

The Elephant Graveyard: Game Theory Analysis of Chinese Investment in Africa

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Research Question

In the past two decades, China has offered loans exceeding \$170 Billion across 49 individual African states¹. Following this surge of economic attention, African states have practiced mixed strategies in handling Chinese credit. Many African states have declined Chinese loans in favor of alternative options offered by the IMF, World Bank, and Western states. This weariness stems in part from Western accusations of “Debt-Trap-Diplomacy”, a term used to describe China leveraging debt for economic, political, and capital concessions from target states. Key amongst these development loans are the debt-for-equity swap clauses, which detail the infrastructure being constructed as the collateral itself for the loan. In this way a moral hazard is created in which China loans to African states with the expectation of a potential default, thus allowing the claiming of African infrastructure, resource rights, or port access. The details of such loans are often obscured by corruption or otherwise intentionally made opaque to the public by the Chinese controlled State-Owned-Enterprises involved.

Despite this narrative, as recently as last year China denied such accusations, stating that “the narrative is imposed upon China and Africa” and that “China will always respect the will of the African people” and “continue to bring tangible benefits to the African people through China-Africa cooperation.”² Indeed, African states do continue to accept such Chinese loans, albeit at a reduced rate than that of a decade ago, often weighing them against Western alternatives marked by stipulations and explicit development expectations. Many economists even praise China for offering investment to impoverished African states less cautiously and more freely than their Western counterparts.

Regardless of ethical implications or fiscal responsibilities, it is clear that the developing economies of Africa are the target of China’s Belt and Road Initiative, and by extension, caught in between the West and China in their struggle for global hegemony. Therefore, a better understanding of the strategic decisions faced by China and their African partners is essential not only in revealing the degree to which China can influence Africa, but also in forming future American development policy in Africa. This project aims to elucidate these strategic relationships by both examining scholarly findings as well as applying game theory to a

¹ “China Regional Snapshot: Sub-Saharan Africa.” Committee on Foreign Affairs, 21 Nov. 2022, foreignaffairs.house.gov/china-regional-snapshot-sub-saharan-africa Accessed 02 May 2024.

² *Qin Gang: So-Called China’s “Debt Trap” in Africa Is a Narrative Trap Imposed on China and Africa.* https://www.mfa.gov.cn/eng/zxxx_662805/202301/t20230112_11006510.html. Accessed 24 Oct. 2023.

simulated strategic model of economic cooperation between China and an example African state. Special focus will be given to identifying what parameters an investment deal must fulfill for 1) China to be willing to offer the deal; and 2) African states to be willing to accept the deal. Analyzing the strategic decisions that follow such investment offers will allow scholars to not only clarify Chinese investment policy, but also identify which African states are susceptible to Chinese influence through investment.

Literature Review

Existing literature regarding alleged Chinese Debt-Trap-Diplomacy arrives upon a mix of conclusions; the issue with regards to both global economic policy and American foreign policy is very divisive, and there are three emergent schools of thought in which scholars' opinions can generally be classified. Acknowledging all three perspectives is necessary in presenting the current state of knowledge.

Perhaps the most prevalent narrative, and one perpetuated by many Western scholars, is that of Chinese exploitation of nascent African economies in Xi Jinping's quest for economic dominance in the region. Scholars such as Addis and Rapanyane at least accuse China of reckless investment practices in part responsible for the African debt crisis, and at most accuse China of targeted debt-for-equity swaps - perpetuating a neocolonial strategy of economic and militaristic exploitation. Such accusations are not completely unfounded. Some scholars cite the continued shift of Ethiopian resource rights to Chinese holders³, while others point to large and often inefficient Chinese-funded infrastructure projects such as the recently constructed Nairobi-Mombasa rail line⁴. Economists also highlight the degree to which African trade deficits with China allow for the leveraging of economic influence, raising particular concern over Zimbabwe's adoption of the RMB as an official reserve currency.

In attempting to verify the claims of Debt-Trap-Diplomacy, other scholars come to the conclusion that while China may not be intentionally inciting defaults to claim infrastructure, they remain responsible for some degree of reckless investment. DeBoom is quick to remind us that China has more "institutional resources in negotiations than do individual African governments", and "uneven power relations are always subject to abuse."⁵ Such beliefs are also marked by the understanding that African actors are most often, accusations of corruption aside, making

³ Addis, Amsalu K., et al. "Chinese and Indian Investment in Ethiopia: Infrastructure for 'Debt-Trap Diplomacy' Exchange and the Land Grabbing Approach." *International Journal of Emerging Markets*, vol. 16, no. 6, 2021, pp. 998–1025. *ProQuest*, <https://doi.org/10.1108/IJOEM-08-2019-0642>.

⁴ Rapanyane, Makhura B. "Neocolonialism and New Imperialism: Unpacking the Real Story of China's Africa Engagement in Angola, Kenya, and Zambia." *Journal of African Foreign Affairs*, vol. 8, no. 3, Dec. 2021, pp. 89–112. *ProQuest*, <https://doi.org/10.31920/2056-5658/2021/v8n3a5>.

⁵ DeBoom, Meredith. "Who Is Afraid of 'Debt-Trap Diplomacy'? Geopolitical Narratives, Agency and the Multiscalar Distribution of Risk." *Area Development and Policy*, vol. 5, Dec. 2019, pp. 1–8. *ResearchGate*, <https://doi.org/10.1080/23792949.2019.1703556>.

educated decisions regarding Chinese investment.⁶ Yet scholars in this camp remain firm in calling for more opacity surrounding Chinese investment agreements.

Finally, some brief attention must be given to the limited Eastern and African scholars in favor of Chinese investment and the Chinese government themselves. Among these scholars are those like Singh, who are critical of America's refusal to invest in non-liberal states, stating that "China's non-interventionist approach has opened space for developing countries, particularly those with governments facing hostility from the US."⁷ Others advocate for cooperation between the IMF and China to better address Africa's debt problems in more sustainable ways. China themselves persistently denies the Debt-Trap-Diplomacy narrative, declaring such criticism hypocritical considering the West's centuries long exploitation of African resources.

All three groups disagree as to what extent China generates influence among African countries through investment strategy. Yet all groups do recognize that such investment is occurring, and more importantly, that African states are caught in the position of having to make strategic choices in funding their development. It is this identified gap of understanding between schools of thought, that's to say the uncertainty regarding China's investments as reckless or calculated with the objective to generate influence, that game theory analysis will allow us to better understand.

Relevant Actors

The strategic interaction explored in this project is conducted between two relevant actors, the People's Republic of China, and a given developing African state. Yet before detailing their respective preferences and objectives, some explanation must first be provided as to the nature of these actors when this interaction occurs in reality.

First, we must acknowledge that realistically, China's strategic decisions are not made completely unilaterally by one informed actor. It is not even the case that all investment is purely conducted by the Chinese Ministry of Commerce. Instead, investment is often facilitated either through various Chinese controlled financial institutions such as the China Development Bank and Export-Import Bank of China, or Chinese controlled State Owned Enterprises (SOEs). However, due to the considerable control China wields over these groups, for the purposes of this strategic model, the actor can be simplified to just 'China'.

Secondly, this model in no way intends to reductively group all African states together. Different African states face various political, geographic, and historical contexts that all influence their economic realities and behavior towards China. Despite this, there is a group of developing African states that do share similar patterns of Chinese investment, it is this group of nascent

⁶ Shen, Xiaofang. "Private Chinese Investment in Africa: Myths and Realities." *Development Policy Review*, vol. 33, no. 1, Jan. 2015, pp. 83–106. *EBSCOhost*, <https://doi.org/10.1111/dpr.12093>.

⁷ Singh, Ajit. "The Myth of 'debt-Trap Diplomacy' and Realities of Chinese Development Finance." *Third World Quarterly*, vol. 42, no. 2, Feb. 2021, pp. 239–53. *EBSCOhost*, <https://doi.org/10.1080/01436597.2020.1807318>.

economies that the 'given African state' represents. Case studies conducted from previous research give specific attention to the countries of Kenya, Djibouti, Cameroon, and Zimbabwe.⁸ From these studies, it can be inferred that the economic factors influencing the second actor in this strategic model most closely resemble those faced by the aforementioned four states.

With these acknowledgments addressed, let us examine the first actor, China. China's ultimate objective is to secure political, economic, and strategic influence over the developing states of Africa, especially through means of infrastructure control. China furthers their objectives by offering loans to African governments in which the infrastructure being developed is the collateral for the loan, often in addition to other clauses that generate influence. While not a major setback, the African state rejecting a deal offered by China serves to galvanize anti-Chinese regional sentiment, the utility pay off reflects this. In this way, China has the following preference structure among the five possible outcomes of interactions with African states, most preferring 1) the African state accepts a deal in which China is heavily favored and the African state does not default. Following that, China prefers 2) that the African state defaults, allowing China to seize the infrastructure regardless of the deal offered. Failing that, China would settle for 3) the African state accepts a deal in which China isn't heavily favored and doesn't default. China may fallback on their unpreferred option of 4) not offering any deal, which still remains superior to their least favored outcome, 5) the African state rejecting the deal.

Now examining the second actor, a given developing African state. The African state's ultimate objective is to secure foreign investment in order to develop their infrastructure and economy. They have the option to further this objective by accepting Chinese loans, yet in doing so risk both China gaining substantial influence over their country and a chance of default - both fates they wish to avoid. As such, they have the following preference structure among the five possible outcomes of this interaction. Their highest preference is the outcome in which 1) they accept a deal not favorable to China and don't default. If 2) such a deal is not offered they are ambivalent to 3) declining Chinese investment. Failing that they would prefer 4) accepting a deal that heavily favors China and not defaulting to 5) defaulting and succumbing to a debt-for-equity swap.

Strategic Interaction

In understanding the strategic interaction displayed in this model, further focus must be applied to the continuous action space possessed by China at the first decision node. The continuum upon which China may make an offer does not represent any measure of monetary investment, but instead various policies that can be included within an investment deal to generate economic and political influence. Some offers strip away more African autonomy than others, and a brief description of such policies is useful in fully understanding the model. Smaller concessions include such demands as insisting the infrastructure construction and maintenance

⁸ Himmer, Michal, and Zdeněk Rod. "Chinese Debt Trap Diplomacy: Reality or Myth?" *Journal of the Indian Ocean Region*, vol. 18, no. 3, Sept. 2022, pp. 250–72. Taylor and Francis+NEJM, <https://doi.org/10.1080/19480881.2023.2195280>.

be contracted to Chinese firms, such as is the case with the Nairobi-Mombasa rail line. The legal ownership of resource rights or exclusive trade is often seen in the context of resource extraction infrastructure, such as the copper mines of Zimbabwe.⁹ Finally and most serious, is the use of debt to align an African state's U.N. General Assembly votes with Chinese agendas, as has been alleged across many African states.¹⁰

The African state in making its decision must weigh the cost of not receiving funding versus the influence generated by Chinese economic cooperation and the associated risk of default. China's behavior, also influenced by the chance of default, is defined by how much influence it can get away with offering before the African state's risk of default motivates them to decline. In this way the African state can leverage its unstable economy to acquire a more favorable deal with China.

Strategic Model

As displayed in the model seen in figure 1 there are two decision nodes, followed by a move from nature. There also exists a continuous action space available to China at the null point, in which it can assign a value to its deal from a continuum of $[0,10]$ or anywhere in between. The model in these ways remains relatively simple, and while this model could easily be adapted to incorporate more nuanced factors as will further be touched on, it has purposely been designed to focus entirely on the core strategic interaction between China and its African partner. In analyzing the game, it's critical not only to specify the options available to the actors at each node, but also explain what such decisions represent and how they fit into a broader strategy profile.

The null point represents China, or an appropriate proxy, approaching a given developing African economy. At this stage China may choose either to not offer any investment opportunities to the developing African state, or do so. In doing so, it creates a deal that may include a variety of previously mentioned criteria that generate political and economic influence. The degree to which the deal generates Chinese influence at the expense of the African state is measured by the exploitation factor, located on the continuum $[0,10]$, also represented by (X) . If China makes the decision to not offer any investment, then the interaction is ended with the *status quo* being maintained and the pay off $(0,0)$ being applied. If China does decide to offer an investment deal at any given exploitation factor across the continuum, then the offer is sent to the respective African country's government to review, advancing to the next decision node.

⁹ Al-Fadhat, Faris, and Hari Prasetyo. "How China's Debt-Trap Diplomacy Works in African Countries: Evidence from Zimbabwe, Cameroon, and Djibouti." *Journal of Asian and African Studies*, Nov. 2022, p. 00219096221137673. *SAGE Journals*, <https://doi.org/10.1177/00219096221137673>.

¹⁰ El-Khawas, Mohamed. "Africa, China and the United Nations." *The African Review: A Journal of African Politics, Development and International Affairs* 2, no. 2 (1972): 277–87. <http://www.jstor.org/stable/45341239>.

This second decision node hosts the choice of the African state's government to either accept the Chinese investment deal at the exploitation factor offered, or decline the deal altogether. Declining the deal means that the African government will not have access to relatively free Chinese credit, devoid of the higher interest rates and austerity stipulations marked by Western and IMF loans. Declining the deal not only represents not accepting the loan, but also being forced into generally less favorable, yet more stable, economic cooperation with the West. If the African state chooses to accept the loan as per detailed by China, then they receive the benefit of infrastructure development, yet risk default and influence. Generally at this stage, the more certain the African state is that it won't default, the more likely it is to accept the deal. Regardless of their expectations, if they accept the deal, the game progresses to the terminal node held by nature.

The final model node contains no strategic decisions by either actor, but rather a move by nature as to whether or not the given African state will be able to pay off its loan to China or not. There are countless economic conditions that influence nascent economies' ability to pay off loans, investment in African economies is famously uncertain with large countries such as Ghana and Kenya defaulting in the recent past. Due to the uncertainty by both China and the African state regarding their ability to repay the loan, the outcome is decided at random along the axis of probability (P) representing the likelihood of default and probability $1-P$ of successfully paying off the loans in the long term. Defaulting allows China to seize the infrastructure in development as per the critical clause of the initial loan, providing a substantial payoff, while the African state is left with a shattered economy in desperate need of restructuring. Paying off the loan results in China attaining influence in accordance with their initial exploitation factor offer, and the African state now possessing a successful infrastructure development, at the expense of whatever influence China can now leverage over their country, represented by $(10-X)$.

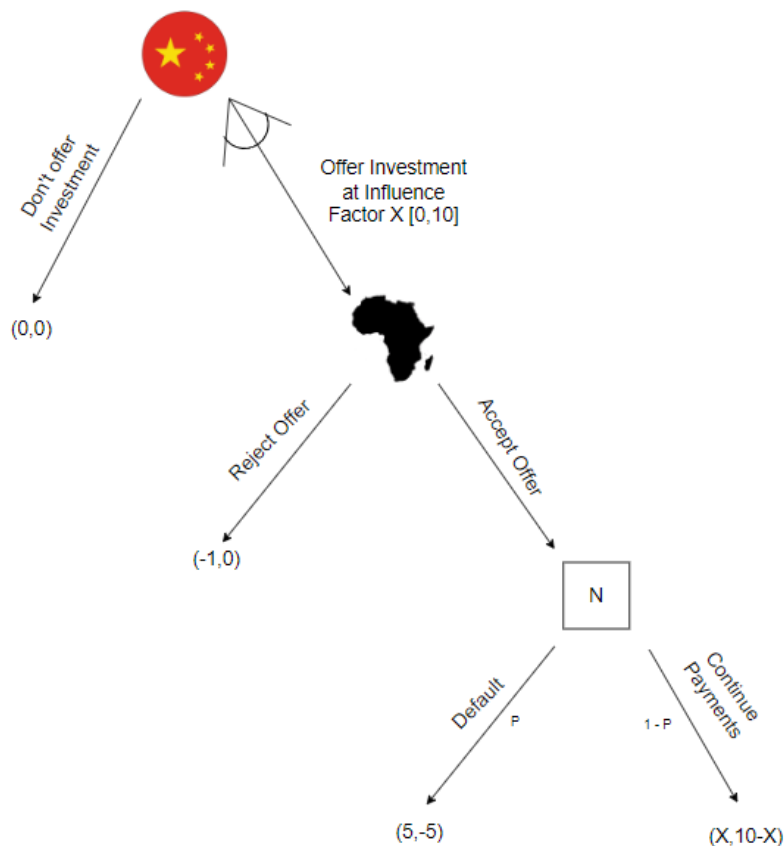


Figure 1. Chinese Investment Model

Equilibria Solution

When solving for the equilibria of this model, the nash equilibria is intended to represent the strategies employed by both actors with no available profitable deviations given both actors as rational and informed. This is to say, in solving for the equilibrium, the model solves for what strategies both actors employ, so that we may identify that pattern of strategy in reality and elucidate the relationships between China and African states.

There remains one critical variable in this model, P , representing the probability that the African state defaults on its loans should it choose to cooperate with China. Despite previous statements stressing the uncertainty of this outcome, it nevertheless serves useful to examine how China and the African states alter their strategies if there is some shared understanding of the likelihood of defaulting. To showcase how the actors may act given different (mutual) beliefs, equilibria are graphed across a continuum of P , ranging from certainty of default and certainty of payment. This indicates scenarios in which there are shared beliefs that defaulting is certain, impossible, or somewhere in between.

The relationship between probability of default and Chinese exploitation factor can be seen in figure 2. What is immediately revealed is that the African state is willing to accept a great deal of Chinese influence so long as the chances of default remain low, going all the way to the extreme in which given no chance to default, they are willing to accept all manner of Chinese demands. As the chance of default increases, African tolerance of Chinese demands decreases, all the way to the terminal of $\frac{2}{3}$ chance of default. At this terminal point, the African state is unwilling to accept any Chinese investment offer regardless of the exploitation factor. Thus a relationship can be identified between the probability of default and what influence Africa is willing to accept, this relationship can be expressed in terms of exploitation factor (X) as follows: $X \leq \frac{15p-10}{p-1}$.

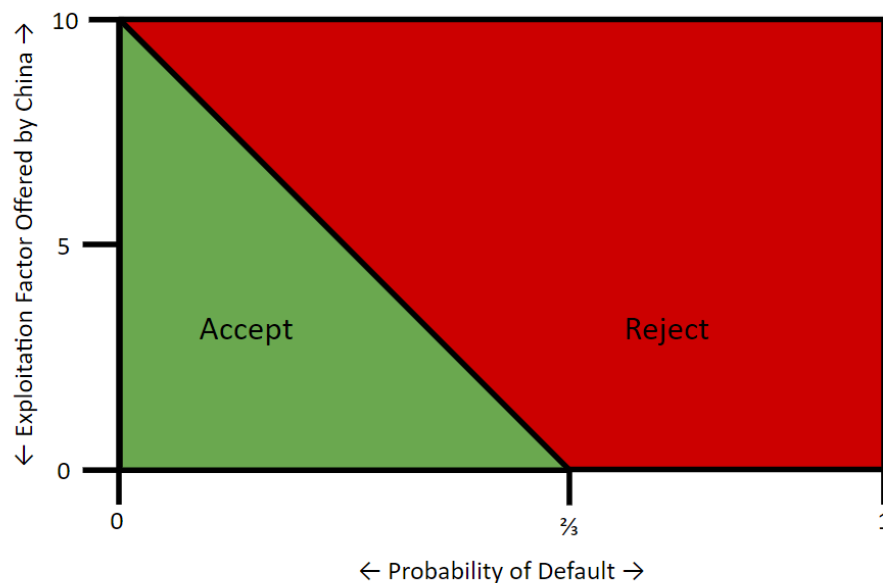


Figure 2. Exploitation Factor as a Function of Default Chance

China, knowing that if the probability of default is above $\frac{2}{3}$, no deal will be accepted, will avoid the minor utility loss of being rejected by nevering offering investment at that probability or higher. It should be noted that China's threshold for reserving investment far exceeds that of the IMF or West, much in part due to the advantages of debt-for-equity swaps available to China through these deals should an African state default. The amount of influence China is willing to press for, if any, is also directly correlated to the chance of default, expressed in terms of probability of default it looks like this: $p \leq \frac{-x}{5-x}$.

Below the full Subgame-perfect nash equilibria is shown, detailing both optimal strategies as well as outcomes and pay offs.

$P \leq \frac{2}{3}$		
SPNE :	Outcome:	Pay Off:
China @ Ø: Offer $X = \frac{15p-10}{p-1}$ Africa @ Offer: if $X \leq \frac{15p-10}{p-1}$ than accept, else reject	Offer $X = \frac{15p-10}{p-1} \rightarrow$ Accept $\rightarrow$ Default Or Offer $X = \frac{15p-10}{p-1} \rightarrow$ Accept $\rightarrow$ Pay	(5,-5) Or $(\frac{15p-10}{p-1}, 10 - \frac{15p-10}{p-1})$
$P \geq \frac{2}{3}$		
SPNE:	Outcome:	Pay Off:
China @ Ø: Don't Offer Africa @ Offer: Reject	Don't Offer	(0,0)

Implications of the Model

Now that the model has been sufficiently described and the equilibria identified, the findings will be presented in the context of global reality. We will additionally explore further potential variants of this model that better focus on specific aspects of the interaction or better represent certain realistic contexts. An initial conclusion is that the higher the chance of default is, the less tolerant African governments are of Chinese influence. Initial intuition may suggest otherwise, with African states being more willing to accept Chinese influence the more desperate and unattractive to other investors they are. Yet, the debt-for-equity swaps allow China to take advantage of default, significantly increasing their threshold of caution. However, China still hesitates to offer investment completely freely, due to the minor setback of rejection in the event they are certain that the African state will reject their offer given the probability of default.

In assessing this, we must compare the results to real case studies of nations. While not privy to the initial details of these investment deals, we can see the results of such loans, and whether the findings are concordant with the model. For example, after past strife, Kenya has evolved into a relatively peaceful democracy possessing a stable economy attractive to foreign investors but remains riddled with economic inefficiencies. This economic attractiveness coupled with a corrupt bureaucracy has led to a major debt crisis, with Kenya currently holding debt equivalent to 73% of its total GDP. Therefore, when China approached Kenya with the offer to fund the Nairobi-Mombasa rail line, knowing their economic risk, they did not press for major

concessions. However, while Kenya did incur a great deal of debt to China amounting to 40% of its GDP, it still maintained legal ownership of the newly developed rail line - the only concession to China was that the rail line would be constructed and operated by Chinese labor¹¹. This case study validates the model in that it represents an African country with a greater chance of default being less tolerant of Chinese exploitation.

Another case study is Zimbabwe, which hosts a very different economic context compared to Kenya. Zimbabwe, while afflicted by numerous economic challenges, has largely overcome them due to the wealth generated by the mineral trade with China. China, aware of both Zimbabwe's reliance on bilateral resource trade and relatively stable economy, has pressured Zimbabwe far more than its African neighbors. In doing so, China has not only insisted on ownership of resource rights for the mineral extraction facilities it funded, but also insisted that Chinese labor be provided to run the mines. Furthermore, China has pressured Zimbabwe to adopt the Chinese RMB as an official reserve currency in which to conduct trade, offering China immense control over Zimbabwe's monetary policy.⁹ Again, the model appears to hold up, demonstrating how China is willing to pressure states for influence beyond the utility granted by a debt-for-equity swap if China is more certain that states will not default. Also, by having a close economic relationship with Zimbabwe, China was more likely to have accurate information regarding its chance of default. This leads us to a possible adaptation of the model.

The model presented here is engineered to capture the strategic interaction between China and its African partner states, yet there are many elements to inform further variants of this model. While the focus of this paper remains on the core model, this section will, without solving equilibria solutions, explore potential variations and their implications on the original model.

In the initial model, it is assumed that given the many factors that influence debt structures of developing nations, that the chance of default was undefined but equally known to both China and the African state. However, in reality this is not necessarily the case. It is more likely that the African state itself, being more familiar with its financial situation than its foreign partners, has greater information regarding its chance of default than would Chinese investors. The model can be modified to reflect this inside knowledge. By adding a nature event at the null point, a world-state can be defined in which the African state is either stable and due to pay their loan, or unstable and subject to a chance of default. Following the initial nature event, China can make their offer (or not), uninformed of the economic situation of their African partner economy. The game then plays out as it did before in the unstable sub-game, and as before, omitting the nature event of default in the stable sub-game. This model variant is displayed in figure 3. This alteration modifies the behavior of China in that their exploitation offer is now not only influenced by the chance of default, but also their belief of whether the world-state is stable or not. Africa's behavior shifts to be more tolerant of Chinese exploitation in a stable world due to their knowledge that default is impossible. For the sake of brevity, full analysis and equilibria solution

¹¹ Rapanyane, Makhura B. "Neocolonialism and New Imperialism: Unpacking the Real Story of China's Africa Engagement in Angola, Kenya, and Zambia." *Journal of African Foreign Affairs*, vol. 8, no. 3, Dec. 2021, pp. 89–112. *ProQuest*, <https://doi.org/10.31920/2056-5658/2021/v8n3a5>.

will be reserved for the initial model; however the thresholds for which these behavior shifts can be observed are graphed as a function of Q and P in figure 4.

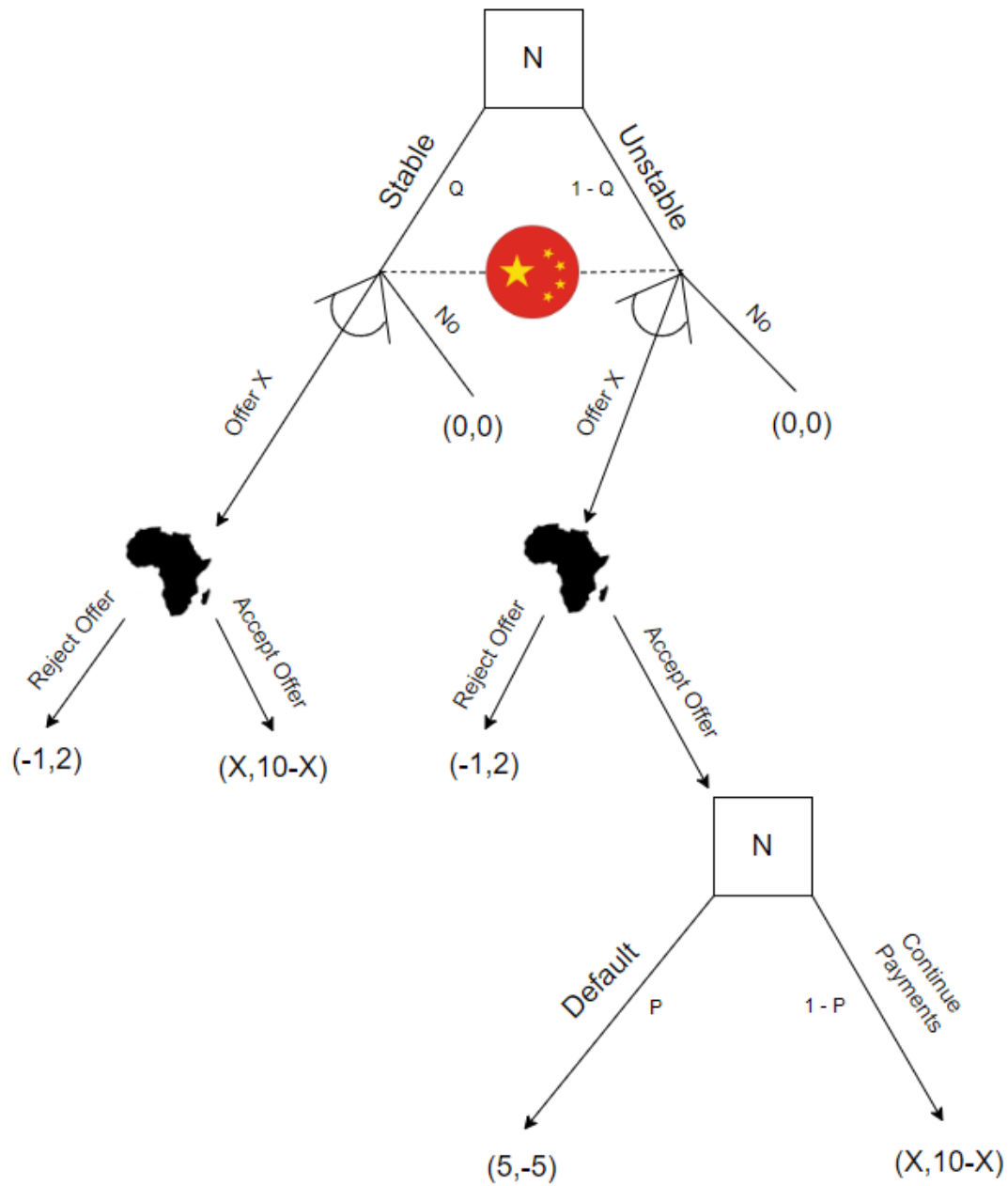


Figure 3. Imperfect Information Variant

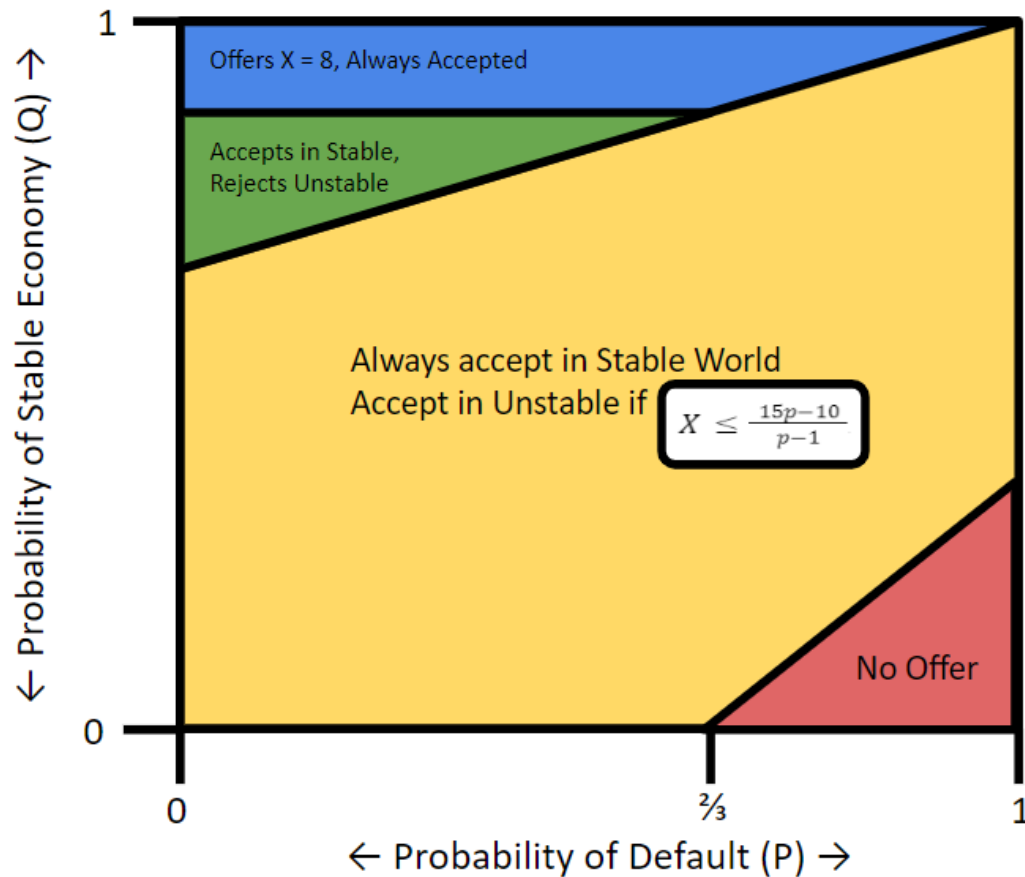


Figure 4. Imperfect Information Variant Equilibrium Graph

The original model can also be modified to introduce additional actors whose actions can be considered relevant to the broader political context as illustrated on figure 5. For instance, the International Monetary Fund (IMF) can be introduced as a tertiary actor who's payoffs differ from that of China's. The IMF, charged with instituting financial security around the world, receives a negative payoff whenever the African state defaults regardless of the donor. It also differs from China in that it has no debt-for-equity agenda and as such suffers no benefit from default, nor does it suffer any penalty from rejection. However, like China, it still offers a deal across a continuum representing not exploitation, but rather the harsh conditionality requirements the IMF insists upon its partners, representing mandatory economic and political restructuring to better pay its loans. Since the IMF receives no benefit from a defaulted African state, its default threshold for offering a loan is far lower than China's; this of course is by design, reflecting the reality of the interaction.

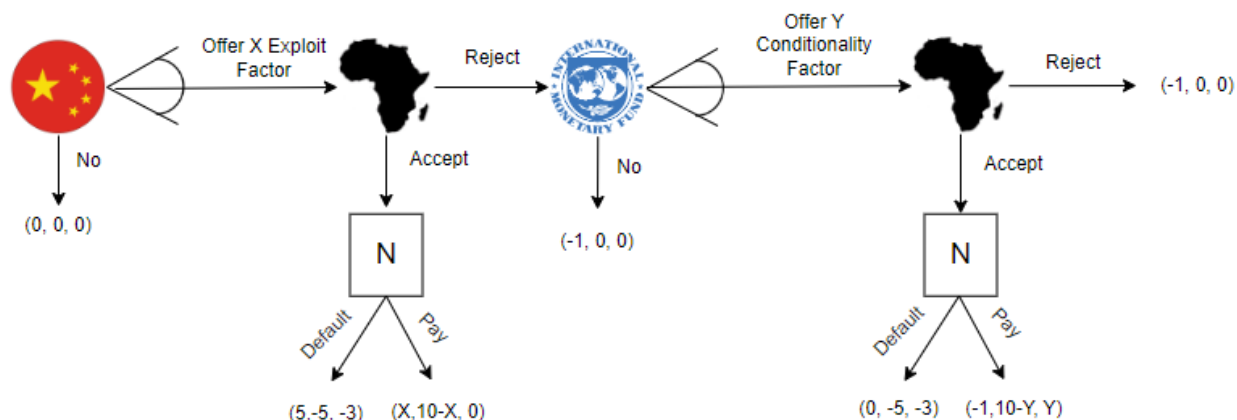


Figure 5. Three Actor Variant

The implications of all three models can be seen on policy. In the context of American foreign policy, such interactions can be utilized to identify which African nations are most vulnerable to Chinese debt-trap-diplomacy, and allow American firms to react accordingly to make preemptive investments or partnerships. The model also serves to be useful for global institutions such as the World Bank and IMF. By identifying potential moral-hazards caused by reckless Chinese lending, such global financial institutions can better forecast economic crises and more effectively address systemic African debt problems. Alternatively, this model could also be applied by Chinese State-Owned-Enterprises to identify exactly how much exploitation is viable in a given African economy. While this paper is a peripheral analysis of Sino-African financial interactions, it can still serve as the basis for future research that can help various actors better understand the complexities of the political economy in which they exist.

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