Entwined Economies: Madagascar's Problematic Economic Nexus with China seen through a Granger Causality Analysis of Real GDP and Net Exports

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This paper answers the research question: how did Madagascar's peaceful transition of power during the 2018 presidential election affect the levels of foreign investment by China in the Madagascan territory as a result of the conflicting Chinese communist and Malagasy semi-democratic ideologies? After reaching its economic boom in the 21st century, China has significantly increased its levels of Foreign Direct Investment abroad, predominantly in poorly-developed countries. Madagascar is a low-income country that has welcomed increasing amounts of Chinese FDI yearly and is located in the global south, proving to have a strategic location that facilitates trade in the Indian Ocean and Southeastern Africa. China's high levels of FDI in certain developing countries like Sri Lanka increased the rate of economic growth in the short-term at the expense of degrading their economies in the long-term because of the high economic dependency on China. Through the use of the Granger causality test, it is found that there is a unidirectional causal relationship between Madagascar's net exports and real GDP. Madagascar's past net export data is useful in predicting future real GDP data because Madagascar is a price taker and its economy is dependent on trade with China. Protectionist policies designed to further Madagascar's domestic industry have been replaced by increased trade with the Chinese Communist Party.

Introduction

The People's Republic of China (PRC) is the second largest economy to date, amassing a total GDP of 17,786 billion USD[1]. The massive economic boom the country experienced from 1978 until 2013 was a result of the market-oriented economic reforms adopted by the Chinese Communist Party to propel China into the ranks of the world's major economic powers[2]. China's economy has grown at a faster pace than that of developed nations, but more interestingly, it has grown at a much more accelerated pace than that of other developing countries. One prevailing argument explaining China's economic boom is the large foreign direct investments received from other countries' investors following China's economic liberalisation policies in 1978. Tian (2022) argues accumulating enough capital to pursue further investment projects is what allowed China to develop its economy to where it stands today, hence claiming that the three basic pillars of economic development that allowed China to boost its economy are: investment, higher quality human capital attained through education, and technological progress. China has one of the highest foreign direct investment rates in the world and has invested about 40% of its GDP in the economy over the past four decades[3]. This investment was financed domestically as well as through the borrowing of money from foreign countries.

Having reached such levels of economic growth, Xi Jinping's administration has not hesitated to invest in other developing countries to develop their economies. China began investing in Africa under the premise of forming a relationship of equals with African countries. It has pledged to give all the needed support to develop their economies as they also come from a background filled with poverty. The PRC has invested 300 billion USD in the continent so far, and the value of Chinese firms operating there amounts to 2 trillion USD[4]. China claims it is not investing in Africa from a political standpoint, but from a commercial one. However, China is known to invest and lend money in large amounts to almost exclusively poorly-performing economies. There is a downside to Chinese FDI found in other countries; namely Sri Lanka, where high levels of Chinese FDI resulted in high indebtedness levels and market monopolisation[5]. However, while several papers discuss China's economic and political influence in Sri Lanka, data on less prominent African countries like Madagascar is limited. Madagascar has a strategic location along the Mozambique Channel and proves to be an ideal location to trade with island nations such as Mauritius, Comoros and Seychelles, as well as mainland African countries such as Mozambique, South Africa and Tanzania[6]. Several world superpowers have demonstrated an increasing interest in the island because of its geographic significance in Southeastern Africa. Moreover, countries such as the United States, France, China,

Canada, Japan and the United Arab Emirates have increased trade with Madagascar and made new investments in the raw material, precious metals and agricultural industries[7]. Madagascar has high deposits of untouched raw materials such as raw nickel, titanium ore, cobalt and gold. It also has some of the most fertile lands in the entire world as a result of its favorable tropical climate, which allows farmers to afford up to four harvests per year[8]. In comparison, the US can afford up to three harvests per year on average under optimal conditions. This posits Madagascar as a nation with a high degree of importance in the global south and a high potential to maximize the use of its vast natural resources and become a middle to high-income country. The presence of high political instability in Madagascar throughout the 20th and 21st centuries however, acts as a barrier to its economic potential. China seems to make investments in countries where political instability or authoritarian regimes are prevalent, as is the case of Sri Lanka[9]. This study thus aims to research how Madagascar's pursuit of a purely democratic regime affects Chinese foreign direct investment, and whether higher Chinese FDI equates to Malagasy economic growth. Hence, how did Madagascar's peaceful transition of power during the 2018 presidential election affect the levels of foreign investment by China in the Madagascan territory as a result of the conflicting Chinese communist and Malagasy semi-democratic ideologies? Finding an answer to this helps to understand the current divergence between the defective democratic and authoritarian political ideologies of Madagascar and China, respectively, and provides insight into the extent to which Madagascar, as a developing country, is dependent on Chinese FDI to maintain economic growth. This will serve as an example to determine whether China's foreign direct investment policies in developing countries are positive to their economies because of fostered growth and development, or will cause harm to the developing economies in the long-term as a result of economic dependence on China.

This paper adopts the Granger causality test to determine whether there is an existent Granger-causation between the net exports from Madagascar to China and Malagasy GDP. Granger causality tests are used to determine whether one time series is useful to predict another. In this case, it will be determined whether Madagascar-China net export data is useful in predicting future Malagasy GDP. If the Granger causality test establishes causation between net exports and GDP, this will indicate that China acts as a price maker in its trade with Madagascar, and will mean that China partially dominates Madagascar's economy to the point where Madagascar, in its current state, is dependent on China to pursue economic growth. Because Madagascar's imports from China surpass its exports to China, the two variables used in the test will be the Madagascar-China trade deficit level (negative numbers) and Malagasy GDP from 2014-2021. This data set allows us to determine whether the trade deficit granger-causes Malagasy GDP, while showcasing information on the changes in trade and GDP in Madagascar after the 2018 presidential election. This will help determine whether the peaceful transfer of power had a positive effect on Madagascar's economy and whether political stability on the island is bound to further economic growth. Hence, the paper will first provide an overview of Madagascar's political history to elucidate why it proves to be attractive to Chinese investors and why economic growth and development are low in the present day.

This paper will add to existing literature on the topic by analyzing the dependence of Madagascar on China and the extent to which increasing Chinese FDI decreases the ability of Madagascar to diversify its investments from abroad. The findings of this paper will serve as a basis for future researchers to evaluate possible solutions to the economic dependency that high FDI from China causes in Madagascar, or the causes behind Madagascar's perceived need for financial investment from overseas.

Background

Transition in Governance from Merina Kingdom to French Malagasy Protectorate

Madagascar's history has been marked by severe political instability and drastic government changes, leading to prolonged economic and political crises both prior to and post-Malagasy independence. The Merina kingdom, a former country located in present-day Madagascar that was supported by the British and ruled by the Merina ethnic group, dominated the island prior to French colonisation taking place[10]. The Merina kingdom's economy relied on trade and slave labour from nearby plantation economies such as Mauritius, Reunion, and societies on the Cape and Swahili coasts. This trade, alongside the development of rice plantations, sustained the Merina people. The Merina kingdom then started to pursue a controlled economic style as trade was completely severed with the outside world, and protectionist policies were placed under Ranavalona I, the Merinas' first queen[11]. The presence of desertion and banditry eventually destroyed the labour system and paved the way for France's colonisation of Madagascar, during which Madagascar was officially established by France under the name *The Colony of Madagascar and its Dependencies.* French colonialism later failed to develop Madagascar's economy due to the lack of French-built liveable infrastructure that would enhance standards of living alongside industrialization and the prime focus on the exploitation of natural resources, such as timber and vanilla[12]. After the end of WW2 and countless insurgencies in favour of pursuing Madagascar's independence from the French, France agreed to establish the Malagasy Protectorate, diminishing the influence and control it held over the country while maintaining their tutelage over the Malagasy voices in parliament[13].

Changes in Government and Economic Instability in post-colonial Madagascar

After gaining independence in 1960, economic prosperity and stability were far from being attained. The first president appointed to Madagascar was Philibert Tsiranana, who had served as prime minister over the island under the French Vichy regime. He managed to oversee the first period of moderate economic growth thanks to his social democratic policies, whereby he tried to advocate government intervention in the Malagasy economy to promote social justice. Despite the stimulus his interventions gave to the Malagasy economy, he was eventually exiled from the country in 1972 in response to large-scale anti-government demonstrations taking place because of his support for French influence on the island[14].

Madagascar's political instability following its independence from France had a further negative effect on its economy[15]. Tensions between political leaders plunged Madagascar into a civil war between both sides. The Malagasy economy did not see any progress in productivity or output per capita in the long term due to the slow growth and investment rates below 15%, which led to stagnating and later declining income per capita levels between 1963 and 1988[16]. Ratsiraka, part of the political opposition, later resumed power after winning the 1997 presidential election, allowing him to govern Madagascar until the next national elections held in 2001. His governance was characterised by the implementation of extensive protectionist policies to develop the national Malagasy industry, prioritising small and medium enterprises and putting a greater emphasis on rehabilitating the existing productive capacity as opposed to undertaking new investments[16]. He sought to attract foreign private capital and rendered export retentions from Madagascar to other countries more flexible. However, Ratsiraka's economic goals were not achieved due to his poorly formulated Marxist ideology, corrupt and inefficient government, and increasingly autocratic practices[17].

Whereas the regimes of several other African nations collapsed as a result of political instability and economic deterioration, Ratsiraka managed to maintain his presidency by resorting to constitutional manipulation, various protection measures to neutralise political opposition candidates, and the forceful control of the volatile population living in slums[18]. A prevailing argument against Ratsiraka is that his contractionary monetary, fiscal, and exchange rate policies implemented in the 1980s that aimed to combat high rates of inflation that exceeded 20% took a larger toll on economic growth than they did at reducing inflation[19]. The socialist policies implemented and the "malgachisation," which aimed to establish the Malagasy language as an educational language, contributed to the modern-day structural unemployment and the abundance of low-skilled and unskilled labour in the country in both the rural and nonrural poor[20]. These two perceived legacies led to Ratsiraka's eventual suppression and exile from Madagascar.

Outcomes from presidential elections in the following years continued to be contested. As in many low-income democratic countries, there is a severe lack of transparency concerning the origins of funds for expensive electoral campaigns. Evidence points to the politically manipulating roles countries such as Russia play in Madagascar, fueling corruption and distancing democracy by funding political campaigns in exchange for political support[21]. Madagascar then entered a political crisis in 2009, whereby numerous loud and violent protests ensued in the capital city of Antananarivo. By the end of the political crisis, Rajoelina had managed to oust Ravalomanana thanks to the backing of numerous military officials and officers. Following these events, Andry Rajoelina assumed the role of president of Madagascar and took charge of the country. Estimates indicate that the GDP growth rate became negative in 2009 and went down from a pre-crisis projection of 7.5% through the combination of two factors, i.e., the slowdown of private activities in the industrial and service sectors and an inadequate fiscal adjustment of public spending[22].

Although certain political candidates disputed the results in 2018, they all ended up conceding Rajoelina's victory and praised this election as it was one of the only presidential elections in Madagascar where the transfer of power had been peaceful and conveyed respect for republican values. Rajoelina has been governing since, and ran for presidency once again in the Malagasy presidential election on the 16th of November, 2023, securing his role as president of Madagascar. President Rajoelina has requested increased investment in agriculture and industrial development to drive regional economic growth as a response to the insecure affordability and volatile prices of imported agricultural goods as a result of the Ukraine-Russia war. Thus, Rajoelina's plan is to increase rice production by 25% to ensure national food security and surplus for the export market[23].

Madagascar's parliament has been riddled with countless sudden changes in government throughout its history to the detriment of the Malagasy economy. The contractionary and protectionist policies implemented by political leaders have proved to be ineffective and even detrimental in the past. However, those policies were also implemented under a more socialist form of government. Rajoelina's system seems to embrace a controlled capitalist economy model, where global trade is moderated to support infant industries such as the agricultural sector but fully open in the manufacturing and textile industries. Nonetheless, the contrast is still evident. Madagascar was one of the wealthiest nations in Africa after attaining its independence from the French, with a total GDP of 673.1 million USD, and is currently ranked as one of the poorest countries in the entire globe with a total GDP of 14.47 billion USD[24]. Although the total GDP is now higher than when Madagascar first gained its independence from France, the disproportionality in Madagascar's economic

growth is significant compared to other African countries. The last election held in 2019 was one where the transfer of power from one political candidate to another abided by democratic standards. No major violence was experienced in the capital city of Antananarivo or any of the other regions. This may hint at a gradual progress towards full political stability in Madagascar and, consequently, a stable rate of inflation and economic growth.

Political Instability in Madagascar and Chinese Investments

It has not solely been the Malagasy government that has tried to sustain itself these past years. Foreign direct investment from a handful of different countries has proved to be a key factor in keeping the Madagascan economy afloat. Even though France was Madagascar's main trading partner after its independence, China currently secures the number one spot as Madagascar's largest trading partner. China's initial investment in Madagascar was in 1972, and it has since increased its investment in the agricultural, manufacturing, and raw materials sectors. They also surpassed Western democracies' investments in the country, such as Canada and France. Political instability in Madagascar deterred foreign direct investments from the United States, France, Canada, Mauritius, Japan, and other nations. However, China's investments did not falter because of the swift and sudden changes in power in Madagascar, with their FDI remaining relatively stable and gradually increasing over time. This is due to China's distinct investment approach compared to other countries[25]. Whereas France invests on a conditional and developmental approach, i.e., FDI will come from France as long as Madagascar pursues democracy, China seems to invest on a commercial approach, i.e., they will trade with Madagascar regardless of who is in power as they want to establish socio-economic ties with the Malagasy people in order to create some sort of dependency between the trades in both countries. For example, Chinese firms capitalised on the instability created by the political crisis that lasted from 2009 to 2013 in order to achieve their commercial objectives[26]. While several nations, such as Norway, placed sanctions on Madagascar and stopped providing development assistance at this time[27], China kept expanding its economic ties with the nation. China's largest steel producer, Wuhan Iron and Steel Corporation (WISCO), paid the government $100 million to obtain permission to mine iron ore in the western section of the nation known as the Soalala region. This gave WISCO the opportunity to get mining rights in an area close to the Baie de Baly National Park that boasts remarkable biodiversity but might be devastated by the company's operations. WISCO was required to build an international port, roads, and over 100,000 jobs as part of the concession. In spite of this, the neighbourhood feels abandoned because none of these promises came to pass. Furthermore, the $100 million that the previous administration classified as taxes and royalties—roughly 10% of the nation's yearly budget—remain unaccounted for[28].

It can be argued that the political instability experienced in Madagascar benefited Chinese investors by allowing them to have less foreign competition in the region, thus making it easier for them to invest in different sectors of the Malagasy economy and to focus on expanding and growing their businesses instead of investing in non-price competition. However, one cannot assertively state that political instability will benefit the Chinese in the long term. This is due to the need of any foreign investors in the country to have lease agreements for the land their business operates on[29]. Madagascar does not allow foreign proprietors or other foreign entities to own any Malagasy lands privately. However, these required lease agreements are known to falter or not be executed properly until the expiration date following changes in governance and political instability. These disruptions are capable of disincentivizing foreign firms from operating in Madagascar, since net business income decreases as a result of market paralysis, resulting in higher average operational costs[30]. Hence, political instability may not benefit Chinese investors, making it harder to foster a stable commercial environment. Rajoelina's policies have a focus on infrastructure development, primarily encapsulating the transportation and energy industries, through the boosting of exports through expansionary fiscal policy. Anti-monopoly laws and the ban on foreign ownership of businesses have been lifted to ease the inflow of capital into the economy, namely Chinese FDI[31].

Considering the democratically successful transfer of power held in 2019, it is hard to determine the impact political stability has on the Chinese level of investments. This topic is the focus of this research paper. Whether Madagascar's progress towards democracy and political stability through Rajoelina's new protectionist and expansionary economic policies benefited Chinese investors and saw increased levels of FDI or whether the levels of FDI dropped as a result of Rajoelina's policies is to be determined in this study.

Literature Review

The theoretical framework guiding this review focuses on the presumption that earlier forms of a socialist Malagasy government implemented market-based supply-side policies in the form of the nationalisation of several industries which led to high capital flight, decreased investment and high inflation. Hence, the conceptual underpinning of this review is to evaluate the potential of recent attempts to utilise expansionary demand-management and interventionist supply-side policies. In order to analyse the use of supply-side policies, a neoclassical economic approach is used throughout when discussing existing research. As such, the criteria used to select and interpret literature focus on the use of governmental policies other than industrial nationalisation as well as research conducted on Chinese FDI and its

economic and social impact on local communities.

Previous literature illustrates the failed developmental economic policies Madagascar's government has implemented in the past and its attempts at enhancing trade with China in the 21st century. Andriamampiandra (2021) highlights that the growing presence of Chinese investors has created disputes between the Malagasy government and citizens due to non-compliance with environmental conditions and labour laws. This has created a strong animosity between Chinese investors and the local population, further exacerbated by the cultural differences between the Chinese and the Malagasy, which may be a powerful deterrent for further Chinese arrivals[32]. However, the paper also mentions that the Republic of Madagascar wishes to attract investors and make the private sector the main engine for its development. Hence, Rajoelina's administration has adopted laws that aim to provide an attractive and practical climate to do business. The paper also states that the government held as one of its priorities to deal with international competition and build a tangible competitive advantage, presumably to avoid foreign firm monopolisation in the large Malagasy urban areas. The paper uses primary data from Chinese investors and the local population in the form of quantitative analysis to analyse the socioeconomic landscape and draw conclusions. Fienena (2023) suggests that China's Belt and Road Initiative (BRI) could create new business and job opportunities in Madagascar. However, there are concerns about labour laws, working conditions, and the dominance of Chinese companies over local ones[33]. The paper collects data from surveys and questionnaires given to the youthful Malagasy population. A secondary quantitative and qualitative analysis is also conducted and displayed in the form of a literature review. Veeck (2012) examines the perceptions of Malagasy citizens towards the Chinese presence and investments, showing differentiation based on length of residence and intermarriage rates[34]. This also reflects the difference in the method of conducting business between earlier Chinese migrants who immigrated to Madagascar in the early 1900s and the modern-day Chinese immigrants in Madagascar[35]. The former are completely integrated into Malagasy society and take on the roles of producers in the Malagasy economy, working mostly in the primary sector alongside Malagasy farmers. Intermarriage rates are also high within this Chinese community. On the other hand, recent Chinese migrants have no ties with Malagasy local populations and take on the role of wholesalers in the Malagasy economy. Their extensive contacts in mainland China render them more effective wholesalers than their Malagasy counterparts, and hence, Chinese firms dominate the Malagasy export market. It can be argued that Chinese wholesalers have monopolised the wholesaler market in Madagascar. Anaxagorou (2020) explores how electoral motives shape the subnational foreign aid allocation in sub-Saharan Africa, indicating that African leaders may divert Chinese aid to regions with high political support35. However, the World Bank's aid is less susceptible to political manipulation. This proves to be another factor contributing to the ongoing corruption of Madagascar's government; accepting direct aid from foreign countries like China to develop commerce and Russia to fund political campaigns may place Madagascar further away from attaining the status of a real democracy.

However, Chinese FDI in Madagascar has also brought numerous advantages to the Malagasy, namely generating a total of 20,000 local employment opportunities and funding a series of developmental infrastructural projects including routes, well drilling, the modernising of telecommunication networks, hybrid rice cultivation, skill transfer through educational seminars and public health. Extensive FDI from China has contributed to the construction of the Ivato airport in the capital city of Antananarivo, the RN2 highway connecting Moramanga to Andranonampango, the Anosiala medical centre in Ambohidratrimo, and the establishment of a Confucius Institute within the University of Fianarantsoa to promote skill and cultural transfers between the two countries[36]. The Communist Party has also donated a pair of patrol boats in 2017 following Madagascar's vow to enhance its naval forces. Hence, China is aiding Madagascar through a combination of foreign grants and direct investment to increase standards of living in the economy. Similarly, the abolition of tariffs on 95% of African goods by China has also heightened the export of Malagasy mineral resources[37].

Morey (2010) measures the impact of income shocks on women and the well-educated to analyse the effect of political instability in Madagascar on the groups that are worst affected by economic downturns in the Malagasy economy. He takes these two as his experimental groups on the notion that women are more vulnerable to income loss because of the higher spending burden they incur when in families. He displays the differing incomes based on gender as the reason why political instability leads to worse human development indices than expected based on income levels alone. The paper highlights Madagascar being a patriarchal society. Morey uses collections of demographic data, community-level data and crisis-related data to set constant population as a fixed variable and use change in the price level of rice as a metric of political instability to measure its impact on the population's spending patterns. Primary data in the form of surveys is collected, alongside results being derived from coefficients and significance. A severe limitation of this study is that there is no way to ensure homogeneity between samples. Morey retrieves his data from the Recurring Household Survey in Malaysia (EPM) and compares data on population migration before and after political and economic shocks. The roadblocks per mile of road and the number of reported bombings in the different regions also acted as further indicators of political instability in his paper[38].

Dorosh (1994) takes a distinct focus on the policies implemented by the Ratsiraka administration in the 1960s to 1980s, providing insight into the policies implemented by the adminis-

trations earlier on in Malagasy history. This source was included in the study on account of it being Ratsiraka's policies that left Madagascar in a long-term recession well into the 21st century, and it being the policies implemented by his administration in post-colonial Madagascar that resulted in the low levels of human capital present on the island to this day. He highlights that contractionary fiscal policy was used to halt inflation in the 1970s but took a toll on economic growth in Madagascar. Dorosh (1994) also argues that political uncertainty hinders government developmental efforts, discourages private investment, and stalls the flow of foreign aid[39]. To prove this, he created a CGE model to produce simulations of the Malagasy economy. Dorosh uses SAM (a social accounting matrix) constructed using 1984 national accounts and an input-output table. He divides the types of labour into 3 categories, i.e., the highly skilled, the skilled and the unskilled, and collects data on the income levels of each. Dorosh then uses CES (constant elasticities of substitution) functions and determines that Madagascar is a price taker. He focuses on the stabilisation policies implemented by Ratsiraka. He uses 4 simulations to illustrate the impact of the policies on the economy, displaying foreign capital inflows and the exchange rate levels as well as their impact on different household community welfare.

Chen Landy (2016) analyse Chinese levels of investment in Madagascar by investigating the presence of Chinese firms operating in the regions of Antananarivo, Toamasina, Antsiranana, Mahajanga, Toliara and Fianarantsoa and their investments in the Malagasy economy. The paper utilises a mixture of secondary sources and primary data collected from their fieldwork where a series of Chinese firm representatives were interviewed. Two main datasets are used: 1) INSTAT (Malagasy Government Statistical Agency) and 2) MOFCOM (Chinese Ministry of Commerce). Chen Landy (2016) determine that Chinese investments in the construction and mining sectors have been unprofitable. In contrast, Chinese investments in agriculture and manufacturing are deemed profitable and are now the two key industries in Madagascar. Some of the main deterrents entail high political instability in the region due to the frequent coups d'état; the coups occurring in 2002 and 2009, and the diverse challenges arising from restrictions on foreigners placed by Madagascar's constitution. The law prohibiting foreigners from owning Malagasy land causes foreign investors, the Chinese amongst them, to establish long-lasting lease agreements with several government departments without any guarantee that the lease will be seen through the term as changes in the political regime have proved to overturn lease agreements in the past[40]. This proves a risky investment to any foreign investors. A limitation of this paper is that it does not take a deep enough approach when evaluating Madagascar's pursuit of becoming a fully functional democracy, as it does not mention what political elections were most successful and which expansionary policies the Malagasy government implemented to foster national economic growth. The paper gives an extensive overview of China's firm's investments in Madagascar but a fairly limited overview of Malagasy government policies.

Methodology

The data used in this study covers the exports from Madagascar to China and the imports from China to Madagascar through a seven-year time period starting in 2014 and ending in 2021. The data set also includes the real GDP values for Madagascar across the seven-year time period. The methodology used in this paper replicates that of Markova (2016) to ensure precision and conformity in the use of the Granger causality test. The import values are subtracted from their respective export values so as to produce the net export values for Madagascar throughout the time period. The sample period and country selection are both purposefully chosen to reflect the change in net exports during the years prior to the peaceful exchange in power in Madagascar in 2018, and that of the net exports after this change of power took place. The data set only contains information on these variables until 2021 as there was no available information on nominal or real imports and exports of goods and services between Madagascar and China for 2022 and 2023 at the time this study was conducted. The use of more recent data in the test may also hinder the focus of the study, which is to measure the impact of the 2018 Malagasy presidential election on economic variables. Attempting to include macroeconomic data from 2022 onwards may disrupt the perceived effects of the 2018 electoral outcome on Chinese FDI and Malagasy real GDP due to external shocks akin to the Russia-Ukraine War and their implications on global trade dynamics that are posterior to 2018. The data for real exports and imports is extracted from the Observatory of Economic Complexity, *Historical Data - Bilateral Trade by Products,* whereas the data for real GDP was extracted from the World Bank[41], and adjusted for inflation with the use of the GDP deflator and inflation values from the International Monetary Fund[42]. For the former, efforts were made to corroborate the data with other sources, namely[43]. However, net export values are significantly disparate between one another, with the second source featuring trade data that is greater by $100 million on average. For example, a reason why OEC net export values may be lower across all metrics than those of TE are because the former do not estimate, consider or quantify the size of the informal trade market between Madagascar and China, whereas TE does. This may be especially true as of the Malagasy fishing industry, where illegal overfishing is commonplace. Due to the numerical divergence between data sets, it is determined that OEC net export data where the informal market is unaccounted for will be used instead of TE, since the extent of the Malagasy informal economy is an estimate and may lead to a greater margin of error, potentially undermining the robustness of this study's results. A bivariate autoregressive model

Year	Imports (million $)	Exports (million $)	Nominal GDP (billion $)	Net Exports (million $)	Real GDP (billion $)	Inflation %
2014	630	88	12.52	-542	11.80	6.1
2015	7498	144	11.32	-605	10.54	7.4
2016	838	137	11.85	-701	11.17	6.1
2017	906	162	13.18	-744	12.14	8.6
2018	956	79	13.76	-876	12.67	8.6
2019	891	181	14.10	-710	13.35	5.6
2020	853	109	13.05	-744	12.52	4.2
2021	1164	316	14.47	-848	13.68	5.8

Table 1 Madagascar-China Trade and Gross Domestic Product Data

(Granger causality) is used to estimate the causation between net exports and real GDP in Madagascar and to determine whether data on net exports to China is useful in predicting future real Malagasy GDP. A reverse Granger causality test is also run to determine whether real GDP data is also useful in predicting net exports. All the collected and used data is presented in a tabulated format in (Table 1).

Real GDP

The Real Gross Domestic Product of Madagascar from 2014 to 2021 is used as a measure of economic growth and is seen as the dependent variable in this study, as the accuracy of prediction of future real GDP is measured based on previous time series data for Malagasy GDP and previous time series data for Madagascar-China net export levels. Nominal GDP was converted to real GDP with the use of the formula:

$$\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{GDP Deflator}} \times 100$$

The use of the price deflator ensures the values for Malagasy GDP are an accurate representation of the summation of all goods and services produced in the country according to the year of production, and there is no error incurred in the values used for the Granger causality test.

Net Exports

The data for real imports and exports was extracted from the Observatory of Economic Complexity and it represents the value of the total number of goods and services traded in Madagascar in $ yearly from 2014 to 2021. The net exports values were calculated through the formula:

$$\text{Net exports} = \mathit{Exports} - \mathit{Imports}$$

The subtraction produces negative values for Malagasy net exports because Madagascar is and has been operating at a trade deficit with China since 2014 at the minimum. The data has already previously been adjusted for inflation, such that prices are kept constant and accuracy in the Granger causality test is preserved. Net exports act as the independent variable in this study, as the causation between real GDP and net exports is investigated by analyzing a time series where real GDP is predicted based on previous real GDP data, and another time series where real GDP is predicted based on previous real GDP and net export data.

Model

A detailed discussion of the applied empirical approach utilised in the model estimate is given in this section. A bivariate model is evaluated to investigate the presence and direction of the causal association between net exports and economic growth.

The possible Granger causation between net exports and real GDP can be studied with the use of the following vector autoregressive (VAR) models.

$$\text{RGDP}_t = \alpha\text{RGDP}_t + \beta_1 \times \text{RGDP}_{t-1} + \beta_2 \times \text{NX}_{t-1} + \varepsilon_t \quad (1)$$

$$\text{NX}_t = \alpha\text{NX}_t + \beta_1 \times \text{NX}_{t-1} + \beta_2 \times \text{RGDP}_{t-1} + \varepsilon_t \quad (2)$$

where RGDP_t and NX_t are the values of real GDP and net exports at time t, αRGDP_t and αNX_t are the intercept terms for the real GDP and net export equations respectively, $\beta_1 \times \text{RGDP}_{t-1}$ and $\beta_2 \times \text{RGDP}_{t-1}$ are the coefficients of lagged real GDP in equation (1) and lagged real GDP in equation (2) respectively, $\beta_2 \times \text{NX}_{t-1}$ and $\beta_1 \times \text{NX}_{t-1}$ represent the coefficients of lagged net exports in equation (1) and lagged net exports in equation (2), and ε_t are the error terms for the real GDP and net exports equations at time t.

In terms of this system of equations, there are three possible outcomes.

There is one-way Granger causality from net exports (NX_t) to real GDP (RGDP_t) if the coefficient $\beta_1 \times \text{NX}_{t-1}$ that is associated with the lagged net exports $\beta_2 \times \text{NX}_{t-1}$ in equation (1) is statistically significant and a positive value, implying that past values of net exports $\beta_2 \times \text{NX}_{t-1}$ Granger-cause changes in real GDP RGDP_t. This would suggest that past data on net exports provides statistically significant forecasting power for predicting changes in real GDP, thus meeting the criteria for one-way Granger causality from net exports to real GDP.

There is multidirectional Granger causality if both net exports and real GDP Granger-cause each other, for which the coefficients associated with lagged variables in both equations must be examined. If the coefficients for lagged net exports $\beta_2 \times \mathrm{NX}_{t-1}$ are positive values and are statistically significant in the equation for real GDP RGDP_t, and the coefficients for lagged real GDP $\beta_2 \times \mathrm{RGDP}_{t-1}$ in the equation for net exports NX_t are also positive and statistically significant, then there is multidirectional (bidirectional) Granger causality where both variables Granger-cause each other.

There is reversed Granger causality if real GDP values can be used to predict future net export values. If the coefficient $\beta_2 \times \mathrm{RGDP}_{t-1}$ that is associated with the lagged real GDP in equation (2) is statistically significant and a positive value, it suggests that past values of real GDP Granger-cause changes in net exports. This would indicate that past real GDP data $\beta_2 \times \mathrm{RGDP}_{t-1}$ is useful in predicting changes in net exports NX_t.

The lagged order of these equations is determined by the lag term, in this case $t-1$. The order used in this model is 1 due to the short time period being analyzed and the immediate impact and response of Chinese FDI to changes in the Malagasy government. These have previously shown to have significant short-term effects on the economy, as past changing administrations have been accompanied with riots, coups d'état, and terrorist acts such as the bombing of highways which debilitates Malagasy infrastructure and decreases business confidence, all happening in a short time span, requiring a lag length of 1. Hence, using a lag length of 1, we get a model such that real GDP RGDP_t is regressed on one lag of itself RGDP_{t-1} and one lag of net exports NX_{t-1}, and net exports NX_t are regressed on one lag of real GDP RGDP_{t-1} and one lag of itself NX_{t-1}. Using this order allows us to preserve model simplicity and allows for the easier identification of data characteristics, such that relevant data can be adequately captured with minimal error. Higher-order VAR models may not account for the decaying effects of past values on current values because of the long time-span.

To justify the lag length selection, the Akaike Information Criterion, a.k.a, AIC is used, whereby the quality of each model differing by a lag selection is estimated relative to the model equivalents with different lag lengths. The AIC is opted for instead of other criteria such as BIC due to the model not needing to be nested, i.e., the model investigated does not require parameters that are a subset of the parameters used in a different model. Hence, the model with the lowest AIC score is determined to be the most accurate in this study, according to the equation below.

$$\mathrm{AIC}_c = n \times \ln(\sigma^2) + 2K + \frac{2K(K+1)}{n-K-1} \tag{3}$$

where $n =$ sample size $= 8$, $K =$ number of parameters $= 4$, and $\sigma^2 = \frac{\text{residual sum of squares}}{n}$.

The adjusted AIC_c model formula is used instead of the standard AIC due to the small sample size under investigation and the ratio of the model's parameters to the sample size being less than 40. Hence, the addition of the correction term adds proportion to the model and would converge the AIC value for larger samples, increasing the accuracy of the AIC value for equations (1) and (2).

Firstly, using the formula for a best fit line, the relationship between the variables real GDP and net exports can be approximated as:

$$\mathrm{RGDP} = -6.1772(\mathrm{NX}) + 7.7785 \tag{4}$$

Hence, the residual sum of squares is found by calculating the summation of the squared differences between each projected real GDP value and its actual value in a set year, hence the sum of squared residuals is -0.1628. This results in an AIC value of -9.8221, which is significantly low enough to ensure the adequacy of the lag length of order 1 being used in equations (1) and (2).

Granger causality

In time series analysis, our goals are to determine the direction of causality (unidirectional, bidirectional, or none) and whether changes in one variable affect changes in the other and can thus be used to predict future values. By using F-tests to examine whether lagged values of a variable Y convey any statistically significant information about variable X in the presence of lagged X values, one can use the Granger (1969) logic for evaluating causality[44]. Therefore, in the event that no statistically significant information about variable X is retrieved, Y does not Granger-cause X.

The Granger causality test will be performed with the use of a VAR model (vector autoregressive model). VAR models (block exogeneity Wald tests) are econometric models used to represent the evolution and interdependencies between several time series[45]. Each variable in the system has an equation, which allows for a symmetric treatment of all the variables. This contributes to the explanation of its evolution based on its lags and the lags of the other model variables. A set of variables measured over a period of time and described as a linear function of just their past change are described by a VAR model. The majority of VAR models are estimated using symmetrical lags, meaning that each variable in the model has the same lag length applied to it. Alternative methods used to examine causal relationships in time series data include transfer entropies, convergent cross mapping (CCM), and Bayesian networks, among others. However, the Granger causality test is chosen over alternative methods due to its results being easily determined to be significant based on a metric of statistical significance, i.e., p and F-tests. Similarly, the Granger causality test is based on linear regression models, which suits the demands of this paper by

meeting simplicity and easy display and interpretational requirements. Granger tests also require moderate sample sizes and assume a linear relationship between variables and stationarity. This proves adequate since the sample data has been assembled into a VAR model format and has not been differenced to remove non-stationarity, which is unnecessary due to Granger tests not being as sensitive to noise as other statistical methods. Transfer entropy, a.k.a, Shannon entropy, is effective at examining data in non-linear regression, where a non-linear combination of model parameters depends on several independent variables. However, it is computationally intensive due to the need for estimating joint probability distributions, requires sizable datasets for reliable probability estimation, is sensitive to parameter choices and noise, and shows a degrading performance with small sample sizes. CCM involves sophisticated nonlinear dynamical system concepts and requires space reconstruction and cross mapping, making it computationally intensive and difficult to interpret. Bayesian networks are effective at modelling sequences of variables, but necessitate substantial data for structure learning and inference, which is inadequate in the context of this study due to the small sample size used.

Hence, the previously-derived equations (1) and (2) will be used in this Granger causality. To determine whether one time series variable Granger-causes another, the process dictates that the null hypothesis (H_0) and alternative hypotheses (H_a) are needed. The null hypothesis states that lagged values of one variable do not provide any statistically significant information for predicting another variable, such that for past net exports (Net Exports$_{t-1}$) not Granger-causing real GDP (Real GDP$_t$), the null hypothesis would be that the past values for net exports do not have any significant impact on predicting the current values of real GDP, and vice versa[46]. The alternative hypothesis suggests the presence of causality between variables, such that for past exports Granger-causing real GDP, lagged net export values contains information that significantly helps in predicting the current values for real GDP[44]. The significance of the coefficients associated with lagged variables is evaluated using two statistical tests, i.e., p-values from a t-test will determine whether the null hypothesis is rejected or accepted, and the F-test evaluates the joint significance of lagged variables. The corresponding null and alternative hypotheses for equations (1) and (2) are:

Null Hypotheses

$$H_0 \text{RGDP} \rightarrow \text{NE} : \beta \text{RGDP}_2 = 0 \tag{5}$$

$$H_0 \text{NE} \rightarrow \text{RGDP} : \beta \text{NE}_1 = 0 \tag{6}$$

Alternative Hypotheses

$$H_a \text{RGDP} \rightarrow \text{NE} : \beta \text{RGDP}_2 \neq 0 \tag{7}$$

$$H_a \text{NE} \rightarrow \text{RGDP} : \beta \text{NE}_1 \neq 0 \tag{8}$$

Hence, the null hypothesis (3) states that Real GDP_{t-1} does not cause Net Exportst , and the null hypothesis (4) states that Net Exports$_{t-1}$ does not cause Real GDP$_t$. The alternative hypothesis (5) states that Real GDP$_{t-1}$ does cause Net Exports$_t$ because at least one past real GDP value should be different to zero, and the alternative hypothesis (6) states that Net Exports$_{t-1}$ does cause Real GDP$_t$ because at least one past net export value should be different to zero. Therefore, if the calculated F-statistic is large enough and the associated p-value is below a chosen significance level, it provides evidence to reject the null hypothesis[38]. In this study, the significance level is chosen to be $a = 0.05$, such that the p-value must be < 0.05 to reject the null hypothesis. Table 2 below shows the outcome of the Granger causality test.

Table 2 Bivariate Model Granger Causality Test

	RGDP $\rightarrow$ NE	NE $\rightarrow$ RGDP
Pr(>F)	0.9797	0.03128
F	7.00E-04	10.584

Note: The table presents F-test and t-test results.
H_0: Real GDP does not cause Net Exports.

Hence, the test outcome indicates a one-way causal relationship from net exports to real GDP. As noted from the reported probabilities, the p-value for net exports Granger-causing real GDP is 0.03128, which is smaller than the chosen significance level for this test, i.e. 0.05, which replicates the KPSS test, whereby p-test values of less than 0.05 suggest that a data set is non-stationary and hence differencing is required, disproving the null hypothesis[47]. Moreover, the F-test statistic turns out to be 10.584, which is a large enough value to assume a unidirectional causal relationship between net exports and real GDP. This F-test statistic shows that lagged values for past net exports increase the predictive capacity of the model equation as opposed to a model equation where no net export lagged values are considered. Thus, we can reject the null hypothesis for this relationship and determine that changes in past net export data do affect changes in current real GDP data and have significant forecasting power. However, the null hypothesis for real GDP Granger-causing net export levels cannot be rejected as the p-value for this relationship is 0.9797, which is larger than the significance level (0.05), and the F-statistic is 0.0007, which is too small to prove a causal relationship between variables. Hence, both of the probabilities for real GDP Granger-causing net exports are statistically insignificant and we determine that past real GDP data does not have significant forecasting power when predicting future or current net exports. The null hypothesis equation (3) and alternative hypothesis equation (5) are rejected. This shows that net exports cause economic growth and not vice versa. Said estimated effects have meaningful im-

plications for policy, since the magnitude of the coefficients used in the model, i.e., real GDP and net exports are significant as they are what sustains the Malagasy economy and what controls the potential of the average household income in Madagascar rising, leading to a better standard of living and economic development. Hence, understanding Madagascar's position as a price taker may allow for the better crafting of policy in the Republic of Madagascar by continuing with the legalisation of free trade in Malagasy industries that are globally competitive and are capable of avoiding Chinese oligopoly, i.e., tourism[48], and pursuing protectionist measures in industries uncompetitive against Chinese competitors, i.e., agriculture, forestry, fishing, mining, textiles, etc. Test results may also prove useful in examining expenditure-switching policies that could aid in alleviating the trade deficit experienced by Madagascar with China through currency depreciation so as to increment the overall level of exports.

Results

The main empirical results are discussed in this section. The linkages between real GDP and net exports have been analyzed both in the normal and reversed Granger-causality tests and it has been determined there is a unidirectional relationship from net exports Granger-causing real GDP in Madagascar.

This supports the prediction made in the introduction that Madagascar's overall level of economic growth is guided by its trade level with China as a result of Madagascar's increasing Chinese FDI. Referring back to Table 1, the level of imports from China to Madagascar and the level of exports from Madagascar to China have both gradually increased in the time period from 2014 to 2021, albeit in proportion to the initial investment in 2014. Chinese FDI in Madagascar in 2014 was such that $87,961,386 in Malagasy goods and services were exported to China. However, Madagascar imported a total value of $630,004,439 in Chinese goods and services, which caused it to have a trade deficit level of $-542,043,053. This trade deficit level proportionally maintained itself throughout the years leading up to the 2018 presidential election, increasing by approximately $100,000,000 yearly. After the peaceful exchange of power in 2018, the trade deficit level with China eventually dropped from $-876,359,619 in 2018 to $-709,771,176 in 2017. This reflects the new Malagasy administration's attempts to implement protectionist policies in Madagascar to increase overall domestic production levels and allow their industries to mature so as to remain competitive against foreign firms operating in Madagascar. However, the trade deficit level increases in 2020 to $-743,735,394, presumably as a result of COVID-19, causing a short-term increase in consumption in the country which, we assume, made the Malagasy government loosen its protectionist policies and accept a larger quantity of Chinese imports to meet the level of aggregate demand. The trade deficit level then rises in 2021 to $-848,147,069, reflecting the change in policies implemented by the Malagasy government from protecting and growing its domestic infant industries to opening its borders to further trade with China.

As seen in the Granger-causality test, it is the trade deficit Madagascar has with China that Granger-causes Madagascar's real GDP, and hence its economic growth. This shows Madagascar is highly dependent on trade with China to pursue economic growth and increase its real GDP. Increasing yearly trade with China to increase the economic growth rate presents itself as an easier option for Madagascar than trying to implement protectionist policies to decrease trade (with China), at the expense of a decrease in the current rate of economic growth, so as to revert the Granger-causality and make its net exports with China dependent on its level of economic activity, which is the Granger causality followed by most developed countries in Europe and North America[45]. The Malagasy government prioritizes increasing its current economic growth rate at the expense of a higher economic dependence on China.

These results also show that Madagascar's pursuit of democracy does not affect Chinese FDI significantly because of the high degree of economic dependence that Madagascar has on China. Madagascar's pursuit of democracy, represented by the protectionist policies implemented by the newly-elected Malagasy administration that aimed to decrease Chinese product monopolization in urban areas, temporarily decreased the trade deficit level between the two countries. However, the decrease in the trade deficit level was not sustained as a result of Madagascar's need for Chinese FDI to maintain its current economic growth rate. Implementing further protectionist policies may decrease the rate of economic growth in the short term, which is something the Malagasy administration is not willing to undertake. Hence, Madagascar currently follows a bivariate system where its net exports with China determine its real GDP and economic growth, whereas in order to reach the status of a middle to high-income politically stable democratic country, it would have to follow a bivariate system where its real GDP Granger-causes its net exports with China.

Conclusion

The aim of this paper is to investigate whether the 2018 presidential election in Madagascar, which is depicted as the first peaceful transfer of power in the country in the 21st century, decreases or increases Chinese FDI levels in Madagascar and to establish a relationship between Madagascar's net exports with China and the former's economic growth. This was examined through the use of a Granger-causality test between economic growth, measured by the Gross Domestic Product values adjusted for inflation for Madagascar from 2014-2021, and Madagascar's net exports with China. Following the subtraction of Madagascar's imports from China and its exports to

the latter, the net export values calculated are negative, showcasing the trade deficit level between the two countries. After performing the Granger-causality test, a unidirectional causal relationship was identified between Malagasy net exports and real GDP, whereby past data on net exports is useful in forecasting future real GDP data. Because the p-value resulting from the t-test is smaller than the selected significance level (0.05), and the F-statistic is a large number, the values are of statistical significance and the null hypothesis is rejected. Conversely, the reverse Granger-causality test showed statistically insignificant values for the t-test and F-test, as the p-value was significantly larger than 0.05 and the F-statistic was significantly smaller than 0.

Given the results above, the following conclusions can be drawn. Lagged values of past net exports significantly increase the forecasting ability of current and future real GDP values for Madagascar. Madagascar is economically dependent on China so as to maintain its current economic growth rate. Madagascar's trade deficit with China renders it a price taker that must accept prices of goods and services set by the global market and China. The protectionist policies set by the Malagasy administration elected in 2018 failed due to their priority to foster global trade in Madagascar and Madagascar's high dependency on trade with China. There is no case of multidirectional Granger-causality between Malagasy net exports and real GDP. However, there are several omitted variables in the bivariate model used in this study which are capable of inducing error into the obtained results. The model utilises real GDP and net exports as metrics, which provides a detailed numerical description of economic growth in Madagascar and the capital flow in the Malagasy economy, yet this does not serve as an indicator of economic development within Madagascar. The use of a bivariate model is hence a limitation, as it omits important economic variables such as inflation, interest, and employment rates and their causal relationships with Chinese FDI. Conducting an extension to this study using a multivariate model featuring these omitted variables would provide evidence of whether Rajoelina's administration is potentially implementing expansionary monetary policy by depreciating the Malagasy Ariary, whether inflation is outpacing the economic growth rate experienced as a result of Chinese FDI, and whether Chinese FDI leads to higher employment among local communities.

This study supports that, although trade has a positive effect on economic growth, as evidenced by the increasing real GDP and trade deficit levels in Madagascar in Table 1, Madagascar should prioritize decreasing its trade deficit level with China, albeit at the expense of a slowing economic growth rate, so as to implement protectionist policies that will develop Madagascar's domestic industries and render them competitive against Chinese firms operating in the country, hence avoiding long-term economic dependency on China and potentially making Madagascar a price maker. However, implementing protectionist policies will render Madagascar subject to retaliatory measures from China, which may decrease the level of imports, helping reduce the trade deficit, but halt the transfer of skills, knowledge, and funding of infrastructure, education and healthcare projects that are currently modernising the Malagasy economy and promoting long-term economic growth. This may lower human capital to levels similar to those under the Ratsiraka administration, see page 4, and exacerbate unemployment. Further needed research in this field of interest includes the need to establish the causal relationships between Madagascar and its other trading partners, including the United States, France, Canada etc, to determine whether it is only China that has such a high degree of economic dominance over Madagascar and whether reducing the trade deficit level with China will render Madagascar a more financially capable country with a chance to become a price maker. More nuanced investigative studies that answer these conjectures are needed to further evaluate the impact of Madagascar's dependency on China and to interpret the monopolisation of the foreign market in Madagascar's urban areas.

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