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Matching productivity indexes and diachronic evolution: The Old English affixes ful-, -isc, -cund, *and* -ful

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1. AIMS AND SCOPE

This article deals with morphological productivity, a topic that has drawn a good deal of attention within the field of morphology in the last few years. Productivity, in its classic definition, is "the possibility which language users have to form an in principle uncountable number of new words unintentionally, by means of a morphological process which is the basis of the form-meaning correspondence of some words they know" (Schultink 1961, in Plag 1999:13).[1] In Aronoff and Anshen's (2001:242) words, "morphological productivity is the extent to which a particular affix is likely to be used in the production of new words in the language". In order to integrate the diachronic dimension, Bauer (2004:87) distinguishes between two aspects of productivity, namely availability and profitability. Availability makes reference to whether a given process can be used for producing new words, while profitability is concerned with the frequency of a given morphological process. It follows that on the synchronic axis the assessment of productivity focuses on availability and puts aside diachronic processes such as bleaching, loss of semantic analysability, and lexicalization; on the diachronic axis, the assessment of productivity revolves around profitability.

As regards the applications to the morphology of English, though a significant number of studies engage in the productivity of affixes in Present-Day English, such as Plag (1999), Lieber (2005), Kaunisto (2007), and Mühleisen (2010), to cite just a few, other diachronic stages of the English language remain practically unstudied. In this sense, the works on the productivity of Middle English word-formation by Dalton-Puffer (1996), Ciszek (2008), and Lloyd (2011) are exceptional. The same can be said of the studies in the productivity of some Old English affixes by Trips (2009), Haselow (2011), Maíz Villalta (2011, 2012), and Mateo Mendaza (2012,

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[1] See Bauer (2005) for a historical review of productivity theories.

2014). The relatively low number of works in this area is probably due to the nature of empirical data. In spite of the advantage of the absence of new formations, the analysis of morphological productivity in historical languages faces the problems of accessibility, reliability and representativeness. Kastovsky (1992) and Lass (1994) attribute the difficulty of assessing morphological productivity in a historical language to the coexistence of the lexical output of productive and unproductive word-formation processes, which leave at least part of their result in the vocabulary.[2] Kastovsky (1992:356–358) also stresses the diachronic variation of transparency and points out that there is no direct way of testing productivity and, consequently, that the researcher has to rely on indirect evidence such as the frequency or continuity of the process in question. Lass (1994:193) remarks that it is hard to decide whether the occurrence of a derived form constitutes an institutionalized lexical item or a new formation. Given these difficulties, the solution that is often adopted when dealing with morphological processes from a historical perspective is to measure frequency rather than productivity. In Haselow's (2011:89) words:

> In view of the various factors that determine the productivity of a given word-formation process, a study like the present one cannot make use of the term 'productivity' since it is only based on the frequency of attested forms with a particular suffix and does not include hapaxes. Therefore, the term 'frequency' will be used whenever reference to the diachronic development of suffixes is made.

In a more comprehensive approach, Trips (2009:37) finds a point of contact between lexical creativity and morphological productivity so that a new type "implies a new rule or the exploitation of a new rule". There is, to put it another way, "a correlation between hapaxes and neologisms ... implying that the number of hapaxes can be seen as an indicator of productivity" (Trips 2009:37–38). This background not only prompts investigation into productivity in historical languages but also suggests doing so by considering factors additional to frequency, including hapaxes.[3]

With a view to contributing to this line of research, the aim of this article is to compare the productivity measurements of four Old English adjectival affixes, namely, the prefix *ful-* and the suffixes *-isc*, *-cund*, and *-ful*, and to check such measures against the evolution of the affixes. The selection of these affixes is motivated not only by their function of forming adjectives but also by the results of previous research. Mateo Mendaza (2012) compares the productivity of *-isc* and *-cund*, which compete for the expression of similar meanings, and later Mateo Mendaza (2014) gauges the productivity of *ful-* and *-ful* on the grounds of their common origin. In both cases, the only index taken into account was Baayen's hapax legomena approach on productivity. The frameworks brought to the discussion include the ratio of Type Frequency, together with Baayen's (1992, 1993, 2009) and Trips's (2009) statistical

[2]See Martín Arista (2011, 2014) on lexical layers in general and Old English word-formation in particular.

[3]Frequency can be measured with respect to the total number of headwords in a dictionary (*Type Frequency*) and the total number of words in a corpus (*Token Frequency*), although when productivity is gauged on the basis of frequency, it is *Type Frequency* that is generally preferred (thus Dulton-Puffer 1996). See also Bauer (2004) on type and token frequency.

measures of productivity. As in Plag (2003:44), productivity is a property of affixes. The analysis of the affixes is restricted to adjective formation. The expected results include a quantitative assessment of the productivity of the affixes under scrutiny and an evaluation of the available formulae of productivity on the grounds of their compatibility with the history of the affixes under analysis.

The outline of the article is as follows. First of all, the Type Frequency measure for each affix is gauged and the theories of productivity developed by Baayen (1992, 1993, 2009) and Trips (2009) are reviewed in section 2. Section 3 addresses further methodological questions, including empirical evidence. Section 4 provides accounts of the historical developments observed in connection with each affix. Section 5 focuses on the analysis of productivity, whereas section 6 assesses the results obtained from each measure with respect to the continuity of the affixes. Finally, some concluding remarks on the assessment of productivity are offered in section 7.

2. GAUGING MORPHOLOGICAL PRODUCTIVITY

Aronoff (1976) establishes a frequency model based on the ratio of actual (V) to possible (S) words, that is to say, the formula I = V/S, as formalized by Baayen (1989). Aronoff (1976) proposes counting up every word formed in the process under investigation (actual words) and then listing, in a rather intuitive way, every possible word that can be created through that process in order to get its productivity index. Aronoff (1976) himself finds some objections to his formula, including the lack of some actual types in the corpora and/or dictionaries (Baayen and Lieber 1991), as well as the high number of restrictions on the bases that limit the productivity of an affix.[4] Anshen and Aronoff (1981:66, in Scherer 2005:258) also point out that the productivity of a word-formation pattern "can not be determined absolutely, but only with reference to the morphology of its base". This means that the productivity of an affix cannot be measured with respect to a whole morphological category such as the adjective, for example but it can be stated that "*-ness* is more productive than *-ity* when attached to adjectives of the form X_{ive}*(perceptive)*" (Štekauer 2000:142), that is, with adjectives of a specific morphological subclass. Nevertheless, the weakest point of Aronoff's (1976) formula is the number of possible words, which seems impossible to measure (Štekauer 2000:141) given that, if a process is productive, the number of possible words with this process would be infinite and thus uncountable (Zimmer 1964, in Aronoff 1976:45; Plag 1999). Given the indeterminacy of the value S, only the number of actual words, or types (V), should be taken into consideration. Therefore, this index of productivity would be reformulated as I = V (labelled as *Extent of use* by Baayen 1993), where the index of productivity (I) resembles the number of types (V), so that the higher the number of types, the higher the degree of productivity of the process. At this point, this index of productivity clearly overlaps with the Type Frequency measure (I = V) applied by other authors such as Plag (1999, 2006) and Bauer (2001), where productivity is described in terms of the counting of types.

[4] On constraints and restrictions on morphological processes, see Booij (1977), Plag (1999, 2003, 2006), Bauer (2001), Rainer (2005), and Fernández-Domínguez et al. (2007).

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By elaborating on the Type Frequency proposal, some indexes based on frequency have been proposed. Some of them relate Type Frequency to the number of headwords in a dictionary (Baayen and Neijt 1997; Maíz Villalta 2011, 2012). Others combine the counting of types and tokens in a corpus (Haselow 2011). In a more refined analysis, the *type/token* ratio (Baker 2006, Fernández-Domínguez et al. 2007, Trips 2009) is a percentage index that is directly proportional to productivity. Less frequently used is its reversal measure, the *Mean Word Frequency* (Baayen 2001), which results from dividing the number of tokens by the number of types. The index of *Relative Frequency* (Hay and Baayen 2002, Hay 2003) is the ratio of the number of occurrences of the derived word to the frequency of the base word. This index determines how frequently the derivative occurs in relation to its base, in such a way that the Relative Frequency of an affix is inversely proportional to productivity and semantic transparency.

Baayen (1992, 1993, 2008) has developed a model that, in spite of being purely quantitative as frequency models, calculates the probability of encountering new formations in the language.[5] The main advantage of this model is that it can offer a dynamic view on productivity, in contradistinction to the static picture provided by frequency models. Its building blocks are the indexes of *Narrow Productivity* (P), *Hapax-Conditioned Degree of Productivity* (P*), and *Global Productivity* (G). These measures rely on the counting of types (V), that is, the number of different formations with a given morphological process found in the corpus; tokens (N), the total number of words with an affix in the corpus; and the number of *hapax legomena* (n_1), also known as *hapaxes*. These are words occurring only once in the corpus, which are of paramount importance for the assessment of productivity. Indeed, Baayen (2009:15) remarks that hapaxes represent the likelihood of neologisms appearing in the language.

The index of Narrow Productivity is defined as a statistical measure that expresses the probability of new types resulting from a morphological process appearing in the corpus if its extension grows and, consequently, the probability of creating new words with that process in a given language. This index is calculated by dividing the number of hapaxes by the number of tokens with the affix under scrutiny, thus $P = n_1/N$. However, equating hapaxes to the number of neologisms in the given language is not uncontroversial. Words occurring once may represent innovations but also well-established lexical items, including lexicalized forms and morphological residues about to disappear (Kastovsky 1992, Lass 1994). For this reason, Baayen (2001, 2008, 2009) also considers other low frequency words, such as words occurring twice, the so-called *dis legomena*, or even words occurring three times, as possible representatives of neologisms, since, at some stages of a language, a new word is likely to occur more than once.[6]

[5]Recent works by Baayen also insist on the importance of qualitative factors and morphological processing (Hay and Baayen 2002, 2003; Plag and Baayen 2009).

[6]Brown (2001) and Pustylnikov and Schenider-Wiejowski (2009) best illustrate the use of dis legomena for assessing productivity.

In this line, Baayen (1993) introduces a complementary measure to Narrow Productivity index, which he labels Hapax-Conditioned Degree of Productivity (P*). Given that the index of P determines the probability of coming across new types for each affix in isolation, the index of P* let us know the contribution of each affix to the corpus as a whole. The formula provided by Baayen (1993:193), $P^* = n_{1,E,t}/h_t$, is described as the number of hapaxes (n_1) from a certain word class in the corpus ($_{E,t}$), to the total number of hapaxes (h_t) within the corpus under analysis. Therefore, P* estimates the conditional probability of an additional token belonging to the morphological category under analysis, given that this word token represents a new word type (Baayen 1994:6).

Since neither the index of P nor the index of P* take into account Type Frequency, as previous studies do, Baayen (1992:123) distinguishes the index of Global Productivity (G).[7] It is described as a bi-dimensional measure that shows graphically the degree of productivity of the affixes. The horizontal axis stands for P, the degree of productivity previously calculated, whereas the vertical axis shows the extent of use of the affix in the corpus, that is, V. The interpretation of this visual data suggests that the closer a morphological process appears to the bottom left-hand corner, the less productive it will be, whereas productive processes will appear at the upper right-hand corner of the figure.

Overall, the indexes of P and P* constitute a step forward in the study of productivity due to the incorporation of hapaxes as well as the index of G that integrates the ratio of Type Frequency into the formulae. For these reasons, Baayen's (1992, 1993) productivity indexes are widely used and adopted by most studies in productivity.[8]

Finally, in her study of the suffixes *-hood*, *-dom*, and *-ship*, Trips (2009) draws on Baayen's idea about the importance of hapaxes as representatives of neologisms. With this statement in mind, Trips (2009:38) advances her own criterion of productivity:

> A productive series of formations is defined as the occurrence of formations with a morphological category with *at least* two hapaxes where a hapax is a new type built by a new rule and a new type exploiting that new rule.

This criterion differs from the other indexes substantially because, instead of providing a continuum of (un)productivity, it establishes a cut-off point that differentiates between productive and unproductive formations on a discrete basis.

3. FURTHER METHODOLOGICAL QUESTIONS: THE SOURCE OF EMPIRICAL DATA

Previous works in morphological productivity reflect the difficulty of selecting adequate data sources. Whereas some authors such as Plag (1999) stress the advantages of dictionaries for gauging productivity, other authors (Baayen and Renouf 1996)

[7] See the arguments against Narrow Productivity by Van Marle (1992), Plag (1999), and Bauer (2001), among others.

[8] These include, among others, Brown (2001), Scherer (2005), Fernández-Domínguez et al. (2007), Pustylnikov and Schenider-Wiejowski (2009), Trips (2009), and Majtényi (2012).

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claim that corpora are the most reliable tools when it comes to measuring productivity indexes.[9] The arguments in favour of and against dictionaries and corpora as sources of data for productivity studies can be summarized as follows. Dictionary-based accounts (e.g., Cannon 1987; Plag 1999, 2006) point out the fact that some dictionaries such as the *Oxford English Dictionary* offer a thorough view of the lexicon and provide the reader with the historical information needed to place the words in the corresponding period of time so that neologisms can be easily identified. Moreover, lexicographers examine larger quantities of data than those typically found in an electronic corpus. An important consequence of this is that the addition or deletion of a dictionary type does not modify an index of productivity substantially while the addition or deletion of corpus tokens changes the index of productivity significantly. Finally, it is possible to determine the productivity of converted items with a dictionary-based account whereas this cannot be as easily measured in a corpus. On the other hand, dictionaries are written with commercial aims and therefore list not every single word in a language but the most frequent and idiosyncratic ones. The reason for this is that dictionary users can predict the meaning of some complex words, especially of those constructed on productive patterns or resulting from inflection and thus these words are often omitted. Lexicographers, as users of language, may also forget or deliberately omit other words on the grounds of their predictability. Another factor that may affect the analysis of morphological productivity by means of dictionaries is that, while productivity needs to be measured in terms of synchrony, dictionaries tend to include some archaisms that can be considered residues of formerly productive morphological processes.

This brief review shows that, in spite of some shortcomings, both approaches have advantages and, consequently, the methodology of analysis of this research combines both sources of data. The lexicographical sources include the lexical database of Old English *Nerthus* (www.nerthusproject.com) whereas the textual source is the *Dictionary of Old English corpus* (henceforth *DOEC*). *Nerthus* contains approximately 33,000 entries or headwords based mainly on Clark Hall's *Concise Anglo-Saxon dictionary* (1996), Bosworth and Toller's *Anglo-Saxon dictionary* (1973), as well as Sweet's *Student's dictionary of Anglo-Saxon* (1976). The *DOEC* (Healey et al. 2012) consists of 3,060 texts of different genres dated from the 6th century until the end of the Old English period (1150 AD). This represents all surviving written records of the language, approximately a total of 3,000,000 words, which can be considered a quantitatively and qualitatively representative corpus for carrying out a study in morphological productivity.

4. THE AFFIXES ON THE DIACHRONIC AXIS

Once the theoretical background and the methodology have been presented, the next step is to consider the affixes under analysis on the diachronic axis. This involves determining whether their productivity has changed throughout linguistic evolution and, if it has, to decide if it has increased or decreased. An important difference arises

[9] See also Štekauer (2000:157).

with respect to the synchronic analysis of the affixes that deserves some explanation. Whereas the synchronic part relies on the direct analysis of the lexicographical and textual sources and is basically statistical, the diachronic part resorts to secondary sources and, consequently, is qualitative rather than quantitative.

Beginning with the Old English suffix *-isc*, it mainly derives adjectives of place and origin (*frencisc* 'French', *denisc* 'Danish'), as well as some adjectives from existing nouns (*mīlitisc* 'military', *ūtlendisc* 'strange, foreign') with the meaning 'being like, having the character of'. The modern spelling of the suffix (*-ish*) was adopted in the Middle English period, a stage in which *-ish* continues to be used with names of places and origin (*English, Spanish, Icelandish*) and for describing a quality (*aguish, clearish*). The increase in the productivity of *-ish* during the Middle English period is reflected by the development of new meanings of this suffix, including the derogatory and mitigating (*cheapish, coldish*) and the sense of 'nearing, but not exactly' with colour adjectives (*yellowish, blackish, reddish*), which can be dated to the end of the Middle English period. Between the 16th and 17th century, the suffix *-ish* is attached to verbs to create new adjectives denoting the expression of tendency to do something (*peckish, ticklish*) and, as Marchand (1969:305) remarks, *-ish* also creates less frequent derivatives from particles, such as *uppish* 'arrogant, proud' or *offish* 'inclined to keep aloof' and pronouns, such as *ittish* 'sexually attractive' and *selfish*. The meaning 'nearing, but not exactly' paved the way for new combinations of the suffix with other adjectives to denote approximation (*oldish, narrowish*) and, currently, this meaning is also expressed when the suffix is attached to numbers and numerical expressions such as *fifty-ish, three-hundred-fortyish*, and *o'clock-ish* (Marchand 1969, Plag 2003, Stein 2007). In Present-Day English, the suffix is also found in combination with some syntactic phrases in specific contexts (Marchand 1969:306, Stein 2007:88), thus *at-homeish, public-schoolish* and even more complex phrases such as *stick-in-the-muddish* or *silly-little-me-late-again-ish* (Plag 2003:96). In addition, the use for describing similarity appears in Present-Day English when the suffix is found with nouns referring to human beings, as in *James-Deanish, vampirish* or *monsterish* (Plag 2003:96). Concerning the number of formations, whereas the suffix *-ish* shows around one hundred types in Old English, the total number of derivatives coined in Middle English increases to almost 190 derivatives (McSparran 2001). A search launched on the British English Word List,[10] containing 79,773 words, shows nearly three hundred derivatives coined with this suffix that are currently used. These results indicate that, along with its uses, the productivity of *-ish* has increased throughout the different stages of the language until the present (Marchand 1969:305).

The suffix *-cund* produces denominal adjectives conveying the meaning 'of the nature of' (*godcund* 'religious, sacred', *heofoncund* 'celestial, heavenly') and has usually religious connotations (Quirk and Wrenn 1994:115, Kastovsky 1992:389). In the case of *-cund*, its productivity decreases as time goes by. This suffix is found for the last time in Early Middle English (Kurath 1998), where only four forms are

[10] Available at: www.curlewcommunications.co.uk/wordlist.html. Consulted 15 January 2011.

kept, namely *godcund*, *gramcund*, *innacund*, and *nāmecund* (McSparran 2001), until its total disappearance in the Middle English period. The loss of this suffix could be motivated by the competition with the suffix *-ish* during the Old English period. These two affixes compete for meaning in cases such as *eorlisc/eorlcund* 'noble' and *heofonisc/heofoncund* 'heavenly'. As has just been remarked, the productivity of the suffix *-ish* increases throughout linguistic evolution, which must have reinforced the preference of the speakers for *-ish* over *-cund* when competition arose and contributed to the loss of the latter suffix.

Regarding the pair of affixes *ful-* and *-ful*, only their adjectival uses have been taken into account in this study. The prefix *ful-* is attached to verbs, adjectives, and nouns to create adjectives with intensifying function in instances such as *fulbeorht* 'very bright, resplendent'. The suffix *-ful* produces adjectives with abstract meaning from nouns (*wuldorful* 'glorious'), adjectives (*geornful* 'eager, desirious'), and more seldomly, from verbs (*sacful* 'quarrelsome, contentious') with the meaning 'having' (Kastovsky 1992:390). Concerning the evolution of these affixes, the productivity of the prefixal counterpart in Old English is in question, since neither Kastovsky (1992:389) nor Marchand (1969:291) consider *ful-* in their inventory of the most frequent prefixes of this period. Moreover, this prefix disappears after/during the Old English period, since the only adjective found with the segment *ful* found in Middle English (*fulsōm* 'abundant, plentiful') does not correspond to the Old English prefix *ful-* but to the suffix *-som*, which becomes very productive during the Middle English period (Marchand 1969). This loss of the prefix *ful-* can be explained by drawing on Hiltunen (1983), Kastovsky (1992), and Martin Arista (2012), who have identified a tendency towards the weakening, omission, or replacement of Old English prefixes. As Welna (2000) explains, *ful-* is replaced by the French form *very*, which also combines with adjectives expressing the same intensifying meaning as the prefix *ful-*. It is also important to highlight that, although it is quite common to find the segment *ful(l)* in initial position in some Present-Day English words (*fulfilling*, *fullback*, *fullness*, ...), this segment does not reflect the Old English prefix, but the free-form *full*, which functions as an adjunct in adjectival compounds and as modifier in syntactic phrases.

Turning to the suffix *-ful*, Quirk and Wrenn (1994:113) consider it one of the most frequent in the Old English period, notwithstanding its competition with other suffixes that convey a similar meaning, as is illustrated by pairs such as *θrymfæst/θrymful* 'glorious', *ælmesfull/ælmesgeorn* 'charitable', *sorgful/sorig* 'sorry', *sandful/sandiht* 'sandy', *wundorful/wundorlic* 'wonderful', *geðancful/geðancol* 'thoughtful', *genyhtful/genyhtsum* 'abundant', and *rihtful/rihtwīs* 'righteous'. Instead of suffering a gradual loss of productivity, as in the case with *-cund*, the suffix *-ful* prevailed over the rest of the affixes discussed in this article. Indeed, most of the affixes competing with *-ful* progressively disappeared in time. The only exceptions are the suffixes *-sum* (-some) and *-wis* (-wise), which are still very productive in Present-Day English. Some examples of derivatives with *-some* and *-wise* found in the British English Word List (2010) are *adventuresome*, *brothersome*, *darksome*, *quarrelsome*, *piecewise*, *moneywise*, *slantwise*, and *stepwise*. The diachronic evolution of the language is witness to the availability of *-ful*: whereas Old English presents around

one hundred derivatives, in Middle English, there are more than 350 adjectives to which this suffix has been attached, like *almightful* 'almighty, omnipotent (God)', *mislēveful* 'misbelieving, unbelieving', and *tēneful* 'injurious, harmful; pernicious'. In distinction to the prefix *ful-*, during the period of linguistic contact with French, new formations appear such as *merciful, guileful* and *joyful*. Moreover, a new use develops at the beginning of the Middle English period whereby the suffix *-ful* combines with verbs to create adjectives with the sense of 'tending to, apt to what is denoted by the verb', thus *forgetful, wakeful, helpful* (Marchand 1969:292). Nevertheless, around the 17th century, the productivity of *-ful* gradually decreases and there are but a few new formations coined with this suffix (Marchand 1969:291). This reduction in the productivity continues to the present day. Indeed, the British English Word List (2010) contains no more than 150 derivatives of the suffix *-ful*. This may be due to the competition with other suffixes that convey a similar meaning such as *-ed, -ous, -some*, and *-y* (Stein 2007:59). Among its uses in Present-Day English, the suffix *-ful* combines with whole words, native and non-native bases, and, occasionally, roots (Lieber 2005:385) in order to form adjectives with a similar meaning to that which they had during the Old English period. Hence, instances can still be found of denominal adjectives which mean 'having or showing what is denoted by the noun' (*cheerful, colourful, lawful*), 'causing what is denoted by the noun' (*frightful, painful, beautiful*) and of deverbal formations (Marchand 1969:291, Plag 2003:96, Stein 2007:59).

To sum up, the suffix *-isc* has undergone an increase in its distribution and range of meaning from Old English to Present-Day English. In the case of *-ful*, while its productivity has decreased in time, its uses have been enlarged from the Middle English period onwards. On the other hand, *-cund* and the prefix *ful-* have lost their productivity and in practice have disappeared as a result of affix competition and the re-structuring of the affix system caused by lexical borrowing. Given this evolution, the next section turns to the synchronic axis in order to determine which productivity indexes are the most compatible with the evolution of the affixes.[11]

5. THE AFFIXES ON THE SYNCHRONIC AXIS

To recapitulate, this research focuses on three different approaches to productivity, namely, Type Frequency measure; Trips's (2009) proposal, which comprises the Type/Token Frequency ratio, the Relative Frequency ratio, and the criterion of productivity; and Baayen's (1992, 1993) index of P (Narrow Productivity), its complementary measure of P* (Hapax-Conditioned Degree of Productivity), and the index of G (Global Productivity). These indexes are used to determine the productivity of the affixes *-isc*, *-cund*, *-ful*, and *ful-* in the Old English period. Given the nature of the different indexes under investigation, this study relies on both textual and lexicographical sources.

[11] For a quantitative analysis of the semantic functions of adjectival affixes, we refer the reader to Vea Escarza (2012a, 2012b, 2013). See also Martín Arista (2011, 2013).

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Emerging from the reformulation of Aronoff's (1976) formulae of productivity, the Type Frequency measure (I = V) is mainly based on the quantification of types (V). The counting of types in the corpus conveys the results presented in Table 1.

Table 1: Type Frequency in the *DOEC*

Affix	*V*
-isc	590
-cund	94
-ful	512
ful-	21

The Type Frequency measurement concludes that, as can be seen in Table 1, the suffixes *-isc* and *-ful* are the most productive affixes, followed at a distance by the suffix *-cund* and the prefix *ful-*.

Turning to Baayen's P, the quantification on the basis of tokens (N) and hapaxes (n_1) gives the results tabulated in Table 2.

Table 2: Narrow Productivity (P) based on hapax legomena

Affix	*N*	n_1	*P*
-isc	3,893	240	0.062
-cund	1,021	41	0.04
-ful	2,818	194	0.07
ful-	80	10	0.125

In terms of P, the prefix *ful-* is clearly the most -productive. While the suffixes *-ful* and *-isc* show -similar indexes, the index of *-cund* decreases as the number -of tokens increases with respect to the other affixes.

In order to measure these results as a whole, the index of P* is applied. Given that the total number of hapaxes in the corpus is 106,787, the contribution to the growth of the corpus of the affixes is presented in Table 3.

Table 3: Hapax-Conditioned Degree of Productivity (P*)

Affix	n_1	*P**
-isc	240	0.0022
-cund	41	0.0004
-ful	194	0.0018
ful-	10	0.0001

In terms of P*, *-isc* is the most productive affix, closely followed by *-ful*, whereas the productivity of the suffix *-cund* is far from these two affixes. On the other hand,

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in contrast to the results displayed by P, the P* shows that the prefix *ful-* is the least productive affix.

The index of G, which incorporates P and types (V), produces the results presented in Table 4, which correspond to the graphic representation in Figure 1.

Table 4: Global Productivity (G) based on hapax legomena

Affix	*P*	*V*
-isc	0.062	590
-cund	0.04	94
-ful	0.07	512
ful-	0.125	21

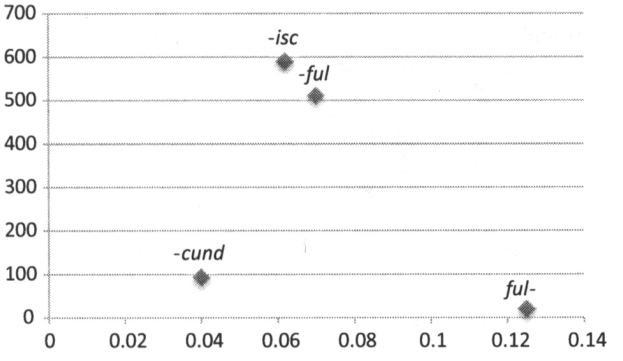

Figure 1: Global Productivity (G) based on hapax legomena

The interpretation of the graphic representation in Figure 1 is as follows. The affix with the highest index of G would be often used, as indicated by V, and there is a higher probability of encountering new forms coined with this suffix, as is denoted by P. For these affixes, while *-cund* presents low results both in terms of V and P, the index of P for the prefix *ful-* is the highest one, although it is not frequently used, as V indicates. On the contrary, although the index of P for *-isc* and *-ful* is lower than that of *ful-*, these suffixes show similar figures. For these situations, Baayen remarks that the number of types (V) deserves more attention, given that, whereas V is a primary measure, P is a secondary index derived from N (Baayen 1993:190). Therefore, in terms of G, the suffixes *-isc* and *-ful* are the most productive ones.

In order to offer a wider perspective, the indexes of productivity are also calculated on the basis of dis legomena (n_2). The indexes of P in terms of dis legomena ($P = n_2/N$) are presented in Table 5.

The comparison of these results with those based on hapax legomena shows that the index of P in general decreases to one half, except for the prefix *ful-*, whose

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Table 5: Narrow Productivity (P) based on dis legomena

Affix	*N*	n_2	*P*
-isc	3,893	143	0.037
-cund	1,021	18	0.018
-ful	2,818	62	0.022
ful-	80	2	0.025

productivity is significantly reduced to a fifth. This reinforces the idea that the number of low frequency words does not always reflect the number of neologisms but often indicates that some residual words are about to disappear, as is the case with the prefix *ful-*, which is gradually lost from the Old English period -onwards.

After obtaining the P index with words occurring twice and given that the number of types remains the same, the index of G in terms of dis legomena can be gauged. It is provided in Table 6.

Table 6: Global Productivity (G) based on dis legomena

Affix	*P*	*V*
-isc	0.037	590
-cund	0.018	94
-ful(l)	0.022	512
ful(l)-	0.025	21

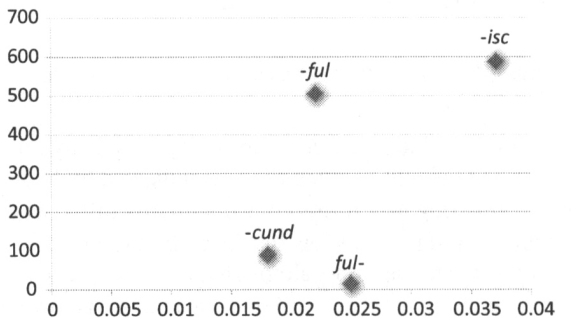

Figure 2: Global Productivity (G) based on dis legomena

The graphic results displayed by Figure 2 are similar to those obtained within the hapax legomena account. The suffixes *-isc* and *-ful* are the most productive affixes in these terms, although the former is more outstanding. The suffix *-cund* appears in the same position as before but the prefix *ful-* is displaced to a lower place with

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respect to the horizontal axis. This is a consequence of the decrease in the index of productivity of *ful-* when it is calculated with respect to dis legomena.

Trips's (2009) criterion of productivity indicates a productivity threshold rather than distinguishing different degrees of productivity. When applied to the affixes under scrutiny, it turns out that all of them are productive because they have at least two hapaxes (see figures for hapaxes (n_1) in Table 2). Trips (2009) also uses other productivity indexes, such as the Type/Token Frequency ratio. As Table 7 shows, *-cund* shows the lowest Type/Token Frequency ratio while the suffixes *-isc* and *-ful* show a similar ratio. One the other hand, the prefix *ful-* significantly outnumbers the rest of the affixes: its ratio is practically double that of *-ful* and *-isc*, which, in turn, is double the Type/Token ratio of *-cund*.

Table 7: Type/token frequency

Affix	*Types*	*Tokens*	*Type/Token Frequency*
-isc	590	3,893	0,1515
-cund	94	1,021	0,092
-ful	512	2,818	0,1816
ful-	21	80	0,26

Calculating the Relative Frequency ratio proposed by Hay (2002, 2003) requires several steps. First, it is necessary to identify the bases of derivation of the types under analysis. The next steps are to quantify the occurrences of the bases in the corpus and to count the tokens with the affixes in question (see detailed results in Appendix A). Finally, the quotient obtained by dividing the number of bases by the number of tokens provides the figures in Table 8.[12]

Table 8: Relative Frequency

Affix	*Relative Frequency*
-isc	≈ 0.32
-cund	≈ 0.052
-ful	≈ 0.217
ful-	≈ 0.005

The results displayed in Table 8 indicate that the prefix *ful-* is by far the most productive, since the lower the ratio of Relative Frequency ratio of an affix, the higher its productivity. The results of the prefix *ful-* are close to those of *-cund* whereas the suffixes *-isc* and *-ful* are remarkably less frequent.

[12] An approximate index (represented by $\approx$) is provided due to the impossibility of identifying some bases of derivation.

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6. PRODUCTIVITY INDEXES AND DIACHRONIC EVOLUTION

This section discusses the strong and weak points of the productivity indexes as applied to the Old English affixes selected in this undertaking.

Beginning with the Type Frequency measure, this index gauges the number of types that stage a certain affix. Consequently, it calculates how frequent a pattern is on the synchronic axis rather than making predictions; that is, it indicates past or realized productivity rather than present productivity (Plag 2003:53, Trips 2009:35, Haselow 2011:89), both in modern and historical languages.[13] Some of the words listed as types may have been accepted by the community a long time ago but they are not regularly used by the speakers of the language. Therefore, that process cannot be said to be productive, since productivity requires that these processes continue to be used throughout time. In the case of the affixes under scrutiny, the results obtained from this index coincide with their evolution. Regarding the divergence between the number of types of *ful-* in the lexicographical source and in the corpus, the former is probably less reliable than the latter, given that dictionaries provide an interpretation of philological data that often includes obsolete, marginal, or reconstructed data.

The Type/Token Frequency ratio relates Type/Token Frequency to productivity so that the higher the ratio, the more productive the process will be. In this research, the results practically coincide with the diachrony of the affixes, except for the prefix *ful-*, which, instead of producing new formations, is gradually lost. These counter-intuitive results cannot be attributed to this ratio, since most of the indexes under analysis present this misstep in the assessment of productivity. Indeed, the rest of the affixes display accurate results in terms of their subsequent history. Nevertheless, although this index seems more dynamic than the Type Frequency measure in that it produces percentage results, it is a strictly synchronic measure of frequency which, as is the case with the Type Frequency measure, cannot predict the number of new formations with the affix in question.

Focusing on the Relative Frequency ratio proposed by Hay (2002, 2003), this measure also presents some limitations. In the case of historical languages, such as Old English, it is sometimes difficult to identify the base of derivation of some complex words, as is the case with *-isc* derivatives such as *arabisc* 'Arabian', *bulgarisc* 'Bulgarian', *cananisc* 'of Canaan, Canaanitish', and *nazarenisc* 'Nazarene'. Although these complex words can be found in lexicographical sources, there is not an entry for their bases of derivation. Moreover, some bases of *-cund, -ful*, and *-isc* derivatives do not have any occurrence in the texts of the *DOEC* (see Appendix A), with which they are likely to constitute ghost entries. Regarding living languages, the research on Present-Day English affixes carried out by Fernández-Domínguez et al. (2007) indicates that, despite the obtained results seeming to reflect the linguistic reality, some difficulties are encountered in the assessment of this ratio. On this issue, Fernández-Domínguez et al. (2007:50) claim that this ratio is restricted to affixation, since it is difficult to select the bases for other word formation processes, such as compounding, conversion or acronymy. Given that this research is only focused on

[13] See Bauer (2001) for other cases in which the number of types does not equal productivity.

affixation, it can be said that Relative Frequency ratio does work in living languages, where affixal productivity is concerned. On the contrary, we are dealing once again with a synchronic analysis from which new formations cannot be foreseen.

As regards the criterion of productivity proposed by Trips (2009), the requirement of the existence of two hapaxes for considering an affix productive seems weak. All these affixes render more than two hapaxes but the analysis and the diachronic evolution have proved that not all of them can be deemed productive. The criterion of productivity might be useful for drawing a principled distinction between productive and unproductive affixes but most of the studies in productivity concur on the scalar nature of the phenomenon, which can show many different degrees.[14] If, following Gruber (1976, in Bauer 1983:322), "to be fully productive, an affix must be usable with all [bases-Bauer] definable by some semantic, syntactic, or possibly phonological property", it is unlikely that many affixes can satisfy the various restrictions and constraints on derivational processes, with which the analysis of productivity has to be aimed at comparing affixes rather than classifying them on a discrete basis.

Turning to probabilistic models, from which conclusions on future productivity can be drawn, Baayen's (1992, 1993) indexes may also pose some limitations in gauging productivity. As already mentioned, the introduction of the notion of hapaxes as an estimate measure for neologims has opened a debate on the role of low frequency words in the assessment of productivity. For this reason, the index of P* is also under suspicion. As he did with the P index, Bauer (2001) questions the reliability of this index and asks whether P* is measuring the right thing. He claims that this index assesses the proportion of new coinages that use a certain affix instead of answering the opposite question about what proportion of words using a certain affix are new coinages (2001:155). Indeed, this index is not devised as an index on its own but a complementary index to P. In this study, the results obtained from the index of P* are compatible with the future evolution of the affixes. However, as a complementary measure, the results do not coincide with those obtained from P. This inaccuracy is also reflected in other studies on productivity conducted by Bauer (2001) and Pustylnikov and Schneider-Wiejowski (2009). This fact contributes to the question of the role of hapaxes as indicators of neologisms.

To continue with the discussion on the role of hapaxes and other low frequency words, Baayen (2009:15) remarks that hapax legomena "only function as a tool for a statistical estimation method aimed at gauging the rate of expansion of morphological categories" and also considers dis legomena and tris legomena although it is not clear whether, concerning P, dis legomena should be measured independently or together with hapaxes. Brown (2001) argues for a combined analysis of hapax and dis legomena in the measure of productivity. In this study, this means that affixes presenting low Type Frequency, such as *ful-*, would be clearly favoured because the figure of low frequency words would increase, thus approaching the number of tokens and increasing the productivity index (see Appendix B). For this reason, it has been preferable to quantify hapax legomena and dis legomena separately. The result is that all affixes undergo a reduction in their productivity index, notably the prefix *ful-*. The

[14] See Bauer (2001:15) on degrees of productivity.

reason for this divergent evolution may be couched in terms of word position, which is tantamount to saying morphological process. This is to say, the grammaticalization of *ful-* in initial position, which entails a change of morphological process from compounding to prefixation, may be related to the loss of productivity and eventual loss of the prefix. Cases like this bear on the question of the role that low frequency words play in the discussion of productivity.

Dealing with Baayen's measures on productivity, the index of P gives figures compatible with the history of the affixes, except for the prefix *ful-*. This situation can be compared to the study on the Dutch suffix *-ster* carried out by Baayen (1993) and necessitates reference to the markedness hypothesis. When it comes to productivity, the marked member of a pair is less productive whereas the unmarked member is the most productive one (Greenberg 1966, in Bybee 2001, Bauer 2001). In terms of frequency, the marked member presents a lower number of types than the unmarked one. Therefore, *ful-*, with 21 types, can be considered the marked member and *-ful*, with 512 types, is the unmarked one (see Table 1). Therefore, with respect to the markedness hypothesis, *-ful* should be the most productive member of this pair. The same situation holds for Baayen's (1993) analysis of Dutch affixes, where the marked form *-ster* erroneously presents a higher index of P than its counterpart *-er*. Such cases led Baayen to propose his index of G. In general terms, the index of G yields accurate results for the affixes under analysis. Given its visual nature, it may pose some limitations in the comparison of affix productivity and, also, when one affix shows a high number of types and a low index of P and another affix presents opposite values. For these cases, it has been established that the number of types (V) deserves more attention, given that, whereas V is a primary measure, P is a secondary index derived from N (Baayen 1993:190).

This being said, it has been shown that most of the formulae used for the assessment of productivity present some weaknesses, especially when applied to historical languages. As for the P* measure, this index has proved to be the simplest way to measure productivity when it is considered a proper index of productivity on its own. However, if it is defined as a complementary measure of P, the results do not always coincide.

All in all, the index of G proposed by Baayen (1993) has proved the most reliable and complete measure of productivity. Even though some linguists such as Bauer (2001) discuss its accuracy, several studies in morphological productivity (Plag 1999, Scherer 2005, Fernández-Domínguez et al. 2007) present consistent results when this index is applied. This is the case because it establishes an indirect relation between Type Frequency, which describes the affixes in synchronic terms, and Narrow Productivity, which tries to determine the probability of encountering new formation on the diachronic axis.

7. Conclusion

Having measured the different indexes of productivity and considered the diachronic evolution undergone by the prefix *ful-* as well as the suffixes *-cund, -isc*, and *-ful*, the following conclusions can be drawn.

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On the descriptive side, the suffixes *-isc* and *-ful*, maintained in Present-Day English, are more productive than the prefix *ful-* and the suffix *-cund*, which have lost their productivity and disappeared. The case of the prefix *ful-* is remarkable because, in spite of its well-attested loss, it shows the highest indexes of productivity with most of the formulae selected for the analysis. As described in the previous section, the counterintuitive results for *ful-* can be checked against the markedness hypothesis and explained by the role of low frequency words.

On the methodological side, this research has tried to determine which index of productivity is the most accurate and reliable one for the historical data under scrutiny. On the grounds of the Old English origin and evolution of the affixes discussed in this article, the index of G accounts for the data in the most faithful way, given that it takes into account both frequency and probabilistic data. On the other hand, since all the measures show some shortcomings or inconsistencies, the search for an overall productivity index still remains a task for future research.

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APPENDIX A

Table A-1: Relative frequency for *-isc* derivatives

Derived word	*Base frequency*	*Tokens*	*Derived word*	*Base frequency*	*Tokens*
Africanisc	42	6	Dūnlendisc	6	2
Alexandrinesc	40	5	Ebrēisc	2	159
Amalechitisc	—	1	Egiptisc	4	108
Ambrosianisc	17	1	Elðēodisc	7	3
Amonitisc	—	5	Englisc	4	749
Amoreisc	3	3	Eorlisc	524	6
Antiochisc	28	2	Ēowerlendisc	—	2
Arabisc	12	8	Ethiopisc	—	2
Armenisc	17	1	Falisc	—	2
Arrianisc	—	19	Fariseisc	1	5
Assirisc	3	1	Folcisc	2,440	9
Athēnisc	11	4	Frencisc	—	56
Babilōnisc	70	21	Fresisc	2	4
Basilisc	112	25	Galilēisc	76	71
Bebbisc	—	1	Gallisc	1	4
Berberisc	—	1	Gotisc	63	1
Bryttisc	2	20	Grēcisc	46	186
Bulgarisc	—	2	Gullisc	1	1
Cæsariensisc	6	1	Hæðenisc	656	3
Caldisc	29	1	Heofonisc	287	2
Cananisc	13	5	Hebrēisc	—	1
Cappadonisc	—	8	Herodiadisc	246	6
Carpianisc	—	1	Hierosolimisc	—	7
Catanenscisc	—	4	Iacobisc	1,121	1
Ceasternisc	61	1	Icarisc	—	1
Cēdrisc	—	1	Idolamitisc	—	1
Centisc	103	8	Ismahēlistisc	10	4
Ceorlisc	104	52	Indisc	2	22
Ċhaldeisc	10	29	Inlendisc	8	9
Chananeisc	20	23	Īudēisc	629	736
Cicropisc	1	1	Lǣdenisc	41	4
Cildisc	583	3	Langbeardisc	54	7
Concupisc	23	14	Libanisc	103	1
Constantinopolisc	36	1	Lindisfarneisc	—	4
Corrinthisc	7	1	Lundonisc	171	8
Crēcisc	10	25	Mæcdonisc	22	5
Cyrinisc	2	8	Madianisc	38	7
Davidisc	23	1	Magdalenisc	20	44
Denisc	5	184	Mechanisc	2	2

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Derived word	*Base frequency*	*Tokens*	*Derived word*	*Base frequency*	*Tokens*
Mennisc	1,254	580	Saracenisc	1	2
Meotedisc	—	2	Saronisc	3	2
Mīlitisc	42	3	Scariothisc	26	4
Moabisc	59	5	Scyððisc	13	7
Nazarenisc	9	59	Scyttisc	40	17
Nicēnisc	3	2	Sicilisc	36	1
Niniueisc	15	8	Sidoneisc	9	8
Norðmandisc	9	1	Siracusanisc	6	1
Odolamitisc	—	4	Sirophinisc	2	2
Ofersæwisc	—	4	Sodomitisc	36	25
Pannonisc	4	2	Sordisc	—	1
Pannormitanisc	—	1	Spēonisc	—	2
Pelagianisc	—	2	Syrisc	23	19
Persisc	31	7	Sūðseaxisc	33	1
Phariseisc	7	6	Tirisc	25	7
Philisteisc	5	2	Trāisc	—	2
Pictaurisc	4	12	Troianisc	11	2
Rēmisc	478	1	Turonisc	6	16
Rōmānisc	478	200	Tyrrenisc	—	3
Sabīnisc	2	2	Ūplendisc	—	6
Saducēisc	1	1	Ūtlendisc	4	11
Samaritanisc	1	52	Wielisc	33	55
			TOTAL	12,172	3,893
			Relative frequency		≈ 0.32

Table A-2: Relative frequency for *-cund* derivatives

Derived word	*Base frequency*	*Tokens*	*Derived word*	*Base frequency*	*Tokens*
Dēofolcund	671	1	Innancund	774	5
Eorðcund	782	5	Innecund	431	3
Gāstcund	1,618	1	Mētercund	—	3
Gesīðcund	33	16	Sāwolcund	2	1
Godcund	11,326	812	Ufancund	170	6
Hellcund	46	2	Ūpcund	1,954	8
Heofoncund	289	51	Ūtancund	592	7
Incund	216	63	Woruldcund	605	37
			TOTAL	19,509	1,021
			Relative frequency		≈ 0.052

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Table A-3: Relative frequency for *-ful* derivatives

Derived word	*Base frequency*	*Tokens*	*Derived word*	*Base frequency*	*Tokens*
Ārweorðful	—	12	Gesundful	128	51
Æfestful	37	1	(ge)swincful	212	39
Ælmesfull	46	5	(ge)trēowful	206	19
Andgietful	8	15	Geðancful	128	15
Andwliteful	8	1	Gewinful	136	4
Ārful	85	24	Glengful	5	1
Bealuful	1	7	Grimful	3	1
Bismerful	24	26	Hearmful	70	1
Brerdful	8	1	Hefeful	46	2
Brystful	19	2	Hleahterful	13	1
Carful	16	53	Hlīsful	75	11
Cēacful	17	2	Hohful	7	20
Cēastful	5	2	Hrēohful	17	1
Deorcful	29	2	Hyhtful	179	6
Dīegolful	5	1	Hyrnful	6	2
Earmful	225	3	Ieldful	2	2
Edwītful	125	4	Inwitful	20	16
Egeful	899	33	Leahtorful	27	16
Egesful	29	73	Lustful	110	4
Ēstful	13	80	Mæðful	33	1
Fācenful	74	97	Mānful	7,413	241
Fæcful	100	3	Mihtful	549	1
Firenful	7	24	Mōdful	998	1
Foreðancful	2	1	Nebwlātful	—	2
Forhtful	64	1	Nēodful	177	3
Frēcenful	1	17	Nīðful	95	26
Frecful	4	2	Rihtful	742	2
Fremful	11	21	Sandful	61	1
Fȳrenful	36	47	Scandful	2	5
Fyrwitful	1	2	Sceaðful	—	1
Gālful	10	8	Scyldful	221	5
Gecwealmful	62	2	Sideful	8	17
(ge)cwildful	5	3	Slacful	14	1
(ge)flitful	70	9	Sorgful	21	43
Gehlystful	49	1	Swicful	1	14
Gelāstful	34	2	Synnful	84	949
(ge)lēafful	7	379	Tælful	14	1
(ge)limpful	13	1	Tēamful	59	7
Gemyndful	299	1	Tēonful	39	24
Genyhtful	6	1	Tūddorful	7	3
Geornful	37	71	Tungful	2	1
Gestrēonful	121	7	Ðēawful	150	1

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Derived word	*Base frequency*	*Tokens*	*Derived word*	*Base frequency*	*Tokens*
Đēostorful	—	3	Wistful	14	1
Đræcful	5	4	Wliteful	274	1
Đrīstful	3	1	Wōhful	83	14
Đrȳðful	—	3	Wordful	2,226	5
Đrymful	5	8	Wræcful	48	7
Wæterful	851	2	Wuldorful	914	97
Weorðful	108	57	Wundorful	374	4
Weorcful	993	1	Yfelful	1,069	1
			TOTAL	12,948	2,818
			Relative frequency		≈ 0.217

Table A-4: Relative frequency for *ful-* derivatives

Derived word	*Base frequency*	*Tokens*
Fulgōd	11,326	1
Fullhealden	3,009	1
Fullcūð	344	22
Fulnēah	383	55
Fulriht	778	1
TOTAL	15,840	80
Relative frequency		≈ 0.0051

APPENDIX B

Table B-1: Narrow Productivity of the affixes *-isc*, *-cund*, *-ful* and *ful-* in terms of hapax + dis legomena

Affix	N	n_1	n_2	$n_{1+}\, n_2$	$P\,(n_{1+}\, n_2)$
-isc	3,893	240	143	383	0.098
-cund	1,021	41	18	59	0.058
-ful	2,818	194	62	256	0.091
ful-	80	10	2	12	0.15

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