Dictators Under The Weather[1]

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Abstract: We show how and when dictatorships are able to use international trade policy to forestall democratization in the face of weather shocks. Our model shows when a domestic weather shock creates the threat of a revolution. Under a 'mild' weather shock, the dictatorship are able to defuse the threat of revolution by setting a 'status quo policy'. Under a 'severe' weather shock, the dictatorship face a commitment problem: they must democratize in order to defuse the threat of revolution. Using a dataset of Sub-Saharan African countries, we find econometric results that are consistent with the predictions of our model.

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1 Introduction

This paper provides empirical evidence, based on a theoretical model, of a new motivation for international trade policy. The new motivation is that dictators may use international trade policy to ensure their political survival. Evidence of the fact that trade policy is used in this way is important because it flies in the face of over two centuries of thinking about the relationship between trade liberalization and democratization.

Building on the point that free trade enhances efficiency, Adam Smith famously argued that countries should seek to democratize and liberalize, because democracy supports harmonious international economic relations, of which free international trade is a central pillar (Smith 1776). His argument has developed considerable intellectual force through over two centuries of research and political discourse. And it now forms the basis for the advice of multilateral organizations in their attempts to support economic development around the world (Woods 2006, Zissimos 2019). Yet the evidence we present in this paper shows that trade liberalization is routinely undertaken in a way that undermines Adam Smith's argument: trade liberalization may in fact be undertaken to forestall democratization.

More broadly, the purpose of this paper is to explore how and when dictators are able to use trade policy to forestall democratization, and when they must democratize in order to defuse the threat of revolution. The new motivation for international trade policy has been explored theoretically by Zissimos (2015, 2017). Empirical studies on the relationship between democracy and trade liberalization have been undertaken by O'Rourke and Taylor (2007), Decker and Lim (2007), Aidt and Gassebner (2010). Schonhardt-Bailey (2006) argues that Britain's repeal of the Corn Laws in 1846, possibly the most studied case of trade liberalization, was actually undertaken by the British aristocracy to forestall democratization. The present paper is the first to present evidence, motivated by theory, on when a dictatorship will be able to use trade liberalization to forestall democratization and when it will not.

We will examine systematically when a dictatorship will not be able to forestall democratization using international trade policy, and will have instead to extend the franchise. The basic idea is that a transitory negative income shock created by a drought can create the threat of a revolution. The model shows that if the drought is not too severe then the elite will be able to use trade policy to defuse the threat of revolution and ensure their political survival as a

dictatorship. However, if the drought is severe enough, they will have to respond to the threat of revolution by extending the franchise.

The question of how income is related to democratization is one of the fundaments of political economy. Toqueville (1835) argues that industrialization and the associated increase in income give rise to democratization. His argument has found support in the econometric work of Przeworski and Linongi (1997), Barro (1999), Prezeworski, Alvarex, Cheibub and Limongi (2000) and Epstein, Bates, Goldstone, Kristensen and O'Halloran (2006).

Conversely, Lipset (1959) was the first to argue that democratic reform is often sparked by economic recessions; that is, by changes in income that are negative and transitory. Acemoglu and Robinson (2000, 2001, 2005) develop the 'commitment theory of democratization' to explain how a transitory negative income shock can provoke democratic reform. According to this theory, in a developing country dictatorship characterized by poorly functioning asset markets and high inequality, 'the poor' would like to achieve a more equitable distribution of resources, but they face a coordination problem in doing so. A shock can resolve the coordination problem, giving rise to the threat of revolution through which the poor can press for transfers. But the elite face a commitment problem in making transfers over time. Acemoglu and Robinson's key insight is that democratization hands to the poor the power to tax, thus providing a way that the elite can commit to the poor to make transfers over time, thereby defusing the threat of revolution.

Acemoglu and Robinson have opened up an entire field of research on the purpose of democracy. However, so far, this field is limited in terms of detail about the specific mechanisms through which the elite attempt to survive in power, and the circumstances under which they fail. Our paper examines this mechanism and provides evidence of its working.

Our theoretical model focuses on how, in a small open economy, transitory shocks in the form of adverse weather shocks reduce the food consumption of the poor and hence can create the threat of a revolution. Under dictatorship, the elite have control over government, and hence the power to set a tariff on imported food. A drought reduces the availability of food to the poor, but additional food can be imported to alleviate a domestic food shortage by a reduction of the tariff. A drought also lowers the coordination cost to the poor of revolution, because the resulting food shortage brings people onto the streets. The ruling elite who control the government through dictatorship, by contrast, do not want to lower tariffs, perhaps because they collect the tariff revenue or because protection increases their factor income. So there is a

conflict of interest between the ruling elite and the poor over tariff policy. An adverse weather shock, if sufficiently severe, will give the poor an incentive to gain control of government through a revolution, thereby lowering the import tariff and increasing the availability of food.

In our model, the elite also have the power to set an export tax on cash crops, and (by Lerner symmetry) this has the same effect as an import tariff on food in two ways. First, both an import tariff and an export tax raise revenue for the government. Second, if trade is broadly balanced, an import tariff will serve to reduce exports through the reduction on imports, while an export tax will serve to reduce imports through the reduction in exports: hence the symmetry in the effects of these policies. However, an import tariff is the more familiar trade policy instrument and so we discuss the workings of our model in terms of this policy. The reason we mention export taxes is because they will be important in our econometric implementation.

Why focus on trade policy rather than other forms of domestic progressively redistributive taxation such as income taxation? It has long been recognized that trade taxation is a powerful, though inefficient, form of redistributive taxation (Stolper and Samuelson 1941). While domestic progressively redistributive taxation is undoubtedly more efficient, the data show that the capacity for this type of taxation is not installed until after democratization (Aidt and Jensen 2009).

The most recent and comprehensive study of taxation by autocratic regimes is by Dodlova and Lucas (2021). They assemble a detailed dataset of 105 autocracies over the period 1950 to 2004. These data show that, on average, more government revenue is raised from trade taxes than any other form of taxation, at 30 percent, while redistributive income taxation raises less than 1 percent of tax revenues on average in autocracies.

Besley and Persson (2009) provide the logic for why dictatorships are so reluctant to install domestic redistributive tax capacity. If this capacity provides a relatively efficient mechanism to tax the elite's wealth for the purposes of redistribution, then this undermines their incentive to install such capacity. Consequently, for the purposes of redistribution, dictatorships (among other developing countries) tend to rely instead on relatively inefficient trade taxes (Besley and Persson 2011).

We use the model to show that when the weather is in a 'normal range', food is sufficiently plentiful and revolution is sufficiently costly that the poor have no incentive to mount a revolution

even though the ruling elite set the import tariff on food at a level that extracts resources from the poor. However, under a sufficiently large negative weather shock, the poor will have an incentive to mount a revolution if the elite set the tariff at their preferred level. We are then able to show that if the weather shock is 'mild' then the elite will not face a commitment problem, and hence they will be able to defuse the threat of revolution by setting a sufficiently low import tariff. It is only if the weather shock is 'severe' that the elite will face a commitment problem that can only be defused by democratizing through voluntary extension of the franchise.

Our econometric implementation uses Bruckner and Ciccone (2011), henceforth BC, as a reference point. Using a dataset of 40 Sub-Saharan African countries covering the period 1981-2003, they show that transitory shocks in the form of droughts tend to precipitate democratization. They adopt a standard approach in the literature of using the Polity IV database to measure the form of government: democracy or dictatorship. The Polity IV measure takes a value of -10 to 10, with countries in the negative range classed as dictatorships and those in the positive range classed as democracies. Using a two-stage least squares (2SLS) approach, they show that a transitory 1 percent negative income shock leads to an improvement in the Polity IV score of about .2 points and this is statistically significant.

The first step in our econometric implementation is to replicate this result. Importantly, BC's first-stage regression has income measured using gross domestic product per capita (GPC) on the left hand side, and rainfall on the right hand side. To replicate their result, we use the same dataset as they do, and the same econometric specification. The first set of results that we report show that we successfully replicate their main result.

Our next step is to explore whether trade policies serve as valid instruments for GPC. To do this, we first rerun the first-stage regression with GPC on the left hand side and rainfall on the right hand side as in BC's specification, and in addition introduce a measure of import tariffs on the right hand side as well. We then do exactly the same again, except that instead of introducing a measure of import tariffs on the right hand side, we introduce a measure of export taxes.

Our incorporation of trade policies as instruments for GPC is informed by our theoretical model, whereby the elite's motivation for trade policy is to offset the effects of a weather shock in order to ensure their political survival. Under this specification, we find that only the specification with rainfall and export taxes as instruments remains valid. Neither the specification

with rainfall on its own (BC's specification), nor with rainfall and import tariffs, remains valid.

We then re-run the second-stage regression, based on our first-stage regression that has rainfall and export taxes as instruments. Under our modified specification, we estimate that the effect of a transitory 1 percent negative income shock on an improvement in the Polity IV score drops from about .2 points to about 0.05 points, because the elite use an export tax to offset the effect of the shock. We interpret this result as an affirmation of the prediction of our theoretical model, that the elite use trade policy in general, and an export tax in particular, to try to defuse the threat of a revolution that might otherwise be triggered by a drought. In the process, they use trade policy to forestall democratization if they can.

The next step in our econometric analysis is to specify calorific consumption as the dependent variable in the first stage regression, instead of GPC. We used GPC for direct comparison to BC. And since the poor spend a large share of their income on food, GPC is a is valid proxy for food consumption in poor countries such as those in Sub-Saharan Africa. However, we have data on food consumption and so we are able to use this instead of GPC in our regressions. We find broadly the same set of results using food consumption as we do for GPC.

This paper contributes to two strands of the literature. First, it contributes to the literature on the economic determinants of democratic change (Burke and Leigh 2010, Bruckner and Ciccone (2011), Chaney 2013, Aidt and Franck 2015, Dasgupta and Ziblatt 2015, Aidt and Leon 2016). This line of research looks for econometric evidence that a negative real income shock, say through a drought, lowers the opportunity cost to the poor of mounting a revolution, and the threat of revolution in turn precipitates democratic reform.

A central assumption of this econometric work is that if a negative real income shock gives rise to the threat of a revolution, then it will always be resolved by democratization. Building on this line of research, the purpose of the present paper is to focus attention not just on when the elite must defuse the threat of revolution through democratization, but also on when and how they can instead maintain the status quo of their rule through their manipulation of redistributive economic policy. We do this by developing a theoretical model that elucidates the policy mechanism through which the elite maintain the status quo.

Second, our paper contributes to the nascent literature on the political economy of trade protection in authoritarian regimes. Zissimos (2017) combines the models of Mayer (1984) and

Acemoglu and Robinson (2000) to determine when a dictatorship can use trade policy to forestall democratization, and when it must extend the franchise to defuse the threat of revolution. Hence, the theoretical model in the present paper is in one sense a simplified version of the model in Zissimos (2017), but in another sense it is an extension because it can be used to consider the effect of temporary weather shocks while the prior model could not. Ruckteschler, Malik and Eibl (2021) also offer complementary evidence to that of the present paper. While Zissimos (2017) and the present paper are grounded in the problem of authoritarian control where the regime faces a threat from outside the elite, Ruckteschler et al (2021) consider the use of trade policy to reward subgroups of the elite for their loyalty in supporting the ruling regime.

The paper proceeds as follows. Section 2 develops the basic model of the economy. Section 3 then embeds this into a dynamic game with weather shocks. Section 4 characterizes equilibrium and derives the testable predictions. Section 5 then discusses the empirical design and the data. Section 6 presents the results of the econometric analysis. Section 7 concludes.

2 The Basic Model

We model a single small country that takes world prices as given. The population of the country is divided into two groups: a rich ruling elite, e, and the rest of society who are poor, p. The population of the poor is normalized to 1, and the population of the elite is less than 1, so the elite are in the minority. The model has two periods, $t = 0, 1$, to capture the commitment problem that the elite face when they are under the threat of revolution.

The model is partial equilibrium in the sense that we model only the production and consumption decisions of the poor. These are all that will be needed to determine whether the elite need to respond to a weather shock, either by extending the franchise or by temporarily adjusting trade policy. We do not need to model the elite explicitly to understand that they would always prefer to maintain their rule under dictatorship since they benefit from the trappings of power.

The poor consume only food, which is the sole consumption good in the model, and their consumption in period t is denoted by f_t. The poor spend all of their income on food, with all their income being generated through their ownership of two specific factors. They are endowed with a unit of land that is specific to the production of food. They are also endowed with a

unit of labor which they can use to work on the production of cash crops. In the background, the elite are assumed to own the land on which the production of cash crops takes place. The elite are assumed to consume only a negligible amount of food, because they form a negligible share of the population and/or because food is an inferior staple good and elite incomes are sufficiently high that their demand for it has fallen to zero. Hence f_t is also aggregate demand for food in period t by the economy as a whole.

The productivity of both the poor's factors is determined partly by the weather. The weather in each period, w_t, $t = \{0, 1\}$, is given by a probability density function that has support $[0, 2]$, and mean at 1. Then the poor's output of food in period t is w_t. Only the poor produce food, so w_t is also aggregate output of food by the economy as a whole. Output of the cash crop is also dependent on the weather. Accordingly, the poor's payment for their role in the production of the cash crop is given by $w_t a$, where a is the value of a unit of the cash crop measured in units of food.

Since the poor consume only food, they will use all of their income from cash crop production to buy food, and since they consume all the food that they produce, all of the food that they buy with their income from cash crop production must be imported. Hence, denoting the imports of food in period t by m_t, the import demand function for food in period t is given by $m_t = w_t a$. However, the amount of imported food that they get to consume in each period will be reduced by a specific tariff, τ_t. The specifics of how the tariff is set will be specified in due course. Note that the poor are assumed not to receive any tariff revenue.

Each member of the poor is identical in terms of their preferences and discount factor, $\beta \in (0, 1)$. Representative poor agent p's expected utility at time 0 is $U_0^p = \mathbb{E}_0 \sum_{t=0}^{1} \beta^t f_t$, where $\mathbb{E}_t$ is the expectations operator conditional on information available at time t. Using the above specification of poor income, the poor's overall consumption of food in a given period is given by

$$f_t = w_t \left(1 + a - \tau_t\right) \tag{1}$$

At time $t = 0$, while agent p knows w_0 and so can use this in the formation of their expected utility. While they do not know w_1, they know the probability distribution function of w and can use this to form an expectation of their payoff in period 2, and hence their formation of expected utility.

2.1 Tariff Setting and Preferred Tariff Levels

If in period t there is a dictatorship then the import tariff will be set by the elite, denoted by τ_t^e. If on the other hand in period t there is democracy then the tariff will be set by the median voter who is a member of the poor, hence denoted by τ_t^p. The dynamic game specified below will determined the form of government, dictatorship or democracy, that arises in equilibrium.

We will assume that each group has a 'preferred tariff level,' which is the tariff level that maximizes their welfare. It is fairly easy to see from (1) that the poor's preferred tariff level, $\hat{\tau}^p$, will be free trade: $\hat{\tau}^p = 0$, since this maximizes the amount of food that they are able to consume. On the other hand, the elite's preferred tariff level is assumed to be positive. This could be for two reasons. One is that they benefit from the revenues raised, say through the rents that are raised for government from which they benefit. Or, following the prediction of the Stolper-Samuelson Theorem they may own a relatively scarce factor and hence benefit from protection because this increases the returns to that factor. Hence we will assume that the elite's preferred tariff is positive: $\hat{\tau}^e > 0$. Thus we have a conflict of interest between the elite and the poor over how tariff policy is set. The fact that the elite set a positive tariff level under dictatorship will provide motivation for the poor to want to democratize, hence gaining the power to adopt free trade.

3 Dynamic Game with Weather Shocks

The approach to characterization of equilibrium follows Zissimos (2015), but extends the approach to accommodate random weather shocks. To examine which outcome will arise in equilibrium, we will first formalize the payoffs to the respective groups under the various possible outcomes of elite rule, E, democracy (through an extension of the franchise), D, or (democracy through) revolution, R. Note that the form of government, F, is either D or E.

The concept of equilibrium is Markov Perfection, wherein each player's strategy depends only on the state (F, w) in a given period. The elite's strategy consists of a choice over whether or not to extend the franchise and how to set the import tariff. The poor's strategy consists of whether or not to respond to the elite's choices by mounting a revolution. A best response by the elite is their welfare-maximizing choice for all F, w, given the strategy of the poor, and vice versa. Then a pure strategy Markov Perfect Equilibrium (MPE) is a set of mutual best

responses.[4]

3.1 The Sequence of Events

Initially, in period 0 there is elite rule. Within a period, t, the sequence of events is as follows. First, the weather, $w_t \in (0, 2)$, is realized. Second, the elite decide whether or not to extend the franchise: if they do then there is democracy; if they do not, they set trade policy, $\tau_t = \tau_t^e$. Third, if the elite have not extended the franchise then the poor decide whether or not to mount a revolution: if they do so it is successful for sure, leading to democracy. Fourth, if there is democracy then trade policy τ_t is set by the median voter (a member of the poor because they are in the majority). Fifth, production takes place, demands are realized, markets clear and consumption takes place.

If democracy does not arise in period 0, then in period 1 the sequence of events starts again at the first stage, and proceeds through all stages. If in period 0 democracy does arise then in period 1, $w_t \in (0, 2)$ is determined in the first stage as before, but the second and third stages are skipped, moving straight to the fourth stage where the median voter sets trade policy.[5] The assumption that all members of the poor are identical to one another, and in the background all members of the elite are also identical to one another, means that we can model the members of each group as a single player. So the game between the elite and the poor can be modeled as a two-player game.

3.2 The Threat of Revolution, Commitment Problem, and Democratization

We can dramatically simplify the specification of the game if we can find a condition under which, if period 1 begins with dictatorship then under no circumstances would the poor want to mount a revolution that period. If the poor would not want to mount a revolution in period 1, then the elite can set $\tau_1^e = \hat{\tau}^e$ with impunity that period. This creates the potential for the elite to face a commitment problem if they face a threat of revolution in period 0. To defuse the threat of revolution in period 0, the elite must be able to credibly commit to induce at least

[4] In this paper, we do not consider mixed strategy MPE. We will discuss informally the implications of allowing for mixed strategies in the characterization of equilibrium.

[5] Democracy is assumed to be an absorbing state, enabling us to focus the analysis on whether or not it is possible to set trade policy to forestall democratization. Acemoglu and Robinson (2001) present a model where democracy may fail to consolidate, and the present model could straight-forwardly be extended in that direction.

as high a level of food consumption for the poor under the status quo of dictatorship than they could obtain by mounting a revolution. If they face the threat of a revolution in period 0, then they can credibly commit to any tariff level in period 0, $\tau_0^e < \hat{\tau}^e$ to try to defuse that threat, including free trade, $\tau_0^e = 0$. But say they also need to set $\tau_1^e < \hat{\tau}^e$ in period 1 in order to induce at least as high a level of welfare for the poor as they could obtain from revolution. If they will not face the threat of revolution in period 1, they cannot credibly commit to set $\tau_1^e < \hat{\tau}^e$. In that case we say that they face a commitment problem. Then democratization through extension of the franchise represents the only way that they have to make a credible commitment to a tariff profile that would defuse the threat of revolution.

To make this calculation, we need to know the cost of revolution. We will assume that this is an increasing function of the weather. That is, in period t, the cost of revolution is $w_t c$. This reflects the idea that a revolution becomes increasingly easy to coordinate as the weather shock becomes more severe. Note that the cost to revolution is borne entirely in the period that it takes place.

Now consider the condition required for the poor to obtain a lower payoff in period 1 from mounting a revolution than from living with the status quo of elite rule. This is formalized as

$$w_1 \left(1 + a - \hat{\tau}^e\right) > w_1 \left(1 + a - c\right). \tag{2}$$

The left hand side is just (1), with $\tau_1 = \hat{\tau}^e$ being the tariff under dictatorship. The right hand side is the payoff to the poor from mounting a revolution in period 1. Having mounted a revolution they gain power over trade policy and set $\tau_1^p = 0$, but they must also bear the cost of revolution $w_1 c$. We can see by inspection that for (2) to be satisfied simply requires $c > \hat{\tau}^e$. Intuitively, the cost of revolution to the poor must be higher than the cost implied by the elite's preferred tariff, $\hat{\tau}^e$. Note that this holds for any realized weather, $w_1 \in [0, 2]$. We will assume $c > \hat{\tau}^e$ throughout.

3.3 Payoffs under Franchise Extension, Revolution, and Elite Rule

Let $V^p\left(D; w\right)$ represent the value function for the poor under democracy as a result of elite extension of the franchise. For a member of the poor, the payoff to democracy via an extension

of the franchise takes the form:

$$V^p(D; w_0) \equiv w_0(1+a) + \beta(1+a). \tag{3}$$

Given the realization of w_0, the first term measures the payoff to a member of the poor in period 0, and the second term measures the expected payoff in period 1. At t_0, the poor expect w_1 to take its mean value, $w_1 = 0$, and hence we do not see w_1 appear in the second term of (3). The fact that neither term in (3) depends on τ_t reflects the fact that, under democracy, the poor adopt free trade: $\tau_0^p = \tau_1^p = \hat{\tau}^p = 0$.

The value function for the poor under revolution is given by

$$V^p(R; w_0) \equiv w_0(1+a-c) + \beta(1+a). \tag{4}$$

The first term captures a member of the poor's payoff in the period of revolution, given w_0. The second term is the same as in (3). No tariff appears in (4) because, as with democracy achieved through extension of the franchise, the poor set $\tau_0^p = \tau_1^p = \hat{\tau}^p = 0$. Hence, given that the continuation payoffs are the same under extension of the franchise and revolution, the poor would prefer an extension of the franchise because this avoids the cost of revolution. Thinking along similar lines for the elite, we assume that they would prefer to avoid the cost of revolution as well. Hence, extension of the franchise always has the potential to defuse revolution.

Finally, let $V^p(E, \tau_0^p; w_0)$ denote the value function for a member of the poor under the status quo of elite rule. This is given by

$$V^p(E, \tau_0^e; w_0) = w_0(1+a-\tau_0^e) + \beta(1+a-\hat{\tau}^e). \tag{5}$$

The second term of this function reflects our assumption that $c > \hat{\tau}^e$, and so we know that the elite will set $\tau_1^e = \hat{\tau}^e$ in period 1. However, if the elite face the threat of revolution in period 0 then they can set commit to set τ_0^e at some level other than $\hat{\tau}^e$, and if possible will want to do so in order to try to defuse the threat of revolution. We will use this expression to show that the elite can use trade policy to defuse the threat of revolution instead of extending the franchise if the poor's expected payoff under trade policy set by the elite is at least as high as under revolution.

4 Characterization of Equilibrium

Our characterization of equilibrium will show that in the face of a relatively mild adverse weather shock the elite will be able to maintain the status quo using trade policy, but under a relatively severe adverse weather shock they will have to extend the franchise in order to defuse the threat of a revolution. The outcome will depend on whether the ruling elite can credibly commit to compensate the poor using trade policy for what they could gain from a revolution. If not, then the elite face a commitment problem. We will then show that, when the elite face a commitment problem, democratization offers the only way to avoid a revolution; when they do not, the elite can forestall democratization using trade policy.

4.1 The Commitment Problem and Democratization

As defined above, the elite face a commitment problem if, given the realization of w_0, it is not even feasible for them to use trade policy to maintain the status quo. To examine the commitment problem, let $\widetilde{V}^p(E; w_0)$ be the maximum expected welfare that they can induce for the poor using trade policy (as an alternative to extending the franchise). This is induced by setting free trade: $\tau_0^e = \hat{\tau}^p = 0$. Formally, by setting $\tau_0^e = \hat{\tau}^p = 0$ in (5), $\widetilde{V}^p(E; H) \equiv V^p(E, \hat{\tau}^p; w_0)$. Then, the condition for the elite to face a commitment problem is $\widetilde{V}^p(E; w_0) < V^p(R; w_0)$.

We can use Figure 1 to determine the range of w_0 for which the elite face a commitment problem. The horizontal axis shows w_0. The vertical axis shows the present discounted value to the poor from democracy $V^p(D; w_0)$, revolution $V^p(R; w_0)$, and the maximum level of expected welfare that the elite can feasibly induce for the poor using trade policy, $\widetilde{V}^\rho(E; w_0)$. For each line, the intercept gives the payoff to period 1 and the slope gives the increase in the payoff as a result of a marginal increase in w_0.

The payoff to democracy, $V^p(D; w_0)$, given by (3), is illustrated by the upward-sloping dashed line with origin at $\beta(1+a)$. We can see from the diagram that this line has slope $1+a$. The solid upward-sloping line with the same origin as $V^p(D; w_0)$ is $V^p(R; w_0)$, given by (4). As the diagram shows, this has a shallower slope, $1+a-c$, reflecting the fact that revolution entails an additional cost cw relative to democracy achieved through extension of the franchise. The solid line showing $\widetilde{V}^p(E; w_0)$ has its origin at $\beta(1+a-\hat{\tau}^e)$, lower than the origins for

$V^p(D; w_0)$ is $V^p(R; w_0)$, but slope $1 + a$ which is the same as the slope of $V^p(D; w_0)$. This shows the poor's payoff when the elite set their preferred tariff level in period 1, but adopt free trade in period 0. Finally, the dashed line for $V^p(E, \hat{\tau}^e; w_0)$ has its origin at $\beta(1 + a - \hat{\tau}^e)$ and slope $1 + a - \hat{\tau}^e$. This shows the poor's payoff when the elite set their preferred tariff, $\hat{\tau}^e$ in both periods 0 and 1.

Critical levels of w_0 are shown on the diagram by $\tilde{w}_0$ and $\bar{w}_0$. First, $\tilde{w}_0$ shows the level of w_0 at which the payoff to revolution, $V^p(R; w_0)$, is identical to the payoff to the maximum level of expected welfare that the elite can feasibly induce for the poor using trade policy, $\widetilde{V}^p(E; w_0)$. For convenience of exposition, we will define $w_0 < \tilde{w}_0$ as a 'severe weather shock', and $\tilde{w}_0 < w_0 < \bar{w}_0$ as a 'mild weather shock'. For $w_0 < \tilde{w}_0$, it is not feasible for the elite to use trade policy to maintain the status quo because they cannot feasibly induce a level of welfare for the poor that is at least as great as from revolution: $\widetilde{V}^p(E; w_0) < V^p(R; w_0)$ over this range. For $w_0 > \tilde{w}_0$, $\widetilde{V}^p(E; w_0) > V^p(R; w_0)$ and so it is feasible for the elite to induce, using trade policy, a level of welfare for the poor that is at least as high as they could obtain from revolution. Hence, the elite face a commitment problem for $w_0 < \tilde{w}_0$, but not for $w_0 > \tilde{w}_0$.

We can also see from Figure 1 that when the elite face a commitment problem, the only way they can resolve it is to democratize through extension of the franchise. If they fail to do so, then the poor's best response is to mount a revolution. Through an extension of the franchise, the elite are able to credibly commit to the trade policy of free trade that will defuse the threat of revolution and avoid its cost.

4.2 The Status Quo Tariff

If there is a mild weather shock then the elite do not face a commitment problem and are able to set a status quo tariff to defuse the threat of revolution. To see this, first recall from the discussion above that $\widetilde{V}^p(E; w_0) > V^p(R; w_0)$ for $w_0 > \tilde{w}_0$. But note that, in order to maintain the status quo, the dictatorship only need to set a tariff that induces a level of welfare for the poor that is the same as they could obtain from revolution. We will refer to this tariff as the 'status quo tariff' and denote it by τ^{sq}. By definition, τ^{sq} solves $V^p(E, \tau^{sq}; w_0) = V^p(R; w_0)$. Using (4) and (5), we have

$$\tau^{sq} = c - \frac{\beta \hat{\tau}^e}{w_0}. \tag{6}$$

While we have already seen that the lower bound for τ^{sq} is $\tilde{w}_0$, the upper bound is shown in Figure 1 as $\bar{w}_0$. As we can see from the diagram, while $\tilde{w}_0$ solves for the level of w_0 at which $\widetilde{V}^p(E; w_0) = V^p(R; w_0)$, $\bar{w}_0$ solves for the level of w_0 at which $V^p(E, \hat{\tau}^e; w_0) = V^p(R; w_0)$. Solving explicitly,

$$\begin{aligned} \tilde{w}_0 &= \frac{\beta\hat{\tau}^e}{c}; \\ \bar{w}_0 &= \frac{\beta\hat{\tau}^e}{c - \hat{\tau}^e}. \end{aligned}$$

We can now say that τ^{sq} takes a value of $\tau^{sq} = 0$ at $w_0 = \tilde{w}_0$, and is increasing in w_0 from $w_0 = \tilde{w}_0$ until it reaches $\tau^{sq} = \hat{\tau}^e$ at $w_0 = \bar{w}_0$. For $w_0 > \bar{w}_0$, the elite can set $\tau_0^e = \hat{\tau}^e$ with impunity because, as shown by Figure 1, over that range of w_0 the payoff to the poor of elite rule with $\tau_0^e = \hat{\tau}^e$ is greater than the payoff to revolution: $V^p(E, \hat{\tau}^e; w_0) > V^p(R; w_0)$.

We will say that when the weather is at an average level of $w_t = 1$ then there is no weather shock. Therefore, we will want to fix parameters such that $\bar{w}_0 < 1$. We can ensure this by assuming that, given β and $\hat{\tau}^e$, c is sufficiently large that $\bar{w}_0 < 1$. This is consistent with our earlier assumption that $c > \hat{\tau}^e$.

4.3 Complete Characterization of Equilibrium Tariff

We can now provide a complete characterization of the equilibrium import tariff in each period. For this purpose, define the ranges of w_0 as follows:

$$\begin{aligned} \text{Severe weather shock:} \quad & 0 \leq w_0 < \tilde{w}_0 \\ \text{Mild weather shock:} \quad & \tilde{w}_0 \leq w_0 < \bar{w}_0 < 1 \\ \text{Normal weather:} \quad & \bar{w}_0 \leq w_0 < 2. \end{aligned}$$

The following result characterizes equilibrium.

Proposition 1. *There exists a unique MPE in pure strategies with the following characteristics.*
(i) If at $t = 0$ there is a severe weather shock, $0 \leq w_0 < \tilde{w}_0$, then the dictatorship face a commitment problem, and so respond by extending the franchise, as a result of which the poor set equilibrium tariffs at free trade, $\tau_0^p = \tau_1^p = \hat{\tau}^p = 0$.
(ii) If at $t = 0$ there is a mild weather shock, $\tilde{w}_0 \leq w_0 < \bar{w}_0$, then the dictatorship do not face a commitment problem, and so do not extend the franchise, responding instead by temporarily

setting the status quo tariff for a single period, $\tau_0^e = \tau^{sq}$*, before returning to* $\tau_1^e = \hat{\tau}^e$ *in period* 1.

(iii) If at $t = 0$ *there is normal weather,* $\bar{w}_0 \leq w_0 < 2$ *then the elite set their preferred tariff* $\tau_0^e = \tau_1^e = \hat{\tau}^e$.

5 Empirical Design and Data

5.1 Empirical Design

We follow the empirical design of BC, who study the effect of rainfall shocks in a sample of 40 sub-Saharan African countries over 1981-2003. They are interested in seeing whether negative rainfall shocks cause elites to make significant changes to the country's governance. They find that rain shocks offer "windows of opportunity" for non-democracies to move in the direction of democracy. BC employ the econometric specification

$$\Delta\text{Polity}_{i,t} = \gamma_i + \lambda_t + \eta_i t + \phi_G \log GPC_{i,t-2} + u_{it}, \qquad i = 1, \ldots, C, t = 1981, \ldots, 2003. \quad (7)$$

In (7), $\text{Polity}_{i,t}$ is the Polity2 score for for country i in year t (Marshall and Jaggers 2002). Polity scores vary between -10 and 10, where the extreme scores indicate dictatorship (-10) and liberal democracy (10), with intermediate scores indicating the extent to which the country's political institutions satisfy the requirements to be called a democracy.[6] In (7) $\Delta\text{Polity}_{i,t} = \text{Polity}_{i,t} - \text{Polity}_{i,t-1}$, and so $\Delta\text{Polity}_{i,t} > 0$ indicates a move towards democracy. The variable GPC is measured as gross domestic product per-capita, and GPC shocks affect $\text{Polity}_{i,t}$ with a one-year lag.

The specification is designed to test the idea that a negative income shock, by lowering the opportunity cost of revolution, poses a credible threat to elite rule, and forces the elite to democratize or at least become more democratic. The null hypothesis H0: $\phi_G = 0$ is therefore tested against the alternative H1: $\phi_G < 0$.

Shocks to income and political institutions can, however, be co-determined and therefore endogenous. BC use an instrumental variables strategy to identify ϕ_G. Rainfall crucially determines income, especially in the primarily agrarian sub-Saharan nations, which are reliant on rainfall in the growing seasons. Since rainfall shocks are exogenous and properly excluded from

[6] Polity scores are built upon three foundational concepts: Checks and balances onthe Executive etc etc xxxxxxx

(7) they are a valid instrument.

BC use contemporaneous rainfall to instrument income in (7) and find that a negative 1% income shock improves Polity2 scores by 0.18 points (BC, Table 5). With a single instrument, the coefficient ϕ_G is exactly identified. Rainfall is, however, a "weak" instrument and the 2SLS standard errors are therefore overstated. BC, instead, use the Anderson-Rubin chi-squared statistic (Anderson and Rubin 1949) to test the window-of-opportunity hypothesis, and reject the null.

The view through the lens of our model is nuanced. The consequences of negative rainfall shocks are clear to the dictator, and if circumstances allow it, he will use the policies at his disposal to mitigate the effects of the rainfall shock. Since the sudden drop in income due to the rain shock primarily affects food consumption of the citizens in poor countries, one way to reverse the shock to income is to lower the price of food to the poor. If import tariffs on food are positive, then lowering the import tariff will serve exactly this purpose. If imports of food are being subsidized, then increasing the size of the import subsidy will serve this purpose. If the country exports cash crops in order to fund the import of food staples, then a rain shock that depletes income may be offset by a reduction of the export tax.

As our theoretical framework shows, there are circumstances in which the threat of revolution cannot be resolved using international trade policy. If the commitment problem remains unresolved in the face of a rain shock, then the dictator is forced to democratize, affirming the BC result. However, if the dictator is able to use policy to offset the effect of the shock to the incomes and livelihoods of the poor, then it is possible that the BC results may not hold.

We use two specifications to test our theory of how dictators attempt to survive the drought. The first is the same as (7). However we make a fundamental break from BC in our instrumental variables strategy, which is motivated by our theory. The policy variables that measure the dictator's response to undo the effect of a weather shock serve as additional instruments. Just as rain, in the BC view, inflicts a transitory shock to income, the policy response of the dictator is to undo this transitory shock, which is the least costly action he can take and maintain his political power. Policy is used as a device to counteract a shock, and is properly excluded from the structural equation (7). Conditional on the control variables in (7), the residual variance in the policy variable is the transitory policy "shock" that is used to counteract the transitory rain shock.

We get more directly to the first order effect of rain shocks, namely shocks to food consumption, with a second specification

$$\Delta \text{Polity}_{i,t} = \gamma_i + \lambda_t + \eta_i t + \phi_C \log(\text{Calories})_{i,t-2} + u_{it}, \qquad i = 1, \ldots, C, t = 1981, \ldots, 2003. \quad (8)$$

In (8) food consumption is measured in log calories. We estimate the coefficient ϕ_C for calories from different sources: vegetal i.e. all non-meat consumption (log Veg); and total calories (log TotCal).

5.2 Data

To Bruckner and Ciccone's data set we add measures of trade policy. An income shock is synonymous with a shock to food consumption in sub-Saharan countries, where spending on food comprises between xx and xx % of household expenditures in xx% of households. Therefore, trade policy to restore food consumption is the most relevant policy, and import subsidies on foods and staples the most direct and effective measures. We measure trade policy targeted at food with the nominal rate of assistance (NRA) afforded by governments to import agricultural products. Anderson and Valenzuela's (2008) measurement of NRAs spans over seventy countries and the six decades 1960-2010. The NRA for an imported agricultural product is the percent difference, due to policies, in price paid by consumers compared to what they would have been without the government's intervention. Taking the world price as a reference, a product's NRA is positive when import policy raises its domestic price above the world price and negative when import policy lowers its price below the world price. For an imported good, a positive NRA amounts to taxing the import, while a negative NRA amounts to subsidizing it.[7]

Suppose the government of Egypt taxes its imports of wheat with an ad valorem tariff t_m, and taxes its exports of rice with an export tax, t_x. Each trade policy would be precisely measured by the NRA, operationally defined as

$$NRA^K = \frac{E \times P(1 + t_k) - E \times P}{E \times P}, \quad (9)$$

where E is the Egyptian pound (or Livre Égyptienne, shortened to LE) per US dollar (USD) rate, P is the price in LE of Egyptian wheat on the international market, and $K \in \{M, X\}$,

[7]The predominant distorting influences contained in the NRAs are border distortions and not domestic distortions (Anderson et al. 2008).

where NRA^M and t_M correspond to an import tariff, and NRA^X and t_X correspond to an export tax.

Taking this formula to the field requires determining the domestic LE price paid by Egyptian wheat consumers, $E \times P(1 + t_K)$. Anderson et al.'s (2008) NRA measures are the product of detailed field studies used to determine the domestic price of agricultural products. In our example, if the tariff is the sole distortion, the NRA on wheat imports computes to $t_M > 0$. If wheat imports are subsidized instead, then $t_M < 0$. If, on the other hand, an export tax is the sole distortion, the NRA on rice exports computes to $t_X < 0$. If exports are subsidized, then $t_X > 0$. The ad valorem equivalent of a government-imposed trade policy subsidy of a particular commodity may be computed using (9) once field work determines the consumer price $E \times P(1 + t_K)$.

Anderson et al. carefully account for exchange rate distortions, for example, tiered exchange rates at different parts of the international transaction chain, which are often used by developing countries as a redistributive policy instrument. Dollar prices are converted to LE dollars (in our example) using market foreign exchange rates, or multi-tiered exchange rates, or shadow exchange rates estimated in other studies to take into account distortions to the foreign exchange market Details of the methodology are in Anderson (2009, Appendix A). We use Anderson and Valenzuela's overall trade-weighted average of the country's NRAs on products it imports. They represent the best available border measures by countries on their imports of agricultural products. Our first set of results replicates BC and reruns their regressions after augmenting the set of instrumental variables with this trade policy instrument.

The BC sample is larger than the sample for which the Anderson-Valenzuela NRA measures have been computed. Our sample consists of thirty five of the forty one countries in the BC sample. Table 1 presents a view of political institutions in the sub-Saharan countries during the five decades between 1961-2013. Most countries have all 53 years of Polity2 data during this period, though some became more recently independent (e.g. Cape Verde in 1975) and have fewer years with polity scores. Only five countries have been democracies (Polity2 scores of +5 or more) for this entire period, namely Botswana, Namibia, Mauritius and South Africa. Gambia is the only other sub-Saharan country that was governed as a democracy for more than 50% of this period. All other countries have been dictatorships for most of the period. 47.5% of all country-years have been spent under dictatorships (Polity2 scores of -5 or lower).

Table 2 shows the incidence of political turnover. A transition-year indicator equals 1 if the country swung from Democracy to Dictatorship (or conversely) in that year. The number of transition years is the sum of this indicator. Table 2 separately indicates the direction of transitions and the number of transitions over the five decades. A transition year implies at least a 9-point swing in the dependent variable in (1): a democratic transition-year implies $\Delta\text{Polity}_{i,t} \geq 9$ and a dictatorial transition-year implies $\Delta\text{Polity}_{i,t} \leq -9$. Transition-years, that is, years in which swings from dictatorship to democracy or from democracy to dictatorship occur, are rare events. 20 of the 41 countries have experienced both dictatorship and democracy over 1961-2013 (16 have remained dictatorships), but their transitions have usually been gradual, after spending considerable time as anocracies. Large swings in $\Delta\text{Polity}_{i,t}$ are therefore exceptional.

The second set of results using specification (2) requires information on food supply. We obtain these data from the FAO food balance sheet database (at http://www.fao.org/faostat/en/data/FBSHFAO-FBS2013). The food balance sheets keep account of the sources of a country's food supply sources.

6 Results

Table 3 presents our replication of the first-stage regression of BC, that rainfall is an instrument for GPC, and then shows that export taxation should also be included as an instrument for GPC.

Column (1) shows the first-stage regression with log Rainfall as the only right-hand-side variable, and hence the only instrument for GPC. The estimated coefficient is 0.082, and this corresponds to a corresponding estimate of 0.077 by BC, as shown in the lower panel of their Table V.

Column (2) shows the first-stage regression not just with log Rainfall on the right hand side, but also NRA^M, as well as the interaction of the two instruments log Rainfall $\times$ NRA^M. From the standard error we see that the coefficient estimate on NRA^M is not significantly different from 0, and we interpret this as undermining the case for consideration of NRA^M as a valid instrument for GPC.

Column (3) shows that the coefficient estimate for NRA^X is positive and statistically sig-

nificant. The fact that the coefficient estimate is positive is in line with the prediction of our model. Recall that an export tax is reflected in a negative value for NRA^X. So a reduction in the export tax will be measured as an increase of the negative value towards zero, and this is associated with an increase in GPC as predicted by the model. The fact that the coefficient estimate is significantly different from zero, while log Rainfall also remains positive and statistically significant, can be taken as confirmation that both should be considered as instruments for GPC.

Table 4 presents the second-stage regressions, showing our results for the effect of a shock to GPC on ΔPolity2. Column (1) shows an OLS regression with $\Delta\text{Polity2}_t$ as the dependent variable, and log GPC_{t-2} as the main explanatory variable. In this specification, the coefficient estimate on log GPC_{t-2}, at -0.410, is not statistically significant.

Column (2) presents the results of the second stage of a 2SLS regression, using the regression in column (1) of Table 3 as the first-stage regression. This approach replicates the main specification of BC, and the result replicates their main result. The estimated coefficient on log GPC_{t-2} is -20.369, and is very close in magnitude to BC's estimated coefficient of -21.410, presented in column (2) of their Table V.

Column (3) adopts the same 2SLS specification as in column (2), except that for the first-stage regression, instead of using the regression in column (1) of Table 3, we use the regression in column (3). That is, both log Rainfall and NRA^X are used as instruments for log GPC in the regression to explain ΔPolity2. As a result of using this specification for the first-stage regression, the estimate of the coefficient on log GPC in the second-stage regression falls to -5.638. The Anderson-Rubin p value of 0.01 shows that the coefficient estimate is significantly different from zero. And the J statistic rejects the hypothesis that the specification is over-identified. We interpret this as showing that when the first-stage regression is correctly specified to include both log Rainfall and NRA^X as instruments, the estimated response of ΔPolity2 is significantly smaller than argued by BC.

This finding is consistent with the prediction of our theoretical model. Our model says that the ruling elite will attempt to offset the effect of a negative rainfall shock on GPC by reducing the export tax by enough to neutralize the incentive of the poor to mount a revolution. This effect is observed in the data as a smaller effect of a given rainfall shock on GPC than would be observed if the elite did not mitigate the effect of the shock by reducing the export tax, as

implicitly assumed by BC.

Thus far we have focused on a comparison of our results to those of BC, by looking in particular at the effect of a shock to GPC on ΔPolity2. In addition, we now check that the predictions of our model hold for food consumption. Our results for this exercise are presented in Tables 5-8.

Tables 5 and 6 present results for vegetal (i.e. non-meat) consumption. We denote by log Veg the log of vegetable consumption in calories. The econometric specifications presented in Tables 5 and 6 are identical to those of Tables 3 and 4, except that we replace log GPC everywhere with log Veg.

The results in Tables 5 and 6 for log Veg are striking in their similarity to our results for log GPC. Again, the specification suggests that in the first-stage regression, presented in Table 5, both log Rainfall and NRA^X are significant and hence should both be used as instruments. Table 6 then shows that, in the second-stage regression, the coefficient on log Veg is under one third of the size when both log Rainfall and NRA^X is used as when only log Rainfall is used: -7.663 vs -22.349. Again, the Anderson-Rubin p value of 0.013 shows that the coefficient estimate of -7.663 is significantly different from zero, and the J statistic rejects the hypothesis that the specification is over-identified.

Our last set of results, presented in Tables 7 and 8, are for total calorie consumption. This essentially adds calories consumed from meat to our variable measuring calories from vegetal (i.e. non-meat). We refer to the log of this variable as log TotCal. Our econometric results are presented in Tables 7 and 8. The results are essentially the same as for for GPC and log Veg. We interpret these results as saying that meat consumption does not make a difference to our results for vegetal/non-meat consumption.

7 Conclusion

In this paper, we have presented a new theoretical model and evidence to support a new motivation for international trade policy. The motivation is that dictators use international trade policy in general, and liberalization, to ensure their political survival. The relationship that the model predicts between trade liberalization and democratization undermines a classical prescription, going all the way back to Smith (1776) that trade liberalization and democratization

should go hand in hand. We have identified patterns in the data consistent with our theoretical prediction that in fact, dictators in Sub-Saharan Africa have used trade liberalization as a way to forestall democratization if they were able to.

Our paper opens up the possibility of understanding more deeply the mechanisms that dictatorships use to maintain their grip on power. We believe that we have identified trade policy as a policy instrument that dictatorships use for this purpose. But there are likely to be others, and future research could usefully seek to identify them. For example, media blackouts aimed at increasing the opportunity costs of coordinating a revolution have received significant attention in recent research, including the possibility that such measures may backfire and actually encourage people onto the streets. (See Hassanpour 2014 and the references therein.) Our framework could be used to consider the effectiveness of such policies, among others.

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Figure 1: Characterization of Equilibrium

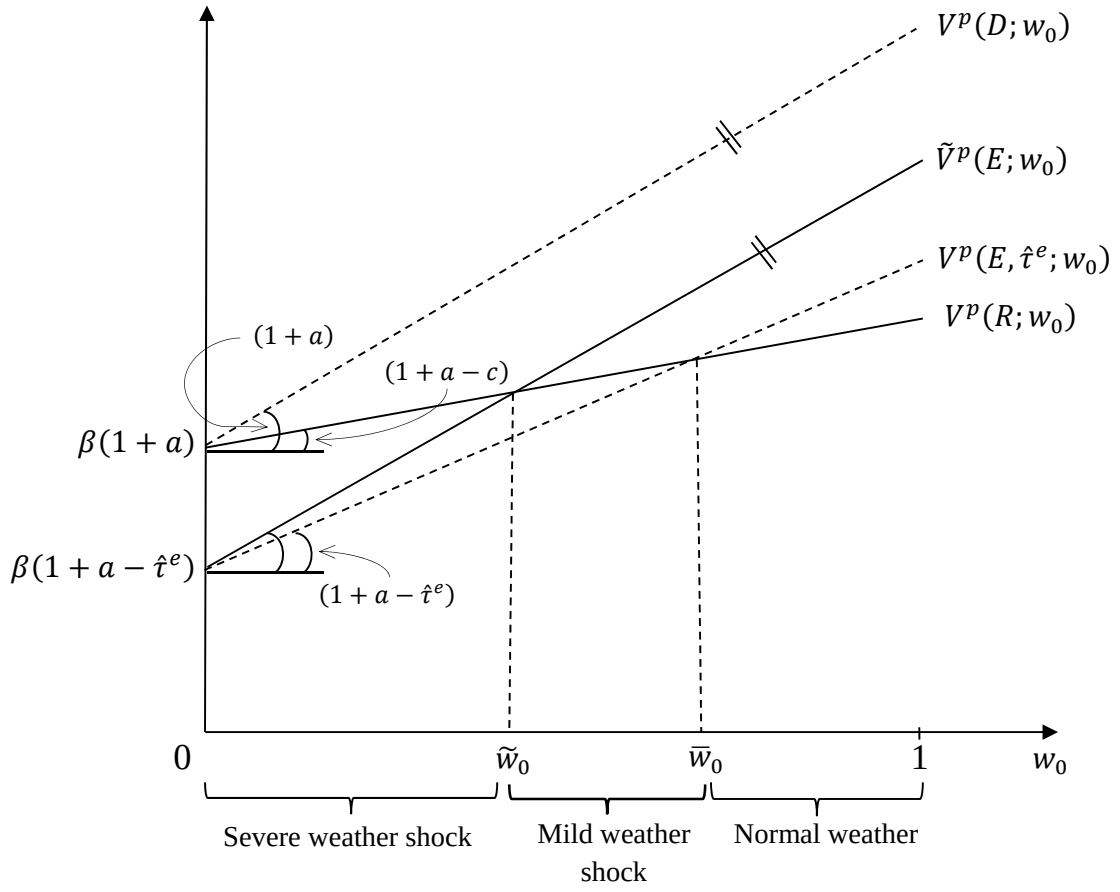

Table 1: Regimes: 1961-2013

Country	# years between 1961-2013: Democracy	Dictatorship	w/ Polity2 data	fraction of period: Democracy	Dictatorship	Anocracy
Algeria	0	30	52	0	0.58	0.42
Angola	0	16	39	0	0.41	0.59
Benin	23	23	53	0.43	0.43	0.13
Botswana	48	0	48	1.00	0	0
Burkina Faso	2	26	53	0.04	0.49	0.47
Cameroon	0	31	53	0	0.58	0.42
Cape Verde	23	0	39	0.59	0	0.41
Central African Republic	10	32	53	0.19	0.60	0.21
Chad	0	24	53	0	0.45	0.55
Congo	8	28	53	0.15	0.53	0.32
Djibouti	0	22	37	0	0.59	0.41
Egypt	0	44	52	0	0.85	0.15
Ethiopia	0	29	53	0	0.55	0.45
Gabon	0	30	53	0	0.57	0.43
Gambia	29	20	49	0.59	0.41	0
Ghana	15	24	53	0.28	0.45	0.26
Guinea	0	34	53	0	0.64	0.36
Guinea-Bissau	14	20	40	0.35	0.50	0.15
Kenya	12	28	51	0.24	0.55	0.22
Lesotho	22	23	48	0.46	0.48	0.06
Liberia	9	29	53	0.17	0.55	0.28
Madagascar	17	16	53	0.32	0.30	0.38
Malawi	18	30	50	0.36	0.60	0.04
Mali	21	30	53	0.40	0.57	0.04
Mauritania	0	45	53	0	0.85	0.15
Mauritius	46	0	46	1.00	0	0
Morocco	0	46	53	0	0.87	0.13
Mozambique	19	19	39	0.49	0.49	0.03
Namibia	24	0	24	1.00	0	0
Niger	17	33	53	0.32	0.62	0.06
Nigeria	10	26	53	0.19	0.49	0.32
Rwanda	0	39	53	0.00	0.74	0.26
Senegal	14	15	53	0.26	0.28	0.45
South Africa	24	0	53	0.45	0	0.55
Sudan	7	33	51	0.14	0.65	0.22
Tanzania	0	34	53	0	0.64	0.36
Togo	0	31	53	0	0.58	0.42
Tunisia	0	32	50	0	0.64	0.36
Uganda	4	19	51	0.08	0.37	0.55
Zambia	18	19	50	0.36	0.38	0.26
Zimbabwe	0	12	44	0	0.27	0.73

Notes:

1. A country-year is classified as a Democracy if $5 \leq$ Polity2 ≤ 10. Dictatorships are defined as having $-10 \leq$ Polity2 ≤ -5 and Anocracy as having $-5 <$ Polity2 < 5.

Table 2: Regimes transitions: 1961-2013

	During 1961-2013:						
	Polity score		**Regime**		**#Transition-years**		
country	Max Polity score	Min Polity score	Ever Democracy?	Ever Dictatorship?	Dictatorship to Democracy	No Transition	Democracy to Dictatorship
Algeria	2	-9	0	1		28	
Angola	0	-7	0	1		15	
Benin	7	-7	1	1		43	
Botswana	8	6	1	0		47	
Burkina Faso	5	-7	1	1		25	1
Cameroon	-4	-8	0	1		30	
Cape Verde	10	-4	1	0		22	
Central African Republic	5	-7	1	1	1	40	
Chad	0	-9	0	1		22	
Congo	5	-9	1	1		34	
Djibouti	4	-8	0	1		21	
Egypt	-2	-7	0	1		43	
Ethiopia	1	-9	0	1		27	
Gabon	3	-9	0	1		29	
Gambia	8	-7	1	1		47	1
Ghana	8	-9	1	1		34	1
Guinea	4	-9	0	1		33	
Guinea-Bissau	6	-8	1	1	1	30	
Kenya	9	-7	1	1		38	
Lesotho	9	-9	1	1	1	41	1
Liberia	6	-7	1	1		36	
Madagascar	9	-6	1	1		31	
Malawi	6	-9	1	1	1	45	
Mali	7	-7	1	1		48	
Mauritania	4	-7	0	1		43	
Mauritius	10	9	1	0		45	
Morocco	-3	-9	0	1		45	
Mozambique	5	-8	1	1	1	36	
Namibia	6	6	1	0		23	
Niger	8	-7	1	1	1	45	1
Nigeria	8	-7	1	1		32	2
Rwanda	-3	-7	0	1		38	
Senegal	8	-7	1	1		27	
South Africa	9	4	1	0		23	
Sudan	7	-7	1	1		35	1
Tanzania	-1	-6	0	1		33	
Togo	-2	-7	0	1		30	
Tunisia	-3	-9	0	1		31	
Uganda	7	-7	1	1		20	
Zambia	7	-9	1	1	1	34	
Zimbabwe	4	-6	0	1		11	

Notes:

1. A country-year is classified as a Democracy if 5≤Polity2 ≤10. Dictatorships defined as having -10≤Polity2 ≤-5.
2. Transition-year =1 if the country swung from Democracy to Dictatorship (or conversely) in that year.
   A transition-year by definition (of regime) implies a swing of at least 9 Polity2 score points in that year.
   #Transition-years is the sum of transition-years over the 1961-2013 period.
3. Note this is the extended sample. Bruckner-Ciccone sample period is 1981-2004.

Table 3: First Stage Regression

Dependent variable: log GPC_t

	(2)	(3)	(4)
log $Rainfall_t$	0.082*	0.077*	0.069*
	[0.043]	[0.043]	[0.041]
NRA^M_t		0.241	
		[0.496]	
log $Rainfall_t$ x NRA^M_t		-0.042	
		[0.074]	
NRA^X_t			0.799
			[0.565]
log $Rainfall_t$ x NRA^X_t			-0.101
			[0.087]
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes
N	815	815	815
#countries	35	35	35
∂ log GPC_t / ∂ log $Rainfall_t$		0.075*	0.085**
∂ log GPC_t / ∂ NRA_t		-0.039	0.123**
(Weak Instrument) F-stat	3.58	1.52	5.73

Notes:

1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. Total effects evaluated at mean of interacted variable.

Table 4: Income Shocks and Polity Change
Dependent variable: $\Delta Polity2_t$

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS
Instrument(s):		log Rainfall$_{t-2}$	log Rainfall$_{t-2}$ & NRA$^{X}_{t-2}$	log Rainfall$_{t-2}$ & NRA$^{M}_{t-2}$
log GPC$_{t-2}$	−0.410	−20.369**	−5.638***	−3.557
	[0.472]	[.044]	[.033]	[.019]
	(robust se)	[A-R p-value]	[A-R p-value]	[A-R p-value]
Country fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes	Yes
N	815	815	815	815
Anderson−Rubin p value		0.044	0.033	0.019
Overidentification: J stat		exact	4.059	5.996
Overidentification: p value		exact	0.131	0.05
#countries	35	35	35	35

Notes:

1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. The first column is the OLS estimate with clustered se reported below it. All other columns contain 2SLS estimates. Due to the weak instrument problem, we report the Anderson-Rubin chi-squared test p-values [in square brackets] belowthe 2SLS estimates. The A-R test is robust to weak instruments while the 2SLS standard errors are not (Andrews and Stock 2005).

Table 5: First Stage Regression
Dependent variable: log Veg_t

	(2)	(3)	(4)
log $Rainfall_t$	0.085***	0.084***	0.071**
	[0.027]	[0.027]	[0.029]
NRA^M_t		0.169	
		[0.224]	
log $Rainfall_t$ x NRA^M_t		-0.029	
		[0.036]	
NRA^X_t			0.780
			[0.529]
log $Rainfall_t$ x NRA^X_t			-0.111
			[0.080]
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes
N	815	815	815
#countries	35	35	35
∂ log Veg_t / ∂ log $Rainfall_t$		0.083***	0.089***
∂ log Veg_t / ∂ NRA_t		-0.019	0.061*
(Weak Instrument) F-stat	9.44	3.55	4.79

Notes:

1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. Total effects evaluated at mean of interacted variable.
3. The rain data is from the World Bank (unlike for GPC results which use B-C rainfall.

Table 6: Vegetable (Non-Meat) Consumption Shocks and Polity Change
Dependent variable: $\Delta \text{Polity2}_t$

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS
Instrument(s):		$\log \text{Rainfall}_{t-2}$	$\log \text{Rainfall}_{t-2}$ & NRA^{X}_{t-2}	$\log \text{Rainfall}_{t-2}$ & NRA^{M}_{t-2}
$\log \text{Veg}_{t-2}$	0.225	−22.349**	−7.663**	−13.06***
	[1.354]	[.013]	[.013]	[.003]
	(robust se)	[A-R p-value]	[A-R p-value]	[A-R p-value]
Country fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes	Yes
N	815	815	815	815
Anderson−Rubin p value		0.013	0.013	0.003
Overidentification: J stat		exact	6.230	3.389
Overidentification: p value		exact	0.044	0.184

Notes:

1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. The first column is the OLS estimate with clustered se reported below it. All other columns contain 2SLS estimates. Due to the weak instrument problem, we report the Anderson-Rubin chi-squared test p-values [in square brackets] belowthe 2SLS estimates. The A-R test is robust to weak instruments while the 2SLS standard errors are not (Andrews and Stock 2005).

Table 7: First Stage Regression
Dependent variable: log $TotalCal_t$

	(2)	(3)	(4)
log $Rainfall_t$	0.080***	0.079***	0.067**
	[0.025]	[0.025]	[0.027]
NRA^M_t		0.143	
		[0.233]	
log $Rainfall_t$ x NRA^M_t		-0.024	
		[0.037]	
NRA^X_t			0.774*
			[0.451]
log $Rainfall_t$ x NRA^X_t			-0.109
			[0.069]
Country fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes
N	815	815	815
#countries	35	35	35
∂ log $TotalCal_t$ / ∂ log $Rainfall_t$		.078***	.085***
∂ log $TotalCal_t$ / ∂ NRA_t		-0.014	.059*
(Weak Instrument) F-stat	10.05	3.85	5.81

Notes:
1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. Total effects evaluated at mean of interacted variable.

Table 8: Total Calorie Consumption Shocks and Polity Change
Dependent variable: $\Delta \text{Polity2}_t$

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS
Instrument(s):		$\log \text{Rainfall}_{t-2}$	$\log \text{Rainfall}_{t-2}$ & NRA^{X}_{t-2}	$\log \text{Rainfall}_{t-2}$ & NRA^{M}_{t-2}
Log TotCal_{t-2}	0.233	−23.736**	−7.483**	−16.40***
	[1.447]	[.013]	[.013]	[.003]
	(robust se)	[A-R p-value]	[A-R p-value]	[A-R p-value]
Country fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Country-trend	Yes	Yes	Yes	Yes
N	815	815	815	815
Anderson−Rubin p value		0.013	0.013	0.003
Overidentification: J stat		exact	6.122	2.547
Overidentification: p value		exact	0.047	0.279

Notes:

1. Statistical significance indicated at 10%, 5%, and 1% with *, ** and ***, respectively.
2. The first column is the OLS estimate with clustered se reported below it. All other columns contain 2SLS estimates. Due to the weak instrument problem, we report the Anderson-Rubin chi-squared test p-values [in square brackets] belowthe 2SLS estimates. The A-R test is robust to weak instruments while the 2SLS standard errors are not (Andrews and Stock 2005).