

Diffusion effects in the European fertility transition: historical evidence from within a Belgian town (1846-1910)

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Abstract

This article builds on recent theoretical contributions to the literature on the diffusion of demographic innovations to investigate empirically diffusion effects on married couples' fertility behavior during the historical European demographic transition. To this end, a blended, logistic model of stopping behavior is developed, including indicators for both natural and structural determinants and possible diffusion effects. This model is then applied to the birth intervals of three 19th-century generations of urban working class couples living in the Belgian town of Leuven. The findings indicate that husbands' and wives' occupational status cannot explain the adoption of parity-dependent stopping behavior. Particularly strong evidence of a diffusion effect is that the odds that Flemish couples were applying stopping behavior was significantly enhanced by the proportion of Francophone couples living in their street. Also, working class couples who were living in a town district hosting many upper class people were significantly more likely to apply stopping behavior.

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Since the Princeton Fertility Project, we know that the European fertility transition did not follow a trajectory consistent with the socioeconomic changes that accompanied industrialization and modernization. Indeed, fertility declines took place under a wide variety of economic and mortality conditions (Knodel and van de Walle 1986). Instead, the timing and pace of the decline revealed a strong tendency to be influenced by ethnic, linguistic, and religious boundaries; clusters of contiguous provinces appeared to have been going through the transition together despite significant differences in the extent to which modernization had occurred (Watkins 1986). This finding has been construed as evidence against a structural explanation of fertility decline, and as support for the view that fertility decline was the result of cultural changes and diffusion mechanisms (Palloni 2001).

Structural explanations look for the causes of changing behavior in the consequences of either alterations in the characteristics of the social structure (including structural social mobility) or in the positions that individuals occupy within that structure (i.e. individual social mobility). Diffusion explanations, on the other hand, attempt to identify a mechanism that leads to the cumulative adoption of some behavior by more and more individuals even while their social position and the resources associated with them remain largely unchanged (Palloni 2001). Although these two types of causal explanations have sometimes been presented as rival hypotheses (in particular in the 'adaptation versus innovation diffusion' debate), we agree with many scholars that there is no theoretical reason for setting them in opposition to each other (Casterline 2001a; Lesthaeghe and Neels 2002).

In addition, recent research and theory have casted serious doubt on the assertion that the results from the Princeton project have empirically falsified structural

explanations of the fertility transition. Casterline (2001b) argues that even if fertility declines were motivated by the changing economic structure, one should not expect a straightforward relationship between economic determinants and fertility levels. First, structural effects are path-dependent, i.e. affected by the particular history of the setting. Second, structural effects do not only depend on 'material' conditions but also on the perceptions of these conditions. Many cultural factors may influence these perceptions, causing leads and lags. Diffusion mechanisms are important to explain the leads and lags between all the relevant parameters. Third, because of interaction effects between the motivation to control fertility and contraceptive costs, fertility may decline suddenly and rapidly in a way that does not match the gradual structural evolution that first caused the motivation to change (Casterline 2001b). Finally, it should always be kept in mind that the Princeton project proceeded with data on an aggregated, provincial level, while structural explanations often include hypotheses about individual decision-making processes. As recognized by the participants of the Project, this 'mismatch' entails a risk of ecological fallacy, i.e. falsely inferring a (non-)relationship on the individual level from a (non-)relationship on the aggregated group level. For example, Knodel (1986) did not find the expected relationship between the decline of child mortality and the onset of the fertility transition on the macro-level. Only on the individual micro-level, the link between reproductive behavior and child mortality became evident.

Instead of opposing adaptation and innovation diffusion, this article investigates how the social structure affected the diffusion of innovative demographic behavior that can be seen as an adaptation to changing structural conditions. It tries to find out whether social diffusion significantly affected the adoption of innovative ways of fertility limitation. To this end, we apply a blended model of both structural and diffusion effects to life course data for three 19th century birth cohorts in a Belgian town.

The next section clarifies what is meant theoretically by the concept of diffusion. Then, a model is developed that can be applied to the historical fertility data of three birth cohorts living in a 19th-century, Belgian town. Finally, the model is applied in order to test some hypotheses about diffusion effects furthering the widespread adoption of parity-dependent stopping behavior.

Diffusion

Diffusion theories try to understand why, how, and when people do what other people have done before. Therefore, in essence, most theories of diffusion are in their origins theories of social imitation, building on an intellectual history that goes back to Tarde's 1903 book *The Laws of Imitation* (Wejnert 2002). A standard definition often applied in demography is given by Rogers (1995): diffusion of innovation refers to the spread of information or behaviors among individuals involved in a social system, where 'spread' denotes flow from a source to an adopter. Social influence determines the probability that a potential adopter will actually adopt the innovation. A more recent definition by Palloni (2001) explicitly recognizes that social diffusion involves a decision making process: social diffusion is a process in which the selection of particular ideas or behaviors depends on a decision making process that assigns significant influence to the selections made by others involved in the social system. Selections may be positive or negative: they may result in adoption as well as in rejection of the innovation.

In order to study the role of diffusion effects in the fertility transition, it should be made clear what innovation is involved in the decline of marital fertility. This is done in the following section. The subsequent section discusses the social mechanisms that could be responsible for the spread of the innovation.

Diffusion of what?

The fertility transition involved the widespread adoption of a true innovation, namely parity-dependent stopping behavior. However, we are not convinced by the evidence put forward to demonstrate that fertility control as such was new in the 19th century. Indeed, we believe that exertion of some influence on one's fertility was not an unthinkable idea for pre-transition individuals and couples. Without embarking on an intense debate (Cleland 2001; Carter 2001) – that may have imparted less insight into the underlying mechanisms of fertility change than the intensity of the debate would suggest (Casterline 2001a) – Van Bavel (2002) argues for two reasons that fertility control as such probably existed before the start of the fertility transition. The first reason is that historical sources from virtually all time periods and cultures bear witness to human attempts to either stimulate or curtail fertility (McLaren 1990; Carter

2001). Even if many or most attempts were inefficient or even completely ineffective, they testify of the fact that people thought they might influence their fertility in some way. The second reason is that there is growing evidence suggesting that couples were effectively and deliberately limiting their fertility by means of birth spacing (Friedlander et al. 1999; Van Bavel forthcoming), although this as well remains a matter of debate, not consensus.

Some scholars are not even convinced by the evidence that parity-dependent stopping behavior was an innovation. In particular, they discredit the most widely used method in historical demography to tell whether a population is controlling its fertility through parity-dependent stopping behavior or not, namely the analysis of age-specific fertility rates through the Coale-Trussell model (see Friedlander et al. 1999). A major criticism against this method is that it uses age-specific marital fertility rates aggregated by age at marriage. Indeed, it has been shown that disaggregation of the convex pattern of age-specific fertility rates by marriage duration or age at marriage often yields a linear or even concave pattern that has been considered typical of parity-dependent fertility control. Therefore, the Coale-Trussell (1974) model is incapable of demonstrating whether parity-dependent stopping behaviour was new (Blake 1985).

Van Bavel (2003) has evaluated this criticism empirically. By including net and crude parity, among other covariates, in a Poisson model of age- and duration-specific fertility, the possibility of parity-specific control is ruled out. It is argued that the linearly or concavely declining fertility pattern, after controlling for marriage duration, is a result of declining coital frequency, unrelated to fertility control intentions. Therefore, the current article starts off from the assumption that the real historical innovation to be explained is the widespread adoption of parity-dependent stopping behavior.

Diffusion mechanisms

If individuals are uncertain about the advantages and disadvantages, costs and benefits of adopting an innovation like family size limitation through parity-dependent stopping behavior, social learning mechanisms are likely to be applicable (Festinger 1954; Montgomery and Casterline 1996, 1998; Kohler 1997; Brehm et al. 1999). Social learning means reducing uncertainty by obtaining information from significant

others. Indeed, adopting an innovation entails a risk, “an uncertain balance of costs and benefits, and people manage that uncertainty by drawing on others to define a socially acceptable interpretation of the risk” (Burt 1987: 1288). These others may be personal acquaintances (social learning through personal information transfer) as well as others as observed through mass media (social learning through impersonal information transfers) (Montgomery and Casterline 1998).

If ego learns something from alter, alters exerts some influence over ego. Indeed, social learning should be considered as a special case of social influence, namely as a case of what is called informational influence in social psychology. Informational influence typically occurs under circumstances of uncertainty and takes place whenever people look to others for information. Another case of social influence is called normative influence, which prompts people to feel, think, and act in ways that are consistent with their group's social standards (Brehm et al. 1999). As pointed out by Rosero-Bixby and Casterline (1993), endogenous feedback dynamics may change the normative context: when many people have adopted a new idea or behavior, it may become the group norm and, hence, exert normative influence facilitating further diffusion. Our working hypothesis is that any cultural norms furthering and legitimizing birth control appeared only after the European decline of fertility was already well under way (cf. Lesthaeghe 1983). We assume, therefore, that the take-off basically took place via the social learning mechanism. Because our empirical analysis will be restricted to the start of the fertility transition, the following theoretical discussion is limited to learning.

Although social learning involves observing other people, it does not presuppose *communicating* with others. Indeed, one can distinguish between two different form of social learning: one that involves communication of information (see Kohler 1997), and one that requires observation only, not communication. Rosero-Bixby and Casterline (1993) call the latter way of learning the demonstration effect: the experience of some individuals provides concrete evidence for other individuals about the consequences of particular decisions; the behavior of early adopters can provide empirical demonstrations of the range of consequences that can follow from the adoption of a particular choice. This may influence the probability that a potential adopter will actually adopt (Montgomery and Casterline 1998).

The extent to which the communicative or the observation-only mechanism applies depends, among other things, on the kind of innovation at issue. If actual adoption,

or even just talking about the innovation, is associated with negative sanctioning, as in the case of violating a taboo, the probability that the communicative mechanism will be at work is reduced, although implicit and covert “hinting at” the innovation may still be applicable. In this case, diffusion will proceed chiefly through observation-only mechanisms. The diffusion of parity-dependent stopping behavior in Europe may be a case in point: if overtly and explicitly talking about sexuality is considered indecent, ‘not done’ and associated with shame (Bernos 1985, Ariès and Béjin 1985), talking about fertility control with peers or others is unlikely. Therefore, a satisfactory account of diffusion processes in the 19th century European fertility transition should not presuppose that communication about contraceptive methods and techniques has played a major role.

Another advantage of observation-only mechanisms is that they allow for impersonal learning effects and, hence, for learning from people who are in circumstances very different from one’s own. For example, working class people may observe the reproductive behavior of upper class people and draw their own conclusions without having to talk with any ladies and gentlemen. However, in cases like this another problem arises: if the connections between decisions and their consequences depend on social-structural characteristics, it may be unclear for potential adopters what can be learned from the early adopter. Or: what has been learned, may be misleading (Montgomery and Casterline 1998).

For this reason, learning within one own personal social network is probably easier and safer. Of course, observation-only mechanisms may apply to learning from peers as well as to learning from others with a different social status. The difficulty with learning from peers, however, is that homogeneous groups may not generate sufficient diversity of information (Montgomery and Casterline 1998). Communication networks that are relatively closed to outsiders, involving a homogeneous peer group only, generate a strong *common sense* and leave little room for deviant or new communications, i.e. new information (Burt 1987; Hedström 1994; Kohler 1997, 2001; Milroy and Milroy 1997). This could be called the weakness of strong ties. Conversely, the strength of weak ties is that they leave more room for new information because they can function as a bridge between different communication networks (Granovetter 1973). For that reason, there may also be an advantage to sampling the experiences of non-peers in case of uncertainty about the consequences of some reproductive patterns (Montgomery and Casterline 1998).

The resulting working hypothesis is that the diffusion of parity-dependent stopping behavior chiefly involved observation-only social learning mechanisms, including learning from people with a different social status as well as learning from peers. The two channels of information flow are not mutually exclusive but rather supplementary. Indeed, learning from people with unequal social status may generate spillover effects within the peer group. In economics, these are often called “informational externalities” (Montgomery and Casterline 1998) and sociologists call these kind of effects “latent consequences”: the adoption by someone under the influence of outsiders may have the unintended consequence that this behavior informs and influences potential adopters inside the peer group.

Within a homogeneous status group, say a neighborhood of working class people, diffusion processes may follow two different mechanisms (Burt 1987). The first mechanism is called the cohesion model: the stronger and the more empathetic the relationship between ego and alter, the more likely it is that alter’s adoption will trigger ego’s. The reason is that when people are uncertain about something, they are more likely to be influenced by others who they know well and trust. The second mechanism is called the structural equivalence model: if two persons occupy an equivalent status in the social structure, then ego is likely to adopt any innovation perceived as making an alter-adopter more attractive to relevant others. Diffusion through the structural equivalence model predicts that two persons with more or less the same social status will use each other as a frame of reference for making judgments about competitive advantages and disadvantages of innovation adoption, even if they do not communicate directly with each other (Burt 1987).

The following empirical analysis of diffusion effects during the initial stages of the fertility transition treats the exact nature of the diffusion mechanisms at work as a black box. The logistic model to be developed will simply investigate whether there is evidence of any diffusion effects that cannot be explained away by structural effects.

Model and implementation

The hypothesis to be investigated, then, is that diffusion effects can be found during the fertility transition’s take-off in addition to other determinants of changes in fertility

behavior. To make the contribution of diffusion effects to causal models of fertility behavior explicit, Casterline (2001a) proposes the following algebraic form:

$$Y_{i,t} = \beta X_{i,t} + \alpha \sum_j Y_{j,t-\Delta t} W_j + \varepsilon_{i,t} \quad (1)$$

This represents a blended model of fertility outcome Y of individual i at time t , including both a vector of β -parameters for the effects of the set of conventional and structural variables X , as well as a diffusion effect parameter vector α . ε represents the residual term. Because diffusion is about people doing what other people have done before, the fertility behavior Y of other people j is relevant for diffusion if it occurred before time t . Hence, the the $t-\Delta t$ subscript for the Y_j factor. In addition, the fertility behavior Y of other people j is relevant only if these are *significant* others. Therefore, the model includes the weight W_j denoting the salience of individual j for individual i , which can be a couple as well as a woman or a man. The sum of all $Y_{j,t-\Delta t} W_j$ products represents the previous fertility behavior of other people insofar that it is salient for the individual analyzed, and the parameter α indicates the extent to which this influences the current fertility behavior of i , i.e. the strength of the diffusion effect. In our historical empirical analysis, precise data on who are salient others and what is their fertility are unavailable. Still, following the rule of thumb that indicators of social networks should mimic as far as possible the sampling habits of the actors under investigation (Palloni 2001; Casterline 2001a), we have collected information about the neighborhood characteristics of the working class couples to be analyzed. Indeed, we assume that for the 19th-century working classes, the neighborhood was the first and most significant communication and observation network. Therefore, we give full weight to the neighborhood by assuming $W_j=1$. This amounts to the common practice of normalizing the individual salience-quantities W_j so that the sum over all j is identical to 1 (Palloni 2001: 84). Instead of aggregating individual characteristics of other individuals (see the summation sign in model (1)), we will try to find out whether characteristics Z_j of neighborhood J significantly affected the fertility of urban working class couples, controlling for the own structural characteristics included in the X_i vector. In short, we simplify model (1) to the following approximation:

$$Y_{i,t} = \beta X_{i,t} + \alpha Z_J + \varepsilon_{i,t} \quad (2)$$

where the parameter α represents diffusion effects of the neighborhood on fertility outcome Y of couple i , living in neighborhood J . In order to demonstrate the presence of diffusion effects, we have to find out whether any α -parameter differs significantly from zero (cf. Palloni 2001: 84).

The dependent variable: the termination of childbearing

The fertility outcome to be modeled here, i.e. the behavioral innovation of the fertility transition, is parity-dependent stopping behavior. Van Bavel (2002) argues that stopping and birth spacing can best be modeled by means of a probability model and a conditional hazard or duration model, respectively. Indeed, stopping means that no more child is born after the previous birth, which can be described as happening with some probability. This article models this first step, i.e. the probability that no more birth follows after the last one, by means of a logistic regression.

So we end up with a simple logit model, formally comparable to the one developed by Hedström (1994), who modeled the logit of union formation. Here, we will model the logit of termination of childbearing as a function of natural and social-structural fertility determinants X as well as neighborhood characteristics Z that possibly have diffusion effects α :

$$\ln \frac{P_{i,t}}{1 - P_{i,t}} = \beta X_{i,t} + \alpha Z_J + \varepsilon_{i,t} \quad (3)$$

More precisely, the dependent variable is the logit-transformation of the probability that no more child is born within five years after a previous birth. There are two reasons for applying the five-year limit. First, waiting until women have reached the age of 45 or 50 years means limiting the analysis to completed unions, excluding all observed marriages that are censored by emigration or marriage dissolution. This reduces and probably distorts the sample. The reduction and distortion is smaller if we wait at most five years for a next birth. Second, demographers have argued and demonstrated that the number of children born more than five years after the previous one, is negligibly small (Larsen and Menken 1989; Van Bavel 2002). Therefore, the following analysis assumes that couples who did not get another child

within five years, had terminated childbearing. The model tries to predict the probability that this happened.

Context and data

This model will be applied to the fertility data of three birth cohorts that lived in 19th-century Leuven. This provincial Belgian town was a Dutch-speaking, traditional trades and crafts center and did not undergo a rapid and large-scale industrialization in the 19th century. Instead, its economy drifted with the industrializing and rapidly expanding national economy. The provincial town played a supportive role in the industrialization of Belgium, primarily through its functions as a center of education, trades, and transport. The small-scale local industry expanded and modernized only gradually, and included mainly food industry, craft textile manufacturing, tanneries, wood, and construction. Activities in the tertiary sector included transit, wholesale and retail trade, and an important military settlement. Leuven attracted many migrants, but the immigration was predominantly temporary, including many servants and students. Consequently, population growth was mainly natural: Leuven grew from 30,000 inhabitants in 1850 to 42,000 inhabitants in 1910 (Matthijs et al. 1997).

For women, employment opportunities in industry were scarce. According to the 1846 census, only 11% of the female population between ages 15 and 65 was officially employed in industry. Lace-makers accounted for more than half of these. The others held traditionally female occupations as well: they were seamstresses, dressmakers, knitters, laundresses and comparable female working class occupations. Lace-makers were nearly always Leuven born-and-bred girls educated and supervised in nun-schools and working at home or in small ateliers afterwards, together with peers and daughters. Hence, lace making could be combined relatively easily with the care of infants and young children. For the women's families of origin, it not only meant some small contribution to the budget, it was also at least compatible with older sisters working with and taking care of younger sisters outside the crowded house (Van Bavel 2001; 2002).

Marital fertility data were collected from the population registers and from civil registration (birth, death, and marriage certificates) (see Gutmann and van de Walle 1978; Lebouté and Obotela 1988) for three birth cohorts that lived in Leuven at any point in time between 1846 and 1910, men as well as women, natives as well as

immigrants. The first generation, born in 1830, was included because it completed its fertile life course before any signs of marital fertility decline were visible on the aggregate level (G1830). The second cohort, born in 1850, entered its fertile life phase at a time when marital fertility was starting to decline in Leuven (G1850). The third generation, born in 1864, was living its adult years in full marital fertility transition (G1864).

This paper only uses the marital fertility data from the working class sub-sample because the rest of the population, i.e. the white collar middle and upper classes, were already applying parity-dependent stopping behavior to control their fertility in the first generation (Van Bavel 2002). Therefore, the following analysis investigates how this behavior spread through the population of wage-earners and independent artisans and shopkeepers. For this blue-collar part of the population, the following variables have been constructed.

Natural and structural covariates

First, a number of covariates are included in the logistic regression in order to control for natural fertility differences, i.e. factors that influence the probability that yet another birth occurs, irrespective of deliberate attempts to influence that probability. Table 1 gives information about the distribution of all variables.

- If couples do not deliberately try to stop having children, the most important determinant of the onset of infertility is the *woman's age* (Trussell and Wilson 1985; Larsen and Menken 1989; Wood et al. 1994). Age at the start of the birth interval is included in the form of five-year age categories.
- Secondly, in the absence as well as in the presence of parity-dependent fertility control, *marriage duration* is highly associated with fecundability and, hence, with the probability that another birth occurs within five years (Wood et al. 1994; Van Bavel 2003).
- After controlling for woman's age and marriage duration, the fecundity of marriages still varies significantly. Differences between couples reflect differential fecundability and breastfeeding habits (Knodel 1988; Wood 1994). Couples characterized by high fecundity will have, on average, shorter birth intervals and, hence, a higher cumulative number of births at any age and marriage duration. For these couples, the probability that the current interval is closed by yet another

birth will also be relatively high. Therefore, the *crude parity* covariate, i.e. the number of children already born within the current marriage at the start of the current birth interval, is included to control for natural fecundity differences.

- The survival status of the previous child has been shown to be a very important determinant of the next interval when the previously born infant is breastfed. Death of the infant interrupts breastfeeding, which shortens postpartum amenorrhea (Preston 1978; Santow 1987; David and Mroz 1989; Wood 1994). *Infant mortality* will therefore enhance the likelihood of an additional birth. This covariate is included in the regression equations as a dummy variable that is set to one if the previously born child dies within the current birth interval and before reaching age one.

[Table 1 about here]

The second set of variables represents possible influences on the demand side of marital fertility (Bulatao et al. 1983), including social-structural indicators. More specifically, the regression includes information on the occupational status of both husband and wife.

- Occupations were recorded in the population registers at the time of registration, not at the beginning of each birth interval (Leboutte and Obotela 1988). It can be assumed that the occupations practiced often changed during the couples' reproductive career and it should therefore be recognized that the recorded occupations do not allow making fine-tuned distinctions in terms of the economic activity that men were actually involved in. To each birth interval, we assigned the father's occupation that was recorded at a date as close as possible to the beginning of the interval. Table 1 gives the occupational categories that have been used and the distribution in the study populations. Van Bavel (2002; et al. 1998) gives more details about the underlying occupational coding scheme and explains how the occupational classification has been derived.
- It is well known that census takers and register makers often did not record married women's economic activities, and this tendency became stronger during the 19th century (Matthijs 2001: 68-80). Over the three generations to be analyzed here, the proportion of married women for whom no occupation was recorded increases as well, from about 45% in the first generation to about 70% in

the last one (see Table 1). In addition, pregnancy and the post-natal period supposedly forced many women to stop with paid work, temporarily or permanently. The population registers do not provide this information. Still, it is argued that the occupations that *were* recorded are useful for the present analysis. We assume that the probability that a civil servant recorded an occupation is higher for women that were involved in paid labor regularly than for women that were only occasionally and exceptionally active in the labor market. In other words: it is supposed that there is some association between recorded occupation and real activity in the labor market, but not that there is a one-to-one correspondence. The weaker the association, the more difficult it will be statistically to detect real effects of women's labor (Van Bavel 2002).

- Net parity is calculated as the number of children alive at the start of the interval, including children born out of wedlock (in contrast to the crude parity measure, which includes legitimate births only). If the reproductive behavior would be deliberately aimed at a final family size that the married couple (or one of the partners) does not wish to exceed, we would expect a positive effect of this variable on the odds of stopping. Hence, we are looking here at parity-dependent stopping from the perspective of reproduction, distinguishing net parity from crude parity: the former is the number of children still alive at the beginning of the current interval, while the latter includes all children already born, alive as well as deceased. Therefore, if all birth occur within the current marriage, net parity equals crude parity minus the number of deceased children. If net parity has a statistically significant effect on the likelihood of stopping, even after controlling for crude parity (or, equivalently, the number of deceased children), this would strongly suggest that parity progression was being controlled with a desired offspring in mind.

The inclusion of crude parity is essential in order to control for two opposing mechanisms behind the bivariate association between the number of children already born and subsequent fertility (Van Bavel 2003). On the one hand, we expect a positive association between crude parity and fertility because parity, at a given age and marriage duration, is positively associated with fecundability (cf. *supra*). On the other hand, every birth entails some risk of secondary sterility or subfertility, implying zero or lower subsequent fertility (Trussell and Wilson 1985; Wilson et al. 1988).

Net parity equals crude parity minus the number of deceased children. Therefore, the effect of net parity, after controlling for crude parity, is the opposite of the effect of the number of children lost. To some extent, then, we are capturing the effect of infant mortality on fertility, which is known to be positive, even in the absence of fertility control (Preston 1978). This would blur or even invalidate the analysis because net parity is included in order to detect parity-dependent fertility control while in fact it is capturing an infant mortality effect as well. Therefore, it is essential that we also control for the latter effect (Van Bavel 2003). As explained in the discussion of the “natural supply” covariates, this is done by including a dummy variable for the survival of the previous child.

Hypotheses about diffusion effects

Migration represents a potential threat to any local common sense. The potential strength of migrants, from a local diffusion of innovation point of view, is therefore that their relatively weak ties with the local community puts them in the position to function as a bridge with other communities where some modernism has already taken hold.

To evaluate the role of immigrants as importers of new reproductive ideas and behaviors, it is crucially important to know whether or not they came from regions where the innovation was already relatively established. In the town of Leuven, the Coale-index of marital fertility I_g was 0.73 in 1880, which was well below the average level of marital fertility in the surrounding Leuven district (“arrondissement”, $I_g = 0.85$). The difference remained more or less the same throughout the second half of the 19th century and the beginning of the 20th (see Lesthaeghe 1977 for the district figures and Van Bavel 2002 for the town figures). Therefore, immigration from villages and towns within the district supposedly did not speed up the diffusion of stopping behavior in the town of Leuven. Yet, this town also attracted many immigrants from regions where the fertility transition had started earlier or where it had advanced more rapidly. In the Belgian context of the 19th century, this was the case in Brussels and Wallonia (Lesthaeghe 1977).

Nineteenth-century Belgium can be divided into three linguistic regions: Dutch-speaking Flanders (including Leuven), French-speaking Wallonia, and bilingual

Brussels. In all Flemish districts, the Coale-index of marital fertility was above 0.80 in 1880, whereas the same index was below 0.76 in all Walloon districts except two (Bastogne and Waremme). In the majority of the Walloon districts, the index of marital fertility was even below 0.70, and in the district of Brussels, I_g was 0.67 in 1880 (Lesthaeghe 1977: 106). In France as well, the fertility transition started earlier than in Leuven (Coale and Treadway 1986; Weir 1994). Therefore, and for the sake of simplicity, in the following discussion all districts in Wallonia, except Bastogne and Waremme, plus France, plus the district of Brussels are called “Francophone” (although French-speakers were still outnumbered by the Flemish in Brussels anno 1880).

We expect that immigrants coming from Francophone regions were more likely to control their fertility by means of stopping behavior than the rest of the Leuven population. In order to separate the effects of migration *per se* on the one hand and having a Francophone background on the other, the migration covariate is split up into two variables. One variable distinguishes between people born in Leuven, child immigrants who came before the age of 17, and adult immigrants. The second variable distinguishes between immigrants who were born in Francophone regions and immigrants who were not.

As said before, we assume that for the 19th-century working classes, the *neighborhood* was the first and most significant communication and observation network and, hence, the “sociotope” *par excellence* for learning about the costs and benefits of smaller family sizes. Therefore, our diffusion hypothesis states that the likelihood of stopping behavior was bigger in neighborhoods where there were relatively many shining examples. The Leuven study has measured that neighborhood characteristic in two independent ways: town quarter of residence on the one hand and the proportion of Francophone families living in the street on the other.

First, we know from preliminary analysis that the white collar middle and upper classes had already adopted parity-dependent stopping behavior in the oldest study generation (Van Bavel 2002). Therefore, we hypothesize that working class people living in town districts with a large proportion of upper class people are more likely to adopt stopping behavior than working class couples in neighborhoods with a smaller proportion of bourgeois examples.

For administrative purposes, the city hall divided the medieval, circular map of Leuven into four quarters, each covering approximately a quarter of the surface. Table 2 displays for each town district the distribution of sampled married couples by occupation of the husband. The white collar classes were represented most strongly in the first and the second city quarters, while quarter four was a predominantly blue collar working class neighborhood. In district three, none of the occupational categories was over- or underrepresented. Therefore, we hypothesize that working class couples in the first or second town quarter were more likely to limit their fertility by means of stopping behavior than working class couples living in the fourth quarter.

[Table 2 about here]

On the street level, social segregation was much stronger than on the town quarter level. Many streets were either purely working class or purely middle and upper class (Van 't Dack 1977). Consequently, it is not possible to investigate the effects of the presence of upper class people on the reproductive behavior of working class people on the street level. The spatial segregation of natives and immigrants, however, was much weaker (Van 't Dack 1972). In Leuven, which is located very close to the language border, Francophone people could be found in any neighborhood and street. Hence, it is possible to investigate the effect of the presence of Francophone people on the reproductive behavior of Flemish working class couples living in the same street.

In the following analysis, this is done by including a covariate indicating the proportion of Francophone couples that share their street with the Flemish couples under study – whether “Francophone” or “Flemish” is determined on the basis of place of birth, as indicated above. For couples who are themselves Francophone, this variable is set to zero. This means that the effect of the proportion of Francophone people in the street is included only for couples who are *not* themselves Francophone. Any couple with at least one Francophone partner, is counted as such. On average 10% of the couples sharing their street with Flemish people from the 1830 generation were Francophone. In the 1850 generation, this figure was 7.8% and in the 1864 generation 7.0% (Van Bavel 2002: 316-319). We expect to find a positive diffusion effect of the proportion of Francophone couples on the likelihood of stopping of Flemish couples.

Findings

The results of the logistic regression analysis are in Table 3. The small panel at the bottom displays conventional goodness-of-fit statistics for maximum likelihood fitting procedures, namely deviance and the Bayesian Information Criterion (BIC). The latter measure is widely used because it takes into account both the deviance, i.e. the difference between observed and predicted data, the parsimony of the model (degrees of freedom), and the sample size. Negative BIC-values indicate that the model is statistically acceptable (Long 1997, pp.109-112), which is clearly the case here.

Substantially, first it can be seen that in the oldest generation the termination of childbearing was influenced by natural determinants only. The strongest influence was woman's age, but marriage duration as well had a strong impact. The older the mother and the older her marriage, the lower the probability that yet another child was born. These influences remained operative in the two younger generations. The effect of death of the previous child, however, was statistically significant in the 1830 generation only.

[Table 3 about here]

Occupations had no statistically significant impact at all in the oldest generation. In the second generation, there is some indication that husbands who worked as servants as well as artisans and shopkeepers were stopping their reproductive career earlier than implied by the natural determinants. However, these effects are statistically significant only at the level of $\alpha = 0.07$. In the youngest generation, women who were working as clerks and non-domestic servants probably were applying stopping behavior. It should be remarked that the occupational groups named all share the characteristic that they might have come in contact relatively often with upper class people. Hence, these occupation effects, if any, are more compatible with a diffusion explanation in terms of social learning than with a structural motivation for stopping behavior.

There are stronger indications of the diffusion of stopping behavior in the 1850 and in the 1864 generation. These are in the lower panel of Table 3. For the women of generation 1850 who were born in Francophone regions, the odds of stopping were 2.36 times higher than for all other women, controlling for their age, marriage duration and all other covariates in the model. Whether they came in their child or adult years did not make a significant difference. The origin of husbands and the town district did neither in this generation, but the presence of Francophone families clearly did influence the reproductive behavior of non-Francophone families living in the same street. According to the model estimates, an increase of one in ten in the proportion of Francophone families in the street raised the odds that the current birth interval was the last one with 22%. In the 1864 generation, this effect was even clearer and somewhat stronger (27%). The same holds for the effect of women's Francophone origin: in the 1864 generation, the odds that a working class couple would stop having children rather than continue its childbearing career, was 3.85 times higher if the wife had a Francophone origin. It appears that their presence in Leuven and their stopping behavior was influencing the Flemish couples living in their streets.

In addition, there is a clear effect in the youngest generation of quarter of residence: as expected, couples living in the fourth, predominantly working class town district were the least likely to apply stopping behavior, especially when compared with the first and second quarters, where white collar people were more strongly represented. This is evidence of top-down social learning: apparently, working class people were to some extent imitating the reproductive behavior of upper class people living nearby.

Finally, and confirming the findings from other models and techniques (Van Bavel 2003), it is only in the 1864 generation that the termination of childbearing is evidently parity-dependent for the Leuven working class population *as a whole*. Indeed, net parity (i.e. the number of children alive at the start of the birth interval), has no influence on the likelihood of stopping in the first and second generations. In the youngest one, an additional child alive raised the odds of stopping on average with 23%, holding all other covariates constant.

Conclusion

This article builds on recent theoretical contributions to the literature on the diffusion of innovations, particularly in the field of demography, to investigate empirically diffusion effects on married couples' fertility behavior during the historical European demographic transition. To this end, a blended, logistic model of the probability of termination of the childbearing career is developed, including indicators for both structural determinants and possible diffusion effects. This model is then applied to the birth intervals of three generations of Belgian urban working class couples.

The findings indicate that husbands' and wives' occupational status, as a structural characteristic, cannot explain the adoption of parity-dependent stopping behavior. The effects of occupation, if any, were more consistent with a diffusion explanation than with a socio-economic interpretation. That is not to say that occupational status was irrelevant for the reproductive behavior of the working classes. On the contrary: Van Bavel (forthcoming) found that occupational status strongly influenced controlled birth spacing. However, according to the analysis presented in this article, this socio-economic characteristic did not affect the spread of innovative, parity-dependent stopping behavior.

We know from Lesthaeghe (1977) that the fertility transition started earlier in the French-speaking part of Belgium than in the Flemish part. Within the Flemish population analyzed here, Francophone couples were also more likely to apply stopping behavior already in the 1850 generation than Flemish couples. Clearly, the origin of the wife mattered much more than the origin of the husband. Particularly strong evidence of a social learning effect is that the odds that Flemish couples were applying stopping behavior was significantly enhanced by the proportion of Francophone couples living in their street. Also, working class couples who were living in a town district where upper class people were strongly represented, were significantly more likely to apply stopping behavior. This is evidence of a diffusion effect because we know that the upper classes were already applying stopping behavior in the oldest generation.

This article presented evidence of the contagious presence of Francophone innovators in a Belgian town. Lesthaeghe (1977) found that the fertility transition in Belgium started earlier in the Flemish arrondissements that hosted a significant French-speaking minority. If the findings presented in this article can be generalized,

we know now that this was probably not only the result of the behavior the Francophone minority itself, but that also diffusion effects were involved.

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Table 1: Percentage distributions or means and standard deviations of the variables used in the regression analysis

COVARIATES	G1830	G1850	G1864
Woman's age			
<25 years	11.56 %	17.92 %	18.83 %
25-29	22.92	26.79	29.81
30-34	28.21	25.85	27.43
35-39	23.8	19.43	15.84
40 en +	13.51	10.01	8.09
Marriage duration (mean, in years)	6.54 (5.27) [°]	7.01 (5.74)	6.46 (5.38)
Crude legitimate parity (mean)	4.12 (2.51)	4.53 (2.85)	4.16 (2.53)
Previous infant dies before conception of the next child	17.04 %	15.28 %	13.63 %
Husband's occupation			
Laborer	16.36 %	11.57 %	11.84 %
Artisans & Shopkeepers	17.63	24.21	27.09
Non-factory workers	44.37	45.09	33.90
Clerks & non-domestic servants	4.51	3.40	5.62
Self-employed with minimal capital	6.07	4.40	5.79
Domestic servants	2.84	0.57	0.60
Factory workers	8.23	10.75	15.16
Wife's occupation			
No occupation registered	45.84 %	67.42 %	69.68 %
Shopkeepers & artisans	8.92	7.42	4.01
Non-factory workers	5.58	5.28	6.90
Clerks & non-domestic servants	4.31	2.14	3.75
Self-employed with minimal capital	0.20	0.82	2.73
(Former) domestic servants	13.42	6.48	4.51
Lace-workers	19.98	6.10	0.00
Factory workers	0.69	0.69	2.47
Laborers	1.08	3.65	5.96
Net parity (mean)	3.21 (1.93)	3.60 (2.16)	3.43 (1.93)
Wife: born in Leuven			
Child immigrant	52.50 %	66.47 %	56.39 %
Adult immigrant	32.81	22.52	26.49
Adult immigrant	14.69	11.01	17.12
Wife: born in "Francophone" district? (*)			
Yes	5.09 %	4.15 %	4.77 %
No	94.91	95.85	95.23
Husband: born in Leuven			
Child immigrant	60.92 %	69.81 %	71.38 %
Adult immigrant	22.53	19.62	17.80
Adult immigrant	16.55	10.57	10.82
Husband: born in "Francophone" district?			
Yes	6.86 %	4.21 %	3.58 %
No	93.14	95.79	96.42
Town quarter of residence			
Quarter 1	22.72 %	17.67 %	14.40 %
Quarter 2	27.23	30.94	35.26
Quarter 3	17.53	14.78	14.22
Quarter 4	32.52	36.60	36.12
Proportion of "Francophone" families living in the street per 10	0.57 (0.99)	0.49 (0.93)	0.43 (0.84)
Number of birth intervals	1021	1590	1174
... of which open (no child within 5 years, see text)	173	283	273

(*) Definition of "Francophone": see text; [°]Standard deviations between brackets. Source: Population Registers (Van Bavel 2002)

Table 2: Town district of residence of married couples in Leuven, three generations combined, Leuven, 1846-1910

Occupation of the husband	Quarter 1	Quarter 2	Quarter 3	Quarter 4
White collar	25.3	22.8	19.9	10.0
Self-employed artisans and shopkeepers	17.2	14.0	21.8	14.9
Blue collar working class	48.3	48.4	44.2	65.1
Other (servants etc.)	9.2	14.8	14.1	10.0
Sum	100.0	100.0	100.0	100.0
(N = 100%)	(435)	(644)	(312)	(482)

Source: Population Registers (Van Bavel 2002)

Table 3: Logistic regression of the probability that married, working class couples stopped having children, by generation. Leuven, Belgium, 1846-1910*

	G1830			G1850			G1864		
	e ^{coeff.}	se ^{coeff.}	p	e ^{coeff.}	se ^{coeff.}	p	e ^{coeff.}	se ^{coeff.}	p
Intercept	0.07	0.568	<.0001	0.07	0.401	<.0001	0.19	0.375	<.0001
Woman's age									
<25 years (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
25-29	0.83	0.506	0.713	1.11	0.296	0.719	1.02	0.281	0.939
30-34	0.96	0.495	0.930	1.36	0.303	0.312	1.88	0.286	0.027
35-39	3.23	0.490	0.017	3.46	0.316	<.0001	2.46	0.341	0.008
40 en +	20.69	0.536	<.0001	25.23	0.371	<.0001	11.46	0.425	<.0001
Marriage duration (mean, in years)	1.10	0.037	0.013	1.14	0.026	<.0001	1.19	0.031	<.0001
Crude legitimate parity (mean)	0.90	0.105	0.308	0.77	0.065	<.0001	0.66	0.089	<.0001
Previous child dies before conception of the next	0.54	0.288	0.032	0.86	0.216	0.497	0.76	0.247	0.265
Husband's occupation									
Laborer (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
Artisans & Shopkeepers	1.53	0.350	0.227	1.72	0.296	0.067	1.16	0.269	0.591
Non-factory workers	0.88	0.309	0.685	1.11	0.286	0.717	0.74	0.275	0.281
Clerks & non-domestic servants	0.92	0.645	0.898	1.06	0.503	0.915	0.69	0.427	0.379
Self-employed with minimal capital	0.64	0.509	0.372	1.63	0.420	0.247	1.37	0.381	0.404
Domestic servants	0.98	0.713	0.981	4.74	0.814	0.056	2.98	0.870	0.209
Factory workers	1.66	0.402	0.206	1.63	0.359	0.172	0.82	0.320	0.527
Wife's occupation									
No occupation registered (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
Shopkeepers & artisans	1.45	0.502	0.457	0.64	0.338	0.186	1.16	0.422	0.730
Non-factory workers	0.69	0.535	0.480	0.69	0.389	0.348	1.09	0.339	0.803
Clerks & non-domestic servants	0.88	0.545	0.821	0.79	0.572	0.677	2.27	0.398	0.039
Self-employed with minimal capital	<0.001	>99.999	0.988	1.27	0.806	0.765	0.91	0.587	0.866
(Former) domestic servants	0.70	0.347	0.297	0.69	0.335	0.265	1.32	0.394	0.482
Lace-workers	1.48	0.301	0.196	0.78	0.390	0.523	/	/	/
Factory workers	2.28	1.159	0.477	0.62	1.000	0.633	1.25	0.561	0.696
Laborers	1.61	0.879	0.590	1.01	0.410	0.984	0.91	0.343	0.784
Net parity (mean)	1.00	0.104	0.999	1.02	0.071	0.793	1.23	0.096	0.033
Wife: born in Leuven (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
Child immigrant	1.36	0.266	0.244	1.11	0.212	0.636	0.60	0.230	0.028
Adult immigrant	0.67	0.408	0.326	0.90	0.276	0.707	0.81	0.262	0.419
Wife born in "Francophone" district	0.60	0.571	0.368	2.36	0.387	0.027	3.85	0.365	<0.001
Husband: born in Leuven (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
Child immigrant	1.48	0.336	0.240	0.95	0.220	0.810	0.84	0.248	0.473
Adult immigrant	1.14	0.308	0.681	0.85	0.290	0.575	1.24	0.293	0.463
Husband born "Francophone"	0.43	0.517	0.097	1.34	0.394	0.454	2.20	0.435	0.070
Town quarter of residence: Q1 (ref.)	1.00	/	/	1.00	/	/	1.00	/	/
Quarter 2	0.75	0.305	0.336	1.16	0.237	0.541	0.87	0.252	0.571
Quarter 3	0.79	0.351	0.492	1.13	0.286	0.676	0.81	0.299	0.477
Quarter 4	0.82	0.296	0.499	0.82	0.235	0.393	0.49	0.254	0.005
Proportion of "Francophone" families living in the street, per 10	0.96	0.113	0.707	1.22	0.079	0.011	1.27	0.088	0.006
Number of birth intervals	1021	BIC=	-6177.18	1590	BIC=	-10340.86	1174	BIC=	-7047.24
Deviance	675.15	df=	989	1143.92	df=	1558	1031.68	df=	1143

* Only couples with at least one child are included. Source: Population Registers (Van Bavel 2002)