NSIM: The Neolithic Social Investment Model

The Neolithic Social Investment Model (NSIM) is built on the conversion framework explained in chapter 3. Figure 3.8 lays out the conversion model in as much detail as the abstraction from particular times and places permits. Figure 4.1 is a revised version of that diagram, specific to the neolithic context in which the "before" state (State A) is called "low investment" (LI) and the "after" state (State B) is called "high investment" (HI). The stocks and flows are renamed appropriately, as are the six flowrates. As in Figure 3.8, so in Figure 4.1: the next stage is all about designing a causal architecture capable of specifying the six flow rates and responding to the output variable "HI_Prop," which expresses the proportion of the HI sub-population within the entire population. The notation is also slightly simplified: parameters are designated asa circles having wedges (only one is shown), variables are designated as circles without wedges, stocks are designated as squares, flows are thick arrows, and flowrate adjustment factors are thin arrows. As always, mathematics lurks behind the scenes: simple calculus defines the relations between stocks and flows while intuitive algebraic formulas explain precisely how parameters and variables combine to determine flowrates and other variables.

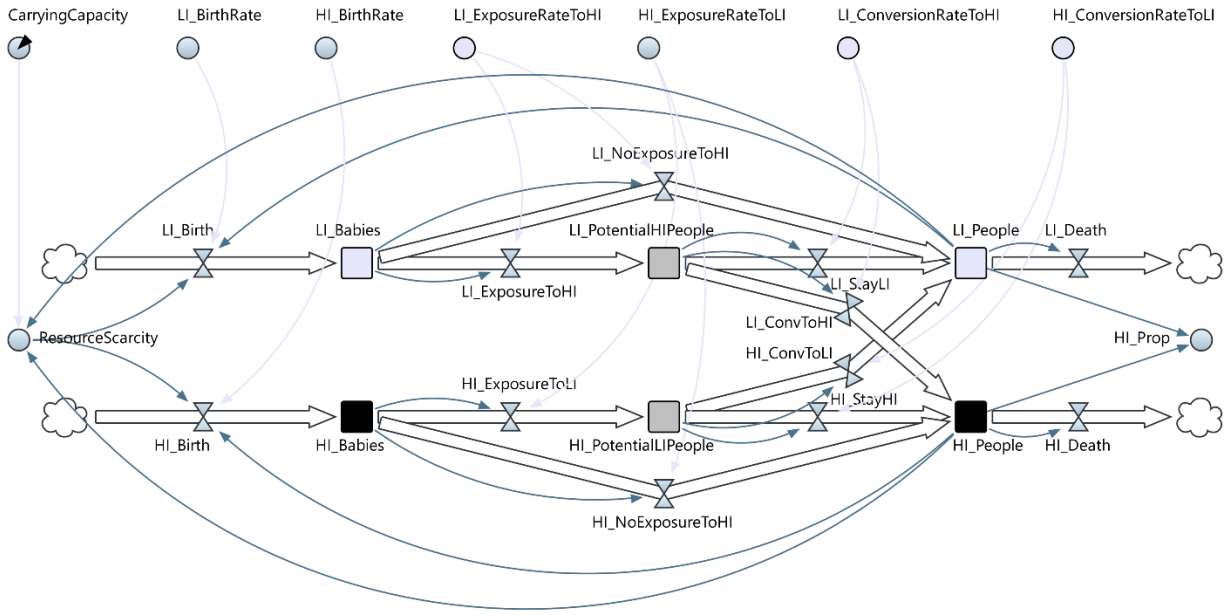

Figure 4.1. Stock-and-flow diagram for conversion model between low-investment (LI) and high-investment (HI) lifestyles.

This specification of the conversion model invites a narrative explanation. The conceptual framework for NSIM is *lifestyle conversion* within a constrained geographical area (such as the Konya Plain, where Çatalhöyük is located). Here "lifestyle" is shorthand for "worldview and lifeway." The low-investment (LI) lifestyle encompasses hunter-gatherer groups and people who used farming techniques without embracing the intensification of sociality and human-thing entanglement that we see in Çatalhöyük. They could plan for the future and delay gratification to some extent, but were not as intensely entangled with people, places, and things. For example, people in LI lifestyles lacked permanent healthy storage facilities for grain, which limited the scale and intensity of crop cultivation. The high-investment (HI) lifestyle involves agricultural settlements with higher levels of entanglement with the vital forces of their environment, including people, animals, plants, objects, and culturally postulated spirits. For example, people in HI lifestyles were far less likely to move around than people in LI

lifestyles because of this difference in entanglement with people and place; they built houses and incorporated healthy storage facilities for grain within them, so they could do a lot more with crop cultivation.

These two lifestyles are treated as alternatives with transition paths between them. The six variables needed to determine how the population flows through the conversion model, and thereby the ratio of HI to LI people, are birth rates for each type, rates of exposure to the other type of lifestyle, and rates of conversion to the alternative lifestyle.

The model presents babies being born into LI (top left) and HI (bottom left) lifestyles according to the corresponding birth rates (LI_BirthRate and HI_BirthRate). The LI people are exposed to the HI lifestyle alternative at the rate dictated by the matching variable (LI_ExposureRateToHI). The LI people who are so exposed then may convert to the HI lifestyle at a rate depending on the conversion variable (LI_ConversionRateToHI). A parallel conversion path exists to move from the HI lifestyle over to the LI lifestyle (with variables HI_ExposureRateToLI and HI_ConversionRateToLI). Of course, everyone dies in the end. The model also includes a Carrying Capacity parameter that contributes, with total population size, to resource scarcity, which in turn modifies birth rates. Figure 4.1 suppresses other parameters that influence the two birthrates.

The links indicate causal connections between elements of the diagram. For example, the ResourceScarcity variable is defined intuitively in mathematical terms by *(LI_People + HI_People) / CarryingCapacity*. The stocks (boxes) are defined by first-order differential equations. For instance, the HI_PotentialConvertsToLI stock is defined by *d(HI_PotentialConvertsToLI)/dt = HI_ExposireToLI – HI_ConvertToLI – HI_StayHI* (the right-hand

side is just inputs minus outputs). The flows (broad arrows) are defined by simple mathematical formulas for flow rates (represented by the double triangle in the center of each flow arrow). For instance, the LI_ConvertToHI flow rate is defined as follows: *LI_ConversionRateToHI * HI_PotentialConvertsToLI*. These formulas are natural and, we believe, non-controversial.

To apply this conversion model to the Neolithic transition, we need a theoretically persuasive way to produce the six key variables (the two birth rates, two exposure rates, and two conversion rates). Think of this "theoretically persuasive way" vaguely for now, and call it a "Causal Nexus." We will define this Causal Nexus, which is a collection of fully specified and carefully clustered mechanisms, in more detail below, but it needs to have several characteristics. (1) We need the Causal Nexus to be responsive to the HI_Prop variable, which expresses the proportion of HI people in the entire population in the geographical area of interest. (2) We also need the Causal Nexus to produce six variables as output. And (3) we need the Causal Nexus to have a range of parameters as inputs, along with the HI_Prop variable input, so that we can explore the model's behavior in a variety of ecologically meaningful conditions. So, what's in the Causal Nexus?

The theoretical core of the Causal Nexus is presented in Figure 4.2. This is the heart of what we consider to be the causal architecture of the Neolithic transition, at least within the limitations of the Neolithic Social Intensity Model (NSIM). The five input parameters on the left side of the diagram define the beginnings of a parameter space whose characteristics we will describe later. The HI_Prop variable (the proportion of high-intensity people in the population, derived from the conversion model) is presented as an input on the right side of the diagram. The remaining variables and the causal connections between them express the theoretical

elements of the causal architecture. After explaining this architecture, we'll show how we extract from it the six input variables (that is, the two birthrates, two exposure rates, and two conversion rates) needed to drive the conversion model.

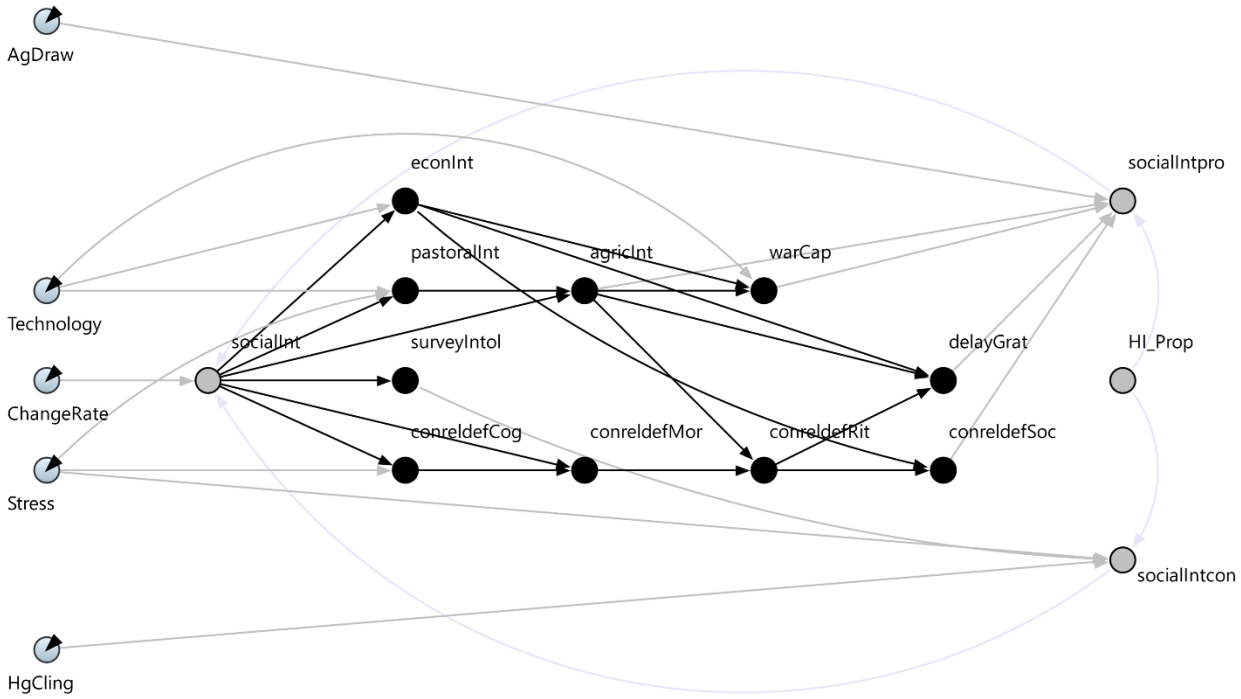

Figure 4.2. The core of the Causal Nexus for the Neolithic transition.

This causal architecture is consistent with Hodder's entanglement hypothesis. However, it also incorporates insights from several other theories derived from empirical research during the last couple of decades within the cognitive science of religion and related disciplines (for a detailed survey, see Shults 2014b).

The Social Intensity variable (socialInt) toward the left side of the diagram is a quantitative proxy for the social aspects of the degree of entanglement present in the region in question. As social relationships become more complex and people's connections to objects,

animals, plants, places, and processes become richer, the Social Intensity variable increases, which in turn influences a variety of theoretically motivated intervening variables.

Note that the Social Intensity variable (socialInt) and the proportion of HI people (HI_Prop) are different conceptual constructs. On the one hand, the contrast between HI and LI lifestyles reflects the degree of entanglement between people and the animals, plants, places, objects, and invisible forces of their environment, and high HI_Prop means that more people have chosen the HI lifestyle. High social intensity, on the other hand, is a narrower concept—it represents a key component of the HI lifestyle but is not equivalent to it. While we expect these two variables to rise and fall in the same direction, it is conceivable that they could change at quite different rates. For instance, HI_Prop might begin to increase early and change slowly, while socialInt might increase quickly but only after the model has been running for a while; or the opposite might occur. We designed the causal architecture of NSIM to reflect the possibility that the aspect of the HI lifestyle we call social intensity, which is particularly relevant to understanding religion, might develop partially independently of the embrace of HI lifestyles. Yet we also expect that HI_Prop could only reach the highest levels if socialInt were also high.

Jumping to the right side of the diagram, we can see that some of these intermediate variables tend to increase Social Intensity (the degree of increase represented by the socialIntPro variable) while others tend to decrease Social Intensity (the degree of decrease represented by the socialIntCon variable). These two variables on the far right increment and decrement (respectively) the Social Intensity variable, with their effects weighted by the proportion of HI people and the proportion of LI people (respectively). The ChangeRate parameter determines how quickly both incremental variables change the Social Intensity

variable, thereby speeding up or slowing down the transition described within the model. The loop established in this way means that Social Intensity both impacts and is impacted by all intermediate variables.

Within this fundamental feedback loop, the theoretical action takes place in the interactions between the intervening variables and between those variables and the four parameters that influence them (AgDraw, Technology, Stress, and HgCling). We'll explain these variables one by one in what follows, spelling out the theoretical underpinnings of the causal architecture along the way. Table 4 lists these parameters and variables with their abbreviations and definitions.

Table 4.1. Causal Nexus parameters and variables constituting the causal architecture of the model.

Abbreviation	Name	Definition
Parameters		
AgDraw	Agricultural Draw	Varies between 0.01 and 1.00
Technology	Technology	Varies between 0.00 and 1.00
ChangeRate	Change Rate	Varies between 0.01 and 1.00
Stress	Stress	Varies between 0.00 and 1.00
HgCling	Hunter-Gatherer Cling	Varies between 0.01 and 1.00
Variables that Co-Vary with Social Intensity		
econInt	Economic Intensity	*(socialInt+Technology)/2*
pastoralInt	Pastoral Intensity	*Technology*socialInt*(4*Stress*(1–Stress))*
agricInt	Agricultural Intensity	*(pastoralInt+socialInt)/2*
warCap	Warmaking Capacity	*(Technology+agricInt+econInt)/3*
surveyIntol	Surveyance Intolerance	*socialInt*
delayGrat	Delay of Gratification	*(econInt+agricInt+conreldefRit)/3*
Variables related to Contesting Evolutionarily Stabilized Religion-Relevant Defaults		

conreldefCog	Contest Religious Defaults: Cognitive	*socialInt*4*Stress*(1–Stress)*
conreldefMor	Contest Religious Defaults: Moral	*(socialInt+conreldefCog)/2*
conreldefRit	Contest Religious Defaults: Ritual	*(agricInt+conreldefMor)/2*
conreldefSoc	Contest Religious Defaults: Social	*(conreldefRit+econInt)/2*
Variables Structuring the Major Feedback Loop		
socialIntpro	Social Intensity Pro	*((econInt+agricInt+warCap+delayGrat+conreldefSoc)/5)*AgDraw*HI_Prop*
socialIntcon	Social Intensity Con	*((surveyIntol+(1–4*Stress*(1–Stress)))/2)*HgCling*(1–HI_Prop)*
socialInt	Social Intensity	*min(max(socialInt+ChangeRate*(socialIntpro–socialIntcon),0.01),0.99)*

First, we will describe the five parameters that function as inputs to the Causal Nexus (note that the names of these parameters begin with upper-case letters to distinguish their from variable names). Parameters are fixed for any given run of the model and define a parameter space that spans all of the possible dynamics of NSIM.

Agricultural Draw (AgDraw parameter) is the tendency to want to embrace the HI lifestyle associated with settled agriculture, domesticated animals, and town life. AgDraw impacts socialIntpro: an increased tendency in the population to embrace the HI lifestyle will ratchet up HI growth.

Technology (Technology parameter) is the level (complexity, quantity, quality, entanglement) of technological advancement within the regional population. Technology includes farming know-how, tool design and manufacture, knowledge of medicinal plants, house-building techniques, and so on. Technology impacts:

- warCap: Increased technological advancement raises the capacity of a population to wage war.

- econInt: Increased technological advancement improves a population's capacity for managing more complex economic exchange and increases the diversity and value of traded products.
- pastoralInt: Increased technological advancement improves a population's capacity to maintain and breed its domesticated animals.

Change Rate (ChangeRate parameter) sets the rate at which socialIntpro increments and socialIntcon decrements the socialInt variable.

Stress (Stress parameter) is the level of anxiety-producing or survival-threatening conditions in the natural environment of the population. Stress impacts other variables in the Causal Nexus in an inverted parabolic way, as the formula 4*Stress*(1–Stress) indicates. This means that the greatest impact occurs when Stress is middling, and that both low and high Stress have less impact. Stress affects:

- pastoralInt: Moderate stress puts pressure on individuals to grow crops and domesticate animals, if they know how. If conditions are less stressful, the LI hunting-and-gathering lifestyle is easier, decreasing pastoralInt. If conditions are more stressful, crops won't grow and domesticated animals die, decreasing pastoralInt.
- conreldefCog: Moderate stress puts pressure on individuals to contest their religious-cognitive defaults (e.g., they resist their tribal tendencies and begin to explore new ways to cooperate and share resources with people beyond their immediate kith/kin group). High levels of stress reinstate religious cognitive defaults (terror-management theory), while low levels of stress do not induce people to challenge those defaults.

- socialIntcon: High stress puts too much pressure on individuals, overriding their capacity to contest defaults or delay gratification, tempting them to adopt LI lifestyles. Low stress yields no incentive to cooperate or increase social intensity. Moderate stress produces the least resistance to social intensity. Note that, in this case only, the formula regarding stress takes the form *(1–4*Stress*(1–Stress))* rather than *4*Stress*(1–Stress)*, inverting the parabola.

Hunter-Gatherer Cling (HGcling parameter) is the tendency to want to conserve the LI lifestyle associated with hunter-gatherers. HGcling impacts socialIntcon because an increased tendency in the population to want to conserve the LI lifestyle will ratchet down HI growth and thus Social Intensity.

Second, let's consider the intermediate variables that the Social Intensity variable directly or indirectly impacts.

Economic Intensity (econInt variable) is the level (complexity, quantity) of economic exchange within and across groups. Economic intensity increases with both social intensity and technology. The econInt variable impacts:

- socialIntpro: Increased economic exchange ratchets up the need to keep investing in a HI sedentary-domestication lifestyle.
- warCap: Increased economic exchange improves social networking and cooperation skills and imports technology and know-how, which raise the capacity to wage war.
- delayGrat: Increased economic exchange contributes to social entrainment of individuals such that they learn to delay gratification.

- conreldefSoc: Increased economic exchange contributes to social entrainment of individuals such that they learn to be less vigilant of non-kith/kin, reciprocators, and cultural others.

Pastoral Intensity (pastoralInt variable) is the level (complexity, extent) of entanglement between a group of humans and the animals they (at least partially) domesticate. Pastoral intensity increases with both the social intensity required to cooperate and the technology required for domesticating animals, and both elements are important simultaneously (this is why the formula uses multiplication rather than averaging). The pastoralInt variable impacts agricInt in the same way because increased pastoral (animal) entanglement requires increased agricultural (plant) entanglement to feed the animals.

Agricultural Intensity (agricInt variable) is the level (complexity, extent) of entanglement between a group of humans and the plants they (at least partially) domesticate. Agricultural intensity rises as pastoral and social intensity rise; both factors are equally important. Of course, agricultural intensity also drives pastoral intensity, a subordinate causal link expressed through the mediation of the socialIntpro variable. The agricInt variable impacts:

- socialIntpro: As more of the population becomes agriculturally entangled, the general willingness to invest in HI lifestyles increases.
- warCap: The capacity to wage war is improved when agricultural entanglement increases because of the way in which the latter improves general social cooperation skills and makes it easier to provide regular food for training and utilizing troops.
- delayGrat: As more of the population becomes agriculturally entangled, it becomes easier to trust the farming process and delay one's need to gratify desires quickly.

- conreldefRit: As more of the population becomes agriculturally entangled, participation in imagistic, high-impact rituals declines in favor of low-impact oft-repeated rituals that bind people more closely together in socially stable and religiously reinforced configurations.

Warmaking Capacity (warCap variable) is the overall capacity of groups to wage war on other groups. The capacity and willingness to wage war increases with technological sophistication, economic intensity, and agricultural intensity. WarCap impacts socialIntpro: increased capacity to wage war ratchets up the general tendency toward investing in HI lifestyles.

Surveyance Intolerance (surveyIntol variable) is the level of annoyance at being watched by others. The more intense sociality becomes, the more everyone knows your business, and the more tension there is around surveyance. The surveyIntol variable impacts socialIntcon: annoyance at being watched can have a ratcheting-down effect, leading to a higher percentage of the population resisting the HI lifestyle. (Note that this variable mirrors Social Intensity (socialInt), and this adds nothing new; it is included only to help explain this dimension of increased intensity of social life.)

Delay of Gratification (delayGrat variable) is the willingness to delay immediate gratification of desires. Experimental studies suggest that religion can increase the ability (Rounding et al., 2012), or at least the motivation (Harrison and McKay 2013), to delay gratification, which lends warrant to the idea that it may have played some adaptive role by enhancing self-control and in-group cooperation. The ability to delay gratification is increased, to about the same degree, by economic intensity, agricultural intensity, and the willingness to

contest both religious ritual defaults. The delayGrat variable impacts socialIntpro: the willingness to invest in HI sedentary-domestication lifestyles is ratcheted up by an increase in the population's willingness and ability to delay gratification.

Third, we come to the variables pertaining to contesting evolutionarily stabilized cognitive defaults that are more directly relevant to religion.

Contest Religious Defaults: Cognitive (conreldefCog variable) is the extent to which the evolved religious cognitive defaults (terror-management-motivated engagement with narratively immediate, small-scale idiosyncratic spirits) are contested. The willingness to contest religious-cognitive defaults increases so long as two other factors both increase (thus multiplication rather than averaging appears in the underlying mathematics): when social intensity increases, and when moderate stress forces people to become more aware of cognitive defaults. Extremely low or extremely high stress has the opposite effect. The conreldefCog variable impacts conreldefMor: preference for and willingness to think outside the scope of a small group calls for contesting default moral intuitions that support small-group lifestyles.

Contest Religious Defaults: Moral (conreldefMor variable) is the extent to which evolved religious moral defaults (e.g., high concern for purity, parochial care for in-group) are contested. The willingness to contest religious moral defaults increases as social intensity increases and when some capacity to contest cognitive defaults is in place. conreldefMor impacts conreldefRit: preference for and willingness to engage in less imagistic, divine agent rituals increases as freedom from small-group moral defaults increases.

Contest Religious Defaults: Ritual (conreldefRit variable) is the extent to which the evolved religious ritual defaults (high-intensity, infrequent, "imagistic" rituals engaging active spirit-agents) are contested and transformed in favor of low-intensity, more frequent, social-bonding, "doctrinal" rituals that imaginatively engage supernatural agents relevant to larger groups (McCauley & Lawson, 2002; Whitehouse, 2004). The willingness to contest religious-ritual defaults in this way increases with agricultural intensity and rising willingness to contest moral defaults. The ritualInt variable impacts:

- delayGrat: Increased openness and willingness to engage in non-imagistic rituals improves one's ability and willingness to delay gratification because the engaged spirits are concerned with the larger group's welfare.
- conreldefSoc: Increased openness and willingness to engage in non-imagistic rituals makes one accustomed to being around and trusting non-kith/kin, reciprocators, and cultural others.

Contest Religious Defaults: Social (conreldefSoc variable) is the extent to which the evolved religious social defaults (vigilance toward non-kith/kin, reciprocators, and cultural others) are contested and transformed in favor of openness to outsiders, to trading goods, and to learning about strangers. The willingness to contest religious social defaults is driven up by increasing willingness to contest religious ritual defaults and by economic intensity that forces mixing with strangers. The conreldefSoc variable impacts socialIntpro: willingness to invest in sedentary-domestication lifestyles is ratcheted up by an increase in the population's trust in non-kith/kin, reciprocators, and cultural others.

Fourth, what about the variables defining the fundamental feedback mechanism of the Causal Nexus?

Social Intensity Pro (socialIntpro variable) is an incrementing mechanism by which SocialInt is increased. Five factors contribute to the increase of social intensity: economic intensity, agricultural intensity, war-making capacity, the willingness to delay gratification, and the willingness to contest religious social defaults. This effect is amplified by both the proportion of HI people and the AgDraw parameter.

Social Intensity Con (socialIntcon variable) is a decrementing mechanism by which SocialInt is decreased. Two factors contribute to the decrease of social intensity: allergy to surveyance, and either low or high stress (but not moderate stress). This effect is amplified both by the tendency to cling to LI hunter-gatherer lifestyles and by the proportion of LI people (that is, 1–HI_prop).

Social Intensity (socialInt variable) has been discussed already as an important component of entanglement in HI lifestyles. The socialInt variable increments (via socialIntpro) or decrements (via socialIntcon) its own old value. All of the model's reinforcing loops involve the link from socialIntpro to socialInt (+) and all balancing loops involve the link from socialIntcon to socialInt (–). The socialInt variable impacts six intermediate variables, as follows:

- econInt: Economic exchange within and across groups will become more complex as willingness to invest in a HI sedentary-domestication lifestyle grows.
- pastoralInt: Pastoral entanglement will become stronger as people become more willing to invest in HI sedentary-domestication lifestyles.

- agricInt: Agricultural entanglement will become stronger as people become more willing to invest in HI sedentary-domestication lifestyles.
- surveyIntol: The more people live close to each other in the same place, doing the same things repeatedly, the higher the susceptibility to being annoyed by having people watching them.
- conreldefCog: Participation in a HI sedentary-domestication lifestyle forces the contestation of defaults toward focusing on narratively immediate, terror-managing engagement with small-scale idiosyncratic spirits.
- conreldefMor: Participation in a HI sedentary-domestication lifestyle forces the contestation of defaults toward overriding purity concerns related to in-group care.

The Causal Nexus has a lot of moving parts! Importantly, the explanation of its parameters, variables, and mathematical relationships in the foregoing makes clear that all three kinds of theoretical factors – ideological-political, material-social, and cognitive-coalitional – are richly represented. Thus, in an important sense, the design of the Causal Nexus expresses the hypothesis that all three types of theoretical factors are *individually* necessary but not sufficient conditions for explaining the Neolithic transition, yet *collectively* a sufficient explanation for the emergence of high-intensity lifestyles in farming communities with domesticated plants and animals.

Generating Outputs from the Causal Nexus

The final challenge on the way to a complete causal architecture is to make the Causal Nexus we have described generate the six key output variables that function as inputs to the conversion model. To reiterate, those output variables are two birth rates (LI_BirthRate and

HI_BirthRate), two exposure rates (LI_ExposureRateToHI and HI_ExposureRateToLI), and two conversion rates (LI_ConversionRateToHI and HI_ConversionRateToLI).

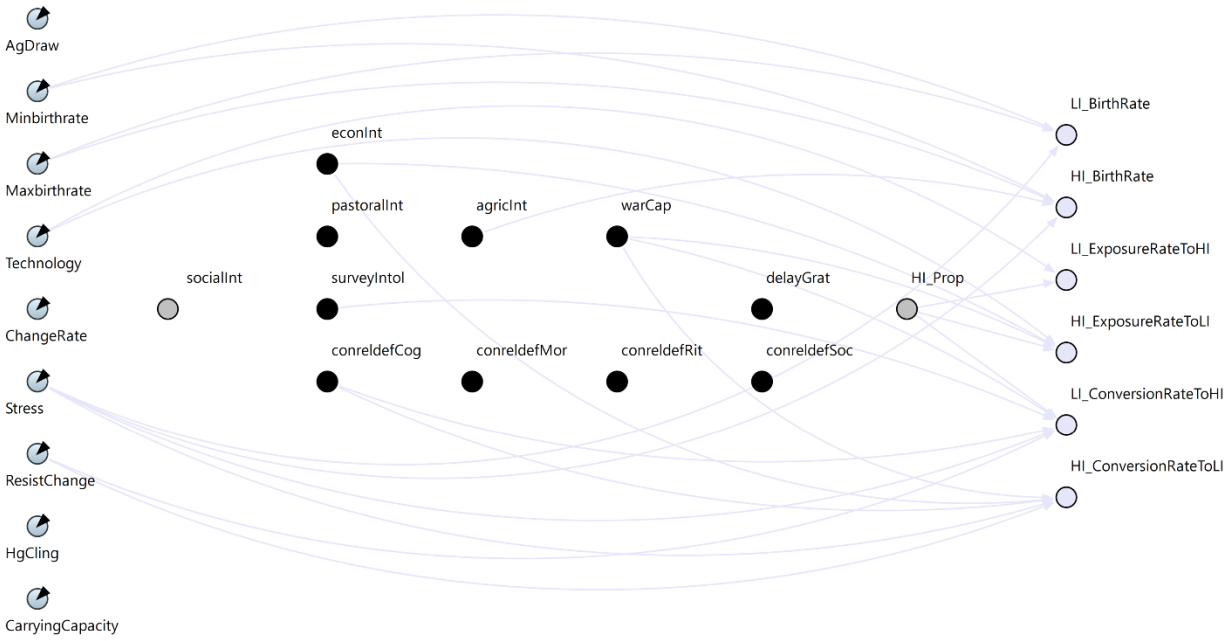

Figure 4.3. Six Outputs from the Causal Nexus.

Figure 4.3 depicts the links between the various components of the Causal Nexus and these six output variables. Note that we have suppressed the display of links already discussed to clarify the diagram. Also, we now display three more parameters; these are important for generating some of the output variables but do not impact variables within the Causal Nexus itself. All three are biologically and environmentally determined aspects of human beings: the minimum birth rate, the maximum birth rate, and the average psychological tendency to resist change.

Table 4 lists those parameters, along with the definitions of the six output variables.

Table 4.2. Additional Parameters impacting output variables but not Causal Nexus variables.

Abbreviation	Name	Definition

Parameters		
Minbirthrate	Minimum Birth Rate	Varies between 0.50 and 2.00 (children per person)
Maxbirthrate	Maximum Birth Rate	Varies between 1.00 and 5.00 (children per person)
ResistChange	Resistance to Change	Varies between 0.00 and 1.00
Six Output Variables from the Causal Nexus that Function as Inputs to the Conversion Model		
LI_BirthRate	LI Birth Rate	*Minbirthrate+(Maxbirthrate–Minbirthrate)*(1–Stress)*
HI_BirthRate	HI Birth Rate	*Minbirthrate+(Maxbirthrate–Minbirthrate)*min((agricInt+(1–stress)),1)*
LI_ExposureRateToHI	LI Exposure Rate to HI	*((econInt+warCap)/2)*Technology*HI_prop*
HI_ExposureRateToLI	HI Exposure Rate to LI	*(1–Technology)*(1–HI_prop)*
LI_ConversionRateToHI	LI Conversion Rate to HI	*((econInt+warCap+conreldefCog+(4*Stress*(1–Stress)))/4)*ResistChange*
HI_ConversionRateToLI	HI Conversion Rate to LI	*((surveyIntol+HI_prop+max(0,2*warCap–1)+(1–conreldefCog)+(1–(4*Stress*(1–Stress))))/5)*ResistChange*

We now explain the mathematical formulas for the six *output* variables.

LI_BirthRate: In LI societies, increasing stress drives birth rates down from the maximum toward the minimum. Note that there is a linear rather than a parabolic effect of the Stress parameter here.

HI_BirthRate: In HI societies, either increasing agricultural intensity or decreasing stress (thus: *min((agricInt+(1–stress)),1)*) will drive birth rates upwards from the minimum to the maximum.

LI_ExposureRateToHI: In LI societies, exposure to HI alternatives occurs through either trade or war, amplified by the prevalence of HI people and the overall level of technology.

HI_ExposureRateToLI: In HI societies, exposure to LI alternatives depends on both low technology and the prevalence of LI people (*1–HI_prop*).

LI_ConversionRateToHI: In LI societies, conversion to HI alternatives becomes more frequent when economic intensity, warmaking capacity, and the willingness to contest religious-cognitive defaults rise. Middling stress increases this conversion rate while low stress or high stress inhibit it. All factors are roughly equal in importance, and their average effect is moderated by resistance to change.

HI_ConversionRateToLI: In HI societies, conversion to LI alternatives occurs under four roughly equally weighted conditions. Surveyance intolerance drives up this conversion rate. So does warmaking capacity, but only when it becomes extreme so that it interferes with the benefits of township life (thus the formula *max(0,2*warCap–1)*). The willingness to contest religious-cognitive defaults has the opposite effect, driving this conversion rate down. And either low stress or high stress makes this type of conversion more likely, while middling stress makes it less likely. All factors are roughly equal in importance, and their average effect is moderated by resistance to change.

All computational simulations need to specify how model time versus real-world-time works. We needed to explore the NSIM dynamics before we could be sure about what real-world time to associate with one cycle of the model. After running a few experiments, we concluded that we could interpret *one cycle of the model as one year of real-world time*.