Open Journal of Social Sciences, 2024, 12, 18-33
https://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

Improving Initial Condition in Coordination Failures

Luis F. Dumlao[1], Helen U. Amante[2], Pilar U. Tolentino[2]

[1]Department of Economics, Ateneo de Manila University, Manila, Philippines
[2]Department of Leadership and Strategy, Ateneo de Manila University, Manila, Philippines
Email: ldumlao@ateneo.edu

How to cite this paper: Dumlao, L. F., Amante, H. U., & Tolentino, P. U. (2024). Improving Initial Condition in Coordination Failures. *Open Journal of Social Sciences*, *12*, 18-33.
https://doi.org/10.4236/jss.2024.124003

Received: February 23, 2024
Accepted: April 7, 2024
Published: April 10, 2024

Abstract

Given initial condition in a social system, we aim to introduce an individual's reaction function that is a logistic function resulting in a logistic curve. With the use of stylized modelling and simulation, we show the following. First, while coordination may be a solution to solve coordination failures, improving the initial condition is an alternative and or a complementary solution. Second, moderate improvement in the initial condition leads to better, albeit inferior equilibrium. And third, significant improvement in the initial condition leads to positive feedback loop that leads to the first best, and permanent equilibrium. Thus, the key difference is whether the improvement in the initial condition is moderate or significant. This helps explain phenomena that occur, for example, in macroeconomics, global warming, credit markets, and organizational behavior.

Keywords

Reaction Function, Logistic Function, Coordination Failure

1. Introduction

In coordination failures, starting from a low equilibrium, because each individual agent takes that state as given, less individual will more than proportionately increase contribution resulting in an externality that stunts the collective contribution, and that keeps the state of a system to a low equilibrium. In the seminal paper of Cooper and John (1988) in economics, the title "Coordinating Coordination Failures in Keynesian Models" outrightly proposes that the solution to the failure is to coordinate agents.

While Cooper and John (1988) introduce the logistic looking curve or reaction function, we offer a much simpler yet practically identically shaped reaction function that is an actual logistic curve resulting from a logistic function. With the use of stylized modelling and simulation, we show that a system can be in two possible initial conditions. One is in the state of coordination failure that keeps a system in a low equilibrium. Another is in a better state that keeps a system in a first best equilibrium.

Assume that the initial condition is in the state of coordination failure, using same stylized modelling and simulation to show the following: first, while coordination may be a solution to solve coordination failures, improving the initial condition is an alternative and or a complementary solution; second, moderately improving the initial condition leads to higher equilibrium, albeit only an inferior equilibrium; third, significantly improving the initial condition results in a positive feedback loop that leads to higher, first best, and permanent equilibrium; in sum, improving the initial condition helps. How much it helps depends on whether the improvement is moderate or significant. While moderate improvement moves the coordination failure equilibrium to a better coordination failure, significant improvement moves a system out of coordination failure and leads to a first best equilibrium.

The rest of the paper is organized as follows. The second section is a review of literature. The third section is the presentation of the model. The fourth shows how the model mimics and applies to other phenomena such as macroeconomics, global warming, credit markets, and organizational behavior. The fifth closes with possible extensions.

2. Review of Literature

The logistic function represented graphically by the logistic curve was first introduced by Belgian mathematician Pierre-François Verhulst (1838). Verhulst (1847) then applied it in explaining population growth. It starts as a curve that increases at an increasing rate building momentum, but at a certain point reaches a threshold or an inflection point, and because of saturation then begins to increase at a decreasing rate. The function was then reapplied on the growth of bacteria by McKendrick & Kesava (1912). In bacteriology, a bacteria's population is hypothesized to first grow exponentially. Given an environment's carrying capacity, the population becomes big enough limiting the available resources and then inverting the exponential growth of the population.

In demography, Pearl and Reed (1920) formalizes Thomas Malthus theory (1798). As population initially grows exponentially and that resources to feed the population increases arithmetically, there comes a level of population when the resources become exhausted limiting the growth of population. In political science, Hart (1948) shows the historical expansion of political areas increasing at an increasing rate with minimum resistance. At a certain size of political reach, the expansion starts to increase at a decreasing rate inverting the previous shape of the expansion. In diffusion of innovation (see Dodd, 1956; Griliches, 1957; Mansfield, 1963), initially, the adopters of innovation are few, and the potential adopters are many. In time, resistance of many potential adopters relaxes causing an exponential shift from potential to actual adopters. As adopters exhaust the population, the shift slows until the population of adopters reaches the maximum.

While the above works have applied the logistic function on entire populations, as far as we are aware, there has not been a renowned application of the same to predict an individual behavior. One that is close to applying the logistic function on individual behavior is the value function introduced by Kahneman and Tversky (1979) in prospect theory. In a cartesian plane, on the negative area of both the X and Y axes, an individual's utility function is convex due to loss aversion. However, on the positive area of both the X and Y axes, the same utility function kinks flatter and become concave due to risk aversion. Though not attributed to the logistic function, a logistic looking curve is shown in Cooper and John (1988) in coordination failures, and one might be able to form a mental image of a logistic looking curve in Asriyan et al. (2019) when explaining liquidity sentiments.

What follows is an explicit derivation of an individual reaction resulting in a logistic curve that is used to predict an individual behavior. The premise is that the individual has an illusion that one cannot affect the average outcome. One reason is taken from coordination problem literature where an individual cannot coordinate its level of contribution to too many individuals in a decentralized system (Bryant, 1983; Diamond, 1982; Hart, 1982; Weitzman, 1982). Another reason is taken from psychology literature which starts with averaging bias where agents react not based on the sum of reactions, rather than the average benefit (Chernev & Gal, 2010; Holmgren et al., 2018). Because an individual's contribution to the average in a big market or a big system is negligible, the illusion is that one cannot affect the outcome.

The outcome is a reaction function like the logistic looking curve in Cooper and John (1988). A result is that a social system "can get stuck at an inefficient equilibrium…even though a better equilibrium exists," and that "coordination failure" occurs when agents fail to coordinate their activities to achieve a "better (cooperative) equilibrium" (Cooper & John, 1988: p. 448). With the title of the paper "Coordinating coordination failures in Keynesian models," Cooper and John outrightly proposes that the solution to the failure is to coordinate agents. For example, from a low output equilibrium, a coordinated increase in output in all firms will increase output; that results in a demand externality that increases demand; and that leads to a higher output equilibrium. In what follows, it can be shown graphically that an alternative or complementary solution to coordination is improving the initial condition.

3. The Model

Where N is population of a given market or system, and C_n is the contribution of individual n resulting in the benefit, and C is an individual's benefit from a collective action, then:

$$C_{t-1} = \left(\Sigma_{n=1}^{N} C_{n,t-1}\right) / N \quad (1)$$

Note that population is big enough (could be in millions) such that the individual cannot affect the outcome of one's individual benefit.

Given the initial benefit, where k is a constant, C_{Min} and C_{Max} are the minimum and maximum possible contributions such that $0 < C_{\text{Min}} \leq C_{n,t} \leq 1$, the warm glow or utility from contributing to cause is:

$$V_{+}\left(C_{n,t}\right)=\left[C_{\text{Min}}+kC_{t-1}^{2}\left(C_{\text{Max}}/2-C_{t-1}/3\right)\right]C_{n,t}. \tag{2}$$

Note that the utility is positive and that the utility increases with $C_{n,t}$. The "pecuniary" cost and the utility from contributing to the cause are:

$$C_{n.t}\ \&\ V_{-}\left(C_{n,t}\right)=-C_{n,t}^{2}/2. \tag{3}$$

Note that the utility is negative, and that the utility decreases exponentially with $C_{n,t}$. The agent maximizes the utility:

$$U\left(C_{n,t}\right)=\left[C_{\text{Min}}+kC_{t-1}^{2}\left(C_{\text{Max}}/2-C_{t-1}/3\right)\right]C_{n,t}-C_{n,t}^{2}/2. \tag{4}$$

The first and second order conditions are:

$$\partial L/\partial C_{n,t}=C_{\text{Min}}+kC_{t-1}^{2}\left(C_{\text{Max}}/2-C_{t-1}/3\right)-C_{n,t}=0\ \&\ \partial^{2}L/\left(\partial C_{n,t}\right)^{2}<0. \tag{5}$$

Therefore, the optimal reaction function is:

$$C_{n,t}=C_{\text{Min}}+kC_{t-1}^{2}\left(C_{\text{Max}}/2-C_{t-1}/3\right). \tag{6}$$

Note that reaction ($C_{n,t}$) is governed by a logistic model in that it is proportional to one's initial benefit (C_{t-1}) and the amount in which it is short of its maximum benefit ($C_{\text{Max}} - C_{t-1}$). In other words, reaction ($C_{n,t}$) is a strategic complementarity of C_{t-1} and C_{Max}-C_{t-1}.

Expanding the reaction function gives:

$$C_{n,t}=C_{\text{Min}}+kC_{t-1}^{2}C_{\text{Max}}/2-kC_{t-1}^{3}/3. \tag{7}$$

The marginal change in reaction per unit increase in benefit (MCR = M) or the slope of the reaction function is:

$$dC_{n,t}/dC_{t-1}=kC_{t-1}C_{\text{Max}}-kC_{t-1}^{2}\quad\text{or}\quad dC_{n,t}/dC_{t-1}=kC_{t-1}\left(C_{\text{Max}}-C_{t-1}\right). \tag{8}$$

The above shows more apparently that reaction is a function of the initial condition and the amount in which the initial condition is short of its maximum level. Put differently, reaction to contribute is a function of how much one has contributed, and how much less the contribution to one's maximum ability. MCR is shown graphically in **Figure 1**. C_{t-1} may be interpreted as some stock of benefit and $C_{Max} - C_{t-1}$ is the potential additional benefit.

Further:

$$M_{t}=kC_{t-1}\left(C_{\text{Max}}-C_{t-1}\right)\left(C_{\text{Max}}/C_{\text{Max}}\right)\quad\text{or}\quad M_{t}=rC_{t-1}\left(1-C_{t-1}/C_{\text{Max}}\right),r=kC_{\text{Max}}. \tag{9}$$

If individual benefit is none, then $C_{t-1} = 0$, and the reaction and MCR are:

$$C_{n,t}=C_{\text{Min}}\ \&\ M_{t}=0. \tag{10}$$

If individual benefit is at maximum, then $C_{t-1} = C_{Max}$, and MCR is:

$$M_{t}=0. \tag{11}$$

In this parametric example only, one's reaction is exhausted at about 0.88.

Given equations (10) and (11), and **Figure 1**, the reaction function starts horizontal, increases at an increasing rate, reaches an inflection, increases at a decreasing rate, and at maximum becomes horizontal. The reaction function drawn with a 45-degree line can be depicted in **Figure 2**, which in principle is the same as credited to Cooper and John (1988).

From left to right, the three "intersections" are defined by *X* which is a stable equilibrium and in coordination failure, *Y* which is an unstable equilibrium, and *Z* which is another stable equilibrium and is the first best solution. Note that strategic complementarity is present in the entire graph; that is, the reaction of all other than the specific individual causes the individual to react. However, positive multiplier effect is present between the origin and *X*, and between *Y* and *Z*; but negative multiplier effect is present between *X* and *Y*.

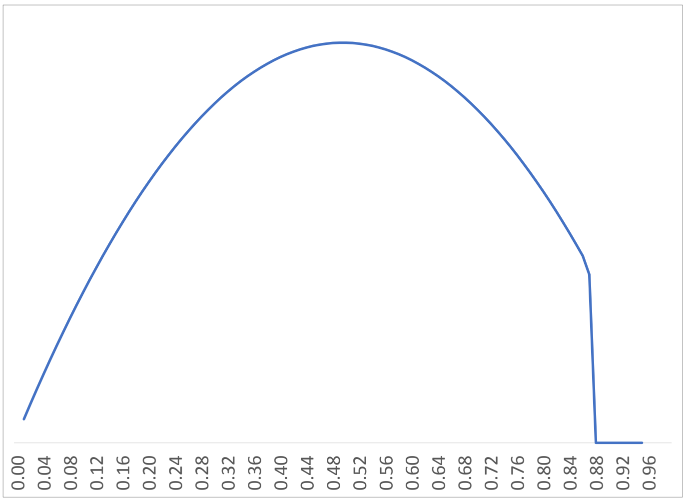

Figure 1. Marginal reaction function (Source: Authors' simulation with $k = 6$, $C_{Min} = 0.04$, and $C_{Max} = 1$).

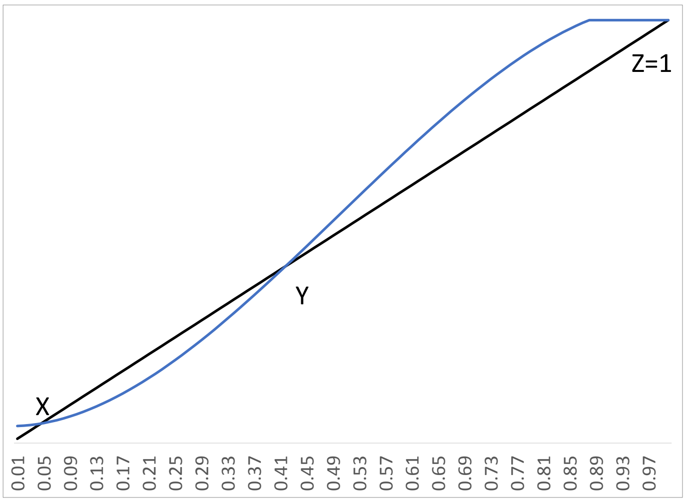

Figure 2. Reaction function (Source: Authors' simulation with $k = 6$, $C_{Min} = 0.04$, and $C_{Max} = 1$).

In positive multiplier effect, the individual's reaction to contribute is greater than the initial condition causing positive feedback loop which results in a graphical movement to the right. In negative multiplier effect, it is the opposite. Consider the case of asset markets per Asriyan et al. (2019). Buyers' willingness to pay for an asset today depends on their expectation of the future when they resell the same. If the present buyers think that future buyers are willing to pay a high price, then the former will pay more today which leads to a positive feedback loop. However, if the present buyers think that future buyers will pay low, then the former will pay less today which leads to a negative feedback loop leading to the coordination failure equilibrium.

If each agent knows that the aggregate outcome will be better if each reacts greater than the initial condition, why not do so? In other words, if each agent coordinates to react greater than the initial condition to get to the better outcome, why not do so? This is how the problem is a coordination failure. Borrowing from the logic of Bouvard and de Motta (2021), it is because each agent does not internalize that one's individual decision to contribute increases one's and others' initial condition thus creating a negative demand externality. Why not internalize? It is because decision and action of a single agent have a negligible effect on the aggregate outcome and therefore on the reaction decisions of all the other agents.

The reaction function mimics what happens when there is self-fulfilling prophecy, a Thomas and Thomas dictum (1928) popularized by Merton (1948). Between X and Y, the appearance, perception, or belief is towards an undesirable outcome. The result is a reaction less than the benefit. The outcome moves future benefits towards X. Between Y and Z, the appearance, perception, or belief is towards a desirable outcome. The result is a reaction greater than the benefit. The outcome moves future benefits towards Z. The function also mimics Keynes' (1936) animal spirits. That is "a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities" (page 161-162). Between X and Y, the relatively low benefit creates a spontaneous pessimism resulting in a relatively low reaction which lead future benefit to X. Between Y and Z, the relatively high benefit creates a spontaneous optimism resulting in a relatively high reaction which lead future benefit to Z.

Consider **Figure 3**. From the initial reaction function in solid line, there are three equilibrium states; from left to right, they are X at roughly 0.05, Y at roughly 0.45, and Z at 1.00. Note that equilibrium X is stable, Y is unstable, and Z is stable. If reaction is at equilibrium X, there is no inherent force that will lead to the higher equilibrium Z. Shifting up the reaction function mildly leads to a higher equilibrium or a higher X.

As stated in the introduction, while coordination might be a solution to solve coordination failures, improving the initial condition is an alternative and or a complementary solution. Second, moderately improving the initial condition

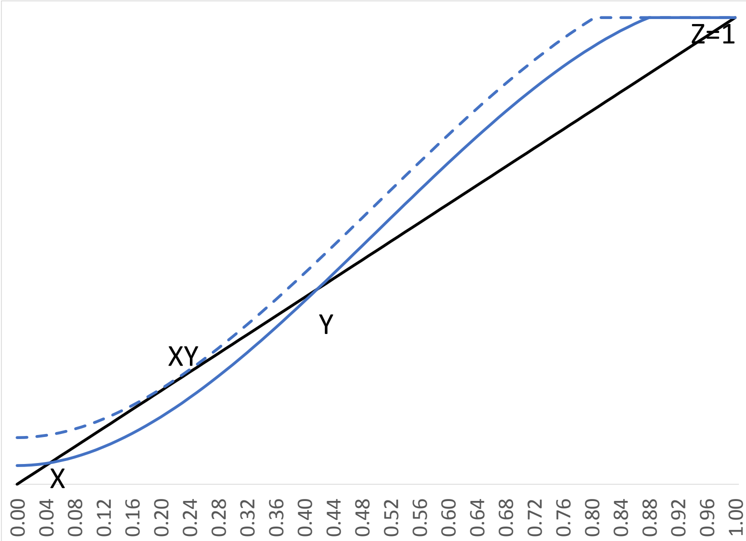

Figure 3. Raising the Minimum Benefit (Source: Dashed line are authors' simulation with $k = 6$, $C_{\text{Min}} = 0.10$, and $C_{\text{Max}} = 1$).

leads to higher equilibrium *X*, albeit only an inferior equilibrium, because equilibrium *Z* is the first-best equilibrium. However, by significantly raising the minimum benefit, the original function shifts up to the dotted line, as stated in the introduction, significantly improving the initial condition results in a positive feedback loop that leads to higher, first best, and permanent equilibrium; as summed up in the introduction, improving the initial condition helps. How much it helps depends on whether the improvement is moderate or significant. While moderate improvement moves the coordination failure equilibrium to a better coordination failure, significant improvement moves a system out of coordination failure and leads to a first best equilibrium.

Applying the analogy from Mathematics for Sustainability (Roe et al., 2018):

1) The point in which the reaction function shifts high enough for *X* and *Y* to converge making *XY* an unstable equilibrium which leads to the much higher equilibrium *Z* is the tipping point.

2) In a stable equilibrium such as *X*, as the reaction approaches the tipping point, the strength of the stabilizing feedback approaches zero. In this case, a positive deviation from *X* results in less shortage in marginal reaction relative to benefit. When the system hits the tipping point, the sensitivity of the system becomes large; that is, a positive deviation from *X* will result in a big change in equilibrium from *XY* to *Z*.

3) Critical slowing down is the tendency of a system in equilibrium to respond more sluggishly to shocks as its parameters approach a tipping point. That is as the reaction function shifts up, the excess reaction on the left of *X* and shortage in reaction on the right of *X* will result in slower adjustment back to *X*.

Consider **Figure 4**. If reaction is at equilibrium *Z*, there is no inherent force that will lead to the much lower equilibrium *X*. However, by some negative shock, the original function shifts down. Mildly shifting down the reaction function

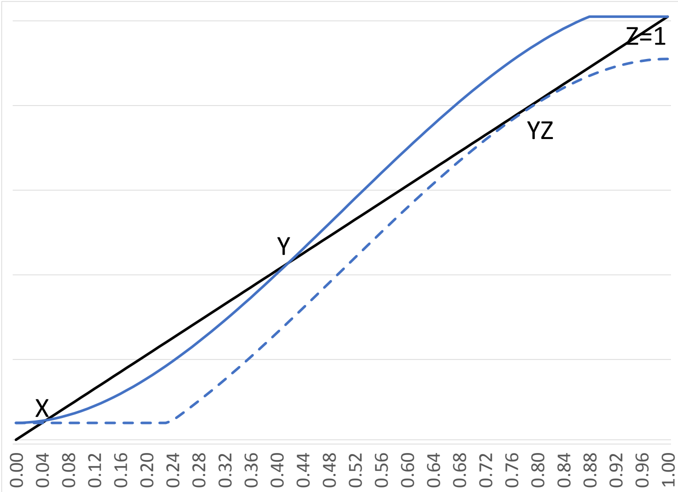

Figure 4. Negative Shock (Source: Dashed line are authors' simulation with downshift of 0.15. $k = 6$, C_{Min} = Maximum of ($C_{n,t}$, −0.15), and $C_{\text{Max}} = 1$).

leads to a lower equilibrium or a lower *Z*, albeit a much lower equilibrium *X* exists. Shifting down the reaction function to the point of reaching the tipping point where *Y* and *Z* converge results in an unstable equilibrium point at *YZ* which leads to the much lower equilibrium *X*.

Note that the value on the horizontal axis is a special case in which the maximum is 100 percent. This special case can be expressed three ways. First, in a universe where agents contribute either 0 or 100 percent reaction, a value of 0.51 means that 49 and 51 percent of the population contribute 0 and 100 percent reactions, respectively. Second, in a universe where agents can exert anywhere in between 0 and 100 percent, a value of 0.51 means that the collective average reaction of all agents in the population in each time is 51 percent. Third is a universe of a combination of the first and second. Either way, lower values of reaction are easier to overmatch thus the convex shape of the function and the upward trend of the MCR. However, higher values of reaction are harder to overmatch thus the concave shape of the function and the downward trend of the MCR.

4. Possible Application in Other Phenomena

4.1. Macroeconomics

Suppose the economy is at point *X*. In policy debates, there has been argument that stimulus packages should be bolder to achieve better outcomes (see Krugman, 2014; Politico, 2020). In this model, stimulus packages that are too small will improve reaction to higher *X*, but stimulus packages that are big enough to reach the tipping point will improve reaction to *Z*. With a higher *X*, the strength of the stabilizing feedback is closer to zero yet stabilizing enough not to get the economy over the threshold. The question is whether there has been evidence of slowing down of adjustment to the higher *X*. If one can observe this, then it could be that the market is nearing the tipping point.

Suppose the economy is at point *Z*. Normal recessions are factually followed by recoveries, but unusually deep recessions may not necessarily be followed by rapid recovery. Such is the case in US' post Great Depression of the 1930s and the Great Recession of 2008. One of the explanations for the phenomena is secular stagnation first coined by Hansen (1939) and recently brought up by Eichengreen (2015). In secular stagnation, an economy suffers "from an imbalance resulting from an increasing propensity to save and a decreasing propensity to invest. The result is that excessive saving acts as a drag on demand, reducing growth" (Summers, 2016).

In the application of this model, normal recessions that takes the economy just to the left of *Z* results in stabilizing feedback that leads to recovery back to *Z*. For as long as the recession is mild enough not to reach the tipping point, the bigger the recession, the greater the strength of the recovery. The business cycle is intact. But in an unusually deep enough recession to get to the tipping point *YZ* leads the economy to the lower equilibrium *X*. The result is a saving-investment reaction that is below the 45-degree line.

4.2. Bystander Effect in Global Warming

De Vries (2020) applied the phenomenon bystander effect on how it can explain inaction towards global warming. De Vries uses Darley and Latane (1968) example to define the bystander effect as the phenomenon when an individual's likelihood of offering help in a critical situation decreases when passive bystanders are present. In this context, the critical situation is the state of global warming. In the application of the model, when there are too many passive bystanders, between equilibria *X* and *Y*, the individual's reaction, or likelihood of offering help declines. Thus, the result is a reaction less than the benefit. While de Vries concludes people not contributing to the common good and therefore the state of global warming not achieving the ideal, the model shows more: that future outcome is bound to move to the worse equilibrium towards *X*.

De Vries explain the lack of global action in three psychological stages. First, in diffusion of responsibility, "the more bystanders there are, the less responsible we feel to take action…given the fact that the world population is over 7.7 billion people." De Vries cites the study of Latané and Nida (1981) to explain that the "effect is perhaps extra strong because we—earthlings—are strangers to one another and anonymity intensifies the bystander effect." Second, in evaluation apprehension, individuals fear of looking odd in performing public action as bystanders (maybe thousands of bystanders) notice your action for something ambiguous as global warming. In the end, the tendency is for individuals to wait until enough of others perform public action. Third, in pluralistic ignorance, as individuals wait for enough of others to perform public action, there will never be enough performers which creates a perception that most of the public perceives global warming as less critical situation.

In Cooper and John (1988), the solution is straightforward which is to coordinate coordination failures. Alternative and or complementary to coordinating, policy may focus on raising the response function of individuals. Cialdini (1993), Latané and Darley (1970), and Latané and Nida (1981) suggest raising awareness to encourage people to come into action. This is because when people understand more clearly that a situation is critical, realize that they are in danger themselves, feel more personally responsible, and believe that they have the skills to contribute, people become more inclined to act. Maran et al. (2023) in their study in Pakistan find that young adults who reported direct experience with climate change are more likely to follow pro-environmental behaviors. We infer that raising awareness involves the messaging of people who directly experienced the effect of climate change.

In the application of the model, raising the response function should lead to the tipping point XY. When each notice that there are enough active performers, the individual's likelihood of offering help in a critical situation increases. When there are enough active performers, between equilibria XY and Z, the individual's reaction, or likelihood of offering help overcompensate for one's benefit. Thus, the result is a reaction greater than the benefit. While de Vries might conclude that coordinated common action for the common good is ideal, the model shows more: that future outcome can bound to move to the best equilibrium towards Z.

4.3. Theory of Mind in Credit Markets

"Theory of Mind is the branch of cognitive science that investigates how we ascribe mental states to other persons and how we use the states to explain and predict the actions of those other persons" (Marraffa, n.d.). Shiller argues that humans have "strong tendency to form a model in their own minds of the activities in others' minds" (Shiller, 2019: p. 63). That is, A acts based on what A thinks B will do, B acts based on what B thinks C will do, and so on.

Borrowers often sustain their borrowing by financing maturing debt with new debt. Hence, borrowers often sustain their borrowing if there is enough credit to pay new debt. If a creditor thinks other creditors will not lend enough to a country, the said creditor will think that the country will not be able to sustain its borrowing and will not lend to the said country. If enough creditors think the same way, the country will not be able to borrow enough and via self-fulfilling prophecy will not be able to sustain its borrowing (Chamon, 2007). In the application of the model, if the credit market falls between X and Y, the representative investor thinks that other investors will not provide enough credit to sustain the country's borrowing. The reaction is to invest not enough, if not at all. The outcome will reach point X.

Chamon (2007) using his model proposes three possible solutions. The first is to coordinate enough investors to commit enough credit. Agnostic to practicality, this solution is comparable to Cooper and John's (1988) which is to coordinate coordination failures. The second is to issue debt to a big enough investment bank; the presumption is that the “big enough” lender will lend enough. Whether a “big enough” investment bank exists is not clear, although multilateral institutions or other countries fearing contagion may be candidates that could lend enough. The third is for the country to allow investors to submit bids contingent on the total amount of debt that will be issued. Practically, the country accepts bids and accepts those with the best terms with enough principal. In the application of the model for either the second and the third solution, the amount should be big enough as to shift the logit curve for X and Y to converge making XY an unstable equilibrium which leads to the much higher equilibrium Z. The representative investor thinks that other investors will provide enough credit to sustain the country’s borrowing. The reaction is to invest enough (even at a discount). The outcome will reach point Z.

An initial condition in which the credit market is in between points Y and Z is possible. This time, if a creditor thinks other creditors will lend enough to a country, the said creditor will think that the country will be able to sustain its borrowing and will lend to the said country. If enough creditors think the same way, the country will be able to borrow enough and via self-fulfilling prophecy be able to sustain its borrowing. Deterioration in the perceived fundamentals occurs. If the deterioration is minor, it will be comparable for the market to move to the left but still stay between points Y and Z, and so the end the outcome will still be at point Z. But if the deterioration is large enough, similar to Chamon’s prediction, the reaction function will shift down to the point of reaching the tipping point where Y and Z converge resulting in an unstable equilibrium point at YZ which leads to the much lower equilibrium X.

Apart from the application of the model to a sovereign borrower, the model may also be applied to Morris and Shin (2004) where a group of creditors decide how much to invest in a firm that issues short term bonds to pay for its maturing obligations. Chamon proposes to solve a market in conundrum between X and Y with the government stepping in to provide enough credit. The model may also be applied to start-ups raising funds; in this case, a start-up may reach out to the colloquial 3Fs, “family, friends, and fools,” to provide enough credit if not equity. In both cases, the key operator is “enough” as to shift the reaction function enough to reach the long run preferred outcome.

4.4. Transformational Leadership and Proactive Behavior

Studies have shown that transformational leadership practices could drive change in the behaviors of organization members (Hallinger, 2007). Furthermore, transformational leadership elicits changes in organizations (Selamat et al., 2013) that contribute significantly to the sustainability of change efforts and are quite crucial to organizational improvement (Özmen & Sönmez, 2007).

At the level of the individual members of an organization, proactive behavior or proactivity refers to an anticipatory, self-initiated action aimed at improving current circumstances (Grant & Ashford, 2008). Organizational leadership, such as transformational leadership, acknowledged as a collection of practices and behaviors that get "extraordinary things done" (Kouzes & Posner, 1995: p. 9), plays a role in eliciting proactive behavior (Bindle & Parker, 2010).

The influence of transformational leadership with proactivity, however, is not a direct one. Studies show several variables that intervene in the relationship between transformational leadership and organizational performance (Amante, 2018). These include trust in the leader (Sarwar et al., 2015), co-worker support (Ahmad et al., 2017), and organizational learning (Raj & Srivastava, 2016). The mediated transformational leadership behaviors and practices result in changes not only in the behavior of individual employees but also on structures and processes (Friedlander & Brown, 1974 as cited in Balci, 2002).

The study by Amante (2018) on Filipino teachers showed that leadership that is transformational by the school principals has an indirect effect on teachers' proactivity. Intervening in this relationship are the school principals' management of innovation and the quality of supervision by the middle supervisors.

Thus, in the absence of intervening variables in this case, management of innovation and quality of supervision, transformational leadership of principals will not sustain the teachers' proactive behaviors. In other words, if school leadership will not be able to put in place systems or structures to reward innovation and teachers are not able to fully reap the benefits of their proactivity; and there is a lack of collaboration and support between teachers and their supervisors, then, teachers are not incentivized enough to innovate further. This collective lack of proactivity of teachers will then create a snowball effect that can create an environment that discourages proactivity which can continually lead teachers to be non-proactive. The collective non-proactivity of teachers will complete a negative feedback loop and each teacher's individual proactivity will slide downward to the low equilibrium point X.

On the other hand, with the presence of intervening variables that are management of innovation and quality of supervision, the transformational leadership of school principals can influence teachers to exhibit proactive behaviors. When school principals put in place systems and structures that provide time and resources for teachers to innovate, and these innovations are rewarded; and direct supervisors facilitate an open line of communication with their teachers such as in the areas of goal setting and attention to the teachers' well-being, then these encourage teachers to sustain proactive behaviors. This will shift the response function up and the new starting point will be point XY. Because proactivity is appropriately supported and rewarded by the school leadership, this creates an environment that encourages more proactivity among teachers. The teachers will then show a higher degree of proactivity which can snowball to a continued and sustained state of proactive behaviors among teachers. The combination of these two expressions of transformational leadership creates a positive feedback loop. The overall proactivity of the school as an organization will move from the new starting point XY towards and ultimately end at the high equilibrium point outcome Z.

Table 1. Coordination failure in different phenomena.

Phenomena in:	Initial Condition	Coordination Failure	Moderate Improvement to a Higher X	Significant and or Additional Improvement to Equilibrium Z
Macroeconomics	Major recession	Secular stagnation	Stimulus package	Bolder stimulus package
Global Warming	Lack of global action	Bystander effect	Awareness on effect on earth	Awareness of one's danger and responsibility, and involvement of the affected
Credit Market	Lack of credit	Self-fulfilling lack of credit	Coordinate investors' commitment	Issue "big enough" debt to major investor
Organizational Behavior	Organization in need of change and culture	Lack of proactivity	Transformational leadership	Systems, structure and reward

4.5. Recap

This section discusses how the model mimics and applies in other phenomena such as in macroeconomics, global warming, credit markets, and organizational behavior. As summed up in Table 1, each starts with a challenging initial condition. Then coordination failure for different reasons puts each in a low equilibrium X. Moderate improvement in the initial condition leads to a better X, albeit inferior to equilibrium Z. Finally, significant and or major improvement leads to the first best equilibrium Z.

5. Closing Remarks

While coordination might be a solution to solve coordination failures, improving the initial condition is an alternative and or a complementary solution. However, moderate improvement in the initial condition leads to higher equilibrium, albeit only an inferior equilibrium. To get a positive feedback loop that leads to higher, first best, and permanent equilibrium, significant improvement must be given. Hence, significant improvements are more effective than moderate improvements. A possible extension is to study and prove whether a few significant improvements in the initial condition are less expensive than many moderate improvements in the initial condition.

While the logistic function has been mainly applied to population (Verhulst, 1847; McKendrick & Kesava, 1912; Pearl & Reed, 1920; Dodd, 1956; Griliches, 1957; Mansfield, 1963), the difference in this paper is that the function has been applied to an individual's reaction function. But there could be a similarity. In previous works, the common theme is that the curve initially increases at an increasing rate generally due to abundant resources, but in higher levels increases at a decreasing rate generally due to exhaustion of resources. Another possible extension is to study whether one's ability to contribute can be synonymized to resource. That is, if one is far off from fully reaching the maximum ability to contribute, then one can easily increase contribution, thus the convex shape of the reaction function in its lower levels. However, if one is close to reaching the maximum ability to contribute, then one can hardly increase contribution, thus the concave shape of the function in its higher levels. Put differently, at lower levels of contribution, there is greater potential energy to increase further contribution, and hence the increasing MCR. As benefit increases, one can only contribute so much and becomes more exhausted, hence the decreasing potential energy to further contribute, and hence the decreasing MCR.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Ahmad, A., Bibi, P., & Majid, A. H. (2017). The Impact of Training and Development and Transformational Leadership over Organizational Commitment among Academic Staff in Public Tertiary Institutions: The Buffering Role of Co-worker Support. *International Journal of Economic Perspectives, 11,* 417-432. https://doi.org/10.22146/gamaijb.24020

Amante, H. (2018). *Enabling Teacher Proactive Behavior in Philippine Schools: The Role of Transformational Leadership, Management of Innovation and Quality of Supervision*. Ph.D. Thesis, Ateneo de Manila University.

Asriyan, V., Fuchs, W., & Green, B. (2019). Liquidity Sentiments. *The American Economic Review, 109,* 3813-3848. https://doi.org/10.1257/aer.20180998

Bindl, U. K., & Parker, S. K. (2010). Proactive Work Behavior: Forward-Thinking and Change-Oriented Action in Organizations. In S. Zedeck, (Ed.), *APA Handbook of Industrial and Organizational Psychology* (pp. 567-598). American Psychological Association. https://doi.org/10.1037/12170-019

Bouvard, M., & de Motta, A. (2021). Labor Leverage, Coordination Failures, and Aggregate Risk. *Journal of Financial Economics, 142,* 1229-1252. https://doi.org/10.1016/j.jfineco.2021.06.036

Bryant, J. (1983). A Simple Rational Expectations Keynes-Type Model. *Quarterly Journal of Economics, 98,* 525-528. https://doi.org/10.2307/1886025

Chamon, M. (2007). Can Debt Crises Be Self-Fulfilling? *Journal of Development Economics, 82,* 234-244. https://doi.org/10.1016/j.jdeveco.2006.03.004

Chernev, A. & Gal, D. (2010). Categorization Effects in Value Judgments: Averaging Bias in Evaluating Combinations of Vices and Virtues. *Journal of Marketing Research, 47,* 738-747. https://doi.org/10.1509/jmkr.47.4.738

Cialdini, R. B. (1993). *Influence: Science and Practice* (3rd ed.). HarperCollins College Publishers.

Cooper, R. W., & John, A. (1988). Coordinating Coordination Failures in Keynesian Models. *Quarterly Journal of Economics, 103,* 441-463. https://doi.org/10.2307/1885539

Darley, J. M. & Latane, B. (1968). Bystander Intervention in Emergencies: Diffusion of Responsibility. *Journal of Personality and Social Psychology, 8,* 377-383. https://doi.org/10.1037/h0025589

de Vries, G. (2020). *How the Bystander Effect Can Explain Inaction towards Global Warming.* London School of Economics. https://blogs.lse.ac.uk/businessreview/2020/01/07/how-the-bystander-effect-can-explain-inaction-towards-global-warming/

Diamond, P. (1982). Aggregate Demand Management in Search Equilibrium. *Journal of*

Political Economy, 90, 881-894. https://doi.org/10.1086/261099

Dodd, S. (1956). Testing Message Diffusion via Harmonic Logistic Curves. *Psychometrika, 21,* 191-205. https://doi.org/10.1007/BF02289099

Eichengreen, B. (2015). Secular Stagnation: The Long View. *American Economic Review, 105,* 66-70. https://doi.org/10.1257/aer.p20151104

Friedlander, F., & Brown, L. D. (1974). Organizational Development. *Annual Review of Psychology, 23,* 313-341. https://doi.org/10.1146/annurev.ps.25.020174.001525

Grant, A. M., & Ashford, S. J. (2008). The Dynamics of Proactivity at Work. *Research in Organizational Behavior, 28,* 3-34. https://doi.org/10.1016/j.riob.2008.04.002

Griliches, Z. (1957). Hybrid Corn: An Exploration in the Economies of Technological Change. *Econometrica, 25,* 501-522. https://doi.org/10.2307/1905380

Hallinger, P. (2007). *Research on the Practice of Instructional and Transformational Leadership: Retrospect and Prospect.* http://research.acer.edu.au/research_conference

Hansen, A. (1939). Economic Progress and Declining Population Growth. *American Economic Review, 29,* 1-15.

Hart, H. (1948). The Logistic Growth of Political Areas. *Social Forces, 26,* 396-408. https://doi.org/10.2307/2571873

Hart, O. (1982). A Model of Imperfect Competition with Keynesian Features. *Quarterly Journal of Economics, 97,* 109-138. https://doi.org/10.2307/1882629

Holmgren, M., Andersson, H., & Sörqvist, P. (2018). Averaging Bias in Environmental Impact Estimates: Evidence from the Negative Footprint Illusion. *Journal of Environmental Psychology, 55,* 48-52. https://doi.org/10.1016/j.jenvp.2017.12.005

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica, 47,* 263-292. https://doi.org/10.2307/1914185

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money.* Macmillan.

Kouzes, J. M., & Posner, B. Z. (1995). *The Leadership Challenge: How to Keep Getting Extraordinary Things Done in Organizations.* Jossey-Bass.

Krugman, P. (2014). *The Tragedy of the Obama Stimulus.* The Press Democrat. https://www.pressdemocrat.com/article/news/krugman-the-tragedy-of-the-obama-stimulus/

Latané, B., & Darley, J. (1970). *The Unresponsive Bystander: Why Doesn't He Help?* Appleton-Century Crofts.

Latané, B., & Nida, S. (1981). Ten Years of Research on Group Size and Helping. *Psychological Bulletin, 89,* 308-324. https://doi.org/10.1037/0033-2909.89.2.308

Malthus, T. (1798). *An Essay on the Principle of Population.* J. Johnson.

Mansfield, E. (1963). Intrafirm Rate of Diffusion of an Innovation. *Review of Economics and Statistics, 45,* 348-359. https://doi.org/10.2307/1927919

Maran, A. D., Begotti, T., & Butt, M. U. (2023). Pro-Environment Behaviors, Efficacy Beliefs, Perceived Individual and Social Norms: A Questionnaire Survey in a Sample of Young Adults from Pakistan. *SAGE Open, 13,* 1-12. https://doi.org/10.1177/21582440231207444

Marraffa, M. (n.d.). *Theory of Mind.* The Internet Encyclopedia of Philosophy. https://iep.utm.edu//theomind/

McKendrick, A. G., & Kesava, P. (1912). The Rate of Multiplication of Micro-Organisms: A Mathematical Study. *Proceedings of the Royal Society of Edinburgh, 31,* 649-653. https://doi.org/10.1017/S0370164600025426

Merton, R. K. (1948). The Self-Fulfilling Prophecy. *The Antioch Review, 8,* 193-210. https://doi.org/10.2307/4609267

Morris, S., & Shin, H. S. (2004). Coordination Risk and the Price of Debt. *European Economic Review, 48,* 133-153. https://doi.org/10.1016/S0014-2921(02)00239-8

Özmen, F., & Sönmez, Y. (2007). Değişim sürecinde eğitim örgütlerinde değişim ajanlarının rolleri [The Roles of Change Agents during Change Process in Educational Organizations]. *Fırat Üniversitesi Sosyal Bilimler Dergisi, 2,* 177-198.

Pearl, R., & Reed, L. (1920). On the Rate of Growth of the Population of the United States. *Proceedings of the National Academy of Sciences of the United States of America*, *6,* 275-288. https://doi.org/10.1073/pnas.6.6.275

Politico (2020). 'They Made a Really Big Mistake': Biden Confronts a Regret of the Obama Years. https://www.politico.com/news/2020/09/14/biden-economics-obama-stimulus-414869

Raj, R., & Srivastava, K. B. (2016). Transformational Leadership and Innovativeness: The Mediating Role of Organizational Learning. *Journal of Management Research, 16,* 201-219. http://www.i-scholar.in/index.php/jmr/article/view/135439/0

Roe, J., de Forest, R., & Jamshadi, S. (2018). *Mathematics for Sustainability.* Springer. https://doi.org/10.1007/978-3-319-76660-7

Sarwar, A., Mumtaz, Z., & Ikram, S. (2015). Improving Organization Citizenship Behavior through Transformational Leadership: Mediating Role of Trust in Leader. *Asian Journal of Business Management, 7,* 28-36. https://doi.org/10.19026/ajbm.7.5166

Selamat, N., Nordin, N., & Adnan, A. A. (2013). Rekindle Teachers' Organizational Commitment: The Effect of Transformational Leadership Behavior. *Procedia Social and Behavioral Sciences, 90,* 566-574. https://doi.org/10.1016/j.sbspro.2013.07.127

Shiller, R. J. (2019). *Narrative Economics: How Stories Go Viral and Drive Major Economic Events.* Princeton University Press. https://doi.org/10.1515/9780691189970

Summers, L. H. (2016). The Age of Secular Stagnation: What It Is and What to Do about It. *Foreign Affairs, 95,* 2-9. https://www.foreignaffairs.com/articles/united-states/2016-02-15/age-secular-stagnation

Thomas, W., & Thomas, D. (1928). *The Child in America: Behavior Problems and Programs.* Knopf.

Verhulst, P. F. (1838). Notice sur la loi que la population poursuit dans son accroissement. *Correspondance Mathématique et Physique, 10,* 113-121.

Verhulst, P. F. (1847). Deuxième mémoire sur la loi d'accroissement de la population. *Mémoires de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 20,* 1-32. https://doi.org/10.3406/marb.1847.3457

Weitzman, M. (1982). Increasing Returns and the Foundations of Unemployment Theory. *Economic Journal, 92,* 787-804. https://doi.org/10.2307/2232668