Appendix A: Additional SEM Capabilities

There are a number of capabilities of SEM that were not used in this thesis. For the most part, they were not necessary; they represent relationships that were not thought to be present in the sample data. Although not used here, it is possible that some of these relationships could be used in another structural model of disclosure.

This appendix discusses some additional capabilities of SEM. The three discussed, in order, are formative latent variables, two-way relationships (both causal and correlation), and the use of higher order latent variables.

A.1: Formative Latent Variable

The concept of formative latent variables was briefly mentioned in section 5.4. This describes the difference in more detail.

In SEM, the indicators attached to latent variables are in most cases considered reflective. The trait which the latent variable represents cannot be observed directly, but there are observable indicators of its underlying value; the indicator variables are reflections of the latent variable. The latent variable causes the values of its indicators and model diagrams accordingly show the latent as a cause of its indicators, as pictured below:

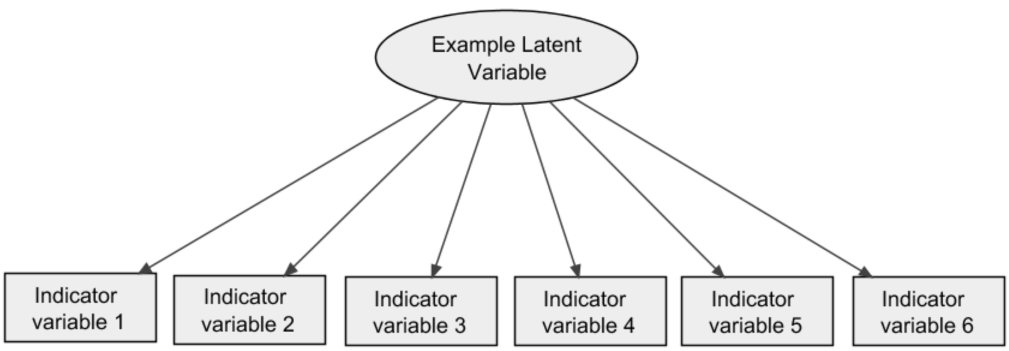

Figure A.1: Example reflective latent variable

A second, less commonly used type of latent variable exists, known as formative latent variables. These reverse the causality of the reflective latent variables above, arguing that the unobservable latent variable is formed from the effects of its indicators. While a given latent variable cannot be both reflective and formative, the two may be used together in a single model for different variables. An example of a formative latent variable is pictured below:

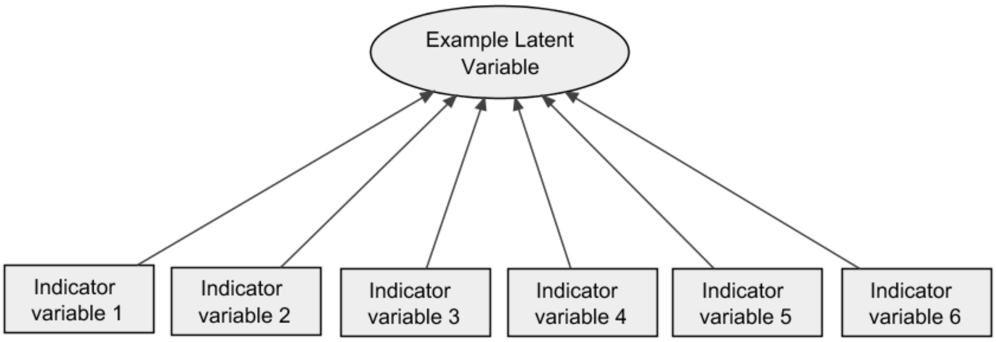

Figure A.2: Example formative latent variable

Although visually similar, formative latent variables have very different properties compared to reflective latent variables. By nature, a reflective latent variable's indicators have certain elements in common. They are all caused by the same underlying events and are expected to act similarly when the unobserved value of the underlying factor changes, i.e. the indicators are expected to be correlated with each other due to the latent variable being a common cause. This is not necessarily the case for a formative variable, however. These are formed from the combined effects of several causes (the indicators) which may be quite disparate, so correlation is not necessary among formative indicators. Researchers using a reflective variable should remove any indicators not consistent with the others, while in a formative system the removal of an inconsistent indicator may be harmful to the model. For this reason, it is important to correctly identify whether a variable is reflective or formative (Mackenzie et al 2005, Petter et al 2007).

It is vital to include all of the indicators of a formative latent variable. A missing indicator in these cases means that part of the value of the latent is not included in the model as a result of their causal nature. If one or more were missing, the set of indicators would not fully explain the possible variation in the latent variable. By contrast, a missing indicator for a reflective latent variable is less problematic as the missing variable should be strongly correlated with the existing ones and is not a cause of the latent value. The absence of a single reflective indicator may distort the latent variable to a small extent, while the absence of a single formative indicator may mean missing an important cause of the latent value. As Jarvis et al (2003) describe the difference, the removal of a formative indicator may change the meaning of the latent variable, while the removal of a reflective indicator should not change the meaning.

No formative latent variables have been used in the thesis. The primary reason for this is that the latent variables used here were better represented as reflective variables. In all cases, the intention behind using a latent variable was to allow multiple measurements of a given concept. For example, as stated in chapter 5, company size is measured in multiple ways to prevent one possible measure from unfairly reflecting the true scale of a company because it is unusually large or small by this one measure, e.g. a company reliant on employee talents appearing small by asset values as the workers cannot be valued. This is an example of a reflective latent variable; the underlying size of the company is not strictly observable, but there are various measures available that reflect the scale of operations.

In addition, formative latent variables are a more recent idea than reflective latent variables and are accordingly less developed. The software used for SEM calculations in this thesis lacks the ability to work with formative latent variables, requiring all to be reflective.

While there are no formative latent variables in this study, it can be used to demonstrate an example. Disclosure is here argued to be caused by six different variables, some quite different to others and not all of them correlated with each other. A different study that used disclosure as a cause of another variable could represent it as a formative latent variable comprising the six causes given here and may include others from elsewhere in the literature.

For clarity, this idea is pictured below. In practice, some of the variables pictured below would be replaced with one of the indicators used (however, see section A1.2 for the alternative approach of making disclosure into a second-order latent variable), and volatility would likely be removed due to having little effect on disclosure.

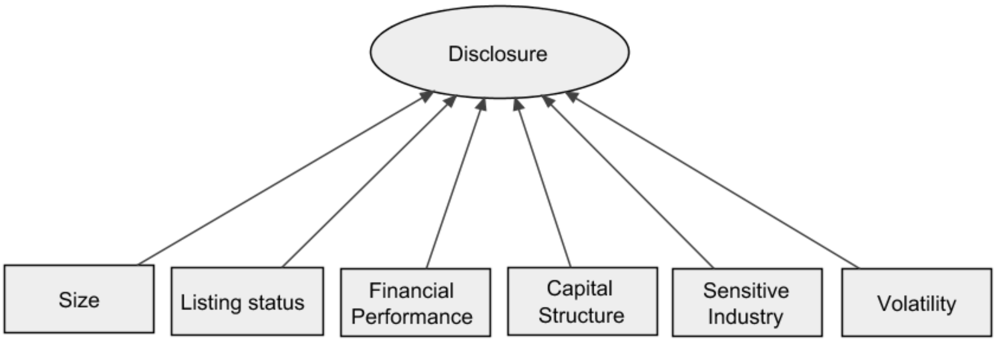

Figure A.3: Practical example of a formative latent variable

A.2: Two-Way Relationships

This section and A.3 below each cover an additional relationship that may exist between two variables in a structural model. For comparison, examples in this section and A.3 are based on the following simple structural model, which was also used as Figure 5.3:

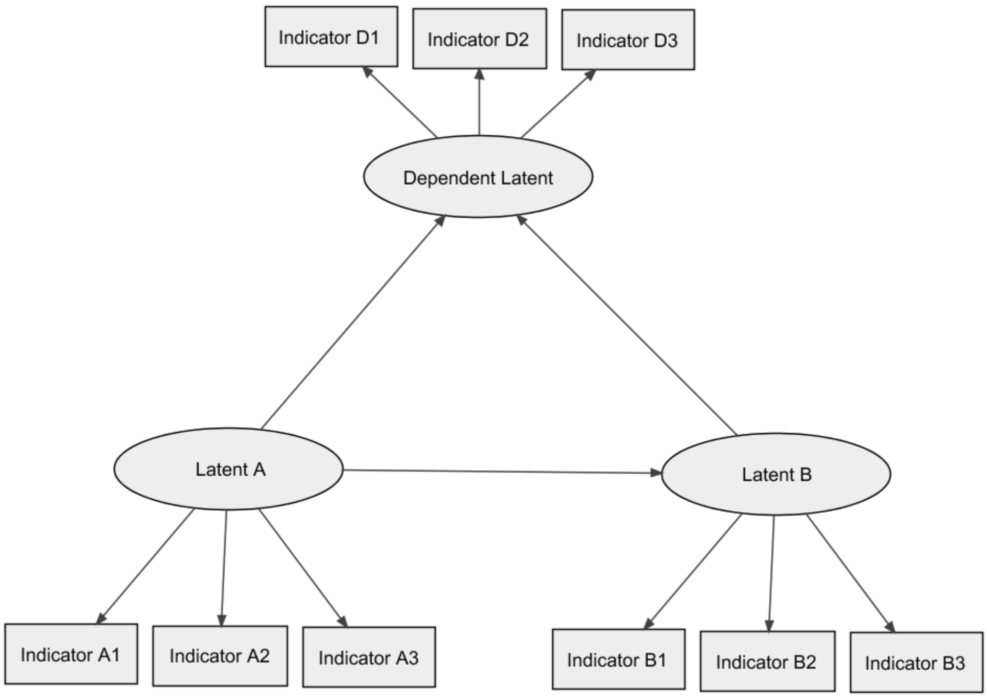

Figure A.4: Example SEM for comparison

Latent variables A and B both have a causal effect on the dependent, itself another latent variable. Latent variable A additionally has a causal effect on latent variable B. The use of a latent dependent variable is a difference compared to the models used in the main body of the thesis, but a common approach in practice.

It is possible for a causal relationship in SEM to apply in both directions as pictured below in Figure A.5, representing a case where variable A causes variable B, while B also has a causal effect on A. James and Singh (1978) present an example of this using the causes of violence at protests, stating that police and protestors each become more violent in response to the other becoming more violent (note that the paper is not on SEM, however). This type of situation is rare and computationally challenging, but can be used within SEM.

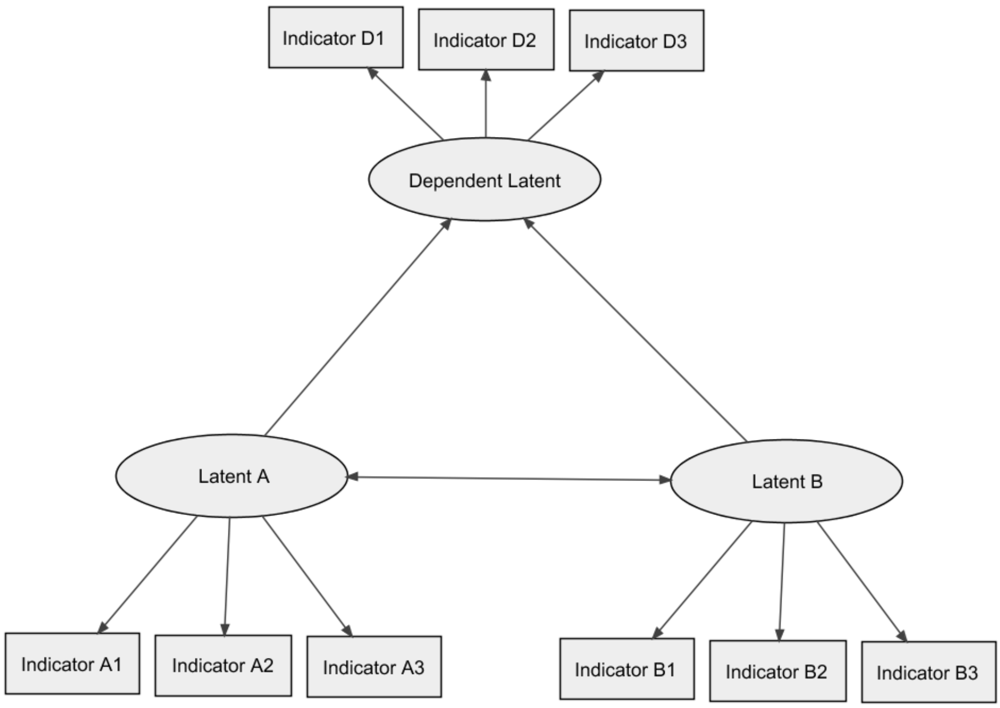

Figure A.5: Two-way causal link

This model is similar to the base model in figure A.6, differing only in that the link between Latent A and Latent B is a double-headed arrow (the relationship could also be represented with two arrows between A and B, pointing in different directions). Effectively, the only change made to Figure A.4 is allowing Latent B to cause Latent A.

Alternatively, rather than specifying that two variables mutually cause each other, they may be linked as a correlation only. When diagramming models, the convention is to include a curved double-headed arrow to represent a correlation while straight arrows with single heads are used for expected causal relations. Figure A.6 below presents a variation in A.4 in which the latent variables have a correlation but are not considered to have a causal link.

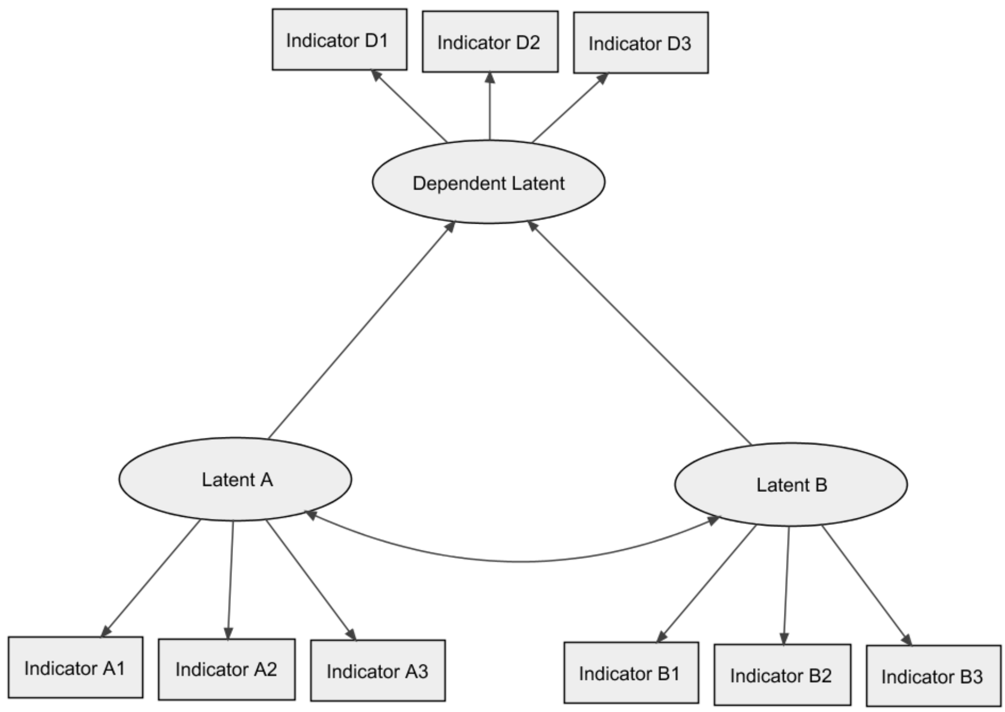

Figure A.6: Correlated Latent Variables

While two latent variables may be correlated, this capability of SEM has not been used at any point in this thesis. In part, the theory testing or wider literature already suggested a causal link between two variables, making a correlation unnecessary as a causal link was in place between two variables expected to be connected. In addition, the nature of reflective latent variables means a correlation link is often a sign of model specification problems. If two latent variables are correlated then they are likely to share a common cause. If this common cause can be identified then it will often be beneficial to include it in the model, making a correlation unnecessary between the two variables linked to this. Further, whether the cause is identifiable or not, a correlation suggests that the two variables involved may be different aspects of the same underlying matter; it may be better to combine the indicators of both into a new latent variable.

The use of correlations is not limited to two latent variables. It is possible for two indicators to be correlated or for an indicator and a latent to be correlated. In practical terms, however, there are problems with any of these alternatives.

Correlated indicators may either be linked to the same latent or different latent variables. In a reflective latent variable, the indicators for a single latent variable should all be correlated by definition, making it unnecessary to include any correlation arrows. In the case of indicators of different variables, the correlation should be close to 0. If two indicators of different latent variables are correlated then there may be a model specification problem as any one indicator should apply to a single latent variable only, yet such a correlation would suggest the indicators involved may each influence two latent variables. This can either mean that one of the indicators is attached to the wrong latent variable or that the two latent variables share a common indicator and may not be different variables.

A correlation between a latent variable and one of its indicators is never necessary as this should be covered by the inherent causal link between the two. A correlation between a latent variable and an indicator from a different latent variable again implies a model specification problem as the indicator may be attached to the wrong latent variable, or else the two latent variables are different aspects of the same underlying concept.

A.3: Higher-order Latent Variables

It is possible that an indicator variable may be latent. This would mean that an indicator is not directly observable, but instead has its own set of observable signs that hint at its true value. An example is pictured in Figure A.7 below.

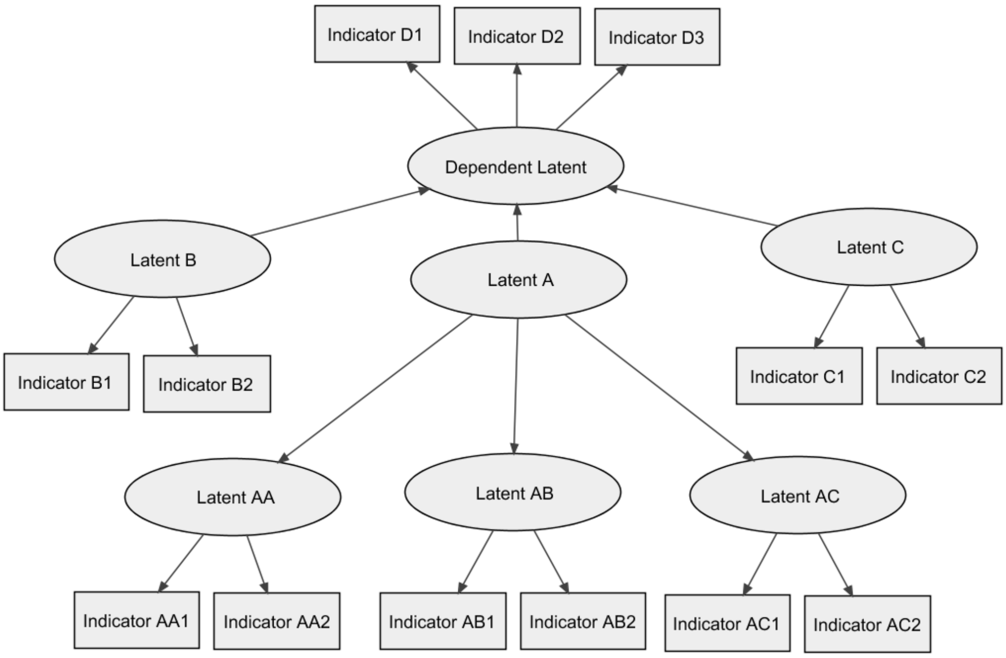

Figure A.7: Second-order latent variable

The dependent is caused by some combination of latent variables A, B, and C, where B and C are latent variables with observable indicators. Latent variable A is different, having further latent variables acting as its indicators. B and C (and all latent variables used elsewhere in the thesis) are referred to as first-order latent variables while A is a second-order latent variable. The pattern of latent indicators can continue nesting; if latent variables AA, AB, or AC were second order latent variables then A would be a third-order latent, and so on.

Note that variables B and C do not need to be first-order latent variables in Figure A.7. Either or both could have been of higher order in the example; a higher-order latent may have any number of latent indicators.

Additionally, a formative latent variable may be second-order or higher. Jarvis et al (2003) describe a possible case where a higher-order latent variable is formative on some levels and reflective on others. For example, in Figure A.7, latent A may be a reflection of AA, AB, and AC, but any of those may be formative.

A.4: Conclusion

SEM is a wide-ranging approach that can incorporate a range of types of variables and connections between variables not used in the main body of the thesis. While the above were not considered appropriate for the research performed here, some or all of them may have applications in additional projects in the area of disclosure.

In particular, some of the correlations identified in section 5.3 suggest that two-way relationships may be appropriate. For example, size and listing status show a correlation. As discussed as early as Chapter 1, the direction of any causal effect is not entirely clear. A company listed in two countries has a wider pool of potential investors who can easily purchase shares in the company, in turn providing a larger pool of potential funds with which the company may grow; by this argument, listing causes size. However, a company large enough to have operations outside of its home nation may list in a second country in which it already has a presence, taking advantage of having built a reputation with that country's investors to gain more from the listing; by this argument, size causes listing. The two are not mutually exclusive; a company may grow large enough to support foreign operations, list in a second location, and grow further from new investment. An argument for a two-way causal relationship, or a correlation arrow, can be made.

No argument for a formative latent variable in the area of disclosure was identified before performing the analysis here, nor the use of a second-order latent variable. This does not necessarily indicate that no such arguments could be made in future research, however. As chapter 8 mentions, the model fits suggest some causes of disclosure are missing. Once these are identified, the SEM treatment of these new variables may involve the alternative techniques described here.