

Measure Readings of Mandarin Classifier Phrases and the Particle *de*^{*}

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In this paper, we show that the particle *de* always induces a measure reading when it follows a classifier head. We show that classifiers such as *ping* ‘bottle’ are ambiguous between a measure and an individuation or counting interpretation, but that *de* always induces the measure reading. We follow Tang (2005) and Hsieh (2008) in arguing that the particle *de* is possible after sortal or individuating classifiers which occur with a high round number or an approximative marker, but we argue that this is because approximation is semantically a kind of measure function, and that in these contexts the sortal classifiers are interpreted as heading a measure phrase. We claim further, following X.P. Li (2011) that when a number-classifier sequence is interpreted as measure phrase, the string “Num-Cl(-*de*-)N” always has the syntactic structure [[[Num-Cl](-*de*-)]N], with Num-Cl forming a constituent which *de* takes as a complement. This allows us to suggest that *de* in classifier constructions has the same grammatical function as in other modificational contexts, and paves the way for a unified analysis of *de*. We conclude with an explicit semantics for the interpretation of [[[Num-Cl](-*de*-)]N] strings.

Key words: *de*, classifiers, counting, measuring, round numbers, approximation

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1. Introduction

The role of *de* in Mandarin classifier phrases has attracted a lot of attention in the last 15 years, in particular in Cheng & Sybesma (1998), Tang (2005), Jiang (2008), Hsieh (2008), Her & Hsieh (2010), X.P. Li (2011), and Zhang (2011). Researchers have focused on whether *de* is possible after ‘count’ or individual classifiers as well as after the so-called ‘massifiers’ or mensural classifiers. Tang (2005) and Hsieh (2008) have shown that, contrary to what was previously thought, *de* may follow classifiers classically considered ‘sortal’ such as *ge* and *ke*. We shall show in this paper that what is relevant is not the lexical classification of classifiers, but the kind of interpretation which they can be assigned. Many classifiers such as *ping* ‘bottle’, are ambiguous between a count and measure reading, but when *de* follows *ping*, the measure reading is obligatory. We argue that when *de* follows classifiers like *ge* and *ke*, a measure reading of the classifier expression is also induced, and we show (despite the apparent oxymoron) what a ‘measure interpretation’ of individuating classifiers actually is. Thus we shall explain the restrictions on Num-Cl_{count}-*de*-N described in Hsieh (2008).

The structure of the paper is as follows. In this introductory section, we give some background on *de* and its uses as a marker of modification, and review the important distinction discussed in Jiang (2008) between Num-Cl-*de* as a true classifier expression and Num-Cl-*de* as an attributive modifier. In §2, we review three previous accounts of Num-Cl-*de*-N: Cheng & Sybesma (1998), Tang (2005), and Hsieh (2008). We show, as argued in Tang and Hsieh, that count or individual classifiers are possible in Num-Cl-*de*-N constructions, but that the essentially syntactic account offered by Hsieh is not adequate. In §3, we show that *de* forces a measure interpretation of so-called ‘massifiers’, while in the *de*-less constructions the measure reading is optional. We argue, following Rothstein (2009, 2010b) and X.P. Li (2011), that counting and measure readings of classifiers are associated with different syntactic structures, and we show that Num-Cl-*de*-N has a measuring syntactic structure rather than a counting syntactic structure. In §4, we work out the semantics for the measure interpretation of classifiers. We shall explain why *de* is always compatible with explicit measure words like *gongjin* ‘kilo’ and why *de* forces the measure reading for classifiers like *ping* ‘bottle’. In §5, we make a proposal as to what the measure interpretation of counting classifiers might be, and give an explicit semantics for these interpretations. We explain why this use of individuating classifiers requires a large round number or an approximative marker. Section 6 concludes this paper by looking at two other cases of measure readings with count classifiers, one which allows *de* and the other which does not.

It is commonly agreed that *de* is a modification marker which takes a complement phrase, and that [XP [*de*]] has the function of modifying the noun it is a sister of.

However, the syntactic status of *de* is under debate. Zhu (1961), Paris (1979), and Li & Thompson (1981) argue that *de* is a nominalizer and XP-*de* is a nominal phrase. Tang (1990, 2007) claims that *de* heads a functional projection FP, with the functional head marking modification relations. A. Li (1990), Sproat & Shih (1991), and Den Dikken & Singhapreecha (2004) propose that [XP [*de*]] is best treated as a relative clause headed by *de*, while Paul (2007, 2010) argues that the particle *de* is a non-root complementizer and XP-*de* is CP, where the head *de* can take any phrase as a complement. We shall not attempt to choose between these analyses here. What is important to us is that [XP [*de*]] is a modifier, that is, a predicate expression. What we shall try to show is that *de* in Num-Cl-*de*-N phrases has the same syntactic and semantic function as in other [XP [*de*]] phrases. Thus we shall argue that Num-Cl-*de*-N phrases have the structure [[[Num Cl] *de*] N] and that [[Num Cl] *de*] is a predicate phrase.

An important step in understanding Num-Cl-*de*-N phrases is made in Jiang (2008). Jiang (2008) uses Schwarzschild's (2006) characterization of the distinction between measure phrases in pseudopartitives and in attributive modifiers and shows that this allows us to distinguish between two types of readings of Num-Cl-*de*-N in Mandarin Chinese: the attributive reading (1a) and the pseudopartitive reading (1b).

- (1) *san bang de yingtao* (Jiang 2008:1)
 three Cl_{pound} DE cherry
 a. 'three-pound cherry' [attributive reading]
 b. 'three pounds of cherries' [pseudopartitive reading]

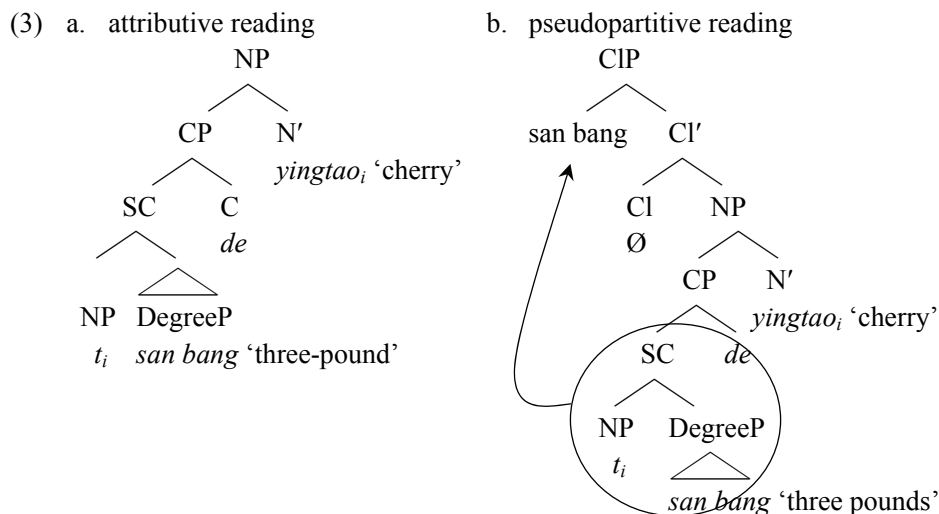
On the attributive reading, *san bang de* is an adnominal modifier and behaves like a classifying adjective, modifying the head noun *yingtao*, with the paraphrase in (1a). Jiang argues that on this reading, (1) denotes a certain type of cherry, the 'three-pound type of cherry'.¹ On this reading, [XP *de*] has the same syntactic position and functions as the adjectival modifier [AP *de*], illustrated in (2), and we assume that this is *prima facie* evidence that here [XP *de*] is a predicate with a predicative interpretation:

- (2) *congming de haizi*
 clever DE child
 'clever child/children'

¹ It is unclear whether for Jiang, this means that each individual cherry has to weigh three pounds, or whether 'three-pound cherry' is a more general name of a kind of cherry. While this is an important question semantically, it is not necessary for us to solve it here, since on either reading, *san bang de* is an attributive modifier in the sense of Schwarzschild (2006).

The pseudopartitive reading, expressed in English by (1b), is associated with the normal classifier use of *san bang*, and on this reading, the Num-Cl-*de* sequence expresses information about the quantity of entities. On this reading, (1) denotes a set of pluralities of cherries whose overall quantity is three pounds.

Jiang (2008) claims that the two readings of *san bang de yingtao* as shown in (1) have two different syntactic derivations and structures. She proposes that on the attributive reading, Num-Cl is a degree phrase, which is treated as a relative clause, and which is taken as complement by the complementizer *de*, as in (3a), and that the pseudopartitive reading of Num-Cl-*de*-N is derived by moving the degree phrase of Num-Cl to the specifier position of a null classifier phrase, as in (3b). While not necessarily accepting the details of her analysis, we shall follow it in assuming that the attributive readings and the pseudopartitive readings have two different structures.



In this paper, we shall not discuss the attributive uses of Num-Cl-*de*. It seems clear that, whatever the details of the syntactic analysis, in the attributive use, Num-Cl-*de* is a predicate phrase denoting a property of entities in the denotation of the nominal head. As such, it falls under the generalization that *de* marked phrases are predicates. We shall focus on the pseudopartitive use of Num-Cl-*de*, and in particular on the following issues:

(a) What is the syntactic structure of Num-Cl-*de*-N on its non-attributive interpretation? Can it be said to fit in with other occurrences of *de*, where *de* occurs roughly in the structure [XP *de*]? We shall argue that indeed even on a pseudopartitive interpretation, *san bang de* has the syntactic structure [[*san bang*] *de*], and that it is a predicate expression with a modificational interpretation.

(b) Does the presence of *de* after Num-Cl in this non-attributive use have any interpretational effect? We shall argue that it requires a measure interpretation of the classifier, and the predicate phrase *[[san bang] de]* denotes a measure or dimensional property.

(c) What kind of classifiers does *de* appear with? Since it requires the classifier to be interpreted as a measure expression, *de* naturally follows explicit measure expressions such as *gongjin* ‘kilo’. We show that it can also occur with a counting classifier, but only if it can induce a measure interpretation of the classifier.

2. Previous analyses of Num-Cl-*de*-N

In this section, we review three proposals about Num-Cl-*de*-N: Cheng & Sybesma (1998), Tang (2005), and Hsieh (2008). We begin with Cheng & Sybesma (1998).

2.1 *De* with massifiers (Cheng & Sybesma 1998)

Cheng & Sybesma (1998) propose that the traditional distinction between sortal and mensural classifiers in Chinese is really a syntactic difference between ‘count’ and ‘mass’ classifiers (or ‘classifiers’ and ‘massifiers’). With Tai & Wang (1990), Croft (1994) and others, Cheng & Sybesma (1998) assume that semantically, massifiers create a unit of measure, and count classifiers simply name the unit in which the entity denoted by the noun naturally occurs. Examples of count or individual classifiers are *tou* ‘head’ and *ben* ‘volume’, and the general classifier *ge*, as illustrated in (4), and examples of massifiers are *wan* ‘bowl’, *bang* ‘pound’ and *xiang* ‘box’, as illustrated in (5):

- (4) a. yi tou niu
 one Cl_{head} cow
 ‘one cow’
- b. wu ben shu
 five Cl_{volume} book
 ‘five books’
- c. san ge xuesheng
 three Cl student
 ‘three students’
- (5) a. yi wan tang
 one Cl_{bowl} soup
 ‘one bowl of soup’

- b. san bang rou
three CL_{pound} meat
'three pounds of meat'
- c. yi xiang shu
one CL_{box} book
'a box of books'

The details of Cheng & Sybesma's analysis about count and mass classifiers are not important to us here. What is important are two claims that they make about the particle *de*. First, following observations by Chao (1968:555) and Paris (1981:32) among others, they claim that only massifiers can co-occur with *de*, and count classifiers cannot, as contrasted in (6) and (7).²

- (6) a. san bang (de) rou [mass classifiers]
three CL_{pound} DE meat
'three pounds of meat'
- b. liang xiang (de) shu
two CL_{box} DE book
'two boxes of books'
- c. san wan (de) tang
three CL_{bowl} DE soup
'three bowls of soup'
- (7) a. ba tou (*de) niu [count classifiers]
eight CL_{head} DE cow
'eight cows'
- b. jiu gen (*de) weiba
nine CL DE tail
'nine tails'

Second, they claim that *de* forces a measure interpretation of container classifiers like *wan* 'bowl'. The important point is that a container classifier can in principle be associated with both a measure and an individuating reading. We discuss the difference

² Cheng & Sybesma (1998) offer a second diagnostic for distinguishing between massifiers and classifiers. They suggest that preclassifier adjectives are possible only with massifiers as in *yi da xiang shu* 'one big box of books'. X.P. Li (2011) argues that this diagnostic is problematic, and discusses examples such as *yi da ge mantou* 'one big steamed bun', where the classifier is clearly the individuating classifier *ge*. For further discussion, see X.P. Li (2011).

between count and measure interpretations in more detail in §3, at the moment noting that this is not a phenomenon which is specific to Mandarin. Thus *three bowls of wine* can have an individuating reading, in which it denotes three concrete bowls filled with wine, and a measure interpretation, in which it denotes a quantity of wine which is equal to the contents of three standardized bowls. Cheng & Sybesma (1998) argue that in Mandarin, the measure interpretation of classifier phrases is induced by *de*: *san wan tang* has an individuating interpretation as in (8a), while *san wan de tang* has the quantity interpretation as in (8b). (8a) is appropriate in a context in which three people have been served individual bowls of soup and the three bowls are waiting on the table. (8b) is appropriate in a context in which soup has been spilled on the table, and you want to say how much soup was spilled.

- (8) a. zhuoshang you san wan tang.
 table-top there-is three Cl_{-bowl} soup
 ‘There are three (individual) bowls of soup on the table.’
 b. zhuoshang you san wan de tang.
 table-top there-is three Cl_{-bowl} DE soup
 ‘There is a quantity of soup equal to three bowlfuls on the table.’

As Cheng & Sybesma write: “The picture evoked by (8b) is that the soup is all over the table, spilled, there are no bowls. The default interpretation of (8a) on the other hand is that there are three bowls, filled with soup, standing on the table.” (Cheng & Sybesma 1998:6). They further support this claim with the examples in (9) (Cheng & Sybesma 1998:6).

- (9) a. #wo yong xiao-wan he le san bei jiu.
 I use small-bowl drink PFV three Cl_{-glass} wine
 b. wo yong xiao-wan he le san bei de jiu.
 I use small-bowl drink PFV three Cl_{-glass} DE wine
 ‘I used a small bowl to drink three glasses of wine.’

(9a) is infelicitous on their account, because *san bei jiu* has an individuating and not a measure reading and it is bizarre to assert that you used a small bowl to drink three concrete glasses filled with wine. In contrast, (9b) is acceptable because *san bei de jiu* denotes a quantity of wine, and it is perfectly felicitous to assert that you used a small bowl to drink that quantity.

While it is clear that *de* is in some sense more natural with so-called massifiers, neither of these claims can ultimately be supported. As has been shown in Tang (2005)

and Hsieh (2008), *de* can appear with count classifiers such as *ge*, *ke*, and *zhi*. We shall return to these examples below. Their second claim about the interpretation of Num-Cl-*de*-N is also problematic. It is clear that *de* forces a measure interpretation, as can be seen from the example (10), where the verb *kai* ‘open’ demands an individuating or counting interpretation of the container classifier:

- (10) #ta kai le san ping de jiu.
 he open PFV three CL_{bottle} DE wine
 ‘He opened three bottles of wine.’

However, while *de* forces a measure interpretation, the absence of *de* does not force a count interpretation, as can be seen from the example in (11):

- (11) a. ta he le san ping jiu.
 he drink PFV three CL_{bottle} wine
 ‘He drank three bottles of wine.’
 b. wo-de jiuliang shi san ping jiu.
 my drinking-ability be three CL_{bottle} wine
 ‘My drinking ability is three bottles of wine.’

It is true that there is a contrast between (9a) and (9b), but for speakers we have consulted, (9a) is not ungrammatical in the way that (10) is, and the infelicity of (9a) follows from the fact that *bei* is not a natural measure unit for *wine*, and thus without the *de* forcing a measure interpretation, *san bei jiu* is most plausibly given a count interpretation.

We shall return to these examples in §3.

2.2 “Information weight” (Tang 1990, 2005)

Tang (1990, 2005) is among the first to discuss the construction Num-Cl-*de*-N in the tradition of formal linguistics. Contra Cheng & Sybesma (1998), Tang (2005) develops ideas set out first in Tang (1990) and argues that the particle *de* is possible after both count classifiers (which she calls ‘sortal’) as in (12) and massifiers (which she calls ‘mensural’) as in (13).

- (12) a. liang bang de rou [mensural classifiers]
 two pound DE meat
 ‘meat that is sorted in accordance with two pounds’

- b. san mi de bu
three meter DE cloth
'cloth that is sorted in accordance with three meters'
- (13) a. liang ben de shu [sortal classifiers]
two CL_{-volume} DE book
'books that are sorted in accordance with two in number'
- b. wu ge de pingguo
five CL DE apple
'apples that are sorted in accordance with five in number'

According to the translation of (12) and (13) provided by Tang (2005), Num-Cl-*de* seems to behave like a classifying adjective, which expresses properties that are able to establish subtypes of entities. These classifier phrases thus seem to be of the kind which Jiang (2008) calls 'attributive'. But while Jiang discusses attributive readings of Num-Cl-*de* with explicit measure classifiers, such as those in (12), Tang discusses also attributive readings of sortal classifiers as in (13). Tang translates (12a) as 'meat sorted in accordance with two pounds', which is a paraphrase of Jiang's 'two-pound meat' or the English equivalent 'two-pound packs of meat'. This allows an analogous translation of the sortal classifiers in (13). (13a) with a *de*-marked sortal classifier denotes pluralities of two-volume books (for example a two-volume Mandarin-English/English-Mandarin dictionary), while (13b) denotes pluralities of apples that come in packages of five. So while it is clear that Tang shows that *de* can follow count or sortal classifiers as well as mensural classifiers, this is not a good counterexample to Cheng & Sybesma, since they discuss Num-Cl-*de*-N in pseudopartitive phrases and not in attributive modifier phrases.

It is important to see that these pseudopartitive and attributive uses of classifier phrases really are syntactically different and occur in syntactically different positions, as argued by Jiang (2008). Num-Cl-*de*-N on the attributive reading is generated within the NP (as shown in (3a)), while Num-Cl-*de*-N on the pseudopartitive reading is generated outside the NP. This correctly predicts that a classifier can appear both in the attributive and the classifier head positions in the same NP, as illustrated in (14).

- (14) wo mai le yi xiang de liang ce (zhuang) de shu.
I buy PFV one CL_{-box} DE two CL_{-volume} pack DE book
'I bought a box of two-volume books.'
Impossible: 'I bought a box with two books in it.'

In the possible reading here, we have no idea how many volumes are in the box, since it is a box of books-which-come-in-two-volumes (e.g. a box of dictionaries each

consisting of two volumes, one English-Mandarin, and the other Mandarin-English). The impossible reading is the reading in which the pseudopartitives are stacked: it is impossible to use (14) to assert that I bought a box containing two books.

Another important fact is that the pseudopartitive reading is always possible with or without *de*, but the post-classifier *de* is always needed in order to get the attributive reading. So, while (15a) is ambiguous between the attributive and pseudopartitive readings, (15b) has only the pseudopartitive reading.

- (15) a. liu ping de pijiu
six CL_{bottle} DE beer
'six bottles of beer'
Or: 'beer that comes in a six pack'
- b. liu ping pijiu
six CL_{bottle} beer
Only: 'six bottles of beer'

Tang (2005) is aware of the fact that Num-Cl-*de*-N is ambiguous in the way that Jiang argues, i.e. as illustrated in (15a), and she points this out in fn.2 of her paper (2005:434). However, it is very hard to find examples of this ambiguity with Num-Cl_{count}-*de*-N, precisely because count classifiers are not usually followed by *de*. Thus (16) will be unambiguously attributive:

- (16) wo qu chaoshi mai le 'wu li de pingguo'. (Tang 2005:437)
I go supermarket buy PFV five CL_{grain} DE apple
'I went to the supermarket and bought the apples in a five pack.'
Impossible: 'I went to the supermarket and bought five apples.'

However, in addition to the attributive use of Classifier Phrases described above, Tang (2005) also discusses examples in which Num-Cl_{count}-*de*-N is interpreted with the pseudopartitive reading and not the attributive reading. She brings the examples in (17).

- (17) a. mingtian de huodong xuyao yi bai zhang de fangzuozi.
tomorrow Mod activity need one hundred CL_{piece} DE square table
'Tomorrow's activity needs one hundred square tables.'
- b. yinian yue zhongzhi le yi-bai-sishi-duo-wan
one year about plant PFV one-hundred-forty-more-ten:thousand

ke de shumu.

Cl DE tree

‘(They) planted more than one million four hundred thousand trees a year.’

c. ta jintian zhongzhi le san ke (*de) shumu.

he today plant PFV three Cl DE tree

‘He planted three trees today.’

The examples in (17) do not have the attributive interpretation of ‘sorted in accordance with...’, but only express the quantity of entities. For example, (17a) means that the total number of tables required is one hundred, and not that the type of tables required is tables that come in packages of one hundred. (17b) means that the overall number of trees planted is more than one million and four hundred thousand. Note that (17c) contrasts in grammaticality with (17a-b) and patterns with the examples (16).³

These examples clearly indicate that in some contexts, the particle *de* can follow count or sortal classifiers to get the pseudopartitive reading: the classifiers illustrated, *zhang* and *ke*, are uncontroversially sortal (Tang 2005:444) and the readings in (17a-b) are uncontroversially pseudopartitive.

Tang (2005) does not distinguish between these examples and the attributive ones discussed above, but treats them all as complex nominal constructions in which Num-Cl-*de* is some kind of modifier. Tang suggests that the acceptability of (17a-b) is related to the ‘information weight’ of the modifier. She suggests that Num-Cl strings such as *yi bai zhang* ‘one hundred pieces’ in (17a) and *yi-bai-sishi-duo wan ke* ‘one million four hundred thousand Cl’ in (17b) are complex and heavy modifiers, and so can be followed by the particle *de*. In contrast, (17c) is infelicitous, even though it has the same classifier and verb as (17b), because the classifier string *san ke* ‘three Cl’ is simple.⁴ A very similar explanation is given by Her & Hsieh (2010), who suggest that *de* can appear in computationally complex classifier constructions. However, an explanation in terms of information weight or computational complexity cannot explain the unacceptability of the following two examples. In (18), the numbers used are *yi bai ling ba*, ‘one hundred

³ It is of course possible to use (17a) with Num-Cl-*de*-N analysed as an attributive modifier. A natural context would be: in a nursery, trees to be planted are either bundled in three units or in five units. I planted those in packs of five and my colleague planted those in packs of three. We can then say:

(i) ta jintian zhong le san ke de (na-xie) shu.
he today plant PFV three Cl DE those trees
‘Today, he planted (those) trees coming in packs of three.’

⁴ Of course, this does not explain the felicitous use of *san ke de* as an attributive modifier, as shown in the previous footnote.

and eight’, or *yibai sanshi qi* ‘one hundred thirty-seven’, which are at least as complex as the numbers used in (17a-b) and give more detail, and thus plausibly have a greater information weight, but the sentences are judged infelicitous.⁵

- (18) a. *women xuyao yi-bai-ling-ba zhang de fangzuozi.
 we need one-hundred-zero-eight Cl DE square-table
 ‘We need one hundred and eight square tables.’
 b. *yinian zhongzhi le yi-bai-sanshi-qi ke de shumu.
 one-year plant PFV one-hundred-thirty-seven Cl DE tree
 ‘(They) planted one hundred and thirty seven trees a year.’

2.3 The ‘Indeterminacy’ account (Hsieh 2008)

Hsieh (2008) takes the discussion much further. In addition to giving examples where *de* freely follows a measure classifier, she brings a large number of examples from the Academia Sinica (A.S.) Corpus in which count classifiers are followed by *de* in pseudopartitive constructions. Examples in (19) and (20) are taken directly from Hsieh’s book.

⁵ A reviewer pointed out that the following two examples are grammatical, and might support the computational complexity account.

- a. di-shang you yi-bai-san-shi-qi ke de xigua, wu-shi-jiu ke
 floor-on there-be one-hundred-thirty-seven Cl DE watermelon fifty-nine Cl
 de fengli, haiyou san-shi-er ke de mangguo.
 DE pineapple and thirty-two Cl DE mango
 ‘On the floor lie one hundred and thirty seven watermelons, fifty nine pineapples and thirty two mangos.’
 b. ta you yi wan ling yi ge de liyou bu huanqian.
 he has one ten-thousand and one Cl DE reason not return money
 ‘He has ten thousand and one reasons not to return money.’

However, note that (a) and (b) are non-standard constructions with special properties. (a) is a list context. It is well-known that these contexts allow the grammatical constraints to be overridden. For example, in English, *there* insertion contexts allow definites in lists, but in not simple assertions, as in (c) and (d).

- c. *There is the chair in the kitchen.
 d. What do we still need to pack? There is the chair in the kitchen, the suitcase in the living room and the books on the desk.

With respect to (b), the phrase with ‘ten thousand and one’ is an exaggerated expression. It does not mean *exactly ten thousand and one reasons* but *a lot of reasons* and therefore cannot be taken as evidence for computational complexity in counting contexts.

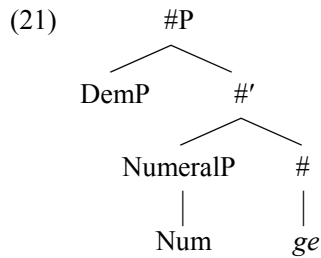
- (19) a. *jin yi-bai wei de qiangjiu renyuan* (A.S. Corpus)
 close one-hundred Cl DE rescue worker
 ‘close to one hundred rescue workers’
- b. *hao ji bai tiao de haishe* (A.S. Corpus)
 quite several hundred Cl DE sea-snake
 ‘quite several hundreds of sea snakes’
- (20) a. *pai-le wu-qian zhang de yizi...* (A.S. Corpus)
 put-in-order-ASP five-thousand Cl DE chair
 ‘put five thousand chairs in order...’
- b. *wu-bai-wan zhi de yazi* (A.S. Corpus)
 five-hundred-ten:thousand Cl DE duck
 ‘five million ducks’

Hsieh (2008) points out that the examples in (19) and (20) can be characterized in different ways. In the examples in (19) the *de*-marked individual CIPs include an explicit expression of indeterminacy or approximation: in (19a), the Number Phrase is modified by the approximation modifier *jin* ‘close to’, and in (19b), Num is filled in by *ji* ‘several’ and modified by the indeterminate expression *hao*, which Hsieh glosses as ‘quite’. In (20), there is no approximation modifier and Hsieh considers the numeral to be precise: *wu-qian* ‘five thousand’ *wu-bai-wan* ‘five million’. She suggests that (20) is an emphatic or contrastive context, where the *de*-marked CIP emphasizes large quantities. She translates it as ‘as many as five thousand/five million...’.

Hsieh (2008) concludes that post-classifier *de* can be used in three contexts:

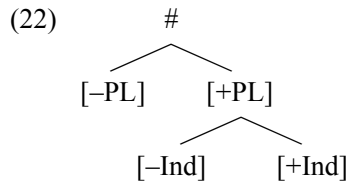
- (i) freely after a mass classifier (as argued by Cheng & Sybesma 1998)
- (ii) after a count classifier in a context contrastive or emphatic context in which a large number is used (these are similar to Tang’s examples in (17));
- (iii) after a count classifier, when the numeral is modified by an approximator.

Hsieh (2008) attempts to give a unified syntactic analysis for the use of post-classifier *de* in these three contexts. She argues that in Num-Cl-N strings, the Numeral and the Classifier form a single constituent. The classifier is a number head, marked #, and the number heads a Numeral phrase which combines with # to form a #'. A demonstrative optionally fills the specifier position, to form a #P. This whole #P takes the NP as a complement. The structure of the #P (headed by the classifier) is sketched in (21).



Hsieh maintains that the structure in (21) is a unified structure for count and mass classifiers, that is “the # head is occupied by a sortal classifier/massifier” (2008:52), and NP is a complement of this #P.

Hsieh (2008) proposes a feature taxonomy for the # head, as given in (22).⁶ She argues that in Chinese, singularity *versus* plurality is marked by a [\pm PL] feature. She assumes also that a [+PL] feature must be marked for fixed *versus* non-fixed quantity, for which she uses the diacritic [\pm Ind(eterminate)]. This gives the following structure for the # head.



Hsieh does not explicitly say where approximators such as *hao* and *jin* are generated, but it is plausible to assume that they are generated within the #P, since they guarantee the [+indeterminate] feature on the #head. She then claims that *de* is compatible with mensural heads or with count classifiers which are marked as [+Indeterminate]. In order to account for all three contexts, she formulates the principle below (her (52), p.53).

- (23) A #P is compatible with *de* when the # head is marked with either [+mensural] or [PL, +ind(eterminate)] or when the whole #P is emphasized or contrastively focused.

(23) is not satisfactory, since it gives a different reason for why each context above is compatible with *de* without explaining either what they have in common or what the

⁶ From Hsieh’s principle (52) on p.53 which we cite above, it appears (plausibly) that this feature analysis is relevant for count classifiers and not for massifiers.

relation is between *de* and features mentioned. Furthermore, it is not empirically adequate, since Hsieh assumes that [+mensural] is a lexical feature of the classifier and thus predicts that such classifiers can always be followed by *de*. However, as we already remarked in §2.1, so-called massifiers cannot always be followed by *de*: *de* is licensed only when the classifier is used in a measure context. Thus we get the following contrast:

- (24) a. fuwusheng kai le san ping (*de) jiu, yi zhuo yi ping.
waiter open PFV three CL_{bottle} DE wine one table one CL_{bottle}
'The waiter opened three bottles of wine, one bottle for one table.'
- b. ta he le san ping (de) jiu.
he drink PFV three CL_{bottle} DE wine
'He drank three bottles of wine.'

(24a) is a counting or individuating context, in which the classifier phrase denotes three individual bottles of wine, each of which the waiter opened. In this context, *de* is impossible. In (24b) we have a measure context in which we indicated how much wine was drunk, and here *de* is allowed but not obligatory. An account which says that *ping* is lexically a mensural classifier or massifier, and that this lexical property is what licenses post-classifier *de*, cannot explain the contrast.

Another issue is that Hsieh's account relies on the assumption that count and mass classifiers have the same syntactic structure, and that in either case, the classifier combines first with the number to form a complex classifier, and then Num+Cl modifies the N. As we shall show in the next section, there is good reason to assume that this is not the case. Furthermore, it is unclear why a [+Indeterminate] feature should license *de*.

As we saw in §2.1, and as the examples in (24) show, *de* is licensed after classifiers like *ping* only on their measure reading and after approximate uses and high round number uses of count classifiers. We should therefore ask what these usages have in common both syntactically and semantically, and see whether we can use this commonality to explain the distribution of post-classifier *de*.

3. Measurement and Num-Cl-*de*-N

3.1 Counting and measuring uses of classifiers

The discussion so far shows that it is not possible to give a list of classifiers after which *de* is allowed. The examples in (24) above indicate that *de* is licensed after *ping* 'bottle' on a measure interpretation, but not on a counting interpretation, indicating that it is not the lexical classifier itself which licenses or does not license *de*, but the use to

which the classifier is being put. *De* is also allowed after a count classifier with an approximative marker or with a high round number. Since, as we shall show, it is plausible to analyze these classifier constructions as occurring in measure contexts, we shall argue that it is generally the measure context which allows *de* to follow the classifier. Before setting out this argument in detail, we give some background on measure *versus* counting contexts.

It has often been noticed (Doetjes 1997 for English and Dutch, Chierchia 1998 and Landman 2004 for English, Rothstein 2009 for Hebrew, Partee & Borschev 2012 for Russian) that container classifiers are ambiguous between a counting and a measure reading. In (25a), a classic individuating context, the verb *carry* forces a counting reading of the container classifier *bottle*, in which the nominal denotes three concrete bottles, each of which is filled with water, which are being carried and the number indicates that the total number of individual bottles is three. In contrast, (25b) is a natural measure context, since it has the interpretation that I poured into the soup a quantity of water equaling the quantity contained in three bottles. As long as the right quantity gets into the soup, it does not matter whether the actual measuring was done with bottles, jugs, or tin cans. *Bottles* indicates a unit of measurement and not an individual entity.

- (25) a. John carried three bottles of water home. [Individuating]
 b. I poured three bottles of water into the soup. [Measure]

(25), of course, illustrates the same contrast that we just saw in (24). But this means that a classifier like *ping* should not be categorized as a measure classifier, or mensural classifier, or massifier. Rather, count and measure are two interpretations or uses of *ping*. X.P. Li (2011) argues that in general, Mandarin classifiers should be categorized according to whether they have both a counting and a measure interpretation, just one interpretation or neither. He further argues that counting and measure uses of classifiers are associated with two different syntactic structures: on the counting reading, Num-CI-N has the structure in (26a) while on the measure reading Num-CI-N has the structure in (26b):

- (26) a. Counting reading
- ```

 CIP
 / \
 Num CI'
san 'three' / \
 CIcounting NP
 ping 'bottles' shui 'water'

```
- b. Measure reading
- ```

      CIP
     /  \
  CIP'   NP
 /  \   |
Num CImeasure
san 'three' ping 'bottle' shui 'water'
  
```


In counting contexts, the classifier takes NP as a complement and the number modifies the CI-NP constituent. In measure contexts, the classifier combines with the number element to make a complex classifier, which then combines with NP to form a classifier phrase.⁷ Crucially, classifiers are not lexically identified as appearing in one or other of these two structures. Instead, the structures are associated with the two types of interpretation, and classifiers are lexically identified as being primarily associated with count, primarily associated with measure, or truly ambiguous between them. In this X.P. Li (2011) differs both from Cheng & Sybesma (1998) and Zhang (2011), who argue that classifiers are divided into two lexical groups depending on the syntactic structure in which they occur. We shall argue below that *de* is associated with the structure in (26b), because the constituent [Num+CI] is a constituent which *de* can modify. Any classifier which can appear in a measure construction, with the syntax in (26b), can thus be followed by *de*.

We now present several pieces of evidence in support of the two structures in (26). In what follows, we shall use *ben* ‘volume’ as an example of a classifier which has only a counting function (for short, [+C, –M]). We use *gongjin* ‘kilo’, as an example of a classifier with only a measure use ([-C, +M]).⁸ We continue to use *ping* ‘bottle’ as an example of a classifier which can be used in both ways ([+C, +M]).⁹

(i): Our first piece of evidence is that on the measure reading, the number word is obligatory. This follows from the structures in (26), since on the measure reading in (26b), the number is an essential part of the complex classifier, while in the counting reading in (26a) number is a modifier of the “CI+NP” constituent. This means that with [+C, –M] classifiers, the number can be dropped (27a), with [-C, +M] classifiers, the number is obligatory (27b), and with [+C, +M] classifiers, dropping the number forces a counting interpretation (28).¹⁰

⁷ X.P. Li (2011) labels the measure structure in a different way from the labeling we give in (26b), but the constituent structure is the same in either case. Note that (26b) is similar to Hsieh’s structure given in (21). But she proposes (21) as the structure for all classifier constructions, while we argue that it is associated only with measure readings.

⁸ Both *jin* ‘half kilo’ and *gongjin* ‘kilo’ are [-C, +M] classifiers, but *jin* is a traditional measure unit and *gongjin* is a newly introduced one. Due to the frequent use of *jin* in daily life, it has developed a second, counting interpretation. That is why we here choose *gongjin* and not *jin* as an instance of [-C, +M] classifiers.

⁹ The [-C, –M] classifier type is instantiated by *zhong* ‘kind’, which neither counts nor measures individuals, but which allows kinds or subkinds to be counted.

¹⁰ Yip (2008) shows that a number is obligatory with measure classifiers such as *gongjin*, but optional with sortals like *ge*. But he does not go beyond the classic distinction between two lexical kinds of classifiers.

- (27) a. wo mai le (yi) ben shu.
I buy PFV one CL_{volume} book
'I bought a book.'
- b. wo mai le *(yi) gongjin pingguo.
I buy PFV one CL_{kilo} apple
'I bought a kilo of apples.'
- (28) a. ta zuo-shou na le (yi) ping hong-jiu.
he left-hand take PFV one CL red wine
'He is carrying a bottle of red wine in his left hand.'
- b. ta-de jiuliang shi *(yi) ping hong-jiu.
his drinking-ability be one CL_{bottle} red wine
'His drinking ability is one bottle of red wine.'

A reviewer has suggested that the reason why we cannot delete the numeral *yi* 'one' in the example of (27b) is due to the fact that the measure word *gongjin* 'kilo' is a disyllabic word, and supports the suggestion with the data in (29), which shows that *yi* can be deleted before the monosyllabic *xiang* but not before the disyllabic *xiang-zi*.

- (29) a. ta shangjie mai le (yi) xiang shu.
he go-street buy PFV one CL book
'He went to buy a box of books.'
- b. ta shangjie mai le *(yi) xiang-zi shu.
he go-street buy PFV one CL-NMLZ book
'He went to buy a box of books.'

However, this cannot be the explanation for (27b), since *yi* deletion is also impossible before monosyllabic measure words such as *li* 'mile', *sheng* 'liter', *mi* 'meter', as in (30), indicating that the constraint is dependent on the semantics of the measure classifier and is not phonological:

- (30) a. wo jintian zou le *(yi) li lu.
I today walk PFV one CL_{mile} road
'Today, I walked a mile.'
- b. ta he le *(yi) sheng shui.
he drink PFV one CL_{liter} water
'He drank a liter of water.'

- c. wo shangjie mai le *(yi) mi bu.
 I go-street buy PFV one CL-meter cloth
 'I went to buy a meter of cloth.'

We do not think that the obligatoriness of the numeral in (29b) is caused by the disyllabicity of *xiang-zi* either. While *xiang-zi* clearly does not have a measure interpretation, we suggest that the numeral is obligatory because the deletion of *yi* forces the container classifier and the noun to be interpreted as a coordinated nominal phrase, meaning, 'boxes and books'. The role of the numeral is to force a syntactic analysis in which the container noun is interpreted as classifiers.

Zhang (2011) agrees with our observation that the numeral *yi* 'one' cannot be deleted in a measure reading, but suggests that this is because in measure readings the number is focused and focused elements cannot be deleted. While this does not conflict with our explanation that the measure word selects a numeral, we doubt that the ban on deletion of the cardinal is based on focus. Usually only one element in a constituent is focused and we note that even when the classifier is focused in a measure construction, the (non-focused) cardinal is obligatory. In (31a), the numeral *yi* 'one' is focused, in (31b), the classifier *ping* 'bottle' is contrasted, and in (31c), the head noun *pjiu* 'beer' is the focused element. In none of these contexts can we delete the numeral *yi*.

- (31) ta-de jiuliang buxing:
 his drinking-ability not:good
 'He cannot drink a lot.'
- a. zuiduo zhi neng he *(yi) ping pjiu, liang ping pjiu
 at-most only can drink one CL-bottle beer two CL-bottle beer
 tai duo le.
 too much Part
 'He can only drink **one** bottle of beer, and two bottles of beer is too much.'
- b. zuiduo zhi neng he *(yi) ping pjiu, yi tong pjiu
 at-most only can drink one CL-bottle beer one CL-bucket beer
 tai duo le.
 too much Part
 'He can only drink **one** bottle of beer, and a bucket of beer is too much.'
- c. zuiduo zhi neng he *(yi) ping pjiu, yi ping baijiu
 at-most only can drink one CL-bottle beer one CL-bottle liquor
 tai duo le.
 too much Part
 'He can only drink one bottle of **beer**, and one bottle of liquor is too much.'

- (34) a. er-shi duo gongjin pingguo [-C, +M]
 twenty more CL_{kilo} apple
 ‘more than twenty kilos of apples’ (20 kilos < value < 30 kilos)
- b. san gongjin duo pingguo
 three CL_{kilo} more apple
 ‘more than three kilos of apples’ (3 kilos < value < 4 kilos)

With [+C, +M] classifiers also, either position is possible, but when *duo* follows the classifier, only the measure reading is possible. This is shown in (35). Again, in (35a), *duo* adds the information that the relevant *number* is above ten on either the measure or the counting reading, whereas in (35b), the only reading is that the *overall quantity* is above three bottlefuls of wine, normally between three and four bottlefuls, which, again, is a scalar implicature.

- (35) a. shi duo ping jiu [+C, +M]
 ten more CL_{bottle} wine
 ‘more than ten bottles/bottlefuls of wine’
 (10 bottle(ful)s < value < 20 bottle(ful)s)
- b. san ping duo jiu
 three CL_{bottle} more wine
 ‘over three bottlefuls of wine’ (3 bottlefuls < value < 4 bottlefuls)

The structures proposed in (26) readily provide an account for these facts. *Duo* is a modifier which modifies the constituent immediately preceding it. It is a quantity modifier which means “more” and can only modify constituents that express quantity. Numerals are obviously quantity expressions, so *duo* can follow Num. When *duo* comes immediately after the number and before the classifier in the string [Num-*duo*-Cl-N], either the measure interpretation or the counting interpretation is possible. Num-*duo* is a complex numeral expression meaning ‘more than *n*’.¹¹ On the measure interpretation, the measure classifier combines with Num-*duo* to form a complex classifier as in (26b). On the count interpretation, Num-*duo* is a numerical modifier which modifies [Cl-N] and adds the information that more than *n* entities in the denotation of Cl-N are involved. Therefore, when *duo* occurs between Num and Cl, the classifier can either be counting or measure.

When *duo* follows the classifier, it also modifies the constituent which precedes it. If the constituent is Num+Cl, as in (26b), the complex measure phrase is an expression

¹¹ See Landman (2004) for arguments that numbers appear always with a relation, either <, >, or =, with = the default interpretation.

of quantity and can be modified by *duo*. However, classifiers by themselves, as shown in the structure (26a), only express a kind of counting unit and do not express quantity, and thus cannot be modified by *duo*. So, when *duo* follows the classifier, only the structure in (26b) is possible, that is Num-Cl-*duo*-N can only be assigned the structure [[[Num-Cl]*duo*]N], and this leads to a measure reading.

This account differs from Zhang (2011) who analyses *duo* as an additive marker which modifies the single unit preceding it. She claims that *duo* is an additive marker, which expresses the meaning ‘part of one unit’, where the unit is determined by the word immediately preceding it. According to Zhang, (34a) means twenty plus a part of ten, i.e. 20 kilos < value < 30 kilos, and (34b) means three plus a part of kilo, i.e. 3 kilos < value < 4 kilos. Her arguments are based on the contrasts between the ‘a’ and ‘b’ examples in (34) and (35) above. However, the implication that *san ping duo jiu* means more than three but less than four bottlefuls of wine is pragmatically driven, and cannot be semantically entailed, since it can be cancelled, as in (36):

- (36) a. ta zuido zhi neng he san ping jiu. jintian ta he le
 he at most only can drink three CL_{bottle} wine today he drink PFV
 san ping duo, jieguo hezui le.
 three CL_{bottle} more finally drunk SFP
 zixi suansuan, ta he le zuzu you si ping ban.
 carefully calculate-calculate he drink PFV enough have four CL_{bottle} half
 ‘He can only drink three bottles of wine at most. Today he drank more
 than three bottles, so finally he got drunk. To be more precise, he drank
 four and half bottles.’
- b. wo jintian shangjie yi kou qi mai le shi duo shuang wazi.
 I today go street one CL breath buy PFV ten more CL_{pair} socks
 huijia yi kan, jieguo you ershi-san shuang.
 go home have-a-look, finally there-be twenty-three CL_{pair}
 ‘Today, I went to buy more than ten pairs of socks at one go. After
 getting back home, I found that (I bought) twenty three pairs.’

Further evidence that post-classifier *duo* modifies the Num+Cl constituent comes from the examples in (37):

- (37) ban mu duo di¹²
 half CL_{mu} more land
 ‘half *mu* of land’

¹² *Mu* is a measure unit used in China. 1 *mu* = 0.06667 hectare.

The scalar implication is that we are referring to a piece of land between 0.5 and 1 *mu*, and not, as Zhang would predict, that we are referring to 0.5 plus part of a *mu* of land, which would be anything between 0.5 and 1.49 *mu*. Furthermore, we note that *duo* cannot follow a classifier when the numeral has been deleted. Thus while (38a) and (38b) are acceptable, (38c) is not.

- (38) a. wo qu chaoshi mai le jin baitang.
I go supermarket buy PFV CL_{pound} white sugar
'I went to the supermarket and bought a pound of white sugar.'
- b. wo qu chaoshi mai le yi jin duo baitang.
I go supermarket buy PFV one CL_{pound} more white sugar
'I went to the supermarket and bought more than one pound of white sugar.'
- c. *wo qu chaoshi mai le jin duo baitang.
I go supermarket buy PFV CL_{pound} more white sugar
Intended: 'I went to the supermarket and bought more than one pound of white sugar.'

This strongly supports the claim that *duo* modifies the Num+Cl constituent, and not just the classifier.

The third piece of evidence concerns the approximative modifier *zuoyou* 'approximately'. Paris & Vinet (2010) point out that *zuoyou* can either occur after Num-Cl or the end of a classifier phrase, and both options are equally grammatical. However, when it occurs between Num-Cl and NP, the particle *de* is obligatory. This is shown in (39)-(40).

- (39) a. san gongjin zuoyou *(de) dami
three CL_{kilo} approximately DE rice
b. san gongjin dami zuoyou
three CL_{kilo} rice approximately
'approximately three kilos of rice'
- (40) a. wo he le san ping zuoyou *(de) jiu.
I drink PFV three CL_{bottle} approximately DE wine
b. wo he le san ping jiu zuoyou.
I drink PFV three CL_{bottle} wine approximately
'I drank approximately three bottles of wine.'

Looking carefully, we find a contrast between measure used and counting uses of classifiers. Whatever its position in the sentence, *zuoyou* is always better with a measure classifier, or a classifier like *ping* on the measure reading, than it is with a count classifier. However, while NP final *zuoyou* with a classifier on a count usage is marked, it is ungrammatical immediately following the count classifier, even if *de* is present. This contrast is illustrated in (41)-(42).

- (41) a. *wo kai le san ping zuoyou de jiu.
 I open PFV three CL_{bottle} approximately DE wine
 b. ?wo kai le san ping jiu zuoyou.
 I open PFV three CL_{bottle} wine approximately
- (42) a. *yi/liang duo zuoyou de meiguihua (Paris & Vinet 2010:783)
 one/two CL approximately DE rose
 b. ?yi/liang duo meiguihua zuoyou
 one/two CL roses approximately

Let us assume that *zuoyou* ‘approximately’ modifies only predicate constituents. This is supported by the fact that *zuoyou* can modify the constituent Num-Cl (Numeral-Classifier) when it is used as a predicate as in examples like (43). Note that here *de* is not allowed, a fact we shall return to in §4.¹³

- (43) a. zhe dui pingguo zhong san gongjin zuoyou (*de)
 this CL_{pile} apple weigh three CL_{kilo} approximately DE
 ‘This pile of apples weighed approximately three kilos.’
 b. ta gao yi-mi-ba zuoyou.
 he tall one-meter-eighty approximately
 ‘His height is approximately 1.8 meter.’

Then we can explain the contrasts between (39)-(40) and (41)-(42) as follows. We expect *zuoyou* to occur either as a modifier of nominal predicates or as a modifier of measure predicates.¹⁴ In (39)-(40), in which, according to our hypothesis, the numeral

¹³ Measure phrases in direct object position are generally treated as predicate nominals. See Corver (2009) for a recent discussion.

¹⁴ As a reviewer pointed out, a predicate modifier usually occurs at the left side of the predicate, such as *dayue* ‘about’ and *hen* ‘very’. However, quantity modifiers, such as *duo* ‘more’ and *shangxia* ‘approximately’ or degree modifiers such as *ji* ‘extremely’ in *hao-ji le* ‘extremely good’, occur on the right side. *Zuoyou*, since it can occur on the right or left, has properties of both.

and classifier form a constituent which denotes a measure predicate as in structure (26b), *zuoyou* can follow either the Num-Cl constituent (as in ‘a’ examples) or it can appear at the end of whole nominal phrase (as in the ‘b’ examples). In (41a)-(42a), in the counting context where the numeral and classifier do not form a constituent, *zuoyou* is impossible immediately following the classifier. *Zuoyou* is possible after the nominal, but marked since generally approximate expressions are marked with low cardinals in counting contexts. The expressions in (44) with high round cardinals and postnominal *zuoyou* are all acceptable.

- (44) a. wo kai le san bai ping jiu zuoyou.
 I open PFV three hundred Cl_{bottle} wine approximately
 ‘I opened approximately three hundred bottles of wine.’
 b. san bai ke shu zuoyou
 three hundred Cl tree approximately
 ‘approximately three hundred trees’

We shall discuss post-classifier *zuoyou* with high round numbers in the next section.

It is important to note the contrast between the (a) examples and the (b) examples in (41) and (42). When *zuoyou* modifies the whole nominal, the example is pragmatically marked because of the pragmatic oddness of using an approximate marker with a low cardinal. However, the (a) examples are truly ungrammatical, not for pragmatic reasons but because there is no Num-Cl constituent for *zuoyou* to modify.¹⁵

We are now in a position to explain the restriction of *de* to measure contexts. We discuss the simple cases first, and shall return to the approximate readings in the next subsection. As we have shown in the previous section, in the simple case, that is, classifiers with low or precise number words, [+C, –M] classifiers cannot be followed by *de*, as in (45a) and [–C, +M] classifiers can be naturally followed by *de* (45b), and with [+C, +M] classifiers, *de* forces a measure interpretation. Recall (24), repeated in (46):

- (45) a. san ben (*de) shu
 three Cl_{volume} DE book
 ‘three books’

¹⁵ A reviewer argued that *yi duo zuoyou de meiguohua* ‘a Cl approximately *de* rose’ is acceptable in a context in which you are measuring the quantity of roses in fractions of units. But as we shall argue in the §6 of this paper, fractions always induce measure contexts (see example (72)). Thus *one rose*, when compared with 1.9 roses, must be also considered a measure context, in which it denotes the quantity of rose to be any value from 1.0 to 1.9 roses.

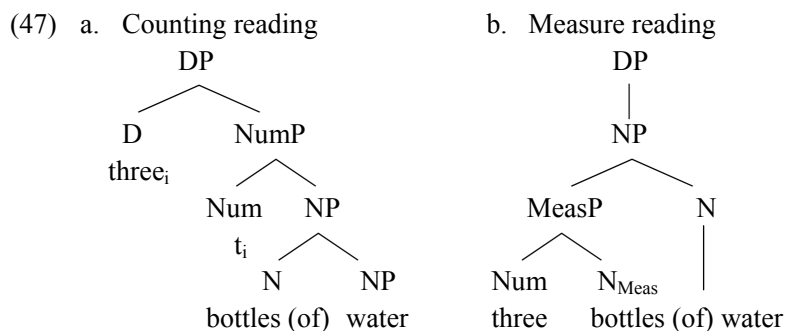
- b. san gongjin (de) pingguo
 three CL_{kilo} DE apple
 ‘three kilos of apples’
- (46) a. fuwusheng kai le san ping (*de) jiu, yi zhuo yi ping.
 waiter open PFV three CL DE wine one table one bottle
 ‘The waiter opened three bottles of wine, one bottle for one table.’
- b. ta he le san ping (de) jiu.
 he drink PFV three CL DE wine
 ‘He drank three bottles of wine.’

Assume, following all analyses of *de* (see references cited in the introduction) that *de* takes a phrasal complement and marks it as a modifier. In a measure reading of *san ping jiu*, which has the structure in (26b), *[[san ping] jiu]*, there is a natural complement for *de*, the constituent *san ping*. However, the counting reading of *san ping jiu* has the structure in (26a), and there is no phrasal constituent to be the complement of *de*. The only element that *de* could attach to is the classifier head, but this is not phrasal, and does not fulfil the selectional requirements of *de*. Thus *[san [ping [de [jiu]]]]* is ungrammatical. In §4, we show how these structures are interpreted compositionally.

In sum, the two syntactic structures we propose for counting and measure classifiers in (26) are well supported syntactically and allow us to explain the distribution of *de* in the simple cases. There is good reason to hold that classifiers on the counting and measure readings are associated with different structures: in the counting contexts, the classifier heads the projection CIP and takes NP as complement, while the numeral modifies the Classifier-NP constituent. In measure contexts, the numeral and the classifier form a complex classifier which combines syntactically with the NP.¹⁶

¹⁶ A reviewer cites A. Li (1998), who claims that Num-Cl-N has a ‘quantity’ reading in examples such as *san ge ren tai-bu-dong yi jia gangqin* ‘three people cannot lift a piano’, *yi zhang chuang shui san ge ren* ‘a bed sleeps three people’, and suggests that there is no evidence that these examples are left-branching. However, A. Li uses the term ‘quantity’ to refer to overall cardinality of a plural entity rather than the genuine measure use that we are talking about, which is stuff equal to a certain value denoted by Num-Cl. Therefore, these classifier phrases on the so-called ‘quantity’ reading are still associated with a counting reading in our sense. As Tsai (2001) points out, A. Li’s quantity readings are only available in modal contexts. In support of our claim that *san ge ren* ‘three Cl people’ in the example just cited involves a counting use of a quantifier in a modal context, we note that contra A. Li, referential anaphor is possible in contexts of modal subordination, as shown for English in Roberts (1989), as in “This bed sleeps three children if they are not big”, is perfectly acceptable in English. The relevant Chinese examples are given in (i) and (ii).

These results are in line with the syntactic and semantic results reported for Modern Hebrew and English in Rothstein (2009, 2010b). Rothstein argues that counting and measure uses of classifiers in English and in Modern Hebrew are associated with pairs of syntactic structures which are parallel to those in (26). Rothstein shows that there is evidence supporting the following structures for English count and measure uses of classifiers, (and that analogous structures are used in Modern Hebrew):



There are obvious differences between the languages, in particular, Mandarin is a classifier language and English is not, so English *bottle* is a relational noun, whereas Mandarin *ping* is a classifier. However, abstracting away from the categorial differences, the analogies between (47) and (26) should be clear. In the counting reading in (26a), the classifier combines with the NP, and the “Cl-NP” constituent is modified by the numeral. In the English example (47), the relational noun *bottle* takes the NP *water* as a complement, and the NP *bottle of water* is modified by the numeral *three* which later raises to D position. (Note that *of* is commonly regarded to be a late insertion which does not project a PP.) In the measure reading in both languages, the classifier combined with the numeral, and the complex Measure Phrase *three bottles* combines with the

-
- (i) yi zhang chuang keyi shui san ge ren,
 one Cl bed can sleep three Cl people
 ruguo tamen dou shi xiaohai de-hua.
 if they all be child case
 ‘A bed can sleep three people if they are all children.’

- (ii) yi-bai-kuai keyi mai san ping jiu,
 one-hundred-dollar can buy thee Cl_{bottle} wine
 ruguo tamen shi wo qu mai de-hua.
 if they be I go buy case

‘One hundred dollars can buy three bottles of wine if they were to be chosen by me.’

Thus, it is reasonable to assume that these uses involve individuating classifier constructions in the scope of a modal.

noun *water*: Rothstein (2009) shows that similar structures are used in Modern Hebrew classifier constructions, and that when independent syntactic constraints block the construction of a syntactic Measure Phrase from the number and classifier, the measure interpretation is not available.

One other possible argument that classifiers are lexically constrained to appear in a certain syntactic structure independent of their semantic function comes from Zhang (2011:7-8), who argues that container classifiers always have left-branching structure, even in counting contexts, since in examples like *dada de yi wan xiao yingtao* ‘big Mod one bowl small cherries’, the adjective *dada-de* ‘big-Mod’ apparently modifies the bowl and not the cherries. However, this is not a good argument. In the exactly same examples, adjectives can modify the noun, such as in (48). In (48), *hei-huhu* ‘black’ and *hen meiwei* ‘very delicious’ modify *Italian noodles* and *dishes* respectively and not the classifiers.

- (48) a. *hei-huhu de yi wan yidali mian*
 black Mod one CL_{bowl} Italian noodle
 ‘a plate of black Italian noodles’
 b. *hen meiwei de yi zhuo cai*
 very delicious Mod one CL_{table} dish
 ‘a table of delicious dishes’

3.2 Counting classifiers in a measure phrase

In this section, we discuss *de* with classifiers which have a counting reading, namely, [+C, –M] classifiers, such as *ge*, and [+C, +M] classifiers such as *ping* on their counting interpretation. We argue that these classifiers in the Num-Cl-*de*-N construction, are also analyzed as measure phrases, and they thus have the syntactic structure [[[Num-Cl]*de*] N].

As we saw above, [+C, –M] classifiers can be followed by *de* when the numeral is a (contextually) high round number or is modified by an approximative expression. We saw this already in (17) from Tang (2005). Further examples are given in (49), with (49b-c) taken from the Peking University Corpus:

- (49) a. *cunchu-ka man le, wo pai le yinggai you bu xia*
 memory card full SFP I take PFV should have not below
 yi-qian zhang de zhaopian.
 one-thousand Cl DE photo
 ‘The memory card is full. I certainly took no less than one thousand photos.’

- b. *sanshi duo ge de pingpang qiutai*
 thirty more Cl DE pingpong table
daduo dou you ren zai da.
 most all have people PROG play
 ‘Most of thirty-some pingpong tables are being used by people.’
 (from PKU Corpus)
- c. *nabian bian zhong le qi ba ke,*
 there then plant PFV seven eight Cl
shi lai ke de juzi shu.
 ten around Cl DE mandarin tree
 ‘On that side were planted seven or eight, or around ten mandarin trees.’
 (from PKU corpus: prose by *Yu Pingbo*)

(49) shows that [+C, +M] classifiers on the counting reading can also be followed by *de*. In these examples, the classifier phrase is the object of the verb *kai* ‘open’, which induces an individuating reading of the container classifier, since it is actual, individual bottles of wine which are opened. These classifier phrases are subject to the same constraint that the numeral must be a large round number and not a low or precise number. See the contrast between (50a) and (50b-c).

- (50) a. *na-ge fuwusheng yi tian kai le*
 that-Cl waiter one day open PFV
liu-bai ping de hong jiu.
 six-hundred Cl_{bottle} DE red wine
 ‘That waiter opened as many as six hundred bottles of red wine within one day.’
- b. *na-ge fuwusheng yi tian kai le liu ping (*de) hong jiu.*
 that-Cl waiter one day open PFV six Cl_{bottle} DE red wine
 Intended: ‘That waiter opened as many as six bottles of red wine within one day.’
- c. *na-ge fuwusheng yi tian kai le liu-bai-ling-yi ping*
 that-Cl waiter one day open PFV six-hundred-and-one Cl_{bottle}
 (*de) hong jiu.
 DE red wine
 Intended: ‘That waiter opened as many as six hundred and one bottles of red wine within one day.’

We now present evidence showing that a Num-Cl-*de*-NP constituent, such as

yiqian zhang de zhaopian ‘one thousand Cl *de* photos’, must be analyzed syntactically as having the same structure as a measure phrase, even when the classifier appears to have a counting interpretation. The first two arguments that we used in §3.1 are not relevant here. The construction without number illustrated in (27a)-(28a) is an alternative only for a *yi*-Cl-N phrase, that is, ‘one-classifier-N’, and since the constructions we are discussing here must appear with high round numbers, we do not expect the numeral to be droppable. The second argument involved the position of *duo*. We shall see below that the semantics of *duo*, which means literally ‘more than’ is not compatible with the approximative semantics we shall propose for these measure phrases. However, the third piece of evidence concerning the position of *zuoyou* is relevant, and the results are consistent with analyzing Num-Cl-*de* as a measure phrase in these cases as well.

As we discussed above, Paris & Vinet (2010) observe that when the approximator *zuoyou* appear between the Num-Cl cluster and NP, *zuoyou* must be followed by *de*. We showed in §3.1 that *zuoyou* can follow the classifier only on the measure interpretation, and not when a classifier is interpreted with a count interpretation. The crucial examples (41a) and (42a) are repeated here:

- (51) a. **wo kai le san ping zuoyou de jiu.*
 I open PFV three Cl_{bottle} approximately DE wine
 Intended: ‘I opened approximately three bottles of wine.’
 b. **yi/liang duo zuoyou de meiguihua*
 one/two Cl approximately DE rose
 Intended: ‘approximately one/two rose(s)’

However, when the low numerals are replaced by high round numbers, these ungrammatical examples become completely acceptable, and *de* is obligatory. The acceptable versions of (51) are given in (52).

- (52) a. *wo kai le san bai ping zuoyou de jiu.*
 I open PFV three hundred Cl_{bottle} approximately DE wine
 ‘I opened approximately three hundred bottles of wine.’
 b. *san bai duo zuoyou de meiguihua.*
 three hundred Cl approximately DE roses
 ‘approximately three hundred roses’

We suggested above that *zuoyou* can be adjoined to predicate constituents, either Num-Cl or the whole nominal phrase. The examples in (52) are good evidence that, even when the classifier is usually associated with a counting interpretation, a grammatical Num-Cl-*de* sequence is assigned a syntactic structure associated with measure readings.

A second piece of evidence supporting this structural analysis comes from the distribution of the modifier *zhengzheng* ‘as a whole’ or ‘overall’, as discussed in Hsieh (2008). As can be seen from the examples in (53), *zhengzheng* can only precede the Num-Cl-*de* sequence. This can be taken as evidence the Num-Class sequence forms a constituent which *zhengzheng* modifies.

- (53) a. ta zhong le zhengzheng wubai ke de shu.
 he plant PFV as-a-whole five:hundred Cl DE tree
 ‘He planted five hundred hundred trees in total/overall.’
 b. *ta zhong le wubai zhengzheng ke de shu.
 he plant PFV five:hundred as-a-whole Cl DE tree
 c. *ta zhong le wubai ke de zhengzheng shu.
 he plant PFV five:hundred Cl DE as-a-whole tree

These two pieces of evidence suggest that when classifiers that have default counting readings occur with large round numbers in the construction Num-Cl-*de*-N, they are also analyzed as measure structures as in (26b), i.e. with the structure [[[Num-Cl] *de*] N].

The question now is what sort of interpretation do expressions like *san bai ke de shu* ‘three hundred *de* trees’ and *yiqian zhang de zhaopian* ‘one thousand *de* photos’ have, and in what sense are they measure readings. Crucially we stress that these *de*-marked phrases are possible only when the number is large and round or when there is an explicit approximative marker.

Counting and measuring are two different semantic operations. Counting is identifying the number of atomic parts that a plural entity has, or more precisely, it puts the atomic parts of a plural entity in one-to-one correspondence with the natural numbers. Measuring, on the other hand, is giving an overall value to a quantity along a certain dimension. Thus *three trees* denotes a plurality entity made up of trees with three atomic trees as its basic parts. *Three kilos of wood* denotes a quantity of wood whose value on the dimension of weight is overall equal to three kilos. In this sense, approximation or expressions like *about 500 (N)*, *around 500,000 (N)* can be seen as measuring expressions, since they do not put the atomic parts of N in one-to-one correspondence with the natural numbers, but they assign an (approximate) cardinality to a quantity without identifying the atoms. Thus a statement like “Prince William and Kate Middleton married in London’s Westminster Abbey today as 1 million people lined the streets...” (BBC News 29/4/2011) does not entail that the people lining the streets were actually counted one by one. Rather it is an estimation that the quantity of people lining the streets is a plurality that we think has a cardinality in the region of one million on the scale of natural numbers. Similarly, in examples like (49) and (52), you do not really

count the number of bottles or the number of flowers one by one. The values of “no less than one thousand” in (49a) and ‘three hundred’ in (52a) are computed by the mechanism of estimation which assigns an overall value to a quantity without individuating and counting the atomic parts. Take (49a) for example. If you know that the memory card of the camera is 1.5G and each photo approximately 1.2M, then, when the camera shows that the memory card is full, you know that probably around 1,000 photos have been taken. You get this value by dividing 1.5G by 1.2M to get a round number. Thus, (49a) means that the number of photos is estimated or evaluated to be around one thousand.

We suggest that *de* forces a measure structure for all classifiers, including default ‘count’ classifiers. When the classifier is interpreted as count, the combination of count classifier and *de* results in ungrammaticality. However, when the count meaning can be incorporated into an approximative measure expression using a contextually large round number or an approximator, the *de* marked ‘count’ classifiers are acceptable. This correctly predicts that ‘real’ counting environments cannot be marked with *de*. We show this in the following examples:

- (54) wo tongchang yi tian mai yi jian tixu, suoyi pingjun
 I usually one day buy one Cl T-shirt so average
 mei ge yue wo yao mai sanshi jian (de) tixu.
 every Cl month I will buy thirty Cl DE T-shirt
 liuyuefen, wo ganghao mai le sanshi jian (*de) tixu.
 June I just buy PFV thirty Cl DE T-shirt
 ‘I usually buy one T-shirt one day, so on average I buy thirty T-shirts every month. In June, I bought just thirty T-shirts.’

The number *sanshi* ‘thirty’ appears twice in the example (54). In the first occurrence, it is used in the context of estimation, which is indicated by *pingjun* ‘on average’, where it is possible to have an optional *de* after the classifier *jian*. In the second, it is used to express a precise value. June only has exactly thirty days, so there can only be exactly thirty T-shirts. In this case, it is not appropriate to have *de* follow the classifier *jian*.

In the next section, we offer an explicit semantics to show how this works.

4. Semantics of Num-Cl_{measure}-*de*-N

In this section, we give an interpretation of measure uses of classifiers which explains (i) why *de* insertion is always compatible with explicit measure classifiers such

as *gongjin*, ‘kilo’, (ii) why it forces a measure reading of [+C, +M] classifiers like *ping*, and (iii) why on a simple interpretation, *de* is incompatible with [+C, –M] classifiers like *ge*.

We assume a type theory in which *t* is the type of truth values, *d* is the type of individuals, and *n* is the type of numbers. $\langle \alpha, \beta \rangle$ is the type of functions from α into β . In non-classifier languages, measure classifiers are semantically of the type $\langle n, \langle d, t \rangle \rangle$, and combine with number words to give predicates, which then modify the noun they combine with. Thus *kilo* in English has the interpretation $\lambda n \lambda x. \text{MEAS-WEIGHT}(x) = \langle n, \text{kilo} \rangle$, which combines with a number expression such as *two* to give the predicate expression *two kilos* which has the denotation in (55a). In *two kilos of apples*, the denotation of *two kilos* modifies the denotation of *apples*, as in (55b):

- (55) a. $\lambda x. \text{MEAS}(x) = \langle 2, \text{kilo} \rangle$
 b. $\lambda x. \text{APPLES}(x) \wedge \text{MEAS}(x) = \langle 2, \text{kilo} \rangle$

We assume that [–C, +M] classifiers like *gongjin* ‘kilo’ and [+C, +M] classifiers like *ping* ‘bottle’ have interpretations as measure heads, and that *liang gongjin/liang ping* have interpretations like the English expressions, and these are given in (56). Note we use the English-based gloss BOTTLE-FUL to express the measure interpretation of the expression.

- (56) a. $\|gongjin\|$ = $\lambda n \lambda x. \text{MEAS}(x) = \langle n, \text{KILO} \rangle$
 b. $\|liang gongjin\|$ = $\lambda x. \text{MEAS}(x) = \langle 2, \text{KILO} \rangle$
 c. $\|ping\|$ = $\lambda n \lambda x. \text{MEAS}(x) = \langle n, \text{BOTTLE-FUL} \rangle$
 d. $\|liang ping\|$ = $\lambda x. \text{MEAS}(x) = \langle 2, \text{BOTTLE-FUL} \rangle$

These Num-Cl measure predicates can be used in prototypical predicate positions, for example, after the verb *zhong* ‘weigh’ or *you* ‘have/reach’, as in (57a-b), and also in the attributive cases in (57c). Note also that, as pointed out above, these bare measure expressions can be directly modified by *zuoyou*, further indicating that they are genuine predicates:

- (57) a. zhaxie pingguo zhong liang gongjin (zuoyou).
 those apple weigh two kilos approximately.
 ‘These apples weigh two kilos.’
 b. ta he de jiu you san ping (zuoyou).
 he drink Mod wine have three CL_{bottles} approximately
 ‘The wine he drank reaches three bottles.’

- c. liang gongjin de pingguo
two CL_{kilo} DE apple
'two-kilo apples'

On the classifier use, as illustrated in (58a), *liang gongjin* is a complex classifier, which takes the NP expression as a complement.

- (58) liang gongjin pingguo
two kilo apple
'two kilos of apples'

Following Chierchia (1998), Yang (2001) and X.P. Li (2011), we assume that the NP following the classifier denotes a kind, and is therefore of type **k**. In (59a), the classifier interpretation of *gongjin* is at type $\langle n, \langle \mathbf{k}, \langle d, t \rangle \rangle \rangle$, and it combines with a number expression to give the complex classifier *liang gongjin* 'two kilos', which is of type $\langle \mathbf{k}, \langle d, t \rangle \rangle$. This expression applies to the kind expression *pingguo* and gives sets of (possibly plural) instantiations of the kind which weigh two kilos. The derivation for the Classifier Phrase in (58) is given in (59). Note that we use **k** as a variable over kinds and that APPLE is the kind denoted by *pingguo*. '^U' is the operation which takes a kind into the set of its instantiations, and thus ^UAPPLE is the set of instantiations of the apple kind (see Chierchia 1998 for details).

- (59) a. $\|gongjin_{CL}\| = \lambda n \lambda \mathbf{k} \lambda x. x \in {}^U \mathbf{k} \wedge \text{MEAS}(x) = \langle n, \text{KILO} \rangle$
b. $\|gongjin\|(\|liang\|) = \lambda \mathbf{k} \lambda x. x \in {}^U \mathbf{k} \wedge \text{MEAS}(x) = \langle 2, \text{KILO} \rangle$
c. $\|liang gongjin\|(\|pingguo\|) = \lambda x. x \in {}^U \text{APPLE} \wedge \text{MEAS}(x) = \langle 2, \text{KILO} \rangle$

(59) gives a compositional interpretation for the structure (26b), since the denotation of *gongjin* applies to the denotation of *liang*, and the complex expression *liang gongjin* applies to the denotation of the NP.

On its measure reading, *liang ping* 'two bottles' is interpreted in exactly the same way. Since *ping* is a [+C, +M] classifier, it is associated with two interpretations. One is the counting classifier interpretation, which we shall discuss below, which is used in structures associated with (26a). The second is the measure interpretation illustrated in (56c-d) above. Like *gongjin*, *ping* shifts to a classifier expression of type $\langle n, \langle \mathbf{k}, \langle d, t \rangle \rangle \rangle$, i.e. an expression which combines with a number and applies to a kind term to give a set of entities. The interpretation of the classifier expression *liang ping jiu* 'two bottles of wine' on the measure interpretation in (60), is given in (61).

- (60) ta he le liang ping jiu.
 he drink PFV two CL_{bottle} wine
 ‘He drank two bottles of wine.’

- (61) a. $\|ping_{CL}\| = \lambda n \lambda k \lambda x. x \in {}^U k \wedge MEAS(x) = \langle n, BOTTLE-FUL \rangle$
 b. $\|ping\|(\|liang_n\|) = \lambda k \lambda x. x \in {}^U k \wedge MEAS(x) = \langle 2, BOTTLE-FUL \rangle$
 c. $\|liang ping\|(\|jiu\|) = \lambda x. x \in {}^U WINE \wedge MEAS(x) = \langle 2, BOTTLE-FUL \rangle$

We can now explain the basic facts about the distribution of *de*. We assume, following the general line of Paul (2007, 2010) that *de* is a root complementizer which can combine with any XP constituent. We assume further that semantically *de* is marker of modification, which applies in the normal case to a predicate constituent and gives a predicate modifier. Standard type theory represents a predicate as being of type $\langle d, t \rangle$, (i.e. an expression which denotes a function from entities to truth values), and predicate modifiers as being of type $\langle \langle d, t \rangle, \langle d, t \rangle \rangle$ (i.e. denoting a function from properties into properties). In such a framework, *de*, an expression denoting a function from predicates into predicate modifiers, must be of type $\langle \langle d, t \rangle \langle \langle d, t \rangle, \langle d, t \rangle \rangle \rangle$.¹⁷ Continuing with a type-theoretic approach, we expect the type of *de* to constrain its distribution. Assuming that *de* denotes a function from predicates to predicate modifiers also when it follows a classifier, we expect it generally to combine with a predicate phrase and to yield a modifier of a predicate phrase. When the classifier is a measure head and combines with a numeral as in the examples in (58)–(60), the Num-Cl constituent is a phrase with which *de* can combine. The string numeral + classifier denotes a measure predicate, the property that entities (or quantities) have if they measure N units. *De* combines with this predicate to form a predicate modifier which can modify the N. Since a counting classifier does not combine with a numeral and is not itself a predicate constituent, *de* following a counting classifier does not have a predicate with which to combine, and the string is infelicitous.

We now show in detail how to derive the interpretations. The derivations need to take into account the fact that nouns in Chinese plausibly denote kinds (Chierchia 1998, Yang 2001, X.P. Li 2011) and that classifiers and Numeral+Cl constituents must thus

¹⁷ Things are a bit more complicated than this statement implies. Assuming that APs and relative clauses are predicates, it is reasonable to assume that *de* applies to a predicate constituent and gives a predicate modifier, as suggested in the text. But *de* also takes a proper name as a complement as in *Lisi de shu*, lit: ‘Lisi *de* book’, or ‘Lisi’s book’, which is *prima facie* a problem for this account. However, if Longobardi (1994) is correct, then all proper names begin at the predicate type, and *de* can combine with proper names at the predicate type as well. The suggestion that Mandarin proper names are born at the predicate type is supported by the fact that they can co-occur with demonstratives as in *na ge Lisi*, ‘that Cl Lisi’.

combine with nouns of type **k**. In the derivations (59) and (61), the type of the Num-Cl constituent is $\langle n, \langle \mathbf{k}, \langle d, t \rangle \rangle \rangle$, that is, the classifier combines with a number to give a constituent which takes a kind term into the set of entities which instantiate the kind. If *de* is of type $\langle \langle d, t \rangle, \langle \langle d, t \rangle, \langle d, t \rangle \rangle \rangle$, then we assume that it will not combine with this constituent, but with the measure expression which is of type $\langle d, t \rangle$. We propose the following interpretation:

- (62) a. $\|ping\|$ $= \lambda n \lambda x. MEAS(x) = \langle n, BOTTLE-FUL \rangle$
 b. $\|liang ping\|$ $= \lambda x. MEAS(x) = \langle 2, BOTTLE-FUL \rangle$
 c. $\|liang ping de\|$
 $= \|de\|(\|liang ping\|) = \lambda P \lambda x. P(x) \wedge MEAS(x) = \langle 2, BOTTLE-FUL \rangle$
 d. $\|liang ping de shui\|$ $= \lambda P \lambda x. P(x) \wedge MEAS(x) = \langle 2, BOTTLE-FUL \rangle (\cup WATER)$
 $= \lambda x. \cup WATER(x) \wedge MEAS(x) = \langle 2, BOTTLE-FUL \rangle$

The particle *de* applies to the predicate denoted by *liang ping* to give a predicate modifier. Since the predicate modifier *liang ping de* combines with a predicate and not a kind, the nominal expression *shui* shifts from its denotation at the type of kinds to the predicate at type $\langle d, t \rangle$, denoting the set of instantiations of the kind water. *liang ping de shui* denotes the set of quantities of water (i.e. instantiations of the WATER kind) which measure two bottlefuls. An exactly parallel derivation is given for *liang gongjin pingguo*.

Thus we get the same reading in the last line of (62) as we get in the last line of (61), but from a different structure. These two derivational processes reflect the fact that Num-Cl-N and Num-Cl-*de*-N express the same meaning, namely that the quantity of N amounts to the value expressed by Num-Cl. However, the *de* structure forces the measure reading, and can be used pragmatically for emphasis, since it has the effect of focusing on the predicate phrase *san ping*, meaning that the quantity of N is *as much as the value of Num-Cl*. For example, when saying “you drink *san ping de jiu*”, the speaker really implies that that amount of wine is a lot for the subject. In the example of “you drink *san ping jiu*”, there is no such emphasis implied and the sentence is stated in a rather neutral tone.

Note that if *de* denotes a function from predicates to predicate modifiers, as we have just suggested, we explain why *de* is not allowed following measure expressions as predicates (rather than predicate modifiers). In (63), *liang gongjin (zuoyou)* is a predicate complement of the verb *zhong* and not a modifier of a nominal. Thus shifting it from the predicate type to the predicate modifier type via *de* will result in ungrammaticality.

- (63) zhexie pingguo zhong liang gongjin (zuoyou) (*de)
 those apple weigh two Cl_{kilo} approximately DE
 ‘These apples weigh two kilos.’

5. Semantics of Num-Cl_{count}-*de*-N

We now discuss constructions where *de* follows classifiers which are associated with a counting reading, either [+C, -M] like *ge*, *ke*, and *ben*, or [+C, +M] classifiers like *ping* in contexts which force an individuating reading such as *wo na le Num-Cl-NP* ‘I carried Num-Cl-NP’. We begin by giving an account of the semantics of counting classifiers, following Rothstein (2010a) and X.P. Li (2011).

Rothstein (2010a) argues that counting is a grammatical operation which involves putting entities in one-to-one correspondence with the natural numbers. She argues that this requires a context-sensitive decision as to what counts as one entity. This is because of count nouns such as *fence*, *bouquet*, *wall*, and *line*, where what counts as ‘one wall’ may vary depending on the criterion of individuation. For example, if two neighbors with adjoining gardens build a (continuous) fence between their gardens and the street, we may count one fence or two fences, depending on whether we focus on the fact that each neighbor built a fence (= two fences), or on the fact that both neighbors together built a fence (= one fence). Rothstein (2010a) assumes that all nouns are interpreted with respect to a domain D , which is a complete atomic Boolean algebra generated by a (possibly vague) set of atoms. All lexical nouns are associated with an abstract root N_{root} , the interpretation of which is a subset of D . We have been assuming that in Chinese, NP denotes a kind, we now add to this that NP denotes the kind associated with N_{root} . Rothstein argues that in English, singular count nouns grammaticalize the context-dependent choice of atoms. A singular count noun denotes the set of singular entities which count as one entity in the relevant context. She formalizes this as follows: a context, in addition to all the other parameters (such as time, world, etc), is indexed for a counting context k , k a subset of D , where k is the set of entities that in that context count as one. $COUNT_k$, the operation that derives singular count nouns from root nouns, applies to the set N_{root} and gives the set of entities in $N_{root} \cap k$, the set of N entities which count one in context k , with each entity carrying the k index. We call these entities ‘ k -atomic entities’, i.e. entities which are atomic relative to context k . So while N_{root} denotes a set of unindexed entities, a singular count noun, which we shall call N_k , denotes a set of k -indexed entities. N_k thus denotes a set of ordered pairs, where the first projection of the ordered pair is an entity in $N_{root} \cap k$ and the second projection of the ordered pair is the index k . This means that while N_{root} (and the set of instantiations of the kind term derived via the U operator) are of type $\langle d, t \rangle$, N_k is of type $\langle d \times k, t \rangle$. Rothstein argues that while the $COUNT_k$ operation is a hidden lexical operation deriving count nouns in English, it may be explicitly realized by count classifiers such as *unit*, or *piece* in *a unit of furniture*, or *a piece of furniture*.

X.P. Li (2011) extends Rothstein’s semantics of English count nouns and the

COUNT operator to classifiers in Chinese in general. He argues that on their counting reading, Chinese classifiers are explicit realizations of a version of Rothstein's $COUNT_k$ operation, with the difference that while in English $COUNT_k$ applies to N_{root} , in Chinese languages, $COUNT_k$ has to apply to the denotation of the kind-term. Assuming that Chinese bare nouns are kind-denoting terms, X.P. Li analyzes Chinese classifiers with count usages as expressions of type $\langle \mathbf{k}, \langle d \times k, t \rangle \rangle$, that is as expressions which apply to a kind and give a set of k -indexed entities which are the atomic instances of the kind in context k . The template for classifiers on the counting interpretation is given in (64):

$$(64) \quad \lambda \mathbf{k} \lambda x. \pi_1(x) \in {}^U \mathbf{k} \cap k \wedge \pi_2(x) = k \wedge P_{unit}(\pi_1(x))$$

A classifier denotes a function which applies to a kind denoting term and gives the set of k -indexed atomic instantiations of the kind, where all the atomic instances have the unit property expressed in P_{unit} .

Note that we use x as a variable of type $d \times k$ and x as a variable of type d . Note also that k is a variable over contexts, while we continue to use \mathbf{k} as a variable over kinds. π_1 is a function picking out the first projection of an ordered pair, while π_2 picks out the second projection of an ordered pair. X.P. Li (2011) offers (65) as the interpretation of the classifier *ke* (which individuates trees, vegetables and other members of the plant world).

$$(65) \quad a. \quad \|ke\| = \lambda \mathbf{k} \lambda x. \pi_1(x) \in {}^U \mathbf{k} \cap k \wedge \pi_2(x) = k \wedge PLANT_{unit}(\pi_1(x))$$

ke applies to a kind denoting term and gives the set of k -indexed atomic instantiations of the kind, where the atomic instances have the property $PLANT_{unit}$.

$$\begin{aligned} b. \quad \|ke \ shu\| &= \|ke\| (\|shu\|) = \lambda \mathbf{k} \lambda x. \pi_1(x) \in {}^U \mathbf{k} \cap k \wedge \pi_2(x) = k \wedge PLANT(\pi_1(x)) \\ &\quad (\|shu\|) \\ &= \lambda x. \pi_1(x) \in {}^U TREE \cap k \wedge \pi_2(x) = k \wedge \\ &\quad PLANT(\pi_1(x)) \end{aligned}$$

ke shu denotes the set of k -indexed instantiations of the $TREE$ kind which count as one tree in context k , i.e. k -atomic instantiations of $TREE$.

$$\begin{aligned} c. \quad \|wubai \ ke \ shu\| &= \|wubai\| (\|ke \ shu\|) \\ &= \lambda x. \pi_1(x) \in PLURAL({}^U TREE \cap k) \wedge \pi_2(x) = k \wedge PLANT(\pi_1(x)) \wedge \\ &\quad |\pi_1(x)|_k = 500 \end{aligned}$$

wubai ke shu denotes the set of pluralities of instantiations of the $TREE$ kind which have 500 k -atomic parts.¹⁸

¹⁸ We assume that the pluralization of a set is the set closed under sum, following Link (1983).

As we have argued above, the presence of *de* after counting classifier means that the structure Num-Cl-*de*-N must be analyzed syntactically as [[[Num-Cl] *de*] N]. The subordinator *de* takes the denotation of [Num-Cl] as its complement. We have argued that the denotation of [Num-Cl] must be a predicate expression of type $\langle d, t \rangle$. Thus the counting classifier must be reanalyzed as a measure classifier at type $\langle n, \langle d, t \rangle \rangle$. But the meaning of the counting classifier must be incorporated into the derived measure reading, as we can see from re-examining some of the examples already cited above. Let us look again at the examples in (66), repeated from (17b) (Tang's example) and (50a).

- (66) a. yinian yue zhongzhi le yi-bai-sishi-duo-wan
 one year about plant PFV one-hundred-forty-more-ten:thousand
 ke de shumu.
 Cl DE tree
 '(They) planted more than one million four hundred thousand trees a year.'
- b. fuwusheng yi ge yue kai le liu bai ping de hongjiu.
 waiter one Cl month open PFV six hundred Cl_{bottle} DE red wine
 'The waiter opened six hundred bottles of wine within a month.'

(66a) asserts that the approximate quantity of trees planted is more than 1,400,000 individual trees. Similarly, in (66b), the quantity of bottles of wine opened is around 600 bottles. But crucially, reference is made to the individual trees and the individual bottles and not to a quantity equal in measure to a quantity of tree stuff equal to that comprising 1,400,000 trees or a quantity contained in 600 bottles.

The counting classifier then has to shift from its basic classifier type of $\langle k, \langle d \times k, t \rangle \rangle$ to the type of $\langle n, \langle d, t \rangle \rangle$, incorporating its basic semantic meaning.

We propose the following: *de* looks for a predicate meaning of type $\langle d, t \rangle$. The classifier shifts to a measure function of type $\langle n, \langle d, t \rangle \rangle$. The meaning it shifts to is that of an estimation function, EST, which estimates the overall number of a plurality. We suggest that Num-Cl_{COUNT}-*de*-N expresses the estimated value of a plurality, measured in terms of a 'quantity of counting-units'. The plural entities that it is interested in evaluating are entities in the pluralization of the contextually relevant set of *k*-atoms.

- (67) a. Basic counting meaning of the classifier (from (64)):
 $\lambda k \lambda x. \pi_1(x) \in (\cup k \cap k) \wedge \pi_2(x) = k \wedge P_{\text{unit}}(\pi_1(x))$
- b. Shifted measure meaning of the counting classifier:
 $\lambda n \lambda x. x \in \text{PLURAL}(k) \wedge \text{EST}(x) = \langle n, U_{P\text{-unit}} \rangle$
 The function that maps number *n* onto the set of members of the pluralization of the context set *k* whose *estimated* value is *n* P-units.

- c. This applies to the round number 1,400,000:
 $\lambda x. x \in \text{PLURAL}(k) \wedge \text{EST}(x) = \langle 1,400,000, U_{\text{P-unit}} \rangle$
 The set of pluralities in $\text{PLURAL}(k)$ (the pluralization of the contextually relevant set of atoms), whose cardinality is estimated to be around equal to 1,400,000 P-units.

In (67a) *ke* denotes atomic plant units and in (67b), the classifier shifts to a measure function where it combines with a number to give the measure predicate in (67c). This Num-Cl sequence denotes the set of pluralities of atomic plant-type entities whose estimated value is 1,400,000. Thus, estimation is a contextual operation involving a ‘counting measure’, and the numbers are round, because that is what they are in estimation.

This measure phrase can be used as a predicate as in (68), (without *de*, since *de* denotes a function from predicates into predicate modifiers), and as a classifier in sentences such as (69). The interpretation of (69) is given in (70):

- (68) ta zhong de shu duoda wubai ke.
 he plant Mod tree reach five:hundred Cl
 ‘The trees he planted reached 500.’

- (69) ta zhong le wubai ke de shu.
 he plant PFV five:hundred Cl DE tree
 ‘He planted five hundred trees.’

- (70) a. $\|500 \text{ ke}\| = \lambda x. x \in \text{PLURAL}(k) \wedge \text{EST}(x) = \langle 500, U_{\text{plant unit}} \rangle$
 b. $\|500 \text{ ke de}\| = \lambda P \lambda x. (P(x)) \wedge x \in \text{PLURAL}(k) \wedge \text{EST}(x) = \langle 500, U_{\text{plant unit}} \rangle$
 c. $\|500 \text{ ke de shu}\| = \lambda x. {}^U\text{TREE}(x) \wedge x \in \text{PLURAL}(k) \wedge \text{EST}(x) = \langle 500, U_{\text{plant unit}} \rangle$
 the set of pluralities in the pluralization of the contextually relevant set of atoms that are sums of instantiations of the kind *tree*, whose estimated cardinality is around 500.

The present semantics accounts for the constraint that in the readings discussed here that the Numeral must denote a large round number. The semantics of the measuring operation is dependent on estimation, an operation which gives a ‘ball-park’ overall quantity value to the sum of a plurality, and which conventionally gives values in terms of round numbers, since it is presupposed that estimation cannot be precise. This kind of operation is only relevant when the quantity of entities is contextually large, and thus the entities are too numerous to count in the normal way, since with a small number one does not need to estimate, one just counts. This conforms with Krifka’s (2002, 2007) observation that, “round numbers in measuring contexts tend to have round interpre-

tations”, and that “short expressions have a preference for vague interpretations, (...) long expressions have a preference for precise interpretations” (Krifka 2002:446-447). Given this, estimation will favor round numbers in short expressions. We saw above that Hsieh proposed that *de* was sensitive to a feature of ‘indeterminateness’. Under our analysis, the indeterminateness and approximative properties of this classifier construction are by-products of the semantic reinterpretation of the counting classifier as an estimation measure, given that estimation necessarily involves approximation.

6. Conclusions: two puzzles about [+C, –M] classifiers

In this article, we have made use of the distinction between counting and measure operations to account for the licensing of *de* after classifiers. We argued that the use of *de* after a classifier cannot be correlated with a certain lexical type of classifier, but rather it depends on whether the classifier denotes a measure operation or a counting operation. We showed further that measure and counting uses of classifiers are associated with different syntactic structures: measure Classifier Phrases have the structure [[Num Cl] NP], while counting Classifier Phrases have the syntactic structure [Num [Cl [NP]]].

We have made two claims concerning the licensing of *de*: (i) classifiers that can be interpreted with a measure reading can be followed by *de*, in which case the measure reading is obligatory; (ii) classifiers which are normally associated only with a counting interpretation can be followed by *de* if the numeral is a (contextually) high round number or the numeral is modified by approximative modifier. This is because approximation is a kind of measure operation, and in these constructions the counting classifier is reanalyzed as a measure expression, and Num-Cl-*de*-N always has the syntactic structure [[[Num-Cl]*de*] N].

We propose that *de* denotes a function from predicates to predicate modifiers (is of the type $\langle\langle d, t \rangle, \langle\langle d, t \rangle, \langle d, t \rangle \rangle\rangle$). It combines with a predicate expression of type $\langle d, t \rangle$, and yields an expression which modifies another predicate. While it is beyond the scope of this paper to give a semantic analysis of other uses of *de* as a modification marker, our analysis suggests that a unified account of *de* modification is possible, one that incorporates both Num-Cl-*de* sequences as well as AP-*de*, *de*-marked relative clauses and so on.

There are still two puzzles remaining. The first puzzle is that classifiers with a default counting interpretation can be coerced into a measure reading with low cardinals in recipe type contexts, but, nonetheless, *de* cannot follow the classifier in these contexts. The examples are given in (71).

- (71) zuo zhe ge pingguo-pai wo zonggong yong le you
 make this Cl apple-pie I altogether use PFV have
 yi/san ge (*de) pingguo.
 one/three Cl DE apple
 ‘To make this apple pie, I used one/three apple(s) altogether.’

We assume that in this context, there is a pragmatic shift from the standard meaning of *yi ge pingguo* to a reading roughly paraphrasable as “to make this apple pie, I used one apple’s-worth of apple”. We assume that this pragmatic reanalysis occurs later in the derivation after the classifier has combined with the NP, and thus does not result in a structural reanalysis of the classifier phrase. Therefore, *de* cannot follow the classifier in this case. While this is a somewhat *ad hoc* explanation, it is supported by the fact that recipe contexts are crosslinguistically distinguished from standard counting and measuring contexts. Thus for example, in English, recipe contexts are the only context in which *of* can be dropped from a measure partitive, e.g. ‘two kilos flour’ *versus* ‘two kilos of flour’. Given that these exceptions are limited to a very specific and exceptional context, it seems to us clear that the distribution of *de* is generally associated with a measure interpretation of the classifier, which is reflected in the structural properties of the classifier phrase.

The second puzzle is that when Num is a fraction, such as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$ or a decimal, such as 10%, 15%, it is possible to use *de* after the classifier to get a measure reading, as illustrated in (72), (examples from Li & Rothstein 2010).

- (72) a. yi ge yi sui de yinger mei-ci zhi neng chi
 one Cl one year DE baby every time only can eat
 $\frac{1}{3}$ li de ganmao-yao
 $\frac{1}{3}$ Cl DE cold pill
 ‘A one year old baby can only take $\frac{1}{3}$ of a cold pill every time.’
 b. $\frac{1}{4}$ ge de xigua keyi zha ban bei guozhi zuoyou.
 $\frac{1}{4}$ Cl DE watermelon can crush half Cl_{cup} juice approximately
 ‘ $\frac{1}{4}$ of a watermelon can be crushed into half cup of juice.’

Her & Hsieh (2010:539-540) independently observe that “...fractions of a number, including those with a value smaller than one, drastically increase acceptability”. Their examples are given in (73a-b) and our own example is given in (73c).

- (73) a. ba-fen-zhi-yi ke de gaolical
 one-eight Cl DE cabbage
 ‘one-eighth of a cabbage’

- b. si-fen-zhi-yi ke de yangcong
 one-fourth Cl DE onion
 ‘one fourth of an onion’
- c. ba-fen-zhi-san gongjin de dami
 eight-portion-Mod-three (three eighths) Cl_{kilo} DE rice
 ‘three eighths of a kilo of rice’

The syntax and semantics of fractional expressions has not yet been studied in any detail, but it is clear that crosslinguistically fractions have a different grammar from cardinal natural numbers. In English, they are necessarily partitive as in *a third of a pill*, *a quarter of a kilo of flour*, *a half of an apple* (although *(a) half an apple* is also acceptable), and in English, as in French, the fractional expression is based on the ordinal numeral. In Mandarin, the fraction is expressed by a complex expression using the word *fen* ‘portion’. *Si fen zhi yi* ‘one-fourth’ has the compositional structure in (74), and literally means ‘one of four portions’, with the classifier giving the unit which is divided into portions.

- (74) si fen zhi yi
 four portions Modifier one
 ‘one fourth’

An analysis of the semantics of fractions is beyond the scope of this paper, given that these constructions are highly complicated, both in Mandarin and cross-linguistically. However, it is clear that fractions have a different interpretation from natural number predicates. A natural number such as *san* ‘three’ can be interpreted either as the name for a number at type *n*, as in a measure context, or as the predicate of plural entities, in which case it modifies a Cl-N in a counting context (see discussion in Rothstein 2012). Fractions clearly cannot be predicates of plural entities, since they do not count atomic entities. Similarly, the classifier cannot have its usual interpretation, that in which it denotes function from kinds into atomic instantiations of the kind. Instead, the role of the classifier is to give the name of the unit which the fraction divides into portions. We thus suggest that in these contexts, the fraction and the classifier combine to form a fractional predicate, and thus form a predicate constituent which can be the complement of *de*. Thus syntactically, we suggest, Num combines immediately with the classifier and the insertion of *de* is thus possible after the [N-Cl] constituent. This should not be taken as an analysis of these constructions, but as an hypothesis to be explored in further research. Nonetheless, what does seem clear is that the role of the classifier in these fractional constructions is different in its role in counting constructions which use

natural numbers. This can be seen from the contrast between (75a) and (75b).

- (75) a. ta chi le san-fen-zhi-yi ge de pingguo.
he eat PFV san-portion-Mod-one Cl DE apple
'He ate one third of an apple.'
- b. ta chi le san-fen-zhi-yi de pingguo.
he eat PFV san-portion-Mod-one DE apple
'He ate one third of the apples.'
- Or: 'He ate one third of an apple.'

In (75a), where the fraction is followed by *ge*, the sentence must mean 'he ate one third of a single apple'. Thus the classifier does not have its usual use in which it combines with N and Cl+N denotes a set of atomic individual apples. Instead it indicates what is the single entity which is portioned by the fraction. In (75b) where there is no classifier, we see that the sentence means 'he ate one third of some quantity of apples', either a third of a plurality of apples or one third of a single apple. The data in (75) are sufficient to show us that the use of fractions is very different from other numerical structures: unlike the natural numbers, the fraction does not require a classifier, and when the classifier is present it has a very different meaning from its usual one. So while we do not yet understand either the syntax or semantics of fractional constructions, we can see that these constructions are sufficiently different from normal counting contexts not to constitute a counterexample to the account that we have presented in this paper.

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漢語量詞短語的計量結構和助詞“的”

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本文討論漢語中量詞後加“的”這一語法現象。我們認為，漢語的量詞，比如“瓶”，有計數和計量這兩種功能，但是“的”的出現，我們只能獲得計量這一功能。我們同意 Tang (2005) 和 Hsieh (2008) 的觀點，認為“的”可以出現在個體量詞後面，但是該量詞短語的數詞必須是約整數，如百、千、萬等或者有“大概”、“左右”等表示約量的副詞的修飾。從語義上來看，這是一種“近似化”，是一種計量功能，在這種解讀下，個體量詞不再具有本來的計數功能，相反是獲得了計量功能（計量短語中的中心語）。在 X.P. Li (2011) 觀點的基礎上，我們認為，數-量-名短語在計量解讀時的結構為 [數-量[名]]，當“的”出現的時候，它修飾的是 [數-量] 這一成分。這一處理使得我們能對結構助詞“的”有一個統一的結構和語義。

關鍵詞：的，量詞，計數，計量，約量，近似化