The scope of alternatives

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1 Roadmap

- I'll try to do two things today:
  - Argue for a new kind of *alternative semantics*, one where alternative-inducing expressions interact with their semantic context by **taking scope**.
  - Conservatively **extend this semantics to handle *dynamic binding*** by indefinites, and thereby argue that dynamic and alternative semantics have all along been palping different parts of the indefiniteness elephant.
- The semantics will be developed in three steps, differing from each other only in how they reckon with assignment functions (or, more generally, states).
- While I'll focus on English indefinites, much of what follows is applicable in other domains where alternatives have been argued to offered insight (e.g. questions, focus, indeterminate pronouns).

2 Standard alternative semantics

2.1 Composing sets

- Alternative semantics in a slogan: certain expressions introduce alternatives into the semantics, causing us to consider a number of meanings in parallel.
- For example, indefinites might be taken to denote sets of individuals:

(1) $[\![\text{a linguist}]\!]^{i} = \{x \mid \text{linguist}\, x\}$

Cf. the standard treatment of indefinites as generalized quantifiers:[1]

(2) $[\![\text{a linguist}]\!]^{i} = \lambda\kappa.\, \exists x.\, \text{linguist}\, x \wedge \kappa\, x$

[1] As Partee 1986 shows, these two meanings are inter-derivable via two type-shifters, A and BE. So one or the other may in fact come "for free". I won't have much to say about this, but it's tantalizing to think about, especially *vis à vis* the dynamic semantics I'll discuss later.

- Because (1) occurs in positions where something of type e is standardly expected, we must say how alternatives are brought into the compositional fold.
- The usual way to go: first, suppose that *everything* denotes a set:

(3) $[\![\text{John}]\!]^{i} = \{j\}$ $[\![\text{met}]\!]^{i} = \{\text{met}\}$ $[\![\text{a linguist}]\!]^{i} = \{x \mid \text{linguist}\, x\}$

Then, to compose these sets, define an operation of *point-wise* functional application (**PWFA**) (e.g. Hamblin 1973; Rooth 1985; Kratzer & Shimoyama 2002):

(4) $[\![A\ B]\!]^{i} = \{f\, x \mid f \in [\![A]\!]^{i} \wedge x \in [\![B]\!]^{i}\}$

- A basic example of how this works is in (5). The alternatives expand as we climb the tree, eventually yielding a set of propositions:

(5) $[\![\text{John met a linguist}]\!]^{i} = \{j\ \text{met}\ x \mid \text{linguist}\, x\}$

2.2 Motivating PWFA: exceptional scope

- Why have alternatives and PWFA?[2] A standard motivation since Rooth 1985: *insensitivity to islands*. Each of the following constructions can be interpreted in a way that gives the **bolded** thing apparent scope outside a syntactic ⟨island⟩.

(6) If ⟨**a rich relative of mine** dies⟩, I'll inherit a house. (∃ > if)
(after Reinhart 1997: ex.17)

(7) Taro-wa ⟨**dare**-ga katta mochi-o⟩ tabemasita ka?
Taro-TOP who-NOM bought rice cake-ACC ate Q
'Who is the x such that Taro ate rice cakes that x bought?'
(Kratzer & Shimoyama 2002: ex.2b)

(8) Dr. Svenson only complains when ⟨**BILL** leaves the lights on⟩.
(Rooth 1996: ex.29b)

[2] Hamblin 1973's motivation was simply to derive sets of alternative propositions as question meanings. Karttunen 1977 showed how to derive sets of alternative propositions without alternative semantics.

Alternatives and PWFA give us some traction on data like this. Since the grammar is just *built* to move alternatives up the tree, e.g. the indefinite in (6) can stay in situ, even as its alternatives acquire a kind of "scope" over the conditional:

$$\{\text{dies}\,x \Rightarrow \text{house} \mid \text{relative}\,x\}$$

3 A different approach

3.1 Basics

- My proposal: ditch PWFA, and instead resolve the type mismatch introduced by a set of alternatives by **scoping it**, much as we resolve the type mismatch for quantifiers in object position by scoping them.
- Letting alternatives take scope requires two type-shifters, in (9). $\boxed{\cdot}$ is Karttunen 1977's proto-question operator, aka IDENT (Partee 1986), and $\cdot^{\Uparrow}$ turns a set of alternatives m into a scope-taker by feeding each member of m to a scope argument κ and collecting the resulting sets.[3]

(9) $$\boxed{x} = \{x\} \qquad\qquad m^{\Uparrow} = \lambda\kappa.\bigcup_{x\in m}\kappa\,x$$

$\boxed{\cdot}$ and $\cdot^{\Uparrow}$ are decompositions of LIFT (Partee & Rooth 1983; Partee 1986), in the sense that, for any x, $\boxed{x}^{\Uparrow} = \text{LIFT}\,x = \lambda\kappa.\,\kappa\,x$.

- Typing judgments for these two shifters are as follows, where Fa should be read as "a fancy a". In this case, a fancy a is simply a set of a's, so $Fa ::= \{a\} ::= a \to t$:

(10) $$\boxed{\cdot} :: a \to Fa \qquad \cdot^{\Uparrow} :: Fa \to (a \to Fb) \to Fb$$

- An example of how this works to derive the same result as PWFA for *John met a linguist* is given below and in Figure 1.[4]

(11) $$\textbf{a.linguist}^{\Uparrow}\,(\lambda x.\,\boxed{\text{j met}\,x}) = \{\text{j met}\,x \mid \text{linguist}\,x\}$$

The general pattern on display here will be repeated time and again. The alternative generator takes scope via $\cdot^{\Uparrow}$, and $\boxed{\cdot}$ applies to its remnant.

[3] This pair of shifters, and the others that follow, form something known in category theory and computer science as a *monad* (e.g. Moggi 1989; Wadler 1992, 1995). See Shan 2002; Giorgolo & Asudeh 2012; Unger 2012; Charlow 2014 for discussions of monads in natural language semantics.

[4] **a.linguist**$^{\Uparrow}$ is equivalent to the meaning Cresti 1995 (citing unpublished lecture notes by Heim & Higginbotham) assigns to *which linguist*, and also crops up in recent work by Ciardelli & Roelofsen (to appear).

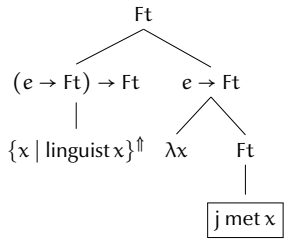

Figure 1: Deriving a set of alternative propositions for *John met a linguist* via scope. The result is a set of propositions: $\{\text{j met}\,x \mid \text{linguist}\,x\}$.

- Analogously, cases with multiple sources of alternatives such as *a linguist met a philosopher* require two applications of $\cdot^{\Uparrow}$, and two scopings:

(12) $$\textbf{a.linguist}^{\Uparrow}\,(\lambda x.\,\textbf{a.philosopher}^{\Uparrow}\,(\lambda y.\,\boxed{x\ \text{met}\ y})) = \{x\ \text{met}\ y \mid \text{linguist}\,x \wedge \text{philosopher}\,y\}$$

- To extract a truth-condition from an alternative set, we can define a categorematic closure operation that requires one of the alternatives to be true:

(13) $$!m = \exists p \in m.\,p$$

For example, applying ! to (12) gives $\exists x.\,\exists y.\,\text{linguist}\,x \wedge \text{philosopher}\,y \wedge x\ \text{met}\ y$.

3.2 Exceptional scope via LF pied-piping

- Since we manage alternatives via scope, it may appear as if we have given up an account of exceptional scope-taking.

(14) If ⟨**a rich relative of mine** dies⟩, I'll inherit a house.

- In fact, this is not so! The grammar readily generates an exceptional scope reading for this case by *scoping the island itself* to a position over the conditional, as follows (see also Figure 2):

(15) $$\{\text{dies}\,x \mid \text{relative}\,x\}^{\Uparrow}\,(\lambda p.\,\boxed{p \Rightarrow \text{house}}) = \{\text{dies}\,x \Rightarrow \text{house} \mid \text{relative}\,x\}$$

The island transmits the indeterminacy induced by the indefinite to the conditional as a whole. Thus, we explain exceptional scope as a kind of **LF pied-piping** (Nishigauchi 1990; von Stechow 1996): movement of the island itself results in exceptional scope of things on the island.

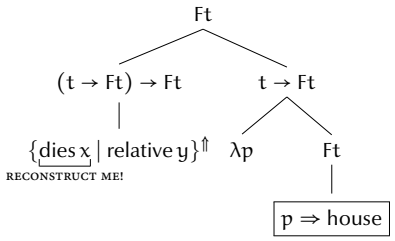

Figure 2: Exceptional scope-taking for *if* ⟨*a rich relative of mine dies*⟩, *I'll inherit a house*. The antecedent is LF pied-piped to a scope position over the conditional.

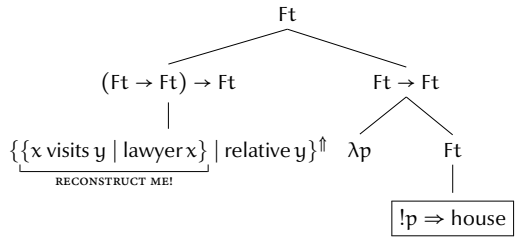

Figure 3: Selective exceptional scope-taking for *if* ⟨*a persuasive lawyer visits a relative of mine*⟩, *I'll inherit a house*. The higher-order antecedent is LF pied-piped.

- More generally, *whenever* an alternative generator takes scope, everything to the right of the "pipe" | scopes high. Everything to the left of the pipe saturates κ and makes its way back down the tree (cf. 'RECONSTRUCT ME!' in Figure 2).

4 Why?

4.1 More categorematic

- A minor-ish point: the semantics is more categorematic (ergo more compositional) than PWFA-based approaches, which rely on syncategorematic rules for (e.g.) closure operations (see e.g. Rooth 1992; Kratzer & Shimoyama 2002):

(16) $$[\![!X]\!]^g_{\text{PWFA}} = \{\exists p \in [\![X]\!]^g . p\}$$

The reason: PWFA-style grammars are *built to point-wise compose sets*. If ever you want to do anything else (like quantify over a set), you need a new composition rule.

4.2 Selectivity

- Here's a data point: indefinites can take *selective* scope outside islands. The following allows an any-old-lawyer, one-rich-relative reading:

(17) If ⟨**a persuasive lawyer** visits **a relative of mine**⟩, I'll inherit a house!

- PWFA doesn't do selective scope-taking. The grammar is just built in such a way that generates flat alternative sets. E.g., for (17)'s antecedent:

(18) $$[\![\langle \cdots \rangle]\!]^g_{\text{PWFA}} = \{x \text{ visits } y \mid \text{lawyer } x \wedge \text{relative } y\}$$

Using this alternative set, there's no way to give one indefinite scope over the conditional without bringing the other along for the ride.

- A closely related case in the domain of focus interpretation (cf. examples in Rooth 1996; Wold 1996; Beck 2006; Krifka 2006):

(19) [John only gripes when MARY leaves the lights on]$_C$, and [JEN only gripes when ⟨SUE leaves the lights on⟩]$_{\sim C}$.

Considering examples like these, Rooth concludes:

> [Their] theoretical imact is quite dramatic: the recursive definition of alternatives [SC: i.e. PWFA-based alternative semantics] has no advantage over the scoping approach to the logical form of focus. (Rooth 1996)

- It might seem that we're similarly out of luck. Won't LF pied-piping *a persuasive lawyer visits a relative of mine*, derived along the lines of (12), over the conditional necessarily give **both** indefinites scope over the conditional?

- Truue. However! The following derivation for the to-be-pied-piped island is lurking in the system. The essential difference relative to (12) is the extra application of $\boxed{\cdot}$.[5]

(20) $$\begin{aligned} &\textbf{a.relative}^{\Uparrow}\,(\lambda y.\,\boxed{\textbf{a.lawyer}^{\Uparrow}\,(\lambda x.\,\boxed{x \text{ visits } y}\,)}\,) \\ &= \{\{x \text{ visits } y \mid \text{lawyer } x\} \mid \text{relative } y\} \end{aligned}$$

The result of iterating $\boxed{\cdot}$ in this way is a *higher-order* alternative set, type FFt. (See e.g. Dayal 1996, 2002; Fox 2012 for arguments in favor of higher-order alternatives.)

- Call this higher-order meaning **S**. LF pied-piping allows us to derive the selective exceptional scope reading we're after, along the following lines (see also Figure 3):

(21) $$\begin{aligned} &\textbf{S}^{\Uparrow}\,(\lambda p.\,\boxed{!p \Rightarrow \text{house}}\,) \\ &= \{(\exists x.\,\text{lawyer } x \wedge x \text{ visits } y) \Rightarrow \text{house} \mid \text{relative } y\} \end{aligned}$$

[5] An analogous result can be achieved in Karttunen 1977-style approaches to the semantics of questions, by iterating the proto-question operator.

The "outer" layer of alternatives scopes above the conditional, while the "inner" layer of alternatives *semantically reconstructs* (cf. Cresti 1995) to within the scope of the conditional, where its alternatives are discharged by !.

4.3 Binding

- Because our compositional apparatus is entirely standard — that is, we've been proceeding with only Functional Application — there is no problem making use of a standard Predicate Abstraction operation.
- However, as argued by Shan 2004; Charlow 2014, this actually *cannot be done* for PWFA-based grammars — more specifically, there is no operation for moving from a set of propositions to a set of properties that behaves the way abstraction should behave — and so binding represents a major challenge.
- Yet it may appear that we have binding issues of our own. For examples like (22) it seems scoping the island over the quantifier unbinds the pronoun:

(22) Every linguist$_i$ is happy if ⟨**a famous expert on indefinites** cites her$_i$⟩.

- It's true: we actually can't handle data of this sort using Heim & Kratzer 1998's approach to binding. However, a minimal shift in perspective to a semantics that allows **binding reconstruction** à la Sternefeld 1998, 2001 gives us what we need.
- The key to binding reconstruction is allowing things to denote *functions from assignments* into values. An example of how this goes for *her$_i$ mother, Polly$_i$ likes*:[6]

(23) $$\underbrace{(\lambda F.\, \lambda i.\, p \text{ likes } (F\,(i \cdot p)))}_{\text{Polly likes \_}}\ \underbrace{(\lambda i.\, i_0\text{'s mom})}_{\text{her mom}} = \lambda i.\, p \text{ likes } p\text{'s mom}$$

- Implementing this perspective simply means tweaking our notion of what a "fancy" meaning is. We now take fancy α's to be functions from assignments into sets of α's:

(24) $$F\alpha = s \to \{\alpha\}$$

This in turn implies tweaked versions of $\boxed{\cdot}$ and $\cdot^{\Uparrow}$, as follows. Their form essentially follows from the types (NB: it still holds that $\boxed{x}^{\Uparrow} = \textsc{lift}\, x$).

(25) $$\boxed{x} = \lambda i.\, x \qquad m^{\Uparrow} = \lambda\kappa.\, \lambda i.\, \bigcup_{x \in mi} \kappa\, x\, i$$

- An example of how this works is given in Figure 4. The derivation is entirely parallel to Figure 3. We rely on higher-order LF pied-piping, which allows the pronoun to semantically reconstruct into the scope of the binder Op.

[6] Sternefeld credits the basic insight to unpublished lecture notes by Heim. See also Barker 2012 for a closely related account attributing reconstruction in questions to *delayed evaluation*.

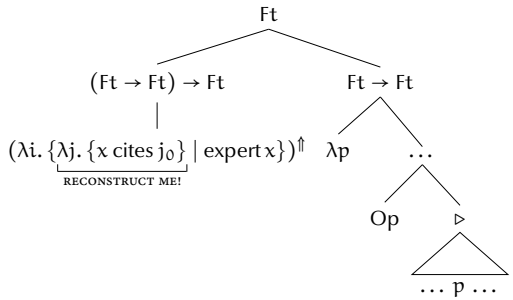

Figure 4: Schematic rendering of reconstruction for *every linguist$_i$ is happy if* ⟨*a famous expert on indefinites cites her$_i$*⟩.

- The tree in Figure 4 invokes ▷, a device for in-scope binding *à la* Partee 1973's Derived VP Rule (interested folks may also consult Table 1 for further details):

(26) $$\kappa^{\triangleright} = \lambda x.\, \lambda i.\, \kappa\, x\, (i \cdot x)$$

- NB: binding reconstruction should be constrained. In particular, we should not be able to assign the indefinite wide scope in **roofing** constructions like the following:

(27) No candidate$_i$ submitted a paper he$_i$ wrote. (Schwarz 2001)

- Here's how we'd have to analyze this reading. Recall that everything to the right of the pipe scopes high. This means that there is no way to give the indefinite *a paper he$_0$ wrote* scope over *no candidate* without unbinding the pronoun!

(28) $$\overbrace{(\lambda i.\, \{y \mid \underbrace{i_0 \text{ wrote } y}_{\text{SCOPES HIGH}}\})}^{\text{A PAPER HE}_0\text{ WROTE}}{}^{\Uparrow}\ (\lambda y.\, \textbf{no.candidate}\ (\lambda x.\, \boxed{x \text{ submitted } y}\,)^{\triangleright})$$

All told, we seem to cut the pie in just the right way. An indefinite's restrictor cannot reconstruct, but anything else on the island with the indefinite can, freely.

- This improves on choice-functional accounts of exceptional scope (e.g. Reinhart 1997), which are able to assign the indefinite a kind of wide scope in examples like these (Schwarz 2001; see also Geurts 2000):[7]

(29) $$\exists f.\, \textbf{no.candidate}\ (\lambda x.\, x \text{ submitted } (f\,\{y \mid x \text{ wrote } y\}))$$
≈ no candidate submitted *every* paper he wrote

[7] It also improves on Romero & Novel 2013's proposed fix to the PWFA abstraction issue, which is likewise able able to assign the indefinite a kind of wide scope in these sorts of examples.

About which Heim 2011 remarks:

> [Given (29)], we may have to concede what Fodor and Sag and most subsequent authors wanted to avoid: indefinites are existential quantifiers that enjoy a greater degree of scopal mobility than other kinds of quantificational DPs.
>
> (Heim 2011: 1022)

I hope to have shown that we do *not* have to concede this. We can have a theory in which scope-taking is island-sensitive — so long as the island itself can take scope.

5 Dynamic semantics

5.1 Standard dynamics

- Let's begin with a familiar data point. Indefinites behave more like names than quantifiers with respect to anaphoric phenomena:

(30) {Polly$_i$, a linguist$_i$, *every linguist$_i$} came in. She$_i$ sat down.

- Basic idea underlying dynamic semantics: sentences add discourse referents (Karttunen 1976) to the "conversational scoreboard" (some key references: Kamp 1981; Heim 1982; Barwise 1987; Groenendijk & Stokhof 1991; Dekker 1994; Muskens 1996):

(31) $i \longrightarrow [\![\text{Polly came in}]\!] \longrightarrow i \cdot p$

- Indefinites (but not quantifiers) also set up discourse referents. In case four linguists came in — a, b, c, and d — we'll have:

(32) $i \longrightarrow [\![\text{a linguist came in}]\!] \begin{cases} \nearrow i \cdot a \\ \rightarrow i \cdot b \\ \rightarrow i \cdot c \\ \searrow i \cdot d \end{cases}$

- Formally captured by modeling meanings as relations on states. For example, here is a candidate meaning for *a linguist came in*:

(33) $\lambda i.\, \{i \cdot x \mid \text{linguist}\, x \wedge \text{came.in}\, x\}$

- I won't go into any detail about formalizing standard varieties of dynamic semantics, but I will note that a standard lexical entry for an indefinite (cf. e.g. Dekker 1994) might look something as follows:

(34) $\lambda \kappa.\, \lambda i.\, \bigcup_{x \,\in\, \text{linguist}} \kappa\, x\, (i \cdot x)$

$F\alpha$	$\boxed{x}$	$m^{\Uparrow}$	$[\![\text{a linguist}]\!]^{F\epsilon}$	$[\![\text{she}_0]\!]^{F\epsilon}$
α	x	$\lambda \kappa.\, \kappa\, m$	N/A	i_0
$\{\alpha\}$	$\{x\}$	$\lambda \kappa.\, \bigcup_{x \,\in\, m} \kappa\, x$	$\{x \mid \text{linguist}\, x\}$	$\{i_0\}$
$s \to \{\alpha\}$	$\lambda i.\, \{x\}$	$\lambda \kappa.\, \bigcup_{x \,\in\, m i} \kappa\, x\, i$	$\lambda i.\, \{x \mid \text{linguist}\, x\}$	$\lambda i.\, \{i_0\}$
$s \to \{\langle \alpha, s\rangle\}$	$\lambda i.\, \{\langle x, i\rangle\}$	$\lambda \kappa.\, \bigcup_{\langle x, j\rangle \,\in\, m i} \kappa\, x\, j$	$\lambda i.\, \{\langle x, i\rangle \mid \text{linguist}\, x\}$	$\lambda i.\, \{\langle i_0, i\rangle\}$

Table 1: Progressively enriching a grammar to handle alternatives, alternatives with state-sensitivity, and alternatives with state modification.

This looks *awfully* similar to a $\cdot^{\Uparrow}$'d indefinite. And, indeed, one way to think of the dynamic treatment of indefiniteness is that it traffics in **alternative updates** to the scoreboard.

5.2 Enriching to dynamics

- What would it take to incorporate dynamic binding into the present perspective? Dynamic semantics relies on the ability to take in states, modify them, and output them. One way to think of this is in terms of a new "fancy" type:

(35) $F\alpha ::= s \to \{\langle \alpha, s\rangle\}$

- Once again, the basic form of the shifters essentially follows from the types, and once again we find that these two shifters are decompositions of LIFT!

(36) $\boxed{x} = \lambda i.\, \{\langle x, i\rangle\} \qquad m^{\Uparrow} = \lambda \kappa.\, \lambda i.\, \bigcup_{\langle x, j\rangle \,\in\, m i} \kappa\, x\, j$

- See Table 1 for comparison of the various paradigms for dealing with alternatives. We begin without any fanciness. We progressively incorporate alternatives, state-sensitivity, and state modification.
- Remarkably, rejiggering the semantics in this way predicts that dynamic binding *also* arises via a kind of LF pied-piping. See Figure 5 for a derivation.[8]
- In contrast with standard dynamic approaches, this derivation does not require any notion of *dynamic conjunction*. In keeping with the general spirit I've been advocating, conjunction is boring and interacts with fancy things via $\boxed{\cdot}$ and $\cdot^{\Uparrow}$.
- In sum, a simple shift in perspective *vis à vis* states turns an alternative semantics into an alternative semantics that countenances dynamic binding.

[8] I have suppressed the derivations of the individual conjuncts, but interested parties should be able to reconstruct them from Table 1, along with the binding operator given in (26).

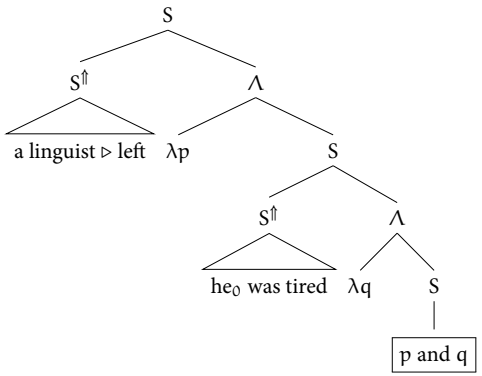

Figure 5: Cross sentential anaphora via LF pied-piping: *a linguist*$_i$ *left; he*$_i$ *was tired.*

6 Wrapping up

- So my bottom line is this: if you want alternatives, let them take scope.[9]
- Setting up the grammar in this way gives a robust account of alternative-inducing expressions — here, we focused on indefinites — including exceptional scope, selectivity, binding reconstruction, and roofing, while avoiding many of the pitfalls inherent in PWFA-based approaches (and other approaches to exceptional scope).
- In addition, taking this perspective opens up a new way to think about *dynamic semantics*, namely as a proper extension of alternative semantics. It's difficult if not impossible to establish this link if we stick to standard approaches to alternative semantics (and, for that matter, standard approaches to dynamics).
- Finally, though I focused on English indefinites, the same strategy allows us to give parallel, empirically robust accounts of focus and in situ *wh*:

> The group of island-escaping operators does not appear to be an arbitrary one.... [Their] semantic similarity, together with the common insensitivity to scope islands, suggest that we should not be satisfied with a theory which treats focus as sui generis. We would like to replace the focus-specific definition with a theory in which focus is one of a family of island-insensitive operators which, roughly, use restricted variables to name families of propositions, open propositions, and/or their existential closures. It is not at all clear to me how this should be done.
>
> (Rooth 1996)

- I hope to have shed some light on this. Thanks!

[9] The centrality of scope-taking to natural language semantics has likewise been emphasized in work on *continuations* by Barker and colleagues. See e.g. Barker 2002; Shan & Barker 2006; Barker & Shan 2014.

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