MEASURMENT AND SCALING CENCEPTS

What is a scale?

We will start this section with the definition of scale. But before we go specifically to the definition of scale that is used to measure concepts in research, let's make sense of the meaning of a scale in general first. A scale is basically a tool that we use to measure things. There are various kinds of scales that we use in daily life. For example, the scale used to measure weight, height, temperature, humidity, speed, etc. A scale in research is not different from a scale that we use in daily life. In research, a scale is a tool that researchers use to measure the concepts of interest. For example, if we study about the effect of salary on job performance of employees, it is necessary to know how to measure salary and job performance; otherwise, it is impossible to analyze the relationship between these two concepts in empirical testing.

Some concepts in research can be easily measured. For example, if we want to measure salary, we can use the amount of paycheck that employees received each month as the indicator. Nonetheless, some concepts can be difficult to measure. Job performance is a good example. Generally, measurement of job performance tends to vary depending on occupations or characteristics of job. For salespersons, we may measure their job performance simply based on the unit of products they sold or the sales volume they made each month. However, for some job like a secretary, job performance may not be easily measured. Job performance of a secretary can encompass many dimensions such as how effective he/she organize his/her boss' schedules, make memos, arrange meetings, prepare documents, etc. In this case, the measure of job performance may come from performance evaluation that a secretary receives from the boss. Yet, some concepts, particularly abstract-level concepts, are even more difficult to measure. Some example of abstract-level concepts is "attitude'" of people. More detail about attitude measurement will be discussed in the next chapter.

Using a 'proxy' to measure concept

Not every concept can be measured. When it is impossible to measure the concept, scholars normally use a "*proxy variable*" as a solution to measure it. For example, GDP per capita is normally used in economic research as a proxy variable for the wealth and quality of life of people in the country (Charoensukmongkol et al., 2012). The sum of exports and imports of a particular country is normally used as a proxy variable for trade openness of the country (Yanikkaya, 2003). The number of patent, the volume of high-tech export, and the intensity of research and

development expenditures are normally used as proxy variables for innovative capability of the country (Charoensukmongkol, 2014; Charoensukmongkol & Elkassabgi, 2011; Motohashi, 2008).

Anyway, finding the proxy variable for some concept may not be easy for some concepts. Let consider this: how can you measure the degree of 'Americanization' of a particular country? Americanization can be understood as the tendency that people in a county have a strong willingness to embrace American culture and want to have a lifestyle like the American. Let's take a few minutes to think how can you evaluate whether a particular country is more or less Americanized? Of course, this is the concept that is extremely difficult to measure. However, a study by Craig et al. (2009) came up with a proxy to measure this concept. The proxy they proposed to represent the degree of Americanization include three indicators, which are (1) imports from the U.S. per capita; (2) the number of McDonald's per capita; and (3) revenue from U.S. entertainment products per capita. The logical explanation why selecting these three indicators as the proxies for Americanization is that they represent the willingness of people in a country to adopt the American culture through consumptions; the more people in the country demand products from the U.S., the more they are willing to embrace the American culture.

However, while using a proxy allows researchers to measure the concept that is difficult or unable to be measured, the major weakness of using a proxy for concept measurement is that it may not truly represent the concept that we aim to measure. For this reason, using a proxy variable can be prone to measurement error, and that it should be use with caution.

TYPES OF SCALE

The typology of measurement scale was first introduced by the psychologist name Stanley Smith Stevens (1946). He claimed that all measurement in science can be classified into four types including (1) nominal scale, (2) ordinal scale, (3) interval scale, and (4) ratio scale. Each type of scale will be discussed in detail as the following:

Nominal scale

A *nominal scale* is used mainly for classification purpose. Generally, we use a nominal scale to assign the value to a person or an object to tell whether a person or an object belongs to which category. However, the main limitation of the nominal scale is that we cannot use it to tell whether one group is better higher than another. It can simply be used to tell that the entities belong to different group.

The good example of a nominal scale is gender. You know that gender can be divided into two groups, which are male and female. However, you cannot tell whether male is superior to female or whether female is superior to male (although in some culture males tend to have more power than female, or *vice versa*). If you want to classify people based on gender, you can assign any value to a person to tell that he/she is male/female. For example, you may assign M to tell that a person is male, or you can assign F to tell that a person is female. Alternatively, you can assign the value to a nominal scale in number. For example, you may assign 1 to male and 2 to female. By the way, when you assign a numerical value to the nominal scale, you still cannot judge whether which group is superior to another group. In this case, even though you know that 2 is higher than 1, you still cannot say that female is superior to male. The numbers you assign to a nominal scale is only used for classification.

Another example of the entity that is measured by a nominal scale is race. You know that people can be classified by race (e.g., white, black, Asian, Latino, etc.) Generally, you assign a value to each person to tell that he/she belong to which ethnic group. For example, you may assign W to white people, B to black people, A to Asian, and L to Latino). However, you cannot judge whether which ethnic group is better than another.

Coding a nominal scale in spreadsheet for data analysis

In data analysis, researchers usually code a nominal scale in terms of a "dummy variable", which either takes a value of 0 or 1. The idea of using either 0 or 1 for a nominal scale comes from the binary langrage in computer sciences, whereby 0 represents 'off' or 'no'; and 1 represents 'on' or 'yes'. Using this logic, if the person or an object belongs to the group that we specify, we assign 1 to it; otherwise, we assign 0 instead.

Gender	Male	Female
Male	**1**	0
Male	**1**	0
Female	0	**1**
Female	0	**1**
Female	0	**1**

The table above is the example of how to code the value for gender in spreadsheet. Let's start by looking at the first column of the table. The data came from five persons, the first two persons are male and the last three persons are female. Before we code the data, we need to create the category name as a variable for each group first. Since gender can be classified into two groups, you create the variables male and female (as shown in the first row of the second and the third column). Then we assign the value (either 0 or 1) based on whether each person belong to which category. Since the first two persons are male, we assign 1 to male and 0 to female; and since the last three persons are female, we assign 1 to female and 0 to male.

The table below is the example of how to code the nominal scale when we have a classification more than two groups. There are seven people, three are single, two are married, and two are divorce. Similarly, the data are coded as the following:

Marital status	Single	Married	Divorce
Single	**1**	0	0
Single	**1**	0	0
Single	**1**	0	0
Married	0	**1**	0
Married	0	**1**	0
Divorce	0	0	**1**
Divorce	0	0	**1**

Ordinal scale

The second type of scale is called an *ordinal scale*. An ordinal scale inherits the same fundamental characteristic of the nominal scale, that is, it is used for classification purpose. However, an ordinal scale has additional property that a nominal scale does not have, that is, it can be used to tell which group or which classification of people or objects are more superior to others. In other words, we can use an ordinal scale to rank people or objects.

The good example of an ordinal scale is education. If we classify people based on the highest education obtained, there are many categories that we can obtain such as primary school, secondary school, Bachelor's degree, Master's degree, and Doctoral degree. With an ordinal scale, not only we can know that people with different levels of education are not the same in terms of knowledge, we can also tell which level of education can be ranked higher or lower than others. For example, we can tell that people who obtained a Bachelor's degree tend to be more knowledgeable than people who only finished a secondary school. We can tell that people who obtained Doctoral degree tend to be more knowledgeable than people with a Bachelor's degree.

Coding an ordinal scale in spreadsheet for data analysis

When assigning the value to an ordinal scale, we assign the number to each category based on its rank, that is, the group that is ranked the lowest get the smallest number, whereas the group that is ranked the highest get the biggest number. For example:

Education	Value
Primary school:	1
Secondary school:	2
Bachelor's degree:	3
Master's degree:	4
Doctoral degree:	5

However, an ordinal scale still has major limitation. Although we can say that one group can be ranked higher or lower than another groups, we cannot know exactly how much the difference is. In other words, we cannot calculate the actual distance between the two categories. Although we can say that people who

obtained a Bachelor's degree tend to be more knowledgeable than people who only finished a secondary school, we cannot tell exactly they are more knowledgeable by how much. Still, someone may argue that we can calculate the difference based on the values that are assigned to them. Using the example above, since a Bachelor's degree was assigned 3 and a primary school was assigned 1, the difference in the level of knowledge is three minus one equals to 2. However, please keep in mind that the numbers that you assign to an ordinal scale are just the numerical representation used for ranking purpose only. They are not the actual value of the thing that is measured. In addition, the numbers assigned is arbitrage and can be adjusted to any values to rank the categories. For instance, instead of assigning 1 to Primary school, 2 to secondary school, and make the numbers increment by one, you may assign 10 to primary school, 20 to secondary school, and make the number increments by ten. In this case, the distance of the value between each level of education will change.

Interval scale

The third type of scale is called an *interval scale*. This type of scale inherits the basic properties of a nominal scale and an ordinal scale, that is, it is used for classification and ranking proposes. In particular, one major property that an internal scale has beyond the ordinal scale is that it can be used to calculate the actual distance between the two values. The reason is because the value that is assigned to an internal scale is based in the true value, not arbitrary like in the case of an ordinal scale.

However, one major limitation of the interval scale is that it does not have a "true zero point". By the way, you may wonder what does it mean by a "true zero point"? To understand about this meaning, you have to think about the fundamental meaning of zero. If something is equal to zero, what does it mean? For example, what does it means if your money right now is equal to zero? Yes, if you money is equal to zero, you don't have any money left (and probably you have to wait a little longer for your next paycheck to come out). Therefore, zero in this sense means the absence of the value; it means emptiness; the value does not exist. The fact that an internal scale does not have a true zero point, in this sense, implies that zero does not mean the absence of the value.

The classic example of an internal scale is "temperature". Temperature can take a positive, a negative, or a zero value. The higher the value, the warmer we feel; the lower the value, the colder we feel. Thus, we can classify temperature as hot,

warn, or cold, based on the value it takes (that is the basic property of a nominal scale). We can also tell that 30 degree Celsius is warmer than 20 degree Celsius (that is the unique property of an ordinal scale). But for the property of an interval scale, we can also tell that 30 degree Celsius is warmer than 20 degree Celsius by 10 degree Celsius (when we subtract 20 from 30). This is the actual distance between the two values that can be inferred by an interval scale. However, what does it mean when the temperature is equal to zero? Does it mean that it is the point where the temperature does not exist? No, zero degree Celsius does not mean the absence of temperature. It means that temperature reaches the freezing point. This is a clear example of internal scale.

Coding an interval scale in spreadsheet for data analysis

Coding the data that is measured by an internal scale is easy and straightforward. Since a value in an interval scale represents the true value of the measure, you can simply code their actual values into the spreadsheet.

Day	Temperature (degree Celsius)
1	-2
2	0
3	1
4	-1

Ratio

The last type of scale is called a *ratio scale*. This type of scale is considered the higher form of scale. Fundamentally, a ratio scale inherits the basic nature of a nominal scale, an ordinal scale, and an internal scale. It can be used for classification and for ranking. Plus, we can calculate the actual distance between two values. Moreover, a ratio scale provides an extra property beyond an internal scale, which is, it has a true zero point. This means that zero in a ratio scale actually means the absence of a value. If the value of something is equal to zero, it means that there is nothing in that measure or the value does not exist. Basically, the ratio scale is used to measure many things in our daily life such as weight, height, price, speed, etc. For example, the price of something can take any value; the higher the price, the more expensive it is; if the price of something is equal to zero, price does not exist (in another words, it is free).

Coding an ratio scale in spreadsheet for data analysis

Like an internal scale, coding the data that is measured by a ratio scale is straightforward. Since a value in a ratio scale represents the true value of the measure, you can simply code their actual values into the spreadsheet.

Item	Price (in Thai Baht)
1	2000
2	1500
3	1000
4	2500

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