the birth rate unambiguously reduces the current death rate — at both county and regional levels. There is no evidence of a Marshall effect in this equation. However the effect of past changes in the death rate on current changes in the death rate is less clear-cut: there seems to be a positive effect (dominant multiplier effect) at regional level, and a negative effect (dominant competition effect) at local level. The former is nearly three times as

TABLE III
Regression results for 1990

'Births' equation

$$\Delta B^s_t = \underset{(0.89)}{2.41} - \underset{(0.19)}{1.26}\Delta B^s_{t-1} + \underset{(0.13)}{0.50}\Delta D^s_{t-1}$$

$$+ \underset{(0.49)}{2.54}(\Delta D^r_{t-1} - \Delta B^r_{t-1}) - \underset{(0.11)}{0.33}\Delta B^s_{t-2}$$

$$- \underset{(0.37)}{1.93}\Delta_3 B^r_{t-2} - \underset{(0.18)}{1.08}\Delta B^s_{t-4}$$

$$- \underset{(0.11)}{0.63}(\Delta B^s_{t-5} + \Delta D^s_{t-5})$$

$$- \underset{(0.42)}{2.43}(\Delta B^r_{t-5} + \Delta D^r_{t-5}) - \underset{(0.13)}{0.45}\Delta B^s_{t-6}$$

$R^2 = 0.48$; F(9,54) = 5.50*; RR(1) = 3.00; JB(2) = 5.45; H(1,62) = 0.93

'Deaths' equation

$$\Delta D^s_t = -\underset{(0.18)}{0.61} + \underset{(0.16)}{0.90}\Delta_2 D^r_{t-1} - \underset{(0.07)}{0.32}(\Delta B^r_{t-1} + \Delta D^s_{t-1})$$

$$- \underset{(0.08)}{0.24}\Delta B^s_{t-2}$$

$R^2 = 0.36$; F(3,60) = 11.40*; RR(1) = 1.06; JB(2) = 1.55; H(1,62) = 1.31

Notes: standard errors in parentheses. Δ_2 indicates first differenced variables with two lags: i.e. $\Delta_2 B^r_{t-2} = B^r_{t-2} - B^r_{t-4}$. Similarly, Δ_3 indicates differencing with three lags. All other Δs indicate differencing on one lag. 'F' tests (and in both regressions accepts) the significance of the R^2. RR is Ramsey's RESET statistic for testing the null hypothesis of correct functional form (distributed as $\chi^2(1)$; JB is the Jarque-Bera statistic for testing the null hypothesis of normality of the residuals (distributed as $\chi^2(2)$); and H is White's statistic for testing the null hypothesis of homoskedasticity: it is distributed as an F-variate, with given degrees of freedom. All null hypotheses for the diagnostic tests are accepted in both regressions.

large as the latter, reinforcing the impression that multiplier effects are dominant for business deaths.

The results for the births equation are hardly surprising given the competitiveness of retailing, particularly in those markets where small scale sole proprietorships — which account for most VAT registrations — are common. The results are compatible with potential entrants either perceiving, direct from the market place, that market prospects are declining, or using actual entry as a signal that the market is becoming more competitive and hence less attractive to them. The delayed multiplier effect suggests, not surprisingly, that any advantages (for example) of clustering take time to work through.

Given the dominance of the competition effect in the births equation it is perhaps a little surprising to find a dominant multiplier effect in the deaths equation. The suggestion that increases in births have had significant positive effects on survivability of existing businesses clearly needs further investigation. It may be of course that increases in births reflect a favourable macro economic environment which also enhances business longevity.

Finally we note that what is happening in the region as a whole has a bearing on the birth and death rates of individual counties. This is not a surprising result. It is consistent with the idea that there are potential spillovers of a competition and multiplier nature between counties. However, our empirical investigation could find no evidence of spillovers operating across wider boundaries than regions. Extra independent variables such as 'mean birth and death rates in adjacent regions' were not found to improve the explanatory power of the regressions.

V. Conclusion

Whilst the preliminary nature of the analysis contained in this paper is readily acknowledged, the results are nevertheless of interest. Support has been found for the existence of both competition and multiplier effects in the 1980s. With the multiplier effects dominating in the case of deaths and competition effects dominating in the case of births, clearly more work is needed into why this asymmetry exists. Any future research might incorporate inter-industry linkages and the relationship between births and deaths generated by the finite limits on business life spans. It might also examine the determinants of the different lags, and additional explanatory county-level variables. It would also be interesting, future data permitting, to examine the robustness of the causal structures uncovered in this study, and the role played by macroeconomic conditions, which may affect both birth and death rates, although to differing degrees and with different lags.

Clearly, an improved data set which separates out the different types of birth and death would enhance the value of further work. In particular it would permit comparisons of the effects of these different types. It might (for example) be argued that a birth resulting from a management buy-out would have much more substantial multiplier and competition effects on subsequent births and deaths than a firm which is set up entirely from scratch. This is because a buy-out will typically already have an experienced management team in place. A more disaggregated data set would enable hypotheses of this kind to be tested.

Perhaps the most important result of this paper is the empirical support it provides for a link between births and deaths over time: births or deaths in one period may affect births or deaths in subsequent periods. The existence of such a link has important implications for the formulation and evaluation of policies designed (for example) to encourage business formation, or to reduce business failure. Any assessment of policies of this type would need to take account of the "knock on" effects on births and deaths in subsequent periods. It is also important to map knock-on effects when assessing the role of new firms in employment creation, a topic which has generated an extensive literature over the past decade or so. Such firms may have adverse or positive effects on the viability of other firms, and hence on their employment. The current job accounting literature does not take these interrelationships into account.

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Notes

[1] Gudgin (1978) examined the effects of plant (rather than firm) births on subsequent plant deaths in East Midlands manufacturing. However he did not explore other possible links between births and deaths in one period and births and deaths in subsequent periods.

[2] This is of course an implication of central place theory. For a general discussion of the theory in the context of retailing, see Jones and Simmons (1990). For empirical studies, see Eaton and Lipsey (1982) and West *et al.* (1985).

[3] In later editions of his *Principles*, Marshall acknowledged that the advent of the joint-stock company might have provided a means for a business to rejuvenate itself from within. However even in the case of these companies, Marshall took the view that an older company is "likely to have lost so much of its elasticity and progressive force, that the advantages are no longer exclusively on its side in its competition with younger and smaller rivals" (1920, p. 264).

[4] A take-over may or may not lead to the full or partial closure of the capacity taken over. It is perhaps worth noting that the capacity released by a death which has *not* involved take-over may nevertheless subsequently be bought up and utilised by another business.

[5] In 1980 the VAT threshold level of £13,500 represented 0.67 of the annual sales per person employed in retailing businesses with less than ten employees. In 1989 (the latest year for which data are available), the equivalent figure was 0.56. These figures, which are taken from the Business Monitor *Retailing* (SDA25) for the relevant years, would be even closer if "persons engaged" were calculated on a 'full time equivalent' basis, since there has been a considerable growth in the relative importance of part-time employment over the period. For example, full time female employment fell by seven per cent over the period, while part-time female employment rose by 16 per cent: see Employment Gazette *Historical Supplement*, no. 3, June 1992.

[6] A technical issue which deserves some attention is the set of identifying assumptions necessary for the unique determination of the dynamic response paths of births and deaths to lagged changes in births and deaths. These assumptions are much simpler than those required in time series studies. As Holtz-Eakin *et al.* demonstrate (1988, pp. 1374–1377), standard orthogonality conditions (which rule out correlation between the disturbance terms and all of the variables in the model) are the appropriate identifying assumptions in the case of panel data VARs. They are sufficient to imply that lagged values of the model's variables qualify as valid instrumental variables — as in equations (2a) and (2b).

[7] On the basis of the identifying assumptions mentioned in note 6 the Granger causality tests inform us about economic causality. Fortunately, as Holtz-Eakin *et al.* point out (1988, p. 1376), there is no need to recover the original parameters of equations (1a) and (1b) in order to test Granger causality between the variables of equations (2a) and (2b).

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