

Critical Mass Theory and Women's Political Representation

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In studies of women's legislative behaviour, the concept of critical mass is widely used and, more recently, criticised as a tool for understanding the relationship between the percentage of female legislators and the passage of legislation beneficial to women as a group. In this research note, we revisit classic contributions by Rosabeth Moss Kanter and Drude Dahlerup and outline and discuss their assumptions regarding anticipated connections between numbers and outcomes. We find that later gender and politics scholars have often misconstrued their work, with crucial implications for subsequent research on relations between the descriptive and substantive representation of women. We argue that clarifying the theoretical origins of the critical mass concept is crucial for forging a more coherent and cumulative research agenda on women's political representation.

A central concept in research on women's political representation is the notion of 'critical mass'. It is frequently invoked to explain why women do not always appear to represent women once they are in political office. Gender and politics scholars and activists suggest that this pattern is due not to the inclinations of female office holders, but rather to the fact that there are fewer women than men in almost all elected assemblies.¹ They argue that women are not likely to have a major impact on legislative outcomes until they grow from a few token individuals into a considerable minority of all legislators: only as their numbers increase will women be able to work more effectively together to promote women-friendly policy change and to influence their male colleagues to accept and approve legislation promoting women's concerns.

Over the last twenty years, 'critical mass' has gained wide currency among politicians, the media and international organisations as a justification for measures to bring more women into political office (Grey, 2006; Krook, 2005). However, gender and politics scholars have become increasingly sceptical of the concept as they have discovered other relationships between the numbers of women elected and the passage of legislation beneficial to women as a group. One scholar finds, for example, that women make a difference – and, indeed, perhaps a greater difference – when they form a very small minority (Crowley, 2004). Another observes that an increase in the proportion of women elected actually decreases the likelihood that individual female legislators will act on behalf of women as a group (Carroll, 2001). These developments have precipitated a crisis of confidence in 'critical mass theory', leading many to question its continued

utility and relevance as a concept in research on the substantive representation of women (Childs, 2004; Sawer *et al.*, 2006). In our earlier work, we go so far as to advocate that feminist scholars walk away from the concept entirely (Childs and Krook, 2006).

In this research note, we seek to determine what might be gained – or lost – by abandoning the concept of ‘critical mass’ in research on women’s political representation. To this end, we revisit the classic contributions of Rosabeth Moss Kanter and Drude Dahlerup – the seminal authors in these debates – to outline and discuss their assumptions regarding women’s legislative behaviour. Although we initially anticipated that this exercise would uncover important gaps that could account for the empirical findings, we discover that later scholars have largely misread – and thus misconstrued – the work of Kanter and Dahlerup, with crucial implications for subsequent research on relations between women’s descriptive and substantive representation. On the basis of our closer reading of the original texts, we conclude that many gender and politics scholars test and reject ‘critical mass theory’ using evidence that is in fact consistent with the expectations of these earlier contributions (compare Childs and Krook, 2006). Clarifying the theoretical origins of the ‘critical mass’ concept is thus crucial for forging a more coherent and cumulative research agenda on links between the presence of women in political institutions and the passage of ‘women-friendly’ policy outcomes.

The Concept of ‘Critical Mass’ in Women and Politics Research

The debate on ‘critical mass’ in women and politics research can be traced back to three seminal works, two by Kanter (1977a; 1977b) and one by Dahlerup (1988), which, respectively, analyse the experiences of women who form small minorities in the corporate and political spheres. Although both authors are concerned primarily with how women respond to dynamics of marginalisation in minority situations, each concludes with some speculations as to how these experiences will change as the number of women increases. These latter ideas form the nucleus of the critical mass concept as it has been taken up by subsequent researchers, who have in turn transformed the possibilities signalled by Kanter and Dahlerup into firmer expectations about the behaviour of women, which we label ‘critical mass theory’. To separate their contributions from these later interpretations, we review the arguments of Kanter and Dahlerup to establish the precise nature of their predictions regarding women’s behaviour as the proportion of female legislators grows. We then highlight shortcomings and ambiguities in their formulations which may be – at least partly – responsible for confusion among other scholars, in order to evaluate the potential of their work for advancing the debate on links between the descriptive and substantive representation of women.

Rosabeth Moss Kanter on 'Skewed' and 'Tilted' Proportions and Group Life

Kanter's work examines women's token status in a large American corporation in the 1970s. Over the course of her fieldwork, she observes that the 'relative numbers of socially and culturally different people in a group' – differences which derive from 'salient master statuses' like sex, race and ethnicity (Kanter, 1977a, p. 966; Kanter, 1977b, p. 208) – are 'critical in shaping interaction dynamics' in group life (Kanter, 1977a, p. 965; 1977b, p. 239). To theorise these interactions, she constructs a typology consisting of four distinct majority–minority distributions: uniform groups with one significant social type, at a ratio of 100 : 0; skewed groups with a large preponderance of one social type, at a ratio of perhaps 85 : 15; tilted groups with a less extreme distribution of social types, at a ratio of perhaps 65 : 35; and balanced groups with a more or less even distribution of social types, at a ratio of 60 : 40 to 50 : 50 (Kanter, 1977a, p. 966). She argues that as the numerical proportions within a group 'begin to shift so do social experiences' (Kanter, 1977b, p. 207). Nonetheless, her empirical evidence derives from a study of only one of these four groups, a case where the ratio of men to women is skewed in men's favour, because her primary concern is to uncover 'what happens to women who occupy token statuses ... in a peer group of men' (Kanter, 1977a, p. 968).

In these skewed groups, she argues, the numerically many – or 'dominants' – 'control the group and its culture', while the numerically few – or 'tokens' – are reduced to symbolic representatives of their social category (Kanter, 1977a, p. 966). Due to their minority status, tokens are subject to greater visibility within the group, leading dominants to stress intra-group differences in ways that compel tokens to conform to dominant models while also suffering stereotypes in line with these perceived differences (Kanter, 1977a, pp. 971–2). These tendencies in turn generate three particular challenges for token individuals: performance pressures, which require them to overachieve or limit their visibility;² token isolation, which forces them to remain an outsider or become an insider by being a 'woman-prejudiced-against women';³ and role entrapment, which obliges them to choose between alternative female stereotypes like the mother, the seductress, the pet or the iron maiden. As a consequence of these dynamics, tokens – even if they are two together – find it difficult to 'generate an alliance that can become powerful in the group' (Kanter, 1977a, p. 966). Thus, in the absence of greater numbers capable of creating a 'counterculture', tokens are left with 'little choice about accepting the culture of dominants' (Kanter, 1977b, p. 231). Tokenism in this manner becomes self-perpetuating: rather than paving the way for others, it reinforces low numbers of women, leaving outside intervention as the only means for increasing their presence (Kanter, 1977a, p. 998; 1977b, p. 210, pp. 233–7, pp. 241–2).

Reflecting on how these dynamics might change in the transition from a skewed to a tilted group, Kanter makes three conjectures regarding women's behaviour as the perceptions of dominants and the responses of tokens take on new forms. The

first is that 'with an increase in relative numbers, minority members are potentially allies, can form coalitions, and can affect the culture of the group', while the second is that 'with an increase in relative numbers, minority members begin to become individuals differentiated from each other' (Kanter, 1977a, p. 966). Together, these two claims suggest that women in tilted groups are able to evade performance pressures and token isolation, which had previously prevented them from forming coalitions with other women, as well as escape role entrapment, so that they can pursue interests that may not conform with female stereotypes. Kanter offers no insights as to which scenario will prove most likely, but simply signals two possibilities whose direction ultimately depends on the choices of individual women.

This sense of contingency similarly pervades Kanter's third intuition regarding a change in absolute numbers, despite a lack of change in relative numbers: 'two ... is not always a large enough number to overcome the problems of tokenism and develop supportive alliances, unless the tokens are highly identified with their own social group' (Kanter, 1977a, p. 987). This claim implies that even when the number of women remains low, the presence of 'feminist' or 'women-identified-women' can reduce performance pressures, token isolation and role entrapment if the particular women involved form coalitions (Kanter, 1977b, p. 238). Thus, as she argues in the case of balanced groups, the characteristics of individual women become paramount because group dynamics 'depend on other structural and personal factors' (Kanter, 1977a, p. 966). Nonetheless, her acknowledgement that two tokens can easily 'be divided and kept apart' leads her to add the qualification that 'it would appear that larger numbers are necessary for supportive alliances to develop in the token context' (Kanter, 1977b, p. 238). All the same, her contention that feminists are central to women-friendly outcomes suggests that numbers may in fact matter less than the presence of 'women-identified-women'.

While the dynamics identified by Kanter share certain parallels with the challenges faced by women in politics, their application to the study of women's political representation is limited in several ways. First, Kanter investigates the experiences of token women in corporations, not women as minorities in political institutions. She thus examines how proportions affect tokens' abilities to fulfil their roles as employees, where job performance is related to economic efficiency and assessed daily by superiors in the job hierarchy. This contrasts with legislators, whose job priorities remain the prerogative of individuals and political parties and are judged on a multi-year basis by voters (Bratton, 2005). Even if business and politics share certain features in common – like 'cultural traditions and folklore' that shape how members 'manage relations' between internal and external actors (Beckwith, 2002) – Kanter's research does not in fact speak to the question of whether or not female legislators will seek to 'act for' women (Mateo Diaz, 2005).

Second, Kanter is unclear about 'tipping points', or the moments when groups move from 'skewed to tipped to balanced' (Kanter, 1977b, p. 237). Although her

ratios of 'up to' 85 : 15, 'perhaps' 65 : 35 and '60 : 40 down to 50 : 50' mark qualitative distinctions among groups, her diagrams suggest a continuous scale (Kanter, 1977a, p. 967; 1977b, p. 209). Furthermore, because the percentage point differences between the categories are large, particularly between the skewed (85 : 15) and tilted (65 : 35) groups, this ambiguity generates opposite predictions regarding 'in-between' proportions and their implications for group interaction: the first reading indicates that groups with proportions like 80 : 20 and 75 : 25 should be categorised as skewed, since no change can occur until the ratio is 65 : 35, while the second suggests that such groups are on their way to being tilted, as they are moving along a continuum.

Third, Kanter explicitly removes gender from her analysis by arguing that 'rarity and scarcity, rather than femaleness per se ... shaped the environment for women in the parts of [the corporation] mostly populated by men' (Kanter, 1977b, p. 207). Indeed, she claims that relative numbers 'can account for any two kinds of people regardless of the category from which the token comes' (Kanter, 1977a, p. 972; 1977b, p. 6). At the same time, however, she relies upon gendered analysis to make sense of her observations: her description of the dynamics of tokenism stems from an appreciation of how women's gender 'master status' is displayed and reproduced on and through women's bodies, especially in sections where she points out how sexual innuendos serve to exclude and demean female tokens (Kanter, 1977a, p. 968; compare Thomas, 1994).

Fourth, given her lack of an explicitly gendered lens, Kanter leaves the role of men in these situations under-analysed. While she recognises that men who are not used to interacting with women are often 'more confused than hostile', she also notes several who are 'openly angry' and simply do not know how to interact with a woman who is not their wife or their secretary, on the basis that they went to 'all-male technical schools' (Kanter, 1977b, p. 42). Yet these reactions cannot be understood without a prior theory of patriarchal gender relations, and in glossing over them Kanter underplays the potential for backlash against women in occupations 'normatively defined as men's work' (Yoder, 1991, p. 188). As such, her saleswomen may feel the 'negative effects not of their small numbers but of their *increasing* numbers' (Yoder, 1991, p. 185, emphasis in original; compare Considine and Deutchman, 1996). Because Kanter views skewed groups as largely self-perpetuating, however, her lack of attention to men's reactions is understandable: she simply does not have the empirical material to theorise in any firm way how male and female behaviour will change in the transition from skewed to tilted groups.

Drude Dahlerup on Small and Large Minorities of Women in Politics

Dahlerup extends Kanter's analysis to the study of women in politics, at least partly in response to the growing tendency among female politicians in the

mid-1980s to refer to the notion of 'critical mass' when describing the limits on their possibilities to 'act for' women. Sceptical of the appropriateness of this metaphor for understanding political behaviour, she draws on Kanter to consider how the performance pressures for saleswomen compare with those for female politicians, who must prove that they are 'just like (just as able as) male politicians' but also that 'it makes a difference when women are elected' (Dahlerup, 1988, p. 279). She thus adopts an explicitly gendered perspective that emphasises how women's minority position in politics relates to their minority group status in society through 'over-accommodation, sexual harassment, lack of legitimate authority, stereotyping, no considerations for family obligations ... [and the] double standard', which are the 'combined consequence of the minority position and women's status in a patriarchal society in general' (Dahlerup, 1988, p. 279, emphasis in original). Seeking to tailor Kanter's insights to the political realm, she then identifies six areas where women might have an impact in politics: reactions to women politicians, with a decline in sexist treatment and sexual harassment; the performance and efficiency of female politicians, with fewer women leaving politics; the social climate of political life, with the arrival of a more consensual style and family-friendly working arrangements; political discourse, with a redefinition of 'political' concerns; the policy-making agenda, with a feminisation of the political agenda; and the influence and power of women in general, with the broader social and economic empowerment of women (Dahlerup, 1988, pp. 283–99).

Although careful to adapt Kanter's work, however, Dahlerup only partially represents the change in interaction dynamics as a group moves from skewed to tilted to balanced. She argues:

in the *tilted group* ('with ratios of perhaps 65 : 35', Kanter writes, from her figure, however, from 15 to about 40), the minority is becoming strong enough to influence the culture of the group, and alliances between minority group members become a possibility (Dahlerup, 1988, p. 280).

With this single sentence, Dahlerup transforms the 'critical mass' debate in two ways with important implications for later research on the substantive representation of women. First, she focuses exclusively on the opportunity for women to form supportive alliances when there is an increased number of women, overlooking the possibility that women as a group will grow more diverse as their numbers grow, as well as the chance for women to have an impact even when they constitute only a very small minority of all political representatives.

Second, she inserts a new definition of tilted groups as those where the proportion of women ranges between 15 and 40 per cent, meaning that they occupy all the space between skewed (85 : 15) and balanced groups (60 : 40). At the same time, she defers to common usage of the term 'critical mass' (Dahlerup, 1988, p. 276, p. 280, p. 296) and identifies 30 per cent as the crucial cut-off point for gauging the impact of women in Scandinavian politics (Dahlerup, 1988, p. 281),

even though a strict reading of Kanter would categorise such a group as skewed rather than tilted or balanced. In light of her reformulation, Dahlerup concludes that available empirical evidence simply does not support a relationship between specific percentages of women and changes in each of her six areas. She suggests that factors beyond numbers – especially those that are impossible to isolate or control, like broader shifts in societal attitudes – might go further in explaining both change and lack of change following the advent of more women to political office (Dahlerup, 1988, pp. 276–8).

Developing this, Dahlerup argues that the specific mechanisms for change lie in ‘critical acts’, or initiatives that ‘change the position of the minority and lead to further changes’. These acts include the recruitment of other women, the introduction of quotas for women and new equality legislation and equality institutions,⁴ and depend crucially on ‘*the willingness and ability of the minority to mobilize the resources of the organization or institution to improve the situation for themselves and the whole minority group*’ (Dahlerup, 1988, p. 296, emphasis in original). In entertaining this possibility, Dahlerup implicitly revives Kanter’s third claim that feminist women can have an impact above and beyond their token status if they form alliances with one another despite their small numbers.

All the same, Dahlerup overlooks Kanter’s second claim – despite her observations regarding the importance of party identities in dividing women’s loyalties – by underplaying the importance of differences among women and how these might prevent coalitions among them when they are present in higher or lower numbers (Dahlerup, 1988, p. 293). Still, Dahlerup remains guarded in her predictions when she links critical acts to larger proportions of women by stating that a ‘growing feminist consciousness among a growing number of women politicians could mean that women are reaching an important turning point, becoming a critical mass (Dahlerup, 1988, p. 293). In her view, therefore, critical acts, the work of individuals, precede but do not necessarily lead to a critical mass, a larger group whose influence inevitably leads to dramatic political change. This shift in focus thus transforms the optimistic outcomes implied by the notion of ‘critical mass’ into a much more contingent future in which outcomes depend closely upon the actions of particular individuals.

The multiple strands and occasional inconsistencies in Dahlerup’s argument easily foster a range of distinct interpretations about whether – and in what ways – numbers matter.⁵ When she discusses changes in the reaction to female politicians, for example, she writes that ‘the presence of women politicians in great numbers does make it seem rather hopeless to try to remove women from the public sphere today. So numbers do count’. She elaborates by explaining that ‘following the growing number of women in politics, stereotyping decreases, because so many different types of women now occupy the political arena’ (Dahlerup, 1988, p. 285). She then adds, however, that ‘it is not possible to conclude that these changes follow from any fixed number of women, e.g. 30 per cent’. Rather, ‘the example of just a few successful women in top positions ... may

have contributed substantially to the change in the perception of women as politicians', leading her to conclude that 'in such cases it is not numbers that count, but the performance of a few outstanding women as role models' (Dahlerup, 1988, p. 287). Dahlerup presents similar arguments across the five other areas that combine individual and collective explanations by switching between statements like 'the entrance of just one woman into an all male group ... changes the discussion and behaviour of that group' and the 'higher the proportion of women, the more social conventions will change' (Dahlerup, 1988, p. 290). As a result, her preference for the concept of 'critical acts' sits alongside comments that 'the opportunity for women to form majority coalitions ... increases when they constitute 30 per cent, rather than 5 per cent' (Dahlerup, 1988, p. 294), an assertion that relies on an assumption about numbers and outcomes that she ultimately rejects.

'Critical Mass Theory' and Women's Legislative Behaviour

Interested in analysing women's legislative behaviour, many subsequent gender and politics scholars draw on the work of Kanter and Dahlerup in order to understand why the increased presence of women in legislatures does not always translate into women-friendly policy outcomes. Reviewing nearly twenty years of literature, we find that – following Dahlerup – many reduce Kanter's three expectations into one, anticipating that increased numbers will facilitate coalitions among women. At the same time, nearly all frame Dahlerup's work as if she had made a strong case in favour of the critical mass concept. As such, applications adopt Kanter's first claim and Dahlerup's notion of 'critical mass', while critiques present evidence that corroborates the second and third claims of Kanter and the idea of 'critical acts' introduced by Dahlerup. We characterise these misrepresentations as 'critical mass theory', recognising that even if these accounts distort the work of Kanter and Dahlerup, these ideas have played a central role in organising research on the substantive representation of women.

Applications of 'critical mass theory' draw on the concept to explain a range of different outcomes, most obviously instances where increased numbers of women result in greater attention to women's issues, but also cases where increased numbers of women result in little or no change, on the grounds that women may not yet constitute a 'critical mass'. These studies assume that the percentage of women in the institution is the *key* determinant of their behaviour. As such, they reflect a 'politics of optimism' that gender differences can be eliminated and, especially, that women's progress can proceed on a non-conflictual basis, provoking little or no reaction from men as a group (compare Blum and Smith, 1988). Empirically, these accounts find that legislatures with high proportions of women introduce and pass more bills on women's issues than their female counterparts in low-representation legislatures (Bratton, 2005; Thomas, 1991; Thomas, 1994). Further, they discover that as the number of women increases, the number and rate of enactment of such bills also increases (Saint-Germain, 1989; Skard and

Haavio-Mannila, 1985), including as a total proportion of the total legislation they introduce (Vega and Firestone, 1995). They explain these changes in terms of the more supportive legislative environment produced by the presence of more women, which leads even those who do not view themselves as representatives of women or women's issues to be drawn into the process (Flammang, 1985). This work thus focuses exclusively on opportunities for women to form coalitions with one another, anticipating that a 'critical mass' of women will be sufficient to promote women-friendly policy outcomes.

Critiques of 'critical mass theory', in contrast, focus primarily on cases where policy change does not occur, even as the percentages of women in the legislature reach 'critical mass' proportions, identified at levels ranging from 10 per cent to 40 per cent (Childs, 2004; Grey, 2002; Lovenduski, 2001; Norrander and Wilcox, 1998; Towns, 2003).⁶ This second set of authors is thus much more sceptical of the magic of numbers and attempts instead to delineate the various boundary conditions that may prevent women from pursuing reforms addressing women's concerns. Focusing on the limits of proportions, they call attention to the opportunities and constraints that stem from political party affiliation (Childs, 2004; Poggione, 2004), legislative committee membership (Norton, 1995; Swers, 2004), institutional norms (Considine and Deutchman, 1996; Kathlene, 1995; Rosenthal, 1998), legislative inexperience (Cowley and Childs, 2003; Jeydel and Taylor, 2003) and the external political environment, including the electoral system (Swers, 2004; Tremblay, 2003). These structures are compounded by potential for backlash, which generally increases as the number of women rises (Kathlene, 1995; Towns, 2003; Yoder, 1991; compare Heath *et al.*, 2005). For this reason, women may be more effective when they are fewer, as they can mobilise individually (Crowley, 2004) or through women's legislative caucuses (Reingold, 2000; Thomas, 1991) to achieve gains for women without having to contend with the opposition of powerful men. As such, these scholars reject 'critical mass theory' but in fact provide empirical support for Kanter's and Dahlerup's intuitions regarding diversity among women, mobilisation despite small numbers and the potential for 'critical acts' at all levels of descriptive representation.

Conclusions

In this research note, we address recent concerns about the utility of 'critical mass' as a concept in research on women's political representation. To explore the terms of this debate, and thus propose a way forward, we engage in a close reading of the two founding authors of this literature, Kanter and Dahlerup, to outline their intuitions about policy change as the proportion of female legislators grows. Although we highlight ambiguities and shortcomings in their formulations, we argue that subsequent gender and politics research fundamentally misinterprets their contributions. More specifically, it frames 'critical mass theory' as if both authors had made only one claim about the impact of rising female representation, namely that increased numbers would enable women to form supportive

coalitions among one another to promote feminist-oriented policy change. Ironically, the misinterpretations that underlie 'critical mass theory' have played a crucial role in the spread of gender quotas around the world, by enabling advocates to lobby successfully for such measures on the grounds that greater numbers of women in politics are required before individual female legislators can begin to 'make a difference' in gendered policy debates. Given its resonance as a tool for change, activists are thus unlikely to give up on 'critical mass' any time soon (Childs and Krook, 2006). Nonetheless, scholars ought to adopt a more guarded approach: rather than simply assuming that women will form alliances with other women as their numbers increase, they must investigate multiple possibilities in the relationship between women's descriptive and substantive representation.

In place of 'critical mass theory', we propose two means by which gender and politics scholars might rethink – and thus study empirically – the links between women's descriptive and substantive representation. First, we argue for shifting the central research question from '*when* women make a difference' to '*how* the substantive representation of women occurs'. Second, we suggest moving the analytical focus from the macro to the micro level, replacing attempts to discern 'what *women* do' to study 'what *specific actors* do'. Combined, these reformulations open up a series of new possibilities for exploring legislative behaviour, not least by relaxing overly restrictive analytical frames regarding the actors, form and content of 'acting for women' (Childs and Krook, 2006). In particular, this new approach allows for more careful study of 'critical actors' in women's substantive representation. Male or female, these legislators can be identified as those who initiate policy proposals on their own and often – but not necessarily – embolden others to take steps to promote policies for women, regardless of the number of female representatives present in a particular institution. Attention to these actors, we argue, offers new opportunities for exploring the legislative behaviour of women – and men – who mobilise on behalf of women as a group, and thus for identifying various possible paths to the improved substantive representation of women's concerns.

(Accepted: 4 June 2007)

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Notes

- 1 The current world average for the lower house of parliament is 17.3 per cent women. The national parliaments with the highest numbers of women are Rwanda with 48.8 per cent women and Sweden with 47.3 per cent women (Inter-Parliamentary Union, 2007a; 2007b).

- 2 In skewed situations, everything that a token woman does attracts public notice such that her actions have symbolic consequences for all women. In such a context, many women seek to limit their visibility by, among other things, 'adopting "mannish dress"' (Kanter, 1977a, p. 974).
- 3 When differences between token and dominant groups are emphasised, tokens are often subject to loyalty tests where being 'one of the boys' means being against 'the girls' (Kanter, 1977a, p. 979).
- 4 The distinction between 'critical mass' and 'critical acts' is sometimes conflated in the literature. In their rebuttal of the 'critical mass hypothesis', for example, Studlar and McAllister (2002) in fact test a 'critical act', the recruitment of more women.
- 5 These inconsistencies are resolved in an interesting way in Dahlerup's later work with Lenita Freidenvall, where they argue that critical mass dynamics do not characterise countries that have followed an 'incremental track' to increased representation, like the Nordic countries, but might characterise countries that have followed a 'fast track' thanks to the use of quotas (Dahlerup and Freidenvall, 2005).
- 6 This more critical literature, however, is much more open than earlier studies to multiple ways of operationalising 'critical mass', although this openness probably derives from attempts to delineate its boundary conditions through the exploration of non-linear and exponential operations (compare Bratton and Ray, 2002; Celis, 2004; Grey, 2002; Schwindt-Bayer and Mishler, 2005).

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