Quotas and Voting Shares in the IMF: Theory and Evidence

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Abstract

Member countries of the International Monetary Fund (IMF) contribute to a pool of resources that is later used to extend credits. A member's quota, its share in the IMF capital, determines not only the required financial contribution but also its voting weight and influence on policy. Heterogeneity among members in terms of population, wealth, and integration to international markets has recently produced a debate about the methods used for quota determination. In September 2005, the IMF embarked on a large-scale program of modernization. Salient among its objectives is governance reform, including adjusting quota shares to "reflect better the relative weight of members in the world economy". With the aim of contributing to this debate, I address the question of the optimal allocation of voting shares in the IMF. To this effect I adapt the model of Barberà and Jackson (2006) of optimal voting rules in a heterogeneous union. The model predicts that: a) member states' votes be weighted according to their share in world exports, income per capita, and the level of foreign reserves, b) voting thresholds be increasing in the importance of international finance positions relative to trade flows, and c) the probability of being bailed out by the IMF is larger for big, open economies. To test the former prediction I use a panel data with 5-year average observations between 1960 and 2000.

1 Introduction

The International Monetary Fund (IMF) is a financial institution founded in 1944 with the main purpose of assisting members facing temporary current account problems. From an initial membership of 44 states, today almost all the countries in the world participate in it. Members of the IMF do not have an equal voice, they contribute a quota subscription,

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and this quota is the basis for determining voting power. Quota allocations have been based mainly on economic size and external trade volume. Heterogeneity among members in terms of population, wealth, and integration to international markets has recently produced a debate about the methods used for quota determination. In September 2005, the IMF embarked on a large-scale program of modernization. Salient among its objectives is governance reform, including adjusting quota shares to "reflect better the relative weight of members in the world economy".

There have been many reform proposals, but none of these, to the best of my knowledge, has been founded on a model of expected utility maximization. I propose to fill this gap by adapting a model of optimal voting rules in a heterogeneous union by Barberà and Jackson (2006). In the model efficient voting weights are assigned to each member of the IMF with the objective to maximize a social welfare function, and the threshold of votes needed to approve a decision depends on structural parameters of the model.

I will model the power structure in the IMF as if each member country had a representative who votes on behalf of the citizens of her country. Votes take place over two alternatives: whether or not to bailout a member country in crisis.[1] The objective is to derive the voting rule that maximizes a welfare function derived from the utilities of all citizens represented in the IMF. I will show that, under certain assumptions, an optimal voting rule consists on a weight for each country's vote and a threshold that indicates how large the total weight of votes cast in favor of a bailout must be in order to implement the policy.

When making a decision, members of the IMF will weight the benefits and costs that a bailout would have on their citizens. Benefits are assumed to derive from trade linkages, and costs are assumed to be related to moral hazard inefficiencies affecting net factor income from abroad. When benefits outweigh costs a country will vote in favor of a bailout, and its vote will be weighted by the intensity of the gains to its population. Conversely, when the costs are larger than the benefits, the country will oppose a bailout and its vote will be weighted by the intensity of the loses that a bailout would inflict on its population.

To see how a crisis abroad affects the welfare of a member country's citizens I use a simple model of aggregate demand and have a real exchange rate shock to its current account due to trade linkages. The welfare effect will be increasing in the size of trade with the crisis country as exports would decrease and imports increase. The effect would be smoothed by the stock of foreign reserves held, as this would help the country dampen the real exchange rate movement. And the effect would be stronger for poorer countries as the marginal utility of income is decreasing. I then use panel data regressions with 5-year average observations between 1960 and 2000 to test for these model predictions. I find that the model provides a good fit to the data.

The model further predicts that the IMF would be more likely to provide assistance to bigger, more open countries. We test this prediction using the same dataset that Barro and Lee (2005) use to study the effect of IMF programs on economic performance. While they find that size measured by GDP is a strong predictor of the probability of being

[1] The formalization generalizes in a straightforward way to cases in which a number of member countries face a crisis simultaneously and the decision is whether to assist all of them, a subset of them, or none.

bailed out by the IMF, adding trade flows makes the influence of GDP to be statistically insignificant.

A third prediction of the model is that voting thresholds should be increasing in the importance of capital flows relative to trade flows. I do not test this prediction, but note that at the same time as capital flows grew approximately three times faster than trade flows for the world economy in the postwar period, the effective threshold for decision-making at the IMF increased both in the largest required supermajority (from 80% to 85%, in 1969), and in the number of decisions requiring supermajorities (from originally 9 to more than 50 currently).

The remainder of the paper is structured as follows. Section 2 summarizes the history and salient features of the IMF. Section 3 describes the model, section 4 describes the data used and the regression results. Section 5 discusses the results and potential quota distributions according to the theoretical model. Section 6 concludes.

2 The IMF

Since its foundation, the IMF has made efforts "to foster global monetary cooperation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty". But the roles it has played have changed since the fall of the system which has brought the IMF into life: the Bretton Woods Agreement. Before 1973, the IMF was basically focused on developed countries: from 1947 to 1967 they have withdrawn a gross amount of USD 9,275.3 million, almost 70% of the total amount. After the liberation of the world exchange rate regime in 1973, the main users of the IMF resources shifted from developed countries to less developed countries in Africa and Latin America with balance of payments crisis. This has widened the already divergent preferences between more or less developed countries on policy issues, and the disagreement over how this preferences are to be aggregated into collective decisions.

The power structure within the IMF is organized in this way: the Board of Governors, which possesses all the powers of the Fund, is composed of all the Funds member countries. In turn, each country has 250 basic votes plus one additional vote for each hundred-thousand Special Drawing Rights (SDRs) that each country possesses. The basic votes were a compromise solution intended to reconcile the principle of sovereign equality with the fact of wide power asymmetries among members. Nowadays basic votes amount to between two and three per cent of the total votes, down from an historic high of 15.6% in 1958. A complex system of five weighted formulas is used to calculate quotas based on GDP, exports and imports, variability of export receipts and reserves. There is no rationale for using this and not other variables, nor for the weights attached to them in the mentioned formulas. In fact it appears that the formulas, as well as actual quotas, which in some cases diverge significantly from the calculated ones, are biased to produce a political outcome close to the one desired by the most powerful members of the IMF.[2]

[2]Mikesell (1944) acknowledges that the original Bretton Woods formula used to assign quotas among the first 44 members of the IMF were built with the objective to match a desired outcome.

At the same time, the Board of Governors can delegate certain decisions to be made to the Board of Executive Directors, which is composed of one representative from each of the five members of the Fund having the largest quotas plus 15 other representatives each of whom represents a certain subgroup of countries. Thus, each Executive Director has the number of votes equal to the sum of votes of the countries it represents. In this way, when the Board of Directors vote, there is at the beginning a first meeting in which each subgroup of countries meets and determines how its representative will vote. Then, the Board of Executive Directors meets and cast their vote. Decisions concerning all IMF members can be adopted either by the required majority of the votes cast by the Board of Governors or by the required majority of votes cast by the Board of Executive Directors. There are two different majority rules and its use depends on the issue being discussed at the moment. The first one, which requires a 70% majority, is used for issues of procedure (decisions involving matters of policy and operations) and the second one, which requires an 85% majority, is used for issues of substance (for example, constitutional revisions or changes in quotas). An important observation of these majority rules and voting system is that the United States is the only country who retains a veto power since it possesses more than 15% of the total quotas.

With these caveats in mind, we can now proceed to explain the several functions the IMF quotas serve and how are they determined. A members quota defines four aspects of the relationship between the member country and the IMF: first, the amount of financial resources that a member contributes to the Fund; second, the amount of resources that members can draw from the IMF; third, the members voting power in institutional decision making, and finally, the members share of SDR allocations. Related to the question of how are quotas determined, since its foundation, the IMF recognized that as it was going to make large disbursements of scarce financial resources, their decisions would have to be legally binding rather than merely advisory. More egalitarian decision methods, say a one-country, one-vote rule, would not be acceptable to the major powers that contribute the bulk of the IMFs resources. Accordingly, a scheme was devised by which each national member of the IMF has a quota that equates to its financial subscription to the organization.

General Quota Reviews are typically undertaken at five-year intervals with the objective of adjusting to changes in members' relative position in the world economy, as well as to accommodate new members. Each quota increase is divided at the discretion of the Board into an equiproportional and selective components. The former is akin to an expansion of capital, simply extending proportionally the existing quotas, while the latter tends to shift the new quotas towards the calculated ones. Since historically the equiproportional component has averaged 70% of the quota increases, there is a significant status quo in the distribution of power in the IMF.

3 Model

There are n countries in the IMF, which are heterogeneous in terms of population, wealth, and integration to the world economy. Country i has a population of p_i citizens, all of

which derive the same utility $u(c_i)$ from per capita consumption c_i. It is known that a subset of the member countries will suffer a negative balance of payments shock and a decision will have to be made on whether to assist the affected country, or countries. For ease of exposition I will assume that only one country, country j, experiences the shock, and later show that the analysis extends to a multi-country crisis. A state of the world is a description of members' preferences on whether to assist or not country j. Without loss of generality utilities can be normalized to zero if the status quo prevails and no assistance is provided, and preferences are denoted by a vector $\vec{u}(j) \in \mathcal{R}^n$ with element $u(j)_i \equiv u_{ij}$ being the utility of a representative agent in country i if country j is bailed out.

After a shock takes place, each country's representative will decide to vote for a bailout or not, based on whether the utility of a bailout is positive or negative for that country's citizens. Thus the representative's voting behavior can be represented by a function $h_i : \mathcal{R} \longrightarrow \{b, nb\}$, which maps the preferences of citizens into a vote. The notation $h_i(u_{ij}) = b$ indicates that the representative of country i votes in favor of a bailout. This indicates that $u_{ij} > 0$, and equivalently a no bail out vote, $h_i(u_{ij}) = nb$, indicates that $u_{ij} < 0$.

In a second stage, the votes of the representatives are aggregated according to a voting rule. Let $v : \mathcal{R}^n \longrightarrow \{0, \frac{1}{2}, 1\}$ denote the outcome of this two-stage voting procedure as a function of the state of the world, $\vec{u}(j)$. Here $v(\vec{u}(j)) = 1$ indicates that a bailout is approved, $v(\vec{u}(j)) = 0$ means that country j will not be assisted, and $v(\vec{u}(j)) = \frac{1}{2}$ denotes a tie that will be resolved by the toss of a coin.

Let an efficient voting rule be one that maximizes the expected social welfare function among the class of feasible voting rules.[3] The social welfare function is given by the expected total utility, giving equal weight to any citizen of the IMF, independent of the country of residence. Therefore I will consider voting rules that maximize the following welfare function:

$$E\left[\sum_i v(\vec{u}(j)) p_i u_{ij}\right]$$

were the expectation is taken over the distribution of balance of payment shocks affecting any subgroup of the countries in the IMF. It will be initially assumed that the probability and severity of a crisis in country j, characterized by distribution function, is independent of the policies it follows. I will later lift the assumption that expectations of a bail-out by the IMF has no moral hazard on country policies.

Consider the following voting rule, proposed by Barberà and Jackson (2006). For each country two weights are assigned, one when the country votes in favor of a bail-out, and another for votes against it. For the former we have,

$$w_i^b = p_i E[u_{ij} | u_{ij} > 0]$$

Therefore the weight assigned to country i is proportional to the total expected welfare of its citizens when a bail-out is indeed their preferred policy. Similarly, the weight assigned

[3]These are voting rules that depend only on the information obtained by the votes of the representatives.

to country i when it votes against the bail-out is given by,

$$w_i^{nb} = -p_i E[u_{ij}|u_{ij} < 0]$$

The efficient voting rule $v^E(u)$ is then defined by,

$$v^E(u) = \begin{cases} 1 & \text{if} \quad \sum_{i:r_i(u)=b} w_i^b > \sum_{i:r_i(u)=nb} w_i^{nb}, \\ 0 & \text{if} \quad \sum_{i:r_i(u)=b} w_i^b < \sum_{i:r_i(u)=nb} w_i^{nb}, \\ \frac{1}{2} & \text{if} \quad \sum_{i:r_i(u)=b} w_i^b = \sum_{i:r_i(u)=nb} w_i^{nb}. \end{cases}$$

Proposition 1. If preferences are independent across countries (meaning that one country's utility for a given alternative does not depend on the full profile of votes of the rest of the countries), then a voting rule is efficient if and only if it is equivalent up to ties to v^E.

This result is Theorem 1 in Barberà and Jackson (2006) and the proof is in their appendix. Under the assumption of homogeneous preferences within a country it could in principle be possible to have a rule that maximizes the realized weighted sum of utilities, and v^E being the efficient voting rule would then be such that it implements the social optimum of choosing a bailout when $\sum_i p_i u_{ij} > 0$.[4]

Under this rule, weights are affected by the intensity of preferences inside a country for the alternatives, as captured by the values of u_{ij}. Thus countries that care more intensely about the bailout decision should be given more weight than countries that are less affected by the outcome. In their work, Barberà and Jackson consider an abstract decision between two alternatives and therefore have no reason for heterogeneity among citizens' *intensity* of preferences. They thus give every citizen the same possible utilities, of plus one or minus one. Given the nature of the problem studied here I introduce more structure about countries' preferences and the extent to which a shock in country j affects a representative citizen in country i.

To relate the intensity of preferences, u_{ij}, to fundamentals I assume CRRA preferences (with coefficient of risk aversion θ) over per capita consumption c_i,

$$u(c_i) = \frac{1}{1-\theta} c_i^{1-\theta}$$

I will assume a simple model of aggregate demand in an open economy where aggregate income is given by aggregate demand plus net factor income from abroad, Z_i. Aggregate demand, Y_i is given by consumption, investment, and net exports. I assume the following behavioral relations for the components of aggregate income, were for simplicity subindex i has been suppressed,

$$\begin{aligned} C &= C_0 + C_1(Y + Z(\varepsilon)) \quad I = I_0 && (1) \\ NX(\varepsilon) &= X(\varepsilon) - \varepsilon M(\varepsilon), \quad X'(\varepsilon) > 0, \quad M'(\varepsilon) < 0 && (2) \\ Z(\varepsilon) = rF - r^*F^* &= (rF)(\varepsilon) - (r^*F^*)(\varepsilon), \quad Z'(\varepsilon) < 0 && (3) \end{aligned}$$

[4] At this stage it might be simpler to motivate what follows by simply noting that the objective is the maximization of expected social welfare. I plan to later incorporate heterogeneity within a country, the case studied in Barberà and Jackson (2006).

Basic manipulations give the equilibrium relation for aggregate demand,

$$Y = \frac{1}{1-C_1}\left(C_0 + I_0 + C_1 Z(\varepsilon) + NX(\varepsilon)\right) \quad (4)$$

$$Y = m\left(Y_0 + C_1 Z(\varepsilon) + NX(\varepsilon)\right) \quad (5)$$

$$C = mC_1\left(\hat{C}_0 + Z(\varepsilon) + NX(\varepsilon)\right) \quad (6)$$

where C is consumption, I investment, NX are net exports of goods and services (X being exports and M imports), F and F^* are foreign assets and liabilities, r and r^* are the, possibly different, interest rate charged and paid on those foreign positions, ε is the real exchange rate, and m is the multiplier of aggregate demand to external shocks. As Fischer (1999) points out, a bailout prevents the overshooting of real exchange rate depreciation in country j. Thus a bailout produces a relative appreciation of the real exchange rate in country j, $\alpha_j = -\frac{\Delta\varepsilon_j}{\varepsilon_j} > 0$.[5] Under the assumption that the Marshall-Lerner condition holds, a currency depreciation, $\frac{\Delta\varepsilon}{\varepsilon}$, has a positive effect on net exports of,

$$(\epsilon_{X,\varepsilon} + \epsilon_{M,\varepsilon} - 1)\frac{(X+\varepsilon M)}{2}\frac{\Delta\varepsilon}{\varepsilon} \equiv a(X+\varepsilon M)\frac{\Delta\varepsilon}{\varepsilon}$$

were the usual assumption of balanced trade is made (i.e. $X = \varepsilon M = \frac{X+\varepsilon M}{2}$), and it will be assumed from now that the elasticities characterizing the response of net exports, represented by parameter a, are the same for all countries. Thus, the effect of a bailout in country j on net exports in country i is given by,

$$a(X_i + \varepsilon_i M_i)\frac{-\varepsilon_j}{\varepsilon_i}\frac{d\varepsilon_i}{d\varepsilon_j}\alpha_j \quad (7)$$

$$a(X_i + \varepsilon_i M_i)\frac{X_{ij} + \varepsilon_i M_{ij}}{\sum_k X_{ik} + \varepsilon_i M_{ik}}\alpha_j \quad (8)$$

$$a\alpha_j(X_{ij} + \varepsilon_i M_{ij}) \quad (9)$$

were in the first expression by the chain rule, $\frac{\Delta\varepsilon_i}{\varepsilon_i} = \frac{-\varepsilon_j}{\varepsilon_i}\frac{d\varepsilon_i}{d\varepsilon_j}\frac{-\Delta\varepsilon_j}{\varepsilon_j} = \frac{-\varepsilon_j}{\varepsilon_i}\frac{d\varepsilon_i}{d\varepsilon_j}\alpha_j$, and $\frac{-\varepsilon_j}{\varepsilon_i}\frac{d\varepsilon_i}{d\varepsilon_j}$ is the impact of a real exchange rate appreciation in country j on the real exchange rate in country i. This effect is assumed to be proportional to the fraction of bilateral trade between both countries, as reflected in the second expression.

A bailout has also negative effects on country i. It increases fears of moral hazard that have a negative impact on all financial relations between country i and the rest of the world, and thus on net factor income from abroad, Z_i. Income received from foreign assets held by citizens in country i, $r_i F_i$ experiences a reduction in expected principal recovery, and income paid to foreigners holding domestic assets, $r_i^* F_i^*$ increases due to risk premia. This effect is modelled to take the form,

$$\Delta Z_i = -\delta m_i \sum_k (F_{ik} + F_{ik}^*)$$

[5] Therefore, α_j is a measure of the magnitude of the balance of payment shock in country j, since a deeper crisis would cause a larger deviation in the real exchange rate if the status quo prevails.

were δm_i measures the impact that a bailout has on income derived from financial positions. With the notation $|F| \equiv F + F^*$, and with consumption per capita given by $c \equiv \frac{C}{p}$ we have

$$u_{ij} = \Delta u(c_i) \tag{10}$$

$$u_{ij} = c_i^{-\theta} m_i C_{1i} \left(\frac{\alpha a(X_{ij} + \varepsilon_i M_{ij}) - \delta \sum_k |F_{ik}|}{p_i} \right) \tag{11}$$

were $c_i^{-\theta}$ is the marginal utility of consumption for country i, a term that reflects that poorer countries are, ceteris paribus, more affected by a crisis abroad. The model therefore assumes that the positive effects for country i when country j is bailed-out arise from trade links between countries i and j. Negative effects are proportional to financial relations between country i and the rest of the world. According to this representation for preferences, a country would be more likely to support a bailout of another country in crisis when it has strong trade relations with this country. And it is less likely to vote for a bail-out the more financially integrated it is with the rest of the world.

Next we will make assumptions on the structure of trade flows between countries i and j and on the size of financial relations that a country has with the rest of the world. These take the form,

$$X_{ij} + \varepsilon_i M_{ij} = (X_i + \varepsilon_i M_i) \frac{(X_j + \varepsilon_j M_j)}{d_{ij} \sum_k X_k + \varepsilon_k M_k} \tag{12}$$

$$|F_i| = b(X_i + \varepsilon_i M_i) \tag{13}$$

were d_{ij} is proportional to the distance between countries i and j and tries to capture "gravity" effects. Thus I assume that trade between two countries is proportional to their volume of trade and inversely proportional to their distance, and that financial positions are proportional to trade flows. The first assumption is made since it has been proved empirically that bilateral trade decreases with the distance between the trading countries. With respect to the second assumption, it can be easily verified that there is indeed a strong correlation between both variables in the data at any given point in time.[6]

An important caveat is that this formulation would imply that any country j that experiences a shock would have the same effects on other countries mutual net factor income from abroad (for example between i and k). Although it might seem more reasonable to assume that the effects of a shock are increasing with the crisis country economic size, the assumption tries to capture the externality effects that a bailout generate and that by their nature are related to the size of aggregate financial positions. Thus while in reality the negative effects of a bailout would be increasing in the size of the crisis country, the rate of increase would likely be less than linear. And what matters for the result is that the positive effects increase faster with the size of a crisis country (measured by its trade flows) than the negative effects.

With this formulation all countries i such that $u_{ij} > 0$ would vote in favor of bailing out country j when in crisis. An inspection of country preferences shows that i would

[6]See Lane and Milesi-Ferretti (2006). This assumption is crucial to collapse weights to a single variable and obtaining a simple weighted formula, as shown below.

bail out all countries j such that,

$$\alpha_j a \frac{X_j + \varepsilon_j M_j}{d_{ij} \sum_k X_k + \varepsilon_k M_k} > \delta b$$

were I have assumed that model parameters a, and δ are the same across countries. Thus, countries experiencing a significant imbalance (high α) are more likely to be assisted, and a bailout will have more support among neighbors of the country experiencing a balance of payments shock. Big, open, countries would be more likely to be bailed out, and small, closed, ones not. Of course it must be recognized that during a crisis country j, regardless of its size, would vote to bail out itself. But this trivial, symmetry-breaking, vote becomes negligible in the limit of an infinite number of countries, all of atomistic size, assumption made henceforth. Under this assumption, and having the probability that a country experiences a balance of payments shock, $\mu(\alpha, q, y, \vec{t})$, i.e. as a function of its participation in world trade, measured with respect to average trade volume, $q \equiv \frac{(X_j + M_j)}{E[X_+ \varepsilon M]}$, its income per capita, y, and its location in the world, given by $\vec{t}$. With the distance between countries i and j given by $d_{ij} = |\vec{t_i} - \vec{t_j}| \equiv \rho$, and with $\psi^* \equiv \frac{\delta b}{a}$ we have,

$$w_i^b = c_i^{-\theta} m_i C_{1i} (X_i + \varepsilon_i M_i) \int_{\vec{t}} \int_0^{\max[\alpha]} \int_{\frac{\rho\psi^*}{\alpha}}^{\infty} \int_0^{\max[y]} (\frac{\alpha a q}{\rho} - \delta b)\ \mu(\alpha, q, y, \vec{t})\ d\alpha\ dy\ dq\ d\vec{t}$$

$$w_i^{nb} = -c_i^{-\theta} m_i C_{1i} (X_i + \varepsilon_i M_i) \int_{\vec{t}} \int_0^{\max[\alpha]} \int_0^{\frac{\rho\psi^*}{\alpha}} \int_0^{\max[y]} (\frac{\alpha a q}{\rho} - \delta b)\ \mu(\alpha, q, y, \vec{t})\ d\alpha\ dy\ dq\ d\vec{t}$$

We impose now an homogeneous distributions of countries around the globe, and independence of the structure of shocks with the geographical distribution of countries, i.e. $\mu(\alpha, q, y, \vec{t}) = \mu(\alpha, q, y)$. Under these assumptions, the integrals in the previous expressions are independent of country i, and we have that $\frac{w_i^{nb}}{w_i^b} \equiv \gamma$ is constant for all countries. Here γ measures a bias towards the status quo (there is more intensity in preferences towards the status quo if $\gamma > 1$). This is the *same* formulation with a bias factor that Barberà and Jackson (2006) assume in order to derive the result that an optimal voting rule is efficient if and only if it is equivalent to a weighted voting rule (their Corollary 1). Under these assumptions therefore it would not be optimal to have a double majority system for votes in the IMF as advocated in some reform proposals.[7] In this case the optimal weights are:

$$w_i^* = w_i^b$$

and the threshold for approving a bailout is

$$\frac{\gamma \sum_i w_i^*}{1 + \gamma}$$

The threshold of votes is increasing in the bias γ and thus we can see how it is affected by structural parameters, such as the importance of international financial investments

[7]For example see O'neill and Peleg (2000) and Rapkin and Strand (2006).

relative to trade flows, b, or the distribution of crisis probabilities across countries, $\mu(\cdot)$, which affects the integrals of w_i^b and w_i^{nb}. In particular we mentioned in Section 2 that before the fall of the Bretton Woods system the IMF focused on developed countries, later switching to assist less developed nations. This means that the density $\mu(\cdot)$ shifted mass from the first integral above to the second one, reducing w_i^b and increasing w_i^{nb}, thus increasing γ, and therefore the vote threshold. An increase in b, the size of financial positions relative to trade flows, would also lead to an increase in γ. This can be observed in the data using gross external positions (from Lane and Milesi-Ferretti (2006)) and trade data. This prediction is consistent with the evolution of decision making at the IMF. There has been an increase both in the largest required supermajority (from 80% to 85%, in 1969), and in the number of decisions requiring supermajorities (from originally 9 to more than 50 currently).

With respect to the possibility of a multi-country crisis, remember that a bailout's negative effects are assumed to be independent of the size of country being bailed out. Thus the negative effects would be the same independently of how many countries are assisted by the IMF. Therefore the criteria to decide whether to help the countries suffering the balance of payments shock is the same as if all of them were lumped into a larger country. Notice how this gives incentives to small countries to have a positive correlation in their exposure to balance of payments shocks to increase the chances of a bailout when one is needed.

3.1 International Reserves

It is possible to add a role for international reserves in the basic model. There are two reasons for doing this. First, since the foundation of the IMF reserves have been one of the variables considered in the formulas used to calculate quotas. Second, and more importantly, the model developed emphasizes trade and finance links between countries as the determinants of the intensity of preferences regarding the bail out decision of distressed countries. And since a country that has a higher level of reserves is better prepared to buffer the effects of a crisis abroad, this should be reflected in its voting power. With respect to the positive effects of a bailout, a higher level of reserves in country i reduces the impact of real exchange volatility in country j on the real exchange rate in country i. Thus the positive effect for country i of bailing out country j is reduced to,

$$a\alpha_j(X_{ij} + \varepsilon_i M_{ij})f(R_i)$$

were $f(\cdot)$ is a decreasing function of the level of international reserves R, and $f(0) = 1$.[8] With respect to the negative effect of a bailout a higher level of international reserves reduces the loss in net factor income from abroad as there is no loss in income received from foreign reserves. This should not be confused with the fact that holding a larger share of foreign assets as reserves could lead to a reduction in income received from these assets. What matters for the bail out decision is the *c*hange in this income due to the

[8] Alternatively the argument of function $f(\cdot)$ could be the ratio of reserves to aggregate income, or trade volume.

negative effects a bailout has on financial positions. Thus the negative effect for country i of bailing out any country is reduced to,

$$-\delta m_i \sum_k (F_{ik} + F_{ik}^*) g(R_i)$$

were $g(\cdot)$ is a decreasing function of its argument and $g(0) = 1$. With this modification it is straightforward to derive the weights that a country should receive when it votes in favor or against a bailout, w_i^b and w_i^{nb}. To guarantee that the integrals in those expressions remain independent of country i, and thus to have a common bias factor, we need to impose that $g(\cdot) = \kappa f(\cdot)$. Under this assumption the result that a weighted voting rule is optimal still holds. Now weights are given by,

$$w_i^* = c_i^{-\theta} m_i C_{1i} (X_i + \varepsilon_i M_i) f(R_i) \int_{\vec{t}} \int_0^{\max[\alpha]} \int_{\frac{\rho\psi^*}{\alpha}}^{\infty} \int_0^{\max[y]} \left(\frac{\alpha a q}{\rho} - \delta b \kappa\right) \mu(\alpha, q, y, \vec{t})\, d\alpha\, dy\, dq\, d\vec{t}$$

It should be noted that the model predicts that, controlling for other determinants, countries having larger positions of foreign reserves should have less power in IMF decision making. This contrasts with the fact that all past and present formulas for quota determination in the IMF give a positive weight to reserves.

3.2 Moral Hazard

To be done.

4 Empirical Evidence

Since the weights are determined independently of the threshold (since they are independent of γ), we can use the actual distribution of quotas in the IMF in the postwar period to test if it is "optimal". We now proceed with this estimation.

4.1 Econometric Specification

It is almost straightforward to derive a regression equation to estimate the previous model. This structural econometric approach contrasts with typical analysis of the distribution of quotas in the IMF that resort to a reduced-form aproach. A minor adjustment has to be done in order to derive the regression equation. This is to include foreign reserves as an explanatory variable. The reason to add this variable is that a country with more foreign reserves is in a better position to buffer an output slowdown associated with a current account shock originated abroad.[9] This intertemporal smoothing is not captured by the simple static model, but since it could reduce the intensity of preference with respect to the bailout decision, and thus the optimal weights, we should control for it.

[9]See, for example, Hviding, Nowak and Ricci (2004). They estimate that a halving of reserves increases real exchange rate volatility by 20%.

Under the assumptions used to derive the optimal weights, namely that we consider the limit of a large number of countries (to avoid symmetry breaking by a crisis country voting in favor of its own bailout), independence of shocks from the geographic distribution of countries, equality of multipliers, m, and structural parameters (a, and δ) the regression equation to estimate is derived by taking logarithms in equation (16). This gives,

$$QUOTA_{i,t} = \beta_0 + \beta_1 TRADE_{i,t-1} + \beta_2 GDPPC_{i,t-1} + \beta_3 RESERVES_{i,t-1} + \epsilon_{i,t}$$

Although the model predicts that $\beta_1 = 1$, it is not true that the multiplier is independent of trade openness. A more open country would have a smaller multiplier, and therefore a lower quota. Thus the coefficient of $TRADE$ is expected to be positive but less than one. We further expect β_3 to be negative. If the social welfare function gives the same weight to every individual irrespective of their country of citizenship, β_2 would be negative, otherwise its sign is indeterminate.[10] Further controls will be added to test for the validity of the model. I will discuss those cases as they show up.

4.2 Data

The data set was obtained from the International Financial Statistics (IFS), and World Development Indicators (WDI). The sample is an unbalanced panel of five-year-average observations (for example the observation for 1975 corresponds to the average of the corresponding variable from 1975 to 1979) for 184 countries over the period 1960-2004. The main reason to use five-year averages is that quota revisions are infrequent, and have taken place at roughly five-year intervals (the longest period without a revision was between June 1990 and January 1998). Table 1 introduces the variables used in the main regressions to determine the relative quota of the IMF member countries.

The dependent variable is the logarithm of the relative share of quotas, net of basic votes, that a country has in the IMF, $QUOTA$.[11] With respect to independent variables, the logarithm of the total trade volume, $TRADE$, comes from IFS data on exports and imports, measured in current USD. The logarithm of GDP per capita, $GDPPC$, is constructed using GDP from IFS measured in current USD, and population data coming from WDI. Since this last variable should capture the intensity of preferences, it would be more accurate to use PPP measurements of GDP. Due to a lack of data I instead use GDP measured in current USD. The logarithm of foreign reserves, $RESERVES$, uses data from IFS measured in current USD. Given that quota decisions are based on past performance I used one period lag of these regressors.

Further controls are used to test for the validity of the model. To this effect a number of dummies are introduced: continental dummies for OECD, Latin America, Asia, Africa,

[10] Another reason why $\beta_3 > 0$ is that quotas serve the double purpose of determining country representation *a*nd capital contributions to the IMF. It is reasonable to assume that the latter should be proportional to GDP. Incorporating this in an objective function balancing representation and contribution capacity the weights would be $w_i^* = w_i^b y_i^\psi$, were $\psi > 0$ measures the relative importance of contribution capacity in the welfare function.

[11] Besides the fact that there is no rationale in the model for basic votes, representation beyond these basic votes is what the model explains. Furthermore, as seen in Section 2, the relative importance of basic votes has declined to close to two per cent of total votes nowadays.

and former communist countries. Other dummies differentiate countries based on whether they were early or more recent members of the IMF. As discussed in Section 2, there is some inertia in the adjustment of quotas, which could give more power to early members. I used a dummy, EARLY, for countries that were members of the IMF before 1960. Another distinction that I want to control for is whether the Bretton Woods agreement is in place or not. Given the fact that the IMF's role changed after the collapse of the fixed exchange rates system in 1973, I use a dummy, AFTER, for periods after that date.

4.3 Results

We will first test the model prediction that the volume of trade is an important determinant of the likelihood that a country would be bailed out by the IMF. To this effect I will use a probit regression used by Barro and Lee (2005) to estimate the importance of political economy variables in determining the likelihood of an IMF loan program approval. In their paper Barro and Lee use U.N. voting patterns and bilateral trade to measure a country's political and economic proximity with the United States and the three big European countries (France, Germany and the United Kingdom), together with quota shares and the number of nationals working at the IMF. They find that these political economy variables help to explain the probability and size of IMF loan programs. In their regressions they use a number of controls, in particular the logarithm of GDP. Among other results, they find that bigger countries are more likely to get a loan approval.

Results are reported on Table 2. In the first column I reproduce the probit regression of Barro and Lee, and in the second column $TRADE$ is introduced replacing GDP. Results show that countries with more trade volume are more likely to be assisted by the IMF. And putting together both GDP and $TRADE$ results in GDP losing its explanatory value while the coefficient on $TRADE$ remains positive and statistically significant.[12] Thus the evidence supports the result found in Section 3 that IMF members are more likely to approve a bailout the larger is the volume of trade of the country experiencing a balance of payments crisis.

Next, I test the model predictions with respect to quota distribution. In table 3 we present the output of three OLS estimations for IMF relative quota $QUOTA$, measured in logarithms. All regressions control for time effects. Column 1 includes lagged $GDPPC$, $TRADE$ and $RESERVES$; column 2 includes continental dummies and column 3 includes a dummy for the countries that have entered the IMF before 1965. The objective of these regressions is to find evidence of systematic deviations from the theoretical model.

The coefficient for $TRADE$ is significantly positive in all of the specifications, implying that a 1 percent increase in trade would increase the relative quota by 0.86%. The coefficient on $GDPPC$ is negative and significant in all of the specifications. The estimated coefficient implies that a 1 percent rise in the GDP per capita in the past five years would reduce the relative quota by 0.24%. Finally, the estimated coefficient for $RESERVES$ indicates a positive and insignificant relationship.

[12]This third regression omits the political economy controls mentioned above. If they were included, both GDP and $TRADE$ are not significant in explaining the probability of approval of an IMF program.

The geographic controls indicate that there are certain regional characteristics that affect their relative quota, implying that it is better to use other estimation mechanism, as fixed effect estimator. It is found that asian countries are underrepresented in IMF relative to the theoretical predictions of the model. This fact has been pointed out by several authors, for example, by Rapkin and Strand (2003), and it shows that there are unobservable factors explaining the distribution of power in the IMF beyond those implied by the model of Section 3. Countries that entered early in the IMF have a significantly larger quota share than more recent members. This is further evidence of the violation of the exogeneity assumption of our main regression, and is not surprising given that, as mentioned in Section 2, equiproportional increases of quotas are very important in General Quota Reviews.

To address the problem of unobserved explanatory variables I do a fixed effects estimation. Results are presented in table 4. Column 1, reports the basic regression with lagged $TRADE$, $GDPPC$ and $RESERVES$. Column 2, presents the same variables interacted with the $EARLY$ and $AFTER$ binary variables used to discriminate the model fit between early and more recent members of the IMF, and whether the fall of the Bretton Woods agreement changed the allocation of quotas among members.

In column 1, $TRADE$ enters with positive sign and it is strongly significant, suggesting that an increase of 1 percent would, holding other variables constant, increase the relative quota by 0.14%. Under the fixed effect estimation, the coefficient of $RESERVES$ is negative and significant but the reduction of the relative quota implied by an increase of 1% of the reserves is just 0.026%. Finally, the estimated coefficient for $GDPPC$ is positive and significant. An increase of 1 percent would augment the relative quota by 0.13%.

As mentioned, the main objective of the specification presented in column 2 is to investigate if the relationship found in the precedent paragraph is constant over time and over groups of countries. We find evidence that there were systematic differences between early and late members in the IMF for the period before the fall of the Bretton Woods agreement. For example, the coefficient on $TRADE$ for early members of the IMF was 0.09 percentage points larger than the one on late members (for which the coefficient was 0.077). After 1975 there are no statistical differences in the coefficients of the regressors between early and late members of the IMF.

5 Reform proposal

Having derived a theoretical formula for the distribution of voting power among IMF members, it seems natural to ask the question of what that distribution would look like, and how it compares with current quota shares. To do that I use the following relation:

$$w_i = (X_i + M_i) y_i^{\nu-\theta} RES^{-\kappa}$$

were RES are international reserves. Imposing a coefficient of 1 on trade, I set $\kappa = 0.18$ to keep the same relative importance of reserves to trade as in the regressions reported before ($0.018 \approx \frac{0.026}{0.14}$). For the coefficient on GDP per capita I consider two cases, $\nu - \theta = -\frac{1}{3}$

and $\nu - \theta = -\frac{2}{3}$. This will show how sensitive the distribution of votes is to GDP per capita. Results for the largest members in the IMF are reported in Table 5 for the period 1995-2000 for which there is more data available. The first column reports actual relative quotas, while in the second column I use an ad hoc specification dependent only on trade. Results are very sensitive to the specification on GDP per capita as can be seen from a comparison of columns 3 and 4. Considering that the power of the United States gets diluted as we reduce $\nu - \theta$ a politically feasible proposal could be the one in column 4 that maintains the US veto power.

Significant outlier among the members with quota shares above one percentage point are: Saudi Arabia, Switzerland, Venezuela, and Argentina among the countries overrepresented in the IMF, and China and Mexico among the underrepresented. It is worth noting that under this rule, the total quota of these big members would only reduce slightly, from 73.3% to 72.6%. Therefore there are no significant gains in representation for small, less developed countries.

6 Conclusions

I have derived a theoretical model for the optimal distribution of quotas among members of the IMF. Under simplifying assumptions a simple weighted voting rule is the efficient voting rule. This has implication for the reform proposals that have been presented to improve the legitimacy of the IMF (See for example Cottarelli (2005) and Rapkin and Strand (2006)). In particular under the assumptions of the model, there is no rationale for a double majority system as the "count and account" proposal of O'Neill and Peleg (2000).

Of the various assumptions made in the model I plan to lift a number of them to check the robustness of the results. This includes the equality of multipliers across countries independently of their openness, as well as homogeneity of structural factors. Further research will be aimed also at developing a more sophisticated model of income and consumption determination, incorporating intertemporal considerations.

Testing the model predictions I found that it has significant explanatory power. On one hand this should not come as a surprise since the ad hoc formulas that the IMF has been using since its creation depend on the model's explanatory variables: exports, imports, GDP and reserves. Nevertheless it is remarkable that regression results show a slightly negative relation between foreign reserves and actual quotas in the IMF, while all past and present formulas give a positive weight to reserves.

References

[1] Allegret, J. and P. Dulbecco, (2003), "The Governance of International Institutions -The IMF and the Evolution of the New International Financial Architecture-". Economics for the future - Celebrating 100 years of Cambridge Economics. Cambridge (UK) 17-19, September 2003.

[2] Barro R. J. and J. Lee, (2005), "IMF programs: Who is chosen and what are the effects?", *Journal of Monetary Economics*, vol. 52, pages 1245-1269.

[3] Bernstein, E. (1968), "The International Monetary Fund", *International Organization*, vol. 22(1), pages 131-151, Winter.

[4] Barberà S. and M. Jackson, (2006), "On the Weights of Nations: Assigning Voting Weights in a Heterogeneous Union", *Journal of Political Economy*, Vol 114 No 2, pages 317-339.

[5] Bird, G. (1996), "The International Monetary Fund and Developing Countries: A Review of the Evidence and Policy Options", *International Organization*, vol. 50(3), pages 477-511, Summer.

[6] Cottarelli, C. (2005), "Efficiency and Legitimacy: Trade-offs in IMF Governance", IMF Working Papers 05/107, IMF.

[7] Deutsche Bundesbank (2002), "Quotas and Voting Shares in the IMF", Monthly Report, September 2002, pages 63-77.

[8] Dreyer, J. and Schotter, A. (1978), "Power Relationships in the International Monetary Fund: The Consequences of Quota Changes", Working Paper 78-06, C.V. Starr Center for Applied Economics, New York University.

[9] Fischer, S. (1997), "Applied Economics in Action: IMF Programs", *American Economic Review*, vol. 87(2), pages 23-27, May.

[10] Fischer, S. (1999), "On the Need for an International Lender of Last Resort", *Journal of Economic Perspectives*, Vol. 13(4), pages 85-104, Fall.

[11] Hviding, K., M. Nowak, and L. Ricci, (2004), "Can Higher Reserves Help Reduce Exchange Rate Volatility?", IMF Working Papers 04/189, IMF.

[12] Knight, M. and J. Santaella, (1997), "Economic Determinants of IMF Financial Arrangements", *Journal of Development Economics*, 54, pages 495-526.

[13] Lane, P. R. and G. M. Milesi-Ferretti, (2006), "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004", IMF Working Papers 06/69, IMF.

[14] Mikesell, R. (1994), "The Bretton Woods Debate: A Memoir", "Essays in International Finance", No 192, Princeton University

[15] ONeill, B. and Peleg, B. (2000), "Voting by Count and Account: Reconciling Power and Equality in International Organizations" (http://www.stanford.edu/ boneill/%26a.html).

[16] Rapkin, D. and Strand, J. (2003), "Is East Asia under-represented in the International Monetary Fund?", *International Relations of the Asia-Pacific*, vol. 3, pages 1-28.

[17] Rapkin, D. and Strand, J. (2006), "Reforming the IMFs Weighted Voting System", *The World Economy*, Vol. 29 (3), pages 305-324.

Table 1: Variable definitions

Variable	Definition	Units
QUOTA	Log of relative quota	% of total quota
GDP	Log GDP	USD Billion
GROWTHRATE	Rate of growth of GDP	%
GDPPC	Log of GDP per capita lagged	USD
TRADE	Log of Exports plus Imports lagged	USD Billion
RESERVES	Log of International reserves lagged	USD Billion
AFRICA	African country indicator	Binary variable
ASIA	Asian country indicator	Binary variable
LAAM	Latin America country indicator	Binary variable
OECD	OECD country indicator	Binary variable
COMUNIST	Comunist or former comunist country indicator	Binary variable
EARLY	Early (1944-1955) IMF members indicator	Binary variable
IN(1944-1960)	(1944-1960) IMF members indicator	Binary variable
AFTER	Period 1975-2000 indicator	Binary variable
PROGRAM	Program approved by IMF	Binary variable

Table 2: Probit Regressions

COEFFICIENT	(1) PROGRAM	(2) PROGRAM	(3) PROGRAM
GROWTHRATE	-2,539	-2,545	-2.313
	(1.990)	(1.991)	(1.955)
RESERVES	-0.116***	-0.109***	-0.114***
	(0.029)	(0.030)	(0.029)
GDPPC	0.203***	0.214***	0.267***
	(0.078)	(0.081)	(0.083)
GDPPCSQR	-0.022***	-0.020***	-0.023***
	(0.006)	(0.006)	(0.006)
GDP	0.831**		0.232
	(0.370)		(0.573)
GDPSQR	-0.045**		-0.009
	(0.020)		(0.029)
TRADE		2.765***	2.415*
		(0.912)	(1.379)
TRADESQR		-0.067***	-0.062**
		(0.021)	(0.032)
Observations	613	604	604
Number of countries	130	130	130
Estimation Method	RE Probit	RE Probit	RE Probit

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: OLS Regressions

COEFFICIENT	(1) QUOTA	(2) QUOTA	(3) QUOTA
TRADE	0.868***	0.889***	0.842***
	(0.041)	(0.039)	(0.043)
RESERVES	0.009	0.015	0.007
	(0.035)	(0.033)	(0.036)
GDPPC	-0.331***	-0.459***	-0.296***
	(0.044)	(0.065)	(0.046)
OECD		0.135	
		(0.129)	
ASIA		-0.570***	
		(0.197)	
AFRICA		-0.127	
		(0.127)	
LAAM		0.093	
		(0.117)	
COMUNIST		0.008	
		(0.117)	
IN(1944-1960)			0.250*
			(0.135)
Time effects	YES	YES	YES
Fixed effects	NO	NO	NO
Number of countries	144	144	144
Observations	851	851	851
R^2	0.923	0.933	0.926

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: FE Regressions

COEFFICIENT	(1) QUOTA	(2) QUOTA
TRADE	0.141***	0.078***
	(0.020)	(0.030)
RESERVES	-0.024***	-0.014
	(0.008)	(0.020)
GDPPC	0.153***	0.182***
	(0.031)	(0.042)
AFTER*TRADE		0.060***
		(0.022)
AFTER*RESERVES		0.000
		(0.020)
AFTER*GDPPC		-0.036*
		(0.021)
EARLY*TRADE		0.090**
		(0.043)
EARLY*RESERVES		-0.015
		(0.027)
EARLY*GDPPC		-0.123**
		(0.058)
AFTER*EARLY*TRADE		-0.059**
		(0.029)
AFTER*EARLY*RESERVES		0.034
		(0.030)
AFTER*EARLY*GDPPC		0.063**
		(0.028)
Time effects	YES	YES
Fixed effects	YES	YES
Observations	851	851
Number of countries	144	144
R^2	0.491	0.540

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Quota Proposals

Country	Rel. Quota	Trade Weight	$\nu - \theta = -\frac{2}{3}$	$\nu - \theta = -\frac{1}{3}$
Argentina	0.0105	0.0049	0.0052	0.0050
Australia	0.0159	0.0118	0.0081	0.0102
Belgium	0.0215	0.0325	0.0208	0.0253
Brazil	0.0148	0.0103	0.0157	0.0130
Canada	0.0298	0.0391	0.0278	0.0349
China	0.0231	0.0304	0.0825	0.0524
France	0.0510	0.0556	0.0431	0.0516
Germany	0.0577	0.0955	0.0673	0.0815
India	0.0208	0.0072	0.0293	0.0166
Indonesia	0.0102	0.0081	0.0202	0.0137
Italy	0.0320	0.0437	0.0331	0.0397
Japan	0.0580	0.0712	0.0428	0.0537
Mexico	0.0121	0.0212	0.0311	0.0267
Netherlands	0.0239	0.0366	0.0233	0.0285
Russia	0.0294	0.0143	0.0270	0.0228
Saudi Arabia	0.0349	0.0078	0.0077	0.0077
Spain	0.0136	0.0222	0.0170	0.0188
Sweden	0.0112	0.0145	0.0091	0.0110
Switzerland	0.0169	0.0144	0.0068	0.0087
United Kingdom	0.0510	0.0542	0.0420	0.0504
United States	0.1814	0.1497	0.1111	0.1509
Venezuela	0.0133	0.0032	0.0046	0.0037