

Dou as *even* and plural universal quantification in Mandarin Chinese

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1 Introduction

One of the most studied morphemes in Mandarin Chinese could be *dou*, which displays a wide variety of uses in different contexts. Out of its many uses, the syntactic and semantic nature of universal quantification involving the elements *mei* and *dou* have generated extensive debate. In the simplest case, a universally quantified sentence is expressed through a combination of *mei* and *dou*, as in the following example:

- (1) mei-ge ren *(**dou**) lai-le.
every-CL person DOU come-PFV
'Everyone came.'

Among the previous approaches to *dou*, Lin (1998) provides a treatment of *dou* as the actual distributor contributing universal force and the 'mei NP' phrase as simply denoting a definite plural, essentially equating (1) with another use of *dou* with definite plural subjects:

- (2) tamen **dou** lai-le.
they DOU come-PFV
'They all came.'

Sun (2018) considers *mei* semantically vacuous and simply returns the denotation of its sister, i.e., a set of individuals; *dou* is an adverbial universal quantifier that combines with the VP first before combining with the set returned by *mei*. Giannakidou & Cheng (2006) and Cheng, Giannakidou & Rathert (2009) analyze *dou* as a maximizer with the semantics of a definite article, returning the unique maximal individual in the domain if defined; M. Xiang (2008) adopts a similar analysis. Y. Xiang (2020) considers *dou* a special exhaustifier that makes a vacuous assertive contribution when used with a 'mei *n*-CL NP,' which is also treated on par as any other plural element. The universal force comes from a separate covert distributor. Liu (2021) equates *dou* with English *even* and *mei* with English *every*, a genuine universal quantifier.

To provide support for one of these approaches, i.e., Liu (2021), over the others, in this paper, I would like to re-examine data presented in Sun (2018) concerning the cases where *mei* is combined with a numeral larger than two, and *dou* becomes optional, moderating a semantic alternation:

- (3) **mei** liang-ge xuesheng (**dou**) he-xie-le yi-pian lunwen.
MEI 2-CL student DOU co-write-PFV 1-CL paper
i. With *dou*: 'Every possible pair of students co-wrote a paper.'

- ii. Without *dou*: ‘Every pair of students in a partition of students into pairs co-wrote a paper.’

To date, this data is only taken into account by Sun (2018) on the literature about *dou*. After a more detailed presentation of the empirical background on *dou* and the specifics of the data in Sun (2018) in section 2, I will develop an account of this data taking the approach to *dou* in Liu (2017, 2021) as the foundation in sections 3 and 4. I will then in section 5 introduce a correct prediction that this approach makes in a separate but related domain, i.e., the free choice inferences of plural negative polarity items, in particular, the interpretation of free choice items of the form ‘any *n* NP’ in both English and Mandarin Chinese. In section 6, I will compare my Liu (2017, 2021)-based approach to other approaches to *dou* and show that it is the most successful in three dimensions: the empirical coverage of the data in Sun (2018), the ability to derive the extension to plural NPI free choice, and the ability to fit into a unified approach to *dou*. Section 7 concludes.

2 The data

In section 2.1, I will present examples for the four basic uses of *dou* to provide some background for the empirical picture. In section 2.2, I will present the data first introduced in Sun (2018) (3) in more detail to set up the main puzzle that this paper is concerned with.

2.1 The four basic uses

First, *dou* has a use that is very similar to English *even*, which takes a focus associate and operates on individual alternatives. I call this the *scalar use*.

- (4) Zhangsan_F **dou** lai-le.
Z. DOU come-PFV
‘Even Zhangsan_F came.’

Second, *dou* generally co-occurs with a universal quantifier headed by *mei*. I call this the *universal use*.

- (5) mei-ge ren *(**dou**) lai-le.
every-CL person DOU come-PFV
‘Everyone came.’

Third, *dou* licenses the universal free choice reading of NPI indefinites and *wh*-phrases, such as those formed from the NPI *renhe* ‘any’ and *shenme* ‘what.’ I call the NPI case the NPI-FC use, and the *wh*-phrase case the *wh*-FC use.

- (6) { renhe ren / shenme ren } *(**dou**) keyi lai.
any person / what person DOU can come
‘Anyone can come.’

Lastly, *dou* can be used with a plural subject and obtains a semantic contribution quite similar to English *all* (or *both*). I call this the *distributive use*.

- (7) zhaxie xuesheng **dou** lai-le.
these student DOU come-PFV
‘These students all came.’

One syntactic curiosity with *dou* is that in all uses except for the scalar, *dou* is only able to associate with an element to its linear left; whatever needs licensing by *dou* in the examples above, when appearing to the right of where *dou* is located, no longer needs licensing by *dou* (except *wh*-FC, which is ungrammatical without *dou* even if the *wh*-phrase appears to the right of where *dou* is located), and in fact, rejects the presence of *dou*:

- (8) *Scalar*
 Zhangsan **dou** chi-le wu_F-wan fan le.
 Z. DOU eat-PFV 5-CL rice SP
 ‘Zhangsan has even eaten 5_F bowls of rice.’
- (9) *Universal*
 Zhangsan (***dou**) jibai-le mei-ge ren.
 Z. DOU defeat-PFV every-CL person
 ‘Zhangsan defeated everyone.’
- (10) *NPI-FC*
 Zhangsan (***dou**) keyi jibai renhe ren.
 Z. DOU can defeat-PFV any person
 ‘Zhangsan can defeat anyone.’
- (11) *wh-FC*
 *Zhangsan (**dou**) keyi jibai shenme ren.
 Z. DOU can defeat-PFV what person
 Intended: ‘Zhangsan can defeat anyone.’
- (12) *Distributive*
 Zhangsan (***dou**) jian-le zhaxie xuesheng.
 Z. DOU meet-PFV these student
 Intended: ‘Zhangsan met all these students.’

Notice that the examples above can be made grammatical if we consider *dou* to associate with the subject *Zhangsan* in a scalar use, since *Zhangsan* is in a position that the scalar *dou* can associate with. Crucially, without this scalar flavor, these examples are all unacceptable with *dou*. In this paper, I will focus on the cases where *dou* is present, which means that except in the scalar use, the associate of *dou* will be to its left, and most likely in the subject position, although a discussion of the situation with positions that overt *dou* cannot associate with will be presented in appendix A. Accordingly, I will also not attempt to give an account of the syntactic constraint on the directionality of association with *dou*.

Also notice that in many of the examples above, *dou* is marked as obligatory. I will refrain from the discussion of the reason for the obligatoriness for now. In section 3.2, I will state a crude generalization about its occurrence and obligatoriness; I will discuss in greater detail the empirical observations and an account of its obligatoriness in section 4.4.

2.2 Plural universal quantification

Now, I will introduce data first present in Sun (2018) on a subcase of the universal use of *dou*. I will now introduce a more complex case of the universal use of *dou*, first noticed and studied in Sun (2018). In Mandarin Chinese, just as in English, *mei* ‘every’ can be combined with a numeral greater than or equal to two; for example, there are phrases such as *mei liang-ge xuesheng* ‘every two students.’ I will use the template ‘*mei n*-CL NP’ to represent the structure of these phrases. I

will refer to phrases with $n \geq 2$ as *plural universal quantifiers* and the phrases with $n = 1$, specified either implicitly, such as *mei-ge xuesheng*, or explicitly, such as *mei yi-ge xuesheng*, as *singular universal quantifiers*. The crucial observation is that the *dou* that usually co-occurs with *mei* is optional and generates a semantic alternation between two different readings.

To illustrate the two readings, suppose that 4 students are salient in the context. The first reading, called the *exhaustive reading* by Sun (2018), is produced when *dou* is present. In general, the universal quantification is over $\binom{N}{n}$ pluralities for ‘*mei n-CL NP*’ in the exhaustive reading with N total individuals. Thus, ‘*mei 2-CL NP*’ quantifies over all 6 possible pairs of students constructible from the 4 salient students. (13) means that all 6 of the 6 possible pairs of students each co-wrote a paper, resulting in 6 total papers written.

- (13) **mei** liang-ge xuesheng ***(dou)** he-xie-le yi-pian lunwen.
 every 2-CL student DOU co-write-PFV 1-CL paper
 ‘Every possible pair of students co-wrote a paper.’

⇒ 6 papers written

The second reading, called the *partition reading* by Sun (2018), is produced when *dou* is absent. It requires an additional licensing condition where the VP predicate must contain an indefinite, reflexive, or a numeral; the reason for this condition on the licensing of the partition reading will not be discussed in the body of the paper.¹ In general, the universal quantification is over $\frac{N}{n}$ pluralities for ‘*mei n-CL NP*’ in the partition reading. ‘*Mei 2-CL NP*’ quantifies over all pairs in a partition of the salient students into pairs. Therefore, (14) means that the 2 pairs of a partition of the 4 students into 2 pairs each co-wrote a paper, resulting in 2 total papers written.

- (14) **mei** liang-ge xuesheng ***(dou)** xie-le yi-pian linden.
 every 2-CL student DOU wrote 1-CL paper
 ‘Every pair in a partition of the students into pairs wrote a paper together.’

⇒ 2 papers written

The analytic goal of this paper is to present an account of the alternation between (14) and (13), which I will call the *exhaustive-partition* alternation. As the approach that I will be advancing takes the analysis of *dou* in Liu (2017, 2021) as its backbone, an introduction to that analysis in the next section is necessary.

3 Liu (2017, 2021): *dou* as *even* and *mei-dou* co-occurrence

Liu (2017) introduces the idea of analyzing *dou* just as the Mandarin counterpart of English *even*. This is motivated by the scalar use of *dou*, as discussed in section 2. Liu (2021) extends this analysis to an account of the co-occurrence of *mei* and *dou* in a universally quantified sentence, which I will present in this section.

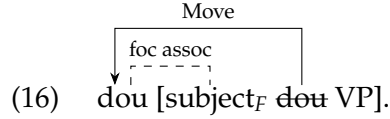
Liu (2017, 2021) treats *dou* as essentially having the same semantic contribution as English *even*, with the following semantics:

- (15) $\llbracket \text{dou}_C S \rrbracket$ is defined iff $\forall q \in \{\llbracket S' \rrbracket \mid S' \in \text{ALT}(S)\} \cap C. \llbracket S \rrbracket \neq q \rightarrow \llbracket S \rrbracket < q$.
 If defined, $\llbracket \text{dou } S \rrbracket = \llbracket S \rrbracket$ *(where $<$ is either $\leq_{\text{likely}}$ or $\subseteq$).

¹I would like to make one suggestion towards a more natural licensing condition: the partition reading is only licensed if the plural universal quantifier binds an overt syntactic variable, which can take the form of an indefinite, reflexive, or numeral. See also appendix A.1 for cases where this condition has effects on readings available for plural universal quantifiers in the object position.

In prose, this definition means that *dou* presupposes that its prejacent is the strongest among the alternatives with respect to an ordering over propositions that is based on either likelihood or entailment. If this presupposition is met, then the prejacent is asserted.

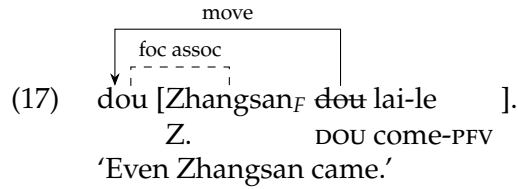
This analysis also makes the common assumption that *dou* covertly moves from its clause-medial position to a position that is able to take the entire clause as its argument; this is also assumed in Crnič (2014). (16) is an illustration of the structure at LF. It should be noted that the lower copy of *dou* is ignored for semantic interpretation.



If the semantic contribution of *dou* is assumed to be equivalent to *even*, then the scalar use is considered the base case. Liu himself has covered the distributive, the universal, and the scalar uses. In sections 3.1 to 3.2, I will recapitulate the derivations Liu (2017, 2021) provides for the scalar and universal uses of *dou*.

3.1 Deriving the scalar use

The scalar use of *dou* follows directly from the definition of *dou* in (15). The ordering relation over propositions $<$ that *dou* takes is based on likelihood. In (17), an illustration of the structure at LF, *dou* moves to the left edge of the clause and takes the clause with a focused element, in this case, *Zhangsan*, as an argument.



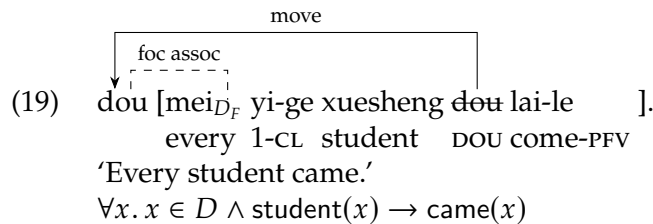
This is felicitous if *Zhangsan came* is the least likely among the alternatives such as *Lisi came*. Therefore, semantically and pragmatically, the scalar use of the *dou* is just like English *even*.

3.2 Deriving the universal use

Liu (2021) contains the derivation of the universal use, summarized here. The universal quantifier *mei* has the following regular semantics, though augmented with a variable D that restricts the domain of quantification:

$$(18) \quad \llbracket \text{mei}_D \rrbracket = \lambda P_{et}. \lambda Q_{et}. \forall x_e. x \in D \wedge P(x) \rightarrow Q(x)$$

The associate of *dou* in the universal use is the domain variable D on *mei*, providing the following LF:



The alternatives of D that are generated are the subdomain alternatives, which are D' such that $D' \subseteq D$. The alternatives of the prejacent are then the prejacent with D replaced with its subsets. The ordering relation over propositions $<$ that *dou* takes is based on entailment. In a context where there are three students $\{\mathbf{a}, \mathbf{b}, \mathbf{c}\} = D$, we have the following alternatives to the prejacent of (19):

$$(20) \quad \left\{ \begin{array}{l} \forall x. x \in \{\mathbf{a}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{b}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{c}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{a}, \mathbf{b}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{b}, \mathbf{c}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{c}, \mathbf{a}\} \rightarrow \text{came}(x) \\ \forall x. x \in \{\mathbf{a}, \mathbf{b}, \mathbf{c}\} \rightarrow \text{came}(x) \end{array} \right\}$$

The alternatives have subsets of D as the domain of quantification and are all going to be entailed by the prejacent. The prejacent is therefore the strongest among the alternatives and the presupposition of *dou* is met. *Dou* is therefore licensed to co-occur with *mei* in a universally quantified sentence. As previously stated, a discussion of why *dou* is not just present but somehow obligatory in a universally quantified sentence will be postponed until section 4.4. However, one generalization on the licensing and obligatoriness of *dou* that I will uphold as a heuristic is the following:

- (21) *Dou-licensing generalization*
Whenever *dou* is licensed through the satisfaction of its presupposition, it is used.

4 *Dou* as *even* and plural universal quantification

In this section, I will make a series of attempts to apply the *dou* as *even* approach in Liu (2017, 2021) to the new data on *dou* and plural universal quantification in Sun (2018). The proposal, as the end result of the multiple accommodations, is that 1) the exhaustive and partition readings each call for a separate domain variable that contains the appropriate pluralities to quantify over:

- (22) D_{exh} is the closure under $\oplus$ of the set of contextually salient atoms in $\llbracket \text{NP} \rrbracket$ (Crnič 2022).
(23) D_{part}^n is different from D_{exh} in that the n -sized pluralities form a partition of $\bigoplus D_{\text{exh}}$.

and that 2) domain alternatives are redefined in terms of parthood relationships between sums of the atomic individuals involved, so that domain alternatives are not necessarily subdomains, but any domain that does not involve atomic individuals not involved in the original domain:

- (24) Given a domain D , if $\forall X \in D'. \forall z. z \sqsubseteq X \wedge \text{ATOM}(z) \rightarrow \exists Y \in D. z \sqsubseteq Y$, D' is a domain alternative of D .

This section will motivate the two accommodations step by step. Section 4.1 tries to account for the exhaustive-partition alternation with minimal adaptations by making the domain variable D contain all sums of the atomic individuals and providing ' n -cl NP' constituents with a denotation. It is then shown that this setup is only able to derive the exhaustive reading, but not the partition reading. Section 4.2 introduces a distinction in the domain variable D on *mei* that reflect an ambiguity present in universal quantification cross-linguistically: the exhaustive reading requires a domain that is closed under sum formation, while the partition requires a domain that contains only plu-

ralities in a partition at a given size. It is shown that the two modifications above are not sufficient: while the two readings are derived, the role of *dou* is unexplained; *dou* is predicted to be acceptable and potentially obligatory in both readings, contrary to the basic exhaustive-partition alternation data. Finally, section 4.3 presents a redefinition of domain alternatives that finally enables the *dou* as *even* approach to account for the exhaustive-partition alternation.

4.1 An attempt to apply Liu (2021) with minimal adaptation

The hope is for Liu’s analysis of *dou* as *even* to be directly applicable to the alternation in the case of plural universal quantifiers with only minimal adaptations. First, the domain variable D on *mei* should be enriched with sums of the atomic individuals, rendering a set closed under $\oplus$; this is also the domain variable assumed by Crnič (2022) when dealing with pluralities.

$$(25) \quad \forall X, Y \in D. X \oplus Y \in D$$

Second, we assume the following semantics for numerals:

$$(26) \quad \llbracket n\text{-CL NP} \rrbracket = \lambda X. |X| = n \wedge X \in * \llbracket \text{NP} \rrbracket$$

Essentially, the denotation of ‘ n -CL NP’ is a set containing n -sized pluralities that are sums of individuals in the denotation of the NP.

However, given these provisions, only the exhaustive reading is derivable:

$$(27) \quad \begin{aligned} \text{a. } & \llbracket \text{mei}_D \text{ 2-CL student} \rrbracket = \lambda P. \forall X. |X| = 2 \wedge X \in * \llbracket \text{student} \rrbracket \cap D \rightarrow P(X) \\ \text{b. } & \llbracket \text{mei}_D \text{ 2-CL student co-wrote a paper} \rrbracket = \\ & \quad \forall X. |X| = 2 \wedge X \in * \llbracket \text{student} \rrbracket \cap D \rightarrow \text{co-write.a.paper}(X) \end{aligned}$$

In this case, since D is the closed under $\oplus$, it will contain every possible pair of students that are constructed out of salient student individuals. What is derived is therefore the exhaustive reading, saying that every possible pair of students co-wrote a paper. Further, it is easy to see that in this case, replacing D with any of its subsets D' will result in a weaker alternative that is entailed by the prejacent. The prejacent, being the strongest, will still satisfy the presupposition of *dou*. This is a configuration where *dou* should appear, as in the singular case, *dou*’s presupposition is also met, and it is generally observed to be present. The partition reading and the absence of *dou* are not yet possible to be derived with the minimal adaptation of a D closed under $\oplus$ and an appropriate semantics for numerals.

4.2 Further accommodation 1: exhaustive and partition domains

It is then clear that additional adaptations must be in place for Liu to be able to explain the exhaustive-partition alternation. As the minimal adaptations, i.e., a D closed under $\oplus$ and the usual semantics for numerals, directly derived the exhaustive reading along with the obligatory presence of *dou*, that will remain the analysis of the exhaustive reading. For the partition reading, one idea that should emerge from the last section rather immediately is to consider alternative candidates for the domain variable on *mei*. Instead of a D closed under $\oplus$, a smaller D whose n -sized elements form a partition of the sum of all the involved atomic individuals in D will properly restrict the domain of quantification to a partition. I will call a D that is closed under $\oplus$, D_{exh} , and D whose n -sized elements form a partition of D_{exh} , D_{part}^n . More formally and more concretely, D_{exh} and D_{part} are defined in the following:

- (28) D_{exh} is the closure under $\oplus$ of the set of contextually salient atoms in $\llbracket \text{NP} \rrbracket$ (Crnič 2022). (29) D_{part}^n is different from D_{exh} in that the n -sized pluralities form a partition of $\bigoplus D_{\text{exh}}$.

In fact, these two domains are motivated for universal quantification in general, with cross-linguistic support. Universal quantification seems to display an inherent ambiguity between the exhaustive and partition readings. Consider the following two English sentences:

- (30) %Every two students shook hands with each other.
(31) %Every two students co-wrote a paper.

Not every English speaker I have consulted considers the phrase *every n students* acceptable, but for those who do find it acceptable, the most salient reading of (30) should be the exhaustive reading, i.e., that all possible pairs of students had a hand-shaking event, while the most salient reading of (31) should be the partition reading, i.e., that all pairs in a partition of the students into pairs co-wrote a paper.² The two domains just defined are suited to capture this ambiguity. (30) would have D_{exh} as the domain variable on *every*, while (31) would have D_{part}^2 as the domain variable on *every*. More importantly, it is clear that these two domains can be used to derive the exhaustive and partition readings of plural universal quantification in Mandarin Chinese:

- (32) *Exhaustive reading*
Domain of ‘mei n -CL NP’ with *dou*: D_{exh} (33) *Partition reading*
Domain of ‘mei n -CL NP’ without *dou*: D_{part}^n

The derivation of the exhaustive is already demonstrated in section 4.1, and will not be repeated, since D_{exh} is the same as the D used there. The partition reading will also be derived straightforwardly given D_{part}^n . Suppose that there are four individual students in the context, a, b, c, d . Consider the sentence (14), repeated here:

- (34) **mei** liang-ge xuesheng (***dou**) xie-le yi-pian linden.
every 2-CL student DOU wrote 1-CL paper
‘Every pair in a partition of the students into pairs wrote a paper together.’

We then have

- (35) a. $D_{\text{exh}} = *\{a, b, c, d\} = \{a, b, c, d, a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}$.
b. $D_{\text{part}}^2 = \{a, b, c, d, a \oplus b, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}$

The 2-sized pluralities from D_{part}^2 , $a \oplus b, c \oplus d$, form a partition of $\bigoplus D_{\text{exh}} = a \oplus b \oplus c \oplus d$. Then, the semantics will be

- (36) $\llbracket \text{mei}_{D_{\text{part}}^2} 2 \text{ student co-wrote a paper} \rrbracket =$
 $\forall X. |X| = 2 \wedge X \in *\llbracket \text{student} \rrbracket \cap D_{\text{part}}^2 = \{a \oplus b, c \oplus d\} \rightarrow \text{co-write.a.paper}(X)$

²Examples of the following forms seem to be acceptable to more native speakers of English that I have consulted:

- (i) a. There is a line between every two points on the graph.
b. There is a triangle connecting every three points on the graph.

(ia, b) seem to have exhaustive readings suggesting that for every pair or triplet of points, one can identify on the graph, there is a line or a triangle connecting the points in the pair or the triplet.

This denotation corresponds to the partition reading, where only pairs in a partition are quantified over by the plural universal quantifier.

However, we have only derived the desired semantics for the two readings in the alternation. The *alternation* that correlates with the presence or absence of *dou*, is not yet handled. In fact, using D_{part}^n , combined with the assumption that its alternatives are also subdomain alternatives, will predict that *dou* should also be licensed and therefore present if it follows the same pattern with the other cases, i.e., it is generally present when licensed, as in the singular case and with the exhaustive reading in the plural case. However, the partition reading is simply incompatible with *dou*, as indicated in (34). The alternatives to (36) based on subdomains $D_{\text{part}}^{2'} \subseteq D_{\text{part}}^2$ are the following:

- (37) a. $\forall X. X \in \{a \oplus b\} \rightarrow \text{co-write.a.paper}(X)$
 b. $\forall X. X \in \{c \oplus d\} \rightarrow \text{co-write.a.paper}(X)$
 c. $\forall X. X \in \{a \oplus b, c \oplus d\} \rightarrow \text{co-write.a.paper}(X)$

The prejacent, (36) or (37c), entails all these alternatives. Therefore, the presupposition of *dou* that the prejacent is strongest among the alternatives is satisfied, and therefore *dou* is also at least compatible with the partition reading. However, we do not detect its presence. Therefore, the alternation is still underived.

4.3 Further accommodation 2: redefining domain alternatives

It should be clear that if alternatives to a domain variable are always subsets of the domain, i.e., subdomains, then as long as the quantification is universal, the prejacent will always entail all the alternatives, satisfying the presupposition of *dou*. Then, we should expect *dou*'s presence regardless of whether the reading is the exhaustive one or the partition one, contrary to the observation that *dou* is only observed in the exhaustive reading. The only way forward is, therefore, to redefine how alternatives are generated for a domain variable, so that D_{part}^n is no longer the maximal compared to its alternatives. I propose the following redefinition of alternatives for domains:

- (38) Given a domain D , if $\bigoplus D' \sqsubseteq \bigoplus D$, D' is a domain alternative of D .

Alternatively and more concretely,

- (39) Given a domain D , if $\forall X \in D'. \forall z. z \sqsubseteq X \wedge \text{ATOM}(z) \rightarrow \exists Y \in D. z \sqsubseteq Y$, D' is a domain alternative of D .

Informally, as long as D' does not involve (contain an element that contains) any atom not involved (contained by an element) in D , D' should be a domain alternative to D . If D' does not involve atoms not involved in D , then as long as we have D , we have everything we need to reconstruct D' , hence allowing D' to become an alternative of D . When the prejacent domain is already the maximal one in the context, for example, D_{exh} , then it becomes the case that any alternative domain constructible from the salient atoms will be a subset of D_{exh} , giving the illusion that domain alternatives are only subdomains. Another case would be when only domains that contain only atoms are concerned. Here, $\bigoplus D' \sqsubseteq \bigoplus D$ is equivalent to $D' \subseteq D$, and what we get are just regular subdomains.

- (40) If $\forall x \in D, \text{ATOM}(x)$, then $\bigoplus D' \sqsubseteq \bigoplus D \Leftrightarrow D' \subseteq D$.

Under this new definition, even though $D_{\text{part}}^n \subset D_{\text{exh}}$, D_{part}^n and D_{exh} are alternatives to each other

because $\bigoplus D_{\text{part}}^n = \bigoplus D_{\text{exh}}$, and so both $\bigoplus D_{\text{part}}^n \sqsubseteq \bigoplus D_{\text{exh}}$ and $\bigoplus D_{\text{exh}} \sqsubseteq \bigoplus D_{\text{part}}^n$ hold. This means that a plural universal sentence with D_{exh} as the variable on *mei* will continue to entail all the alternatives. More formally,

$$(41) \quad \forall D'. \bigoplus D' \sqsubseteq \bigoplus D_{\text{exh}} \Rightarrow D' \subseteq D_{\text{exh}}$$

This translates to the following:

$$(42) \quad \begin{aligned} \forall D' \in \text{ALT}(D_{\text{exh}}). \\ \forall X \in *[[n\text{-CL NP}]] \cap D_{\text{exh}}. |X| = n \rightarrow [[\text{VP}]](X) & \Rightarrow \\ \forall X \in *[[n\text{-CL NP}]] \cap D'. |X| = n \rightarrow [[\text{VP}]](X) \end{aligned}$$

Then, in the exhaustive reading, *dou* is licensed because its presupposition that the prejacent, implicating D_{exh} , is strongest among the alternatives, is satisfied.

However, a plural universal sentence with D_{part}^n as the variable on *mei* will no longer entail all the alternatives, because at least we know that D_{exh} is among the alternatives, and the prejacent is asymmetrically entailed by the alternative based on D_{exh} , among others. More formally,

$$(43) \quad \text{For any } D_{\text{part}}^n, \text{ at least its corresponding } D_{\text{exh}} \text{ is such that } \bigoplus D_{\text{exh}} \sqsubseteq \bigoplus D_{\text{part}}^n \text{ but } D_{\text{part}}^n \subset D_{\text{exh}}.$$

This translates to the following:

$$(44) \quad \begin{aligned} \exists D' = D_{\text{exh}} \in \text{ALT}(D_{\text{part}}^n). \\ \forall X \in *[[n\text{-CL NP}]] \cap D_{\text{part}}^n. |X| = n \rightarrow [[\text{VP}]](X) & \not\Rightarrow \text{and in fact } \Leftarrow \\ \forall X \in *[[n\text{-CL NP}]] \cap D' = D_{\text{exh}}. |X| = n \rightarrow [[\text{VP}]](X) \end{aligned}$$

Then, in the partition reading, *dou* is unlicensed because its presupposition that the prejacent is the strongest among the alternatives is not satisfied. Thus, we are able to account for the exhaustive-partition alternation: in the exhaustive reading, the prejacent is the strongest among the alternatives, satisfying the presupposition of *dou* and licensing its presence; in the partition reading, the prejacent is not the strongest among the alternatives in that at least the alternative corresponding to the exhaustive reading is stronger, and thus the presupposition of *dou* is not satisfied, its presence impossible.

4.4 The obligatoriness of *dou*

Up to this point, we have only discussed when and why *dou* is licensed across its uses and readings, and in particular, its licensing in the exhaustive reading and failure to be licensed in the partition reading. In this section, I will address the question of why *dou* appears to be obligatory whenever it is licensed.

Liu (2017, 2021) invokes Maximize Presupposition (Heim 1991) as the ingredient that ensures *dou*'s obligatoriness in case it is licensed:

$$(45) \quad \begin{aligned} & \text{Maximize Presupposition (MP)} \\ & \text{Make your contribution presuppose as much as possible.} \end{aligned}$$

On a liberal reading of this principle, any lexical item whose presupposition is known to be satisfied will become obligatory in the utterance. Thus, in the cases discussed above where *dou* is licensed, for example, in the singular universal use and in the exhaustive reading of the plural universal use, it is obligatory. On the other hand, Maximize Presupposition will never require the use of items

whose presupposition is not satisfied.³ Therefore, in the partition reading of the plural universal use, *dou* will not be forced to be present by Maximize Presupposition.

However, under a Maximize Presupposition approach to the obligatoriness of *dou*, a problematic prediction is made: the present approach predicts that singular universal quantifiers, such as ‘mei-CL NP’ and ‘mei 1-CL NP’ always require *dou*. This is because $D_{\text{part}}^1 = D_{\text{exh}}$; for the 1-sized individuals to partition $\bigoplus D_{\text{exh}}$, it must be the case that the 1-sized individuals in D_{part} are exactly *all* the 1-sized individuals in D_{exh} , and hence $D_{\text{part}}^1 = D_{\text{exh}}$. In both cases, the prejacent will entail all the alternatives, the presupposition of *dou* is satisfied, and its use becomes obligatory. While in an example like (5), this prediction seems to be correct because *dou* is obligatory in such simplest cases, Sun (2018) reports that when the VP contains an indefinite or a numeral, the licensing condition for the partition reading with plural universal quantifiers, even a singular universal quantifier can be used without *dou*:

- (46) mei yi-ge xiaohai (**dou**) zao-le yi-sou chuan.
 every 1-CL child DOU build-PFV 1-CL boat
 ‘Every child built one boat.’ adapted from Sun (2018: ex. (1a))

In (46), *dou* is reported to be optional. I also share this judgment. This example then poses a genuine to the Maximize Presupposition approach.

However, I would like to make the optionality of *dou* more fine-grained. Whether *dou* is optional is actually conditional upon which constituent bears prosodic prominence or stress, which I take to be reflective of the placement of focus. When *mei* bears stress or focus, *dou* cannot be omitted:

- (47) MEI _{$D_{\text{exh}}=D_{\text{part}}^1$} yi-ge xiaohai *(**dou**) zao-le yi-sou chuan.
 every 1-CL child DOU build-PFV 1-CL boat
 ‘Every child built one boat.’

When some other element bears stress or focus, which is crucially only possible when the VP contains an indefinite or a numeral, *dou* becomes truly optional:

- (48) a. mei YI-ge xiaohai (**dou**) zao-le yi-sou chuan.
 every 1-CL child DOU build-PFV 1-CL boat
 b. mei yi-ge XIAOHAI (**dou**) zao-le yi-sou chuan.
 c. mei yi-ge xiaohai (**dou**) ZAO-le yi-sou chuan.
 d. mei yi-ge xiaohai (**dou**) zao-le YI-sou chuan.
 e. mei yi-ge xiaohai (**dou**) zao-le yi-sou CHUAN.

In this optional case, *dou*’s presence or absence is responsible for a different kind of semantic alternation. If *dou* is absent, the reading interprets the stressed constituent as being contrastively focused. If *dou* is present, its meaning is equivalent to the overt use of *even* in English, or *dou*’s scalar use: the stressed constituent is interpreted as the maximum on a scale.

³There are two issues in the use of Maximize Presupposition that pertain to the current case. First, there is no clearly defined set of lexical alternatives to *dou*, though Liu (2021) suggests, following Singh (2008), that the $\sim$ operator of Rooth (1992) can be *dou*’s alternative in the domain of Maximize Presupposition. Second, the presupposition *dou* is its universal use (as well as the distributive and NPI uses) is tautological; it does not impose any restrictions on the context; the focus-sensitive structure and the meaning of the prejacent alone is sufficient in determining whether the presupposition is satisfied. In this sense, *dou* does not presuppose more than its potential alternatives, and hence it is unclear why an imperative to *maximize* the presupposition would force the use of *dou*. Adopting the lexical presupposition approach to Maximize Presupposition of Percus (2006) might potentially resolve this issue. I leave a full discussion of this issue to future occasions.

Given this complemented set of data, it should be clear that a Maximize Presupposition approach to the obligatoriness of *dou* is not truly challenged by the apparent optionality of *dou* with singular universal quantifiers. Maximize Presupposition will only force the presence of *dou* when *mei* (its domain variable) is focused, generating alternatives based on domain alternatives, which are all entailed by the prejacent. When *mei* (its domain variable) is not focused, the alternatives are of lexical constituents. There is no guarantee of entailment of likelihood relationships among such alternatives, and the use of *dou* is only obligatory when the prejacent is indeed the least likely among the alternative, but this is a contingency rather than a necessity as in the case of alternatives based on domains.

This explanation of the apparent optionality of *dou* with singular universal quantifiers sheds new light on the situation with plural universal quantifiers. Just like with singular universal quantifiers, the complemented empirical picture is stress-dependent. Unlike with singular universal quantifiers, where the exhaustive and partition readings are collapsed into one and *dou* will be required if *mei* is stressed, with plural universal quantifiers, if *mei* is stressed, *dou* is responsible for the alternation between the exhaustive and partition readings, recapitulated here. When *mei* is stressed and the exhaustive reading is the intended reading, *dou* is required.

- (49) MEI_{D_{exh}} liang-ge xiaohai **(dou)** zao-le yi-sou chuan.
 every 2-CL child DOU build-PFV 1-CL boat

When *mei* is stressed and the partition reading is the intended reading, then *dou* is impossible.

- (50) MEI_{D_{part}} liang-ge xiaohai **(dou)** zao-le yi-sou chuan.
 every 2-CL child DOU build-PFV 1-CL boat

When *mei* is not stressed and so some other constituent is stressed, regardless of whether it is the partition or the exhaustive reading, *dou* is optional; if present, it conveys context-dependent scalarity concerning the stressed constituent.

- (51) a. mei LIANG-ge xiaohai **(dou)** zao-le yi-sou chuan.
 every 2-CL child DOU build-PFV 1-CL boat
 b. mei liang-ge XIAOHAI **(dou)** zao-le yi-sou chuan.
 c. mei liang-ge xiaohai **(dou)** ZAO-le yi-sou chuan.
 d. mei liang-ge xiaohai **(dou)** zao-le YI-sou chuan.
 e. mei liang-ge xiaohai **(dou)** zao-le yi-sou CHUAN.

This pattern is exactly what the present approach predicts. Maximize Presuppose will only force the presence of *dou* when its presupposition is satisfied. There are two ways to satisfy the presupposition; one is for *mei* to be focused under the exhaustive reading, and the other is for a different constituent that is the maximum on a scale of likelihood to be focused, a context-dependent condition. In all other cases, *dou* is impossible.

When zoomed back into the exhaustive-partition alternation, the biconditional between the presence or absence of *dou* on the one hand and the exhaustive or the partition reading on the other, is restricted by the caveat that the biconditional only holds when *mei* is stressed (focused). This restricted biconditional can be restated in the following two ways, one in the speaker's perspective and one in the hearer-interpreter's perspective:

- (52) If one conveys the exhaustive reading and focuses the domain of quantification, then they must use *dou*.

- (53) If *mei* is stressed (focused) and *dou* is present, then the only possible reading is the exhaustive reading.

The contrapositives make clear the conditions on *dou*'s absence:

- (54) If the intended reading is the partition reading, then either *mei* is unstressed (unfocused) or *dou* is absent.
- (55) If *dou* is absent, then the speaker either intends the partition reading or does not focus the domain of quantification.

And thus a story for the obligatoriness and optionality in various cases under the Maximize Presupposition approach is provided. A remaining mystery is the fact that an alternative focused element and (recall) the partition reading are only possible with an indefinite, numeral, or reflexive in the VP. I will have nothing to say in terms of an explanation for either correlation.

4.5 Interim summary

In section 4, I have developed an account for exhaustive-partition alternation with plural universal quantification based on the analysis in Liu (2017, 2021) of *dou* as *even*. A recognition of the inherent quantificational ambiguity of universal quantifiers, the implementation of this ambiguity through the choice of D_{exh} and D_{part} domain variables on the universal quantifier, and the redefinition of domain alternatives in terms of the parthood relationship of the sum of all the atoms involved in the domain bridge the gap between the original proposal Liu (2017, 2021) and the new data in Sun (2018). I have also anticipated and responded to a potential challenge to the empirical generalization which is the exhaustive-partition alternation. In the next section, I will discuss a correct prediction that the present approach makes regarding the free choice readings of plural NPIs of the 'renhe n -CL NP' where $n \geq 2$.

5 Extension: plural NPI universal free choice

The present approach makes a prediction in a separate but related domain: the universal free choice readings of plural negative polarity items (NPI). In English, an NPI with free choice readings is *any*, which takes place when embedded under a $\Diamond$ -modal:

- (56) Any (one) student can write a paper.

(56) has the meaning that every student salient in the context is such that they can write a paper. The analogous construction in Mandarin Chinese is as follows:

- (57) renhe (yi-ge) xuesheng dou keyi xie yi-pian lunwen.
 any 1-CL student DOU can write 1-CL paper
 'Any (one) student can write a paper.'

The present approach predicts that universal free choice readings of plural NPIs are limited to the exhaustive rather than the partition reading, which is borne out. I will call the content of this prediction the *exhaustive-only* restriction. By plural NPIs, I mean NPI DPs that are formed from an NPI determiner such as *any* or *renhe* and a numeral larger than two. Examples are the following:

- (58) Any two students can co-write a paper.

- (59) renhe liang-ge xuesheng *(dou) keyi hexie yi-pian lunwen.
 any 2-CL student DOU can co-write 1-CL paper
 ‘Any two students can co-write a paper.’

The present approach will predict that both (58) and (59) will have only one reading, the exhaustive reading, which in the context of free choice is that given a domain of salient students, all possible pairs of students that can be assembled from atomic students in the domain are allowed to co-write a paper, rather than only pairs of students in a certain partition of students into pairs being allowed to co-write a paper. This prediction is indeed borne out, as (58) and (59) only have this reading.

To see how the present approach makes this prediction, several assumptions must be introduced and a derivation of free choice readings of NPIs illustrated. To capture the cross-linguistic pattern involving NPIs *any* and *renhe*, as well as *even* and *dou*, I will use ANY to refer to both *any* and *renhe*, and EVEN to refer to both *even* and *dou*.

I assume, following Lahiri (1998) and Crnič (2017, 2019), that NPIs are licensed through the associates of EVEN (or any element with equivalent semantic and pragmatic contributions), which can either be overt or covert. It is covert in English, but overt in Mandarin Chinese (see (59)), since *dou* is analyzed as EVEN in the present approach, and as long as the NPI is in a position that satisfies *dou*’s syntactic constraint that its associate appears to its left, *dou* is always present in an NPI-FC construction. This lends further cross-linguistic support to the EVEN-approach to NPI licensing just introduced and assumed. I also assume that ANY-phrases are existential quantifiers that are syntactically reconstructed under the scope of the possibility modal; this is evidenced by the interpretation of the following examples (Crnič 2019):

- (60) a. Only John read any book.
 b. John didn’t read any book.

In both (60a) and (60b), the semantic contribution of the ANY-phrases are identical to that of existential quantifiers taking narrow scope with respect to *only* and negation as if the examples were

- (61) a. Only John read a book.
 b. John didn’t read a book.

For the ANY-phrases to be licensed by EVEN, and for the correct semantics to be derived, an additional strengthening mechanism must be in place to turn ANY-phrases from existential quantifiers in the scope of possibility modals into a universal quantifier scoping above the possibility modal. I will demonstrate this fact in section 5.1.

Crucially, with the licensing condition on NPIs requiring the presence of EVEN, and a strengthening mechanism that turns ANY in the scope of possibility modals to a universal quantifier above the possibility modal, the mechanism of forcing the exhaustive reading for plural universal quantifiers carry over to the plural NPI-FC case: plural NPI-FC must also only have an exhaustive reading.

5.1 Licensing of ANY-phrases

5.1.1 The downward-entailingness approach to NPI licensing

Even though for the present approach to make the prediction that plural NPI-FC only has the exhaustive reading, I have assumed the EVEN-approach to NPI licensing in the vein of Lahiri (1998) and Crnič (2014, 2017, 2019), the existence of a strengthening mechanism for ANY-phrases embedded under possibility modals does not depend on this assumption. I will now provide the

motivation for the strengthening mechanism from an older and more widely known approach to NPI licensing that is centered on the idea of *downward-entailingness* (Fauconnier 1975, 1978, Ladusaw 1979, 1980a,b, von Stechow 1999, Gajewski 2005, Crnič 2022: among others). Observe one of the simplest situations where ANY-phrases are licensed:

(62) John didn't read any book.

If we accept (62), it is justified to draw the following inference:

(63) John didn't read any history book.

The generalization here is that if we replace the restriction in the ANY-phrase with a smaller set of individuals, the original sentence will entail the new sentence. It also appears to be the condition that licenses ANY-phrases, which I summarize as the following:

(64) *Licensing ANY-phrases via downward-entailingness*

ANY-phrases are licensed in contexts where replacing the restriction with a smaller set of individuals results in a sentence that is entailed by the original one.

(64) is an informal statement of ideas in the downward-entailingness tradition of NPI licensing, as relevant to ANY-phrases.⁴ Now, consider (65), an ungrammatical sentence, which exemplifies the failure to satisfy this licensing condition:

(65) *John read any book.

Intended: 'There is a book such that John read it.'

Assuming that the meaning of an ANY-phrase is an existential quantifier, (65) cannot mean that there is a book such that John read it. We immediately see that if we make the same replacement of *book* by *history book* as above, the entailment will not go through:

(66) *John read any history book.

Intended: 'There is a history book such that John read it.'

The intended meaning of (65) does not entail the intended meaning of (66), as the existence of a book that John read does not entail the existence of a history that John read; the book that John has read might not be a history book. As the generalization is not, (65) is correctly predicted to be ungrammatical.

Now, let us focus on ANY-phrases in the scope of possibility modals, like CAN.

(67) John can read any book.

We are able to infer from (67) the following:

⁴Many later contributions to the downward-entailingness approach are much more general and sophisticated than the present statement implies. For example, von Stechow (1999) employs *Strawson-downward-entailingness* as the central property that licenses NPIs. The crucial difference is that *Strawson-downward-entailingness* also takes into account presupposition satisfaction, which helps explain cases challenging the simple downward-entailingness approaches:

(i) Only John read any book.

(i) clearly does not entail (ii), so the downward-entailing requirement is not met straightforwardly:

(ii) Only John read any history book.

However, (i) is grammatical indicating that the ANY-phrase is licensed.

(68) John can read any history book.

This indicates that the downward-entailingness licensing condition for the ANY-phrase is met. However, this is not something straightforwardly predicted by the semantics. Again assuming that ANY-phrases are existential quantifiers, (67) will in fact have the following meaning:

(69) Predicted meaning for (68): John can read one of the books.

(69) certainly does not entail (70):

(70) Predicted meaning for (69): John can read one of the history books.

Thus, the semantics suggest that ANY-phrases should not be licensed in the scope of CAN, contrary to judgments. On the other hand, the predicted meanings for (67) and (68) are incorrect to begin with; they should have the following meanings:

(71) Actual meaning for (67): Every book is such that John can read it.

(72) Actual meaning for (68): Every history book is such that John can read it.

Indeed, (71) entails (72), just as what our intuitions speak for (67) and (68). Thus, there must be some mechanism that translates the predicted meanings for (67) and (68) to the actual meanings, so that 1) the actual attested meanings are derived, and the incorrect predicted meanings avoided, and that 2) ANY-phrases are properly licensed via downward-entailingness with respect to the restriction. Crucially, the translation must perform the following:

(73) *Strengthening of $\Diamond$ ANY to EVERY $\Diamond$*

An ANY-phrase in the scope of a possibility modal is strengthened to a universal quantifier that scopes above the modal.

In the next section, we show that the EVEN-approach to NPI licensing also calls for such a strengthening mechanism for ANY-phrases in the scope of possibility modals.

5.1.2 The EVEN-approach to NPI licensing

I follow Lahiri (1998) in the original conception that NPIs are associates of EVEN. I also adopt the specific implementation of that idea with ANY-phrases, where EVEN associates with the domain variable D on ANY, in Crnič (2014, 2017, 2019). In this case, the alternatives to D are subsets D' of D . In the EVEN-approach to NPI licensing, the satisfaction of the presupposition of EVEN, i.e., that the prejacent is strongest among the alternatives, becomes the exact licensing condition for NPIs including ANY-phrases. It should be easy to see that the original data accounted for by the downward-entailing approach are still explained by the EVEN-approach. Consider the following:

(74) EVEN John didn't read ANY _{D_F} book.

For any $D' \subseteq D$, the prejacent of (74) will entail the corresponding alternative:

(75) John didn't read ANY _{D'} book.

Informally, if John didn't read a single book from a larger set of books, it must also be the case that John didn't a single book from a smaller subset of books.

This EVEN-approach will be able to deal with contexts that license NPIs which are not downward-entailing, a situation not predicted by the downward-entailingness approach to NPI licensing:

(76) Exactly three students read any book.

(76) clearly does not entail the sentence with *book* replaced with *history book*:

(77) Exactly three students read any history book.

However, (76) is grammatical, indicating that the ANY-phrase is licensed. A parallel is drawn between (76) and the same sentence with *any* replaced with *even one*:

(78) Exactly three students read even one book.

Crnič (2014) shows that the distribution of ANY-phrases in general mirrors the distribution of phrases like *even one* in non-downward-entailing contexts. Therefore, additional evidence is provided for the original thesis of EVEN being the licenser of NPIs in Lahiri (1998): if ANY-phrases are also associates of EVEN, then it is expected that they have parallel distribution with *even one*. For more details of the proposal, the reader is referred to Crnič (2014).

Crucially, there is also a gap between the assumptions on the semantics of ANY and their licensing in the scope of possibility modals according to the EVEN approach. Consider (79), a sentence containing an ANY-phrase and covert EVEN required by the EVEN-approach, which is assumed to associate with the domain variable D on ANY:

(79) EVEN ANY_{D_F} student can write a paper.

Assuming reconstruction of ‘ANY student’ under *can*, represented by $\diamond$, we have

(80) EVEN $\diamond$ ANY_{D_F} student $\lambda x. x$ write a paper.

The alternatives to (80) are in (81):

(81) $\{\diamond \text{ANY}_{D'} \text{ student } \lambda x. x \text{ write a paper} : D' \subseteq D\}$

Translating the alternatives to their denotations, we have (82):

(82) $\{\diamond \exists x \in \llbracket \text{student} \rrbracket \cap D'. \text{write.paper}(x) : D' \subseteq D\}$

It should be clear that for every $D' \subset D$, the corresponding alternative entails and is stronger than the prejacent with the domain variable D ; the logical strengthen of an existential quantifier grows as the domain restriction shrinks:

(83) $\diamond \exists x \in \llbracket \text{student} \rrbracket \cap D'. \text{write.paper}(x) \Rightarrow$ and $\nLeftarrow \diamond \exists x \in \llbracket \text{student} \rrbracket \cap D. \text{write.paper}(x)$ if $D' \subset D$.

This means that the presupposition of EVEN that the prejacent is the strongest among the alternatives is not satisfied, and therefore ANY should not have been licensed in (79), contrary to judgments.

Additionally, the meaning obtained directly from the structure, also illustrated in (82), is incorrect, which suggests that (79) means

(84) It is allowed for John to read one of the_D books.

However, (79) seems to be able to be paraphrased in the following much stronger way:

(85) Every_D book is such that John can read it.

One can verify that if (85) is indeed the meaning of (79), then ANY will also be licensed because the alternatives

$$(86) \quad \{\text{EVERY}_{D'} \text{ student } \lambda x. \Diamond x \text{ write a paper} : D' \subseteq D\}$$

are all entailed by the prejacent in (85):

$$(87) \quad \forall x \in \llbracket \text{student} \rrbracket \cap D'. \Diamond \text{write.paper}(x) \Leftarrow \forall x \in \llbracket \text{student} \rrbracket \cap D. \Diamond \text{write.paper}(x) \text{ if } D' \subseteq D.$$

Thus, it should be obvious by now that a strengthening mechanism that transforms ANY-phrases, as existential quantifiers, in the scope of possibility modals into universal quantifiers scoping above possibility modals should be in place. This mechanism should always be triggered for ANY-phrases embedded in non-negated possibility modals so as to license the ANY-phrases according to the EVEN-approach to NPI licensing. More precisely, the mechanism should be of the following form:

$$(88) \quad \text{Strengthening of } \Diamond \text{ ANY to EVERY } \Diamond \text{ (more formal version)} \\ \Diamond \text{ ANY}_D \text{ NP } \lambda x. \varphi(x) \longrightarrow \text{EVERY}_D \text{ NP } \lambda x. \Diamond \varphi(x)$$

This is just a more formal statement of the mechanism in (73).

In appendix B.1, an example of such a mechanism, the procedure of Innocent Inclusion of Bar-Lev & Fox (2020), is described and illustrated in detail. For now, it should suffice that the necessity for both the downward-entailingness and EVEN approaches to ANY-phrase licensing is understood, and that the existence of such a mechanism is recognized.

5.2 Strengthening and the exhaustive-only restriction

If the strengthening mechanism that transforms a low-scope existential that is the ANY-phrase into a high-scope universal is available and obligatorily triggered for ANY-phrases embedded under possibility modals, then we can essentially treat them on par with universal quantifiers. More concretely, every sentence of the form

$$(89) \quad \text{EVEN } \Diamond \text{ ANY}_{D_F} \text{ student } \lambda x. x \text{ write a paper.}$$

can be rewritten in the following way:

$$(90) \quad \text{EVEN EVERY}_{D_F} \text{ student } \lambda x. \Diamond x \text{ write a paper.}$$

If D_{exh} and D_{part} can be used with plural universal quantification, then naturally they should also be usable with ANY-phrases that are strengthened to universal quantifiers. We expect the strengthened meaning of the NPI free choice to have both exhaustive and partition readings:

$$(91) \quad \text{Exhaustive}$$

- a. original: $\text{EVEN } \Diamond \text{ ANY}_{D_{\text{exh}}} \text{ two students } \lambda X. X \text{ co-write a paper.}$
- b. strengthened: $\text{EVEN EVERY}_{D_{\text{exh}}} \text{ two students } \lambda X. \Diamond X \text{ co-write a paper.}$
- c. interpretation: Every possible pair of students is such that the pair can co-write a paper.

$$(92) \quad \text{Partition}$$

- a. original: $\text{EVEN } \Diamond \text{ ANY}_{D_{\text{part}}^2} \text{ two students } \lambda X. X \text{ co-write a paper.}$
- b. strengthened: $\text{EVEN EVERY}_{D_{\text{part}}^2} \text{ two students } \lambda X. \Diamond X \text{ co-write a paper.}$
- c. interpretation: Every pair of students in a partition of the students into pairs is such that the pair can co-write a paper.

However, as we have already seen in section 4, the partition reading is incompatible with *EVEN* that associates with it. This is because under the redefinition of domain alternatives, the partition reading, which uses D_{part}^n , which has D_{exh} as an alternative, will not result in the prejacent being strongest among the alternatives, as the alternative corresponding to the exhaustive reading based on D_{exh} will be asymmetrical stronger than the prejacent, failing to satisfy the presupposition of *EVEN*. Due to the licensing conditions of *ANY* assumed in this paper, *EVEN* must be present in the structure as long as the original structure we are dealing with has *ANY*. Therefore, it is predicted that with plural NPI free choice, the partition reading is unavailable, which is borne out by the observation that (92b) is in fact not a reading that *any two students can co-write a paper* has. In appendix B.2, I give an explicit derivation of these results based on the mechanism of strengthening detailed in appendix B.1.

Notice that in the Mandarin Chinese plural NPI-FC, *dou* must be overtly present when the NPI is in the subject position. Therefore, there is no requirement of the *EVEN* approach to NPI licensing to derive the exhaustive-only restriction for plural NPI-FC in subject positions in Mandarin Chinese. However, I would like to also account for the same restriction in English, as well as when the *ANY*-phrase appears inside the VP in Mandarin Chinese:

- (93) $\emptyset_{\text{EVEN}}$ Any $_{D_F}$ two students can co-write a paper.
(94) $\emptyset_{\text{EVEN}}$ Zhangsan keyi du renhe $_{D_F}$ liang-ben shu.
 Z. can read any 2-CL book
 ‘Zhangsan can read any two books.’

In these constructions, there are no overtly present instances of *EVEN*. For *EVEN*’s presupposition to still force the exhaustive reading, a covert *EVEN* must be assumed to be in the structure. The *EVEN* approach to NPI licensing naturally provides us with this covert *EVEN*, since there is an NPI, the *ANY*-phrase, to license, in these constructions.

In this and the last sections, I have given a rough sketch of why the present approach, combined with the *EVEN*-approach to NPI licensing and the inevitable assumption that there is a mechanism that strengthens *ANY*-phrases, which are existential quantifiers in the scope of possibility modals, into universal quantifiers scoping above the possibility modals, the prediction that there is the exhaustive-only restriction on plural NPI-FC is produced. In appendix B, I will derive the prediction explicitly, utilizing a concrete instantiation of such a strengthening method, with my redefinitions of domain alternatives applied.

5.3 Interim summary

In the preceding sections, I have given an account of the exhaustive-partition alternation based on the *dou* as *even* approach of Liu (2017, 2021). I have also demonstrated how this approach makes a correct prediction with the exhaustive-only restriction of the free choice readings of plural NPIs, delivering an analysis of the NPI-FC use of *dou* in the meantime. As Liu (2017, 2021) has accounted for the scalar and distributive uses of *dou*, Liu (2021) the universal use in the singular case, and Liu (2023) the *wh*-FC use, essentially full empirical coverage has been achieved by this approach. Thus, it should be considered as successful as a unifying theory of *dou*. In the next section, I will hold the other approaches to *dou* and *mei* and see if they can account for the data presented in Sun (2018), be extended to exhaustive-only restriction of the free choice readings of plural NPIs, and cover the other uses of *dou*.

6 Previous accounts

In this section, I will examine the previous accounts of *dou* along with *mei* (Lin 1998, Giannakidou & Cheng 2006, M. Xiang 2008, Sun 2018, Y. Xiang 2020) and assess them based on three dimensions: 1) how well they can account for the exhaustive-partition alternation introduced in Sun (2018); 2) can their analysis be extended to NPI free choice in section 5; and 3) whether the analysis can cover the other usages of *dou*, i.e., the scalar and the distributive uses of *dou*. It should be noticed that only Sun (2018), being the one to introduce the data on plural universal quantifiers, takes into account this data; the other accounts leave out a discussion of such data. I will be charitable in that I will attempt to bridge the gap between the previous accounts and the data in Sun (2018), if any.

6.1 *Dou* as a quantifier

The first category contains Lin (1998) and Sun (2018), who consider *dou* as some kind of quantifier with universal force.

6.1.1 Lin (1998)

For Lin (1998), *mei* has the following semantics:

$$(95) \quad \llbracket \text{mei} \rrbracket = \lambda P_{et}. \bigoplus P$$

Essentially, *mei* sums up all the individuals in the set of the individuals P , the denotation of *mei*'s NP sister. *Dou*, on the other hand, is just the generalized distributor Part of Schwarzschild (1996)

$$(96) \quad \text{Part} = \lambda C_{et}. \lambda P_{et}. \forall y. y \in C \wedge y \sqsubseteq x \rightarrow P(y), \text{ where } C \text{ is a cover.}$$

It is clear why this approach cannot handle the data in Sun (2018). A plurality does not contain internal structure, and so *mei liang-ge xuesheng* 'every two students' and *mei-ge xuesheng* 'every student' are predicted to denote exactly the same plurality. While the correct domain of quantification can be obtained by selecting an appropriate cover, for example, selecting a cover which only contains n -sized pluralities for 'mei n -CL NP', the fact that the semantic contribution of the numeral is obliterated is undesirable.

Another way forward would be to implement internal structure inside pluralities, via groups introduced in Landman (1989), i.e., the individuals formed through the use of the $\uparrow$ operator which maps pluralities to atoms, and so pluralities of the form $\uparrow(a \oplus b) \oplus \uparrow(c \oplus d)$ can be constructed as the potential denotation of 'mei 2-CL students,' assuming the students are a, b, c, d in the context. However, that would necessitate a new distributive operator that departs from the semantics usually associated with Part, which is unable to handle groups in pluralities.

6.1.2 Sun (2018)

Sun (2018) provides a related approach. For her, *mei* is semantically vacuous, but presupposes that the denotation of its NP sister has at least two elements:

$$(97) \quad \llbracket \text{mei} \rrbracket = \lambda P : |P| \geq 2. P$$

' n -CL NP' will have its usual semantics:

$$(98) \quad \llbracket n\text{-CL NP} \rrbracket = \lambda x. x \in * \llbracket \text{NP} \rrbracket \wedge |x| = n$$

renhe. This situation will make *even*, assumed to be covert in Lin's and Sun's approaches (since *dou* cannot be *even*, as it is a quantifier), licensed with any P .⁵

(105) If $D' \subseteq D$, then ' ANY_D NP *dou* VP' $\implies$ ' $\text{ANY}_{D'}$ NP *dou* VP'

(106) ' EVEN ANY_D NP *dou* VP' is licensed.

The existence of a $\Diamond$ -modal is thus made irrelevant for the licensing of *renhe*. The following sentence is predicted to be grammatical, contrary to judgment:

- (107) a. **renhe xuesheng dou xie-le lunwen.*
 any student DOU write-PFV paper
 'Any student wrote a paper.'
 b. *renhe xuesheng dou keyi xie lunwen.*
 any student DOU can write paper
 'Any student can write a paper.'

If NPI free choice is not correctly derivable and correctly constrained in Lin's and Sun's approaches in the first place, there is no way to extend them to the exhaustive-only restriction with the free choice readings of plural NPIs.

Further difficulty is encountered when trying to extend the view of *dou* as a universal quantifier to the scalar use of *dou*, where *dou* contributes no quantificational force over individuals at all.

6.2 *Dou* as maximizer: Giannakidou & Cheng (2006)

Giannakidou & Cheng (2006) considers *dou* to be a maximizer, with the semantics of English definite article *the*; ignoring intensionality, the denotation of *dou* would be the following:

(108) $\llbracket \text{dou} \rrbracket = \lambda P_{et}. \iota(\lambda x. P(x))$

Giannakidou & Cheng (2006) proposes that *dou* forms a constituent with the subject, and in this case, it will be the phrase headed by *mei*. What it returns is necessarily an individual, and due to its semantics, this individual is necessarily the sum of all the individuals that need to be quantified over, akin to the assumption of Lin (1998). This will make Giannakidou & Cheng (2006) run into the same problems as Lin (1998). It also incurs one additional problem: there is no element in the structure that performs universal quantification because neither *mei* nor *dou* has any quantificational ability in this approach. M. Xiang (2008) is an analysis in the same vein as Giannakidou & Cheng (2006); the analytical problems are shared between the two, and so a separate discussion will not be given.

6.3 *Dou* as anti-exhaustifier: Y. Xiang (2020)

Y. Xiang (2020) considers *dou* to be an anti-exhaustivity operator with a semantic contribution akin to a recursively applied exhaustifier (O/ExH). The following are adapted from Y. Xiang (2020), who provides different lexical entries for the different uses of *dou*:

(109) *Scalar use*

- a. $\llbracket \text{dou}_C \rrbracket = \lambda p \lambda w : \exists q \in \text{SUB}_{\text{likely}}(p, C). p(w) \wedge \forall q \in \text{SUB}_{\text{likely}}(p, C). \neg \text{JUST}_C(q)(w)$
 b. $\text{SUB}_{\text{likely}}(p, C) = \{q : q \in C \wedge q >_{\text{likely}} p\}$

⁵One does not need to assume the *even*-approach to NPI licensing; as long as one entertains the idea that a downward entailing environment is sufficient for NPI licensing, then the argument goes through.

- c. $\text{JUST}_C(q) = \lambda w. q(w) \wedge \forall r \in C. r(w) \rightarrow q \leq_{\text{likely}} r$
- (110) *Distributive use*
- a. $\llbracket \text{dou}_C \rrbracket = \lambda p \lambda w : \exists q \in \text{SUB}_{\text{EXCL}}(p, C). p(w) \wedge \forall q \in \text{SUB}_{\text{EXCL}}(p, C). \neg \text{EXH}_C(q)(w)$
- b. $\text{SUB}_{\text{EXCL}}(p, C) = C \setminus (\text{EXCL}(p, C) \cup \{p\})$
- c. $\text{EXCL}(p, C) = \{q : p \not\subseteq q \wedge q \in C\}$
- (111) *FC use*
- a. $\llbracket \text{dou}_C \rrbracket = \lambda p \lambda w : \exists q \in \text{SUB}_{\text{IEXCL}}(p, C). p(w) \wedge \forall q \in \text{SUB}_{\text{IEXCL}}(p, C). \neg \text{EXH}_C(q)(w)$
- b. $\text{SUB}_{\text{IEXCL}}(p, C) = C \setminus (\text{IEXCL}(p, C) \cup \{p\})$
- c. $\text{IEXCL}(p, C) = \bigcap \{A : A \text{ is a maximal subset of } C \text{ such that } \{\neg q : q \in A\} \cup \{p\} \text{ is consistent}\}$

The common theme across the three entries for the three uses is that the focus associate of *dou* generates a set of alternatives, some of which are defined to be *sub-alternatives* (SUB above), and *dou* asserts the prejacent and the negation of the exhaustified versions of these sub-alternatives, given that the set of sub-alternatives is non-empty. The universal use and distributive use collapse into one, since Xiang treats universals as the same as plurals, similar to Lin (1998). Xiang is also similar to Lin in assuming that Part is responsible for the distributive (universal) force. However, for her, since *dou* is already taken to be an anti-exhaustifier, Part is not realized as *dou*, but as a covert element. Xiang proposes that *dou* associates with the plural subject. The plural subject produces as alternatives the subparts which correspond to the sum of a subset of the cover on Part. In this case, since the cover is not focused, it cannot vary across the alternatives. If the cover is $D_{\text{part}}^2(2) = \{a \oplus b, c \oplus d\}$,⁶ then the alternatives to the phrase *mei liang-ge xuesheng* ‘every two students’ (understood as a definite plural according to Xiang, though) are:

$$(112) \quad \{X : \exists D' \subseteq D_{\text{part}}^2(2). D' \neq \emptyset \wedge X = \bigoplus D'\} = \{a \oplus b, c \oplus d, a \oplus b \oplus c \oplus d\}$$

In this case, it is clear that the prejacent entails all of its alternatives, i.e., all of its alternatives are sub-alternatives, according to the definition in (110b).

$$(113) \quad \text{If } X' = \bigoplus D', D' \subseteq D_{\text{part}}^2(2), \text{ and } \bigoplus D_{\text{part}}^2(2) = X, \text{ then } \text{Part}(D_{\text{part}}^2(2))(P)(X) \implies \text{Part}(D_{\text{part}}^2(2))(P)(X')$$

The non-emptiness requirement on the set of sub-alternatives is then satisfied, because there is one sub-alternative for every subset of $D_{\text{part}}^2(2)$, making the use of *dou* licensed. The meaning that is obtained from *dou* in this case is also well-behaved; negating the exhaustified versions of sub-alternatives will not provide new information, *dou* provides vacuous semantic contribution overall, and the assertion at the end is simply the prejacent, providing a partition reading even in the presence of *dou*.

$$(114) \quad \forall q \in \text{SUB}_{\text{EXCL}}(p, C). \neg \text{EXH}_C(q)(w) \text{ is implied by } p(w), \text{ if } \forall q \in \text{SUB}_{\text{EXCL}}(p, C). p \subseteq q.$$

The conclusion is that *dou* is compatible with $D_{\text{part}}^2(2)$ as the cover for Part and therefore the partition reading, under Xiang’s analysis. Thus, the exhaustive-partition alternation cannot be derived under Xiang’s approach.

In addition, in terms of a unified approach to *dou*, Xiang’s approach is unsatisfactory. It is obvious that while all three definitions of *dou* follow the same pattern, they are different in substantial ways. They make assertions about different kinds of alternatives, which are lexically specified in the semantics of *dou*, and assertions themselves are different as well: $\neg \text{JUST}_C(q)(w)$ versus

⁶As will be frequently used in the appendices, the notation $D_{\text{part}}^n(n)$ will contain all and only non-overlapping pluralities of size n in D .

$\neg \text{Ex}_{\text{HC}}(q)(w)$.

7 Conclusion

In this paper, I have re-examined the data on the exhaustive-partition alternation concerning plural universal quantification involving *mei* and *dou* first introduced in Sun (2018). I have proposed an account based on the *dou-as-even* approach in Liu (2017, 2021). Specifically, I employ two accommodations: the first is to recognize the inherent ambiguity of plural universal quantifiers between the exhaustive and the partition readings and implement the ambiguity through the domain variable on the universal quantifier, and the second is to redefine domain alternatives in terms of the atoms involved. Assuming that free choice inferences are derived through a certain strengthening mechanism and that NPIs are licensed through association with overt or covert *even* (Lahiri 1998, Crnič 2014), a related prediction is made by this approach about the free choice readings of plural NPIs: there is an exhaustive-only restriction. This approach is compared with other approaches to *dou*; it is found that none of the other approaches can achieve the following three goals at the same time: accounting for the exhaustive-partition alternation with plural universals, being extensible to the exhaustive-only restriction in plural NPI-FC, and covering the other uses of *dou*. Thus, in terms of the overall analytical landscape, the conclusion is that the *dou-as-even* approach in Liu (2017, 2021, 2023), augmented with the modifications proposed in this paper to deal with plural universal quantification and plural NPI free choice, is at present the most promising unifying theory of the various uses of *dou* in Mandarin Chinese.

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A Universal quantifiers and ANY-phrases in object positions

In section 2, I mentioned that this paper will be concerned only with situations where *dou* can be overtly present, i.e., when the associate is to the left of the pre-verbal position where *dou* is located. In this section, I explore the empirical landscape of positions where overt *dou* cannot associate with; in the cases of its universal and NPI uses, these positions are the object positions.

A.1 Universal quantifiers

Universal quantifiers with *mei* can appear in object positions:

- (115) Zhangsan kanjian-le mei-ge xuesheng.
Z. see-PFV every-CL student
'Zhangsan saw every student.'

The crucial data for our purposes, would then be the behavior of plural universal quantifiers in object positions. First, if the predicate is distributive with respect to the object, then the sentence is judged unacceptable

- (116) Zhangsan kanjian-le mei liang-ge xuesheng.
Z. see-PFV every 2-CL student
'Zhangsan saw every two students.'

The unacceptability of (116) can be explained if we adopt a kind of pragmatic competition or pragmatic constraint against redundancy; (116) and (115) express the same proposition due to the object-distributivity of the predicate *kanjian* 'see': for someone to have seen a plurality of students, it follows that they have seen each individual student. However, (115) is simpler, and the numeral 2 in (116) is completely redundant; one might as well have used (115) to convey the same meaning. It is this redundancy that disfavors (116).

If we change the predicate that is collective with respect to the object position, the results change:

- (117) Zhangsan bijiao-le mei liang-ge fangan.
Z. compare-PFV every 2-CL plan
'Zhangsan compared every two plans.'

The verb *bijiao* 'compare' requires a plural object. In this case, with a plural universal quantifier in the object position, the sentence is judged acceptable. Importantly, (117) only has the exhaustive reading: for every possible pair of plans, Zhangsan compared the two plans in the pair. The partition reading, i.e., that Zhangsan compared every pair in a partition of the plans into pairs, is unavailable due to the (unexplained) restriction that partition readings are only available when the universal quantifier binds an over syntactic variable, like an indefinite, numeral, or a reflexive. There is no such syntactic variable in (117).

On the other hand, if the predicate is replaced by a ditransitive, the higher object is a plural universal quantifier, and the lower object is a syntactic variable bound by the universal quantifier, then we expect partition readings to be licensed. This prediction is borne out:

- (118) Zhangsan song-le mei liang-ge xuesheng yi-ge liwu.
Z. give-PFV every 2-CL student 1-CL gift
'Zhangsan gave every two students one gift.'

Now, both D_{exh} and D_{part}^2 would be licensed as the domain restriction on *mei*, since *dou* is absent. (118) is indeed ambiguous between an exhaustive and a partition reading.

A.2 ANY-phrases

Now, let us look at ANY-phrases in object positions. Because I have adopted the EVEN-approach to NPI licensing, whether EVEN is visible overtly or not, as long as the sentence is judged acceptable, and it contains an NPI, some version of EVEN is always present; when it is invisible, it is simply covert. This predicts that ANY-phrases containing a numeral greater than or equal to 2 will never have a partition reading, regardless of the position they are in. This is the case; (119) is unambiguous and has only the exhaustive reading, despite no overt presence of *dou* (EVEN).

- (119) Zhangsan keyi yaoqing renhe liang-ge xuesheng.
 Z. can invite any 2-CL student
 ‘Zhangsan can invite any two students.’

(119) must mean that for every possible pair of students, Zhangsan is allowed to invite the two students in the pair. The English counterpart to (119) behaves analogously:

- (120) John can invite any two students.

B Explicitly deriving the exhaustive-only restriction on plural NPI-FC

In the body of the paper, I have given a rough sketch of why the present approach makes the prediction that NPI-FC only has the exhaustive reading, assuming that there is some way of strengthening NPI ANY-phrases which are existential quantifiers under the scope of possibility modals to universal quantifiers that scope above them. I will now provide the explicit derivations using one of the established mechanisms for such strengthening. I assume that free choice readings, including those of NPI ANY-phrases, are derived as scalar implicatures. For concreteness and simplicity, I adopt the Innocent Inclusion approach of Bar-Lev & Fox (2020). In this approach, a syntactically present operator $\mathcal{Exh}$ associates with an NPI determiner *any/renhe*, which includes the domain variable restriction. As in the body of the paper, I will use the small caps ANY to abstract across the English *any* and Mandarin Chinese *renhe*, and EVEN to abstract across the covert English *even* and overt Mandarin Chinese *dou*. The ANY-phrase, considered as an existential quantifier, reconstructs below the scope of $\diamond$. The EVEN, as noted before, ends up in a position taking the entire sentence as its argument, either through base generation or movement. Therefore, both the English and the Mandarin singular NPI-FC examples (56) and (57) can be simplified and summarized in the following schema:

- (121) [EVEN [$\mathcal{Exh}$ [$\diamond$ [[ANY $_{D_{\text{EVEN}}}$] $F_{\mathcal{Exh}}$ student $_x$ write a paper]]]]]

I will now illustrate, following the derivation laid out in Crnič (2022), how $\mathcal{Exh}$ produces the universal free choice reading of the NPI ANY-phrase and how the presupposition of EVEN is satisfied.

B.1 Singular NPI-FC and Innocent Inclusion

Crnič (2022) has provided an explicit derivation of free choice readings of *any*-DPs in English through Innocent Inclusion, which I will summarize and present here. As the English and Chi-

nese singular NPI-FC examples can be collapsed into the same representation (121), the following derivation also works for singular NPI-FC in Mandarin Chinese.

As the focus associate of *EVEN* is D , and the alternatives of D are its subsets, the alternatives to the prejacent of *EVEN* in (121) are:

$$(122) \{[\mathcal{E}xh [\Diamond [\text{ANY}_{D'} \text{ student}_x \text{ write a paper}]]] : D' \subseteq D\}$$

For each of these alternatives, $\mathcal{E}xh$ further associates with the determiner which contains the domain variable: $\text{ANY}_{D'}$. The alternatives of $\text{ANY}_{D'}$ are derived by either replacing *ANY* with *EVERY* (*EVERY* stands for *every* in English, and *mei* in Mandarin Chinese) or replacing D' with one of its subsets. For any D' above, the alternatives to the prejacent of $\mathcal{E}xh$ in (122) are:

$$(123) \{[\Diamond [\text{ANY}_{D''} \text{ student}_x \text{ write a paper}]], \\ [\Diamond [\text{EVERY}_{D''} \text{ student}_x \text{ write a paper}]] : D'' \subseteq D'\}$$

For ease of presentation, I will simplify the notation in the following way: I will write the formulas of the denotation of the alternatives in place of the alternatives themselves, so (123) is rewritten as (124):

$$(124) \{\Diamond \exists x \in D''. W(x), \Diamond \forall x \in D''. W(x) : D'' \subseteq D'\}$$

Here, W stands for the predicate *write a paper*; all domain variables are assumed to range only over student individuals, so the NP restrictor *student* is dropped from the formulas.

Now, the way to proceed is specified in the definition of $\mathcal{E}xh$ in the Innocent Inclusion approach to scalar implicatures (Bar-Lev & Fox 2020). The operator $\mathcal{E}xh$ negates all the innocently excludable alternatives and affirms all the innocently includable alternatives; these are specified below. Let C be the set of alternatives of the sentence p ,

$$(125) \begin{aligned} \text{a. } & \mathcal{E}xh(C)(p)(w) = \forall q \in \text{IE}(p, C). \neg q(w) \wedge \forall r \in \text{II}(p, C). r(w), \text{ where} \\ \text{b. } & \text{IE}(p, C) = \bigcap \{C' \subseteq C : C' \text{ is a maximal subset of } C \text{ s.t.} \\ & \qquad \qquad \qquad \{ \neg q : q \in C' \} \cup \{p\} \text{ is consistent}\} \\ \text{c. } & \text{II}(p, C) = \bigcap \{C'' \subseteq C : C'' \text{ is a maximal subset of } C \text{ s.t.} \\ & \qquad \qquad \qquad \{r : r \in C''\} \cup \{p\} \cup \{\neg q : q \in \text{IE}(p, C)\} \text{ is consistent}\} \end{aligned}$$

In (125), *IE*, or the set of innocently excludable alternatives is the intersection of all the maximally consistently excludable subsets of alternatives with the prejacent affirmed. *II*, or the set of innocently includable alternatives is the intersection of all the maximally consistently excludable subsets of alternatives with the prejacent affirmed and all the innocently excludable alternatives negated. Then, $\mathcal{E}xh$ asserts all the innocently includable alternatives and the negation of all the innocently excludable alternatives as the strengthened meaning of its prejacent.

Examining the alternatives in (123), the maximally consistently excludable sets are

$$(126) \text{MAXIE} = \{\{\Diamond \exists x \in D''. W(x), \Diamond \forall x \in D'''. W(x)\} : D'', D''' \subseteq D \wedge s \notin D'' \wedge D''' \neq \{s\}\} \text{ for some } s \in D'$$

Informally, these are sets derived by assuming that one and only one of the students, say s , can write a paper; all existential alternatives not ranging over s , and all universal alternatives not exactly ranging s , can be jointly consistently negated. The set of innocently excludable alternatives, i.e., the intersection of all the sets in *MAXIE*, is the following:

$$(127) \text{IE} = \{\Diamond \forall x \in D''. W(x) : D'' \subseteq D' \wedge |D''| \geq 2\}$$

Informally, every universal alternative that ranges over at least two students can be innocently excluded. Then, it should be easy to see that every other alternative is innocently includable:

$$(128) \quad \text{II} = \{\Diamond \exists x \in D''. W(x) : D'' \subseteq D'\}$$

These are basically all the existential alternatives. Notice that the universal alternatives over singleton domains are equivalent to the existential alternatives over singleton domains, and they are collapsed together.

Finally, $\mathcal{Exh}$ negates all the alternatives in IE and affirms all the alternatives in II, giving us this strengthened meaning:

$$(129) \quad \forall x \in D'. \Diamond W(x) \wedge \neg \Diamond \exists 2x. W(x)$$

I will drop the second conjunct stating that no more than one student can write a paper at the same time, as it is not important to further steps in the derivation. Thus, (122) is equivalent to the following set, with each of its members replaced by the strengthened meaning:

$$(130) \quad \{\forall x \in D'. \Diamond W(x) : D' \subseteq D\}$$

Within this set, the prejacent, $\forall x \in D. \Diamond W(x)$, is the strongest as it entails all other alternatives. Thus, the presupposition of EVEN that the prejacent is the strongest is satisfied and is therefore licensed. Now, EVEN and the NPI ANY, with the help of $\mathcal{Exh}$, successfully license each other, and the sentence is predicted and judged to be well-formed.

B.2 Plural NPI universal free choice

Having provided a derivation for singular NPI-FC that works for both English and Mandarin Chinese, I will show that the present approach combined with a similar derivation for plural NPI-FC makes the predictions that the free choice reading of plural NPIs can only have an exhaustive rather than a partition reading, which I will call the *exhaustive-only* restriction. I assume that D_{part}'' in principle can also be used as a domain restriction on ANY, along with the standard D_{exh} . The illustration below will first demonstrate that a universal free choice reading can be derived for both D_{part}'' and D_{exh} . Below, any variable over domains such as D, D', D'' that are not subscripted by either exh or part ranges over both kinds of domains. I will base my illustration on the following generalized sentence:

$$(131) \quad \text{EVEN} [\mathcal{Exh} [\Diamond [[\text{ANY}_{D_{\text{EVEN}}}]_{F_{\mathcal{Exh}}} 2 \text{ student}_X \text{ co-write a paper}]]]$$

The alternatives of the prejacent of EVEN are:

$$(132) \quad \{[\mathcal{Exh} [\Diamond [\text{ANY}_{D'} \text{ student}_X \text{ co-write a paper}]]] : \bigoplus D' \subseteq \bigoplus D\}$$

Now suppose as before that

$$(133) \quad \begin{aligned} \text{a. } D_{\text{exh}} &= * \{a, b, c, d\} = \{a, b, c, d, a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, \\ &\quad a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}, \text{ and} \\ \text{b. } D_{\text{part}}^2 &= \{a, b, c, d, a \oplus b, c \oplus d, a \oplus b \oplus c, a \oplus b \oplus d, a \oplus c \oplus d, b \oplus c \oplus d, a \oplus b \oplus c \oplus d\}. \end{aligned}$$

It should be noted that it does not matter whether D is D_{exh} or D_{part} regarding the set of alternatives in (132); in either case, all subsets of D_{exh} are domain alternatives of D , due to the redefinition of domain alternatives that I have adopted in section 4.

Thus, the crucial difference between the partition reading and the exhaustive reading lies in the prejacent. I will first show that $\mathcal{Exh}$ in each prejacent does strengthen them to universal free choice readings.

The alternatives of the prejacent of $\mathcal{Exh}$ for each prejacent, following abbreviations introduced in appendix B.1, are:

$$(134) \quad \{\diamond \exists X \in D'. |X| = 2 \wedge W(X), \diamond \forall X \in D'. |X| = 2 \rightarrow W(X) : \bigoplus D' \sqsubseteq \bigoplus D\}$$

Essentially, (134) is equivalent to

$$(135) \quad \{\diamond \exists X \in D'. |X| = 2 \wedge W(X), \diamond \forall X \in D'. |X| = 2 \rightarrow W(X) : D' \subseteq D_{\text{exh}}\}$$

I simplify the derivation by considering sets only made up of 2-sized pluralities, as the scope of the quantifiers imposes such a restriction on the individuals quantified over. Suppose that the salient atomic students in the context are a, b, c, d . Let $D_{\text{exh}}(2)$ stand in for the set of 2-sized individuals in D_{exh} :

$$(136) \quad D_{\text{exh}}(2) = \{a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d\}$$

And let $D_{\text{part}}^2(2)$ stand in for the set of 2-sized individuals in D_{part}^2 :

$$(137) \quad D_{\text{part}}^2(2) = \{a \oplus b, c \oplus d\}$$

(135) is thus rewritten as

$$(138) \quad \{\diamond \exists X \in D'. W(X), \diamond \forall X \in D'. W(X) : D' \subseteq D_{\text{exh}}(2)\}$$

However, the prejacentes are different:

$$(139) \quad \begin{aligned} \text{a.} \quad & \diamond \exists X \in D_{\text{part}}^2(2) = \{a \oplus b, c \oplus d\}. P(X) \\ \text{b.} \quad & \diamond \exists X \in D_{\text{exh}}(2) = \{a \oplus b, a \oplus c, a \oplus d, b \oplus c, b \oplus d, c \oplus d\}. P(X) \end{aligned}$$

This difference in the prejacent will result in different strengthened meanings, despite the identity of the set of alternatives. First, let us look at the relevant steps in the computation for the partition reading:

$$(140) \quad \text{MAXIE} = \{\{\diamond \exists X \in D'. W(X), \diamond \forall X \in D''. W(X) : D', D'' \subseteq D_{\text{exh}}(2) \wedge S \notin D' \wedge D'' \neq \{S\}\} : S \in D_{\text{part}}^2(2)\}$$

The maximal consistently excludable sets are those derived from the assumption that only one pair in $D_{\text{part}}^2(2)$ is allowed to co-write a paper.

$$(141) \quad \text{IE} = \{\diamond \forall X \in D'. W(X) : D' \subseteq D_{\text{exh}}(2) \wedge |D'| \geq 2 \vee D' \in \{\{Y\} : Y \in D_{\text{exh}}(2) \setminus D_{\text{part}}^2(2)\}\}$$

The innocently excludable set includes every universal alternative with a domain containing two or more pairs and the alternatives with singleton domains containing exactly one pair not in $D_{\text{part}}^2(2)$.

$$(142) \quad \text{II} = \{\diamond \exists X \in D'. W(X) : D' \subseteq D_{\text{part}}^2(2)\}$$

The innocently includable set includes existential alternatives based on subdomains of $D_{\text{part}}^2(2)$.

Then, we look at the exhaustive case.

$$(143) \text{ MAXIE} = \{\{\diamond\exists X \in D'. W(X), \diamond\forall X \in D''. W(X) : D', D'' \subseteq D_{\text{exh}}(2) \wedge S \notin D' \wedge D'' \neq \{S\}\} : S \in D_{\text{exh}}(2)\}$$

The maximal consistently excludable sets are those derived from the assumption that only one pair in $D_{\text{exh}}(2)$ is allowed to co-write a paper.

$$(144) \text{ IE} = \{\diamond\forall X \in D'. W(X) : D' \subseteq D_{\text{exh}}(2) \wedge |D'| \geq 2\}$$

The innocently excludable set includes every universal alternative with a domain containing two or more pairs.

$$(145) \text{ II} = \{\diamond\exists X \in D'. W(X) : D' \subseteq D_{\text{exh}}(2)\}$$

The innocently includable set includes every existential alternative based on subdomains of $D_{\text{exh}}(2)$. From (144), we see that if D is D_{part}^2 , then $\mathcal{E}xh$ over the II alternatives in (144) and the IE alternatives in (141) will yield the following strengthened meaning for the partition reading prejacent:

$$(146) \quad \forall X \in D_{\text{part}}^2(2). \diamond W(X) \\ \wedge \neg \diamond (\exists 2X \in D_{\text{exh}}(2). W(X)) \wedge \neg \diamond (\exists X \in D_{\text{exh}}(2) \setminus D_{\text{part}}^2(2). W(X))$$

(146) means that the two pairs in the partition, $a \oplus b$ and $c \oplus d$, are both allowed to co-write a paper, while it is not allowed for $a \oplus c, a \oplus d, b \oplus c$ to co-write a paper, and it is not allowed for two pairs to co-write a paper at the same time.

From (145), we see that if D is D_{exh} , then $\mathcal{E}xh$ over the II alternatives in (145) and the IE alternatives in (144) will yield the following strengthened meaning for the exhaustive reading prejacent:

$$(147) \quad \forall X \in D_{\text{exh}}(2). \diamond W(X) \\ \wedge \neg \diamond (\exists 2X \in D_{\text{exh}}(2). W(X))$$

(147) means that all possible pairs of students are allowed to co-write a paper, while it is not allowed for two pairs to co-write a paper at the same time. It should be noted that the two prejacentes are each other's alternatives, in the alternatives quantified over by *EVEN*. It is clearly the case that the strengthened meaning of the exhaustive prejacent (147) asymmetrically entails the strengthened meaning of the partition prejacent (146). By this alone, without needing to compute the strengthened meanings of other alternatives operated over by *EVEN*, we know that the partition prejacent cannot be the strongest among the alternatives. Thus, *EVEN*'s presupposition is not met and cannot be used with a partition prejacent. However, since the partition prejacent contains *ANY*, it must be licensed by *EVEN*. This creates an irresolvable conflict, making the partition prejacent, and therefore the partition reading of universal free choice of plural NPIs unavailable.

The redefinition of domain alternatives plays a crucial role in ruling out the partition reading of plural NPI-FC. If domain alternatives are still subdomains, then the exhaustive prejacent will not be an alternative of the partition prejacent, because D_{exh} will not be an alternative of D_{part} ; the former is a strict superset of the latter. And among the subdomains of D_{part} , the prejacent D_{part} will be the maximal domain, resulting in the strengthened meaning of the prejacent being the strongest among the strengthened meanings of the alternatives of *EVEN*. Then, the presupposition of *EVEN* being satisfied, licensing its presence and therefore the partition reading of universal free choice of plural NPIs, which is unattested.

An implicit assumption is that the free choice inference of the plural NPI is still derived for the partition reading given domain alternatives as subdomains. This is indeed the case, as evidenced

by the following computations:

- (148) a. $\text{MaxIE} = \{\{\Diamond \exists X \in D'. W(X), \Diamond \forall X \in D''. W(X) : D', D'' \subseteq D_{\text{part}}^2(2) \wedge S \neq D' \wedge D'' \neq \{S\}\} : S \in D_{\text{part}}^2(2)\}$
 b. $\text{IE} = \{\Diamond \forall X \in D_{\text{part}}^2(2). P(X)\}$
 c. $\text{II} = \{\Diamond \exists X \in D'. W(X) : D' \subseteq D_{\text{part}}^2(2)\}$

The strengthened meaning is just:

$$(149) \quad \forall X \in D_{\text{part}}^2(2). \Diamond W(X) \wedge \neg \Diamond \forall X \in D_{\text{part}}^2(2). W(X)$$

(149) means that the two pairs in the partition are both allowed to co-write a paper, while it is not allowed for both two pairs to co-write a paper at the same time. (149) is indeed entailed by (147), which is also the strengthened meaning of a prejacent based on D_{exh} given the original subdomain-based definition of domain alternatives.