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Tax base variability and procyclical fiscal policy in developing countries

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Abstract

Based on a sample of 56 countries, we show that fiscal policy in the G7 countries appears to be acyclical while fiscal policy in developing countries is procyclical (i.e., fiscal policy is expansionary in good times and contractionary in bad times). To explain this puzzle, we develop an optimal fiscal policy model in which running budget surpluses is costly because they create pressures to increase public spending. Given this distortion, a government that faces large fluctuations in the tax base–as is the case for developing countries–will find it optimal to run a procyclical fiscal policy.

JEL classification: F41; H30
Keywords: Optimal fiscal policy; Tax smoothing; Political distortions

1. Introduction

How should fiscal policy be set over the business cycle? This question has intrigued several generations of economists. Standard Keynesian models imply that fiscal policy should be countercyclical: when bad times hit, the government should increase government spending and lower taxes to help the economy "spend" its way out of the

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recession. At the other extreme, tax-smoothing models inspired in Barro (1979) imply that fiscal policy should remain essentially neutral over the business cycle (and respond only to unanticipated changes that affect the government's budget constraint). Hence, if policymakers followed Keynesian prescriptions, one should observe over the business cycle a positive correlation between tax rates and output, and a negative correlation between government spending and output. In contrast, if policymakers followed Barro's prescriptions, those correlations should be essentially zero.[1]

What does the evidence show? For G7 countries, the correlation between government consumption and output indeed appears to show no pattern and be clustered around zero (see, e.g., Fiorito and Kollintzas, 1994; Fiorito, 1997). Due to the inherent difficulties in computing tax rates, correlations between tax rates and output are harder to come by. For the United States, however, Barro (1990), Huang and Lin (1993), and Strazicich (1997) conclude that federal tax rates are set so as to smooth out predictable changes in government spending. The inflation tax rate, in turn, appears to increase during expansions and decline during recessions (see Cooley and Hansen, 1995).

In sharp contrast to the evidence for industrial countries, works by Gavin et al. (1996) and Gavin and Perotti (1997a) suggest that fiscal policy in Latin America is procyclical.[2] During expansions, government consumption increases and taxes fall, while the opposite is true during recessions. Furthermore, the inflation tax is also low in expansions and high in recessions. Fiscal policy in Latin America thus appears to differ substantially relative to OECD countries and not to conform with either Keynesian or Barro prescriptions.[3]

In light of this puzzling behavior, a natural question to ask is whether this is exclusively a Latin American phenomenon, or rather a more widespread phenomenon related to some fundamental characteristic of fiscal policy in developing countries. The evidence provided in this paper (Section 2) clearly suggests that procyclical fiscal policy is so pervasive in the world economy that it should arguably be viewed as the rule rather than the exception. Indeed, for a sample of 56 countries (20 industrial and 36 developing countries), we find that, in line with previous studies, the correlation between the cyclical components of government consumption and output in the G7 countries is close to zero. However, this is not the case in the rest of our sample. For starters, as a group, non-G7 industrial countries

[1] See Lucas and Stokey (1983) for a formalization of Barro's argument. Under imperfect competition, Schmitt-Grohe and Uribe (2004b) still find that labor income taxes should be remarkably smooth. Note also that Barro's tax-smoothing prescription applies to the inflation tax rate, which should remain constant in response to anticipated shifts in goverment expenditures; see Calvo and Guidotti (1993). Under sticky prices, Schmitt-Grohe and Uribe (2004a) also show that the volatility of inflation is low. Although not typically modeled, it would be clearly in the spirit of Barro (1979) to keep government consumption constant in response to, say, shocks to the tax base. (As formally shown below, a model in which government consumption yields utility delivers such a result.)

[2] Throughout this paper, a procyclical fiscal policy with respect to taxes is defined as increases in tax rates during recessions and reductions in tax rates during expansions (i.e., a negative correlation of tax rates with the business cycle). This definition stresses the notion that movements in tax rates tend to reinforce the business cycle. In the same vein, procyclical government consumption will be defined as government consumption increasing in good times and decreasing in bad times (i.e., a positive correlation of government consumption with the business cycle).

[3] Further evidence on OECD countries is provided by Hercovitz and Strawczynski (1998).

are procyclical, with nine out of the 14 countries having a positive correlation between government consumption and output. Developing countries as a group are even more procyclical and, quite remarkably, the correlation is positive in every single one of the 36 developing countries in our sample. When it comes to the inflation tax, our findings confirm that, in industrial countries, inflation increases during expansions and falls during recessions, and that the opposite is true for the developing world as a whole. The evidence thus suggests that procyclicality of fiscal policy is a puzzle in search of an explanation.[4]

Our explanation for the puzzling behavior of fiscal policy in developing countries starts from the observation that fluctuations in the tax base are much larger in developing countries than in the G7 countries. Under these circumstances, full tax smoothing would imply running large budget surpluses in good times and large budget deficits in bad times. However, the ability to run large budget surpluses in good times is severely hampered by political pressures, which–although always present–get exacerbated in times of plenty. As a result, fiscal resources may be wasted in favor of, among others, government agencies, state-owned enterprises, provinces or states, and rent-seekers rather than being used to retire debt, as full tax smoothing would require.[5] In fact, it is not unusual for finance ministers in Latin America to argue that the potential for misusing resources in good times makes it preferable to avoid large surpluses by lowering taxes, thus allowing the private sector to use those resources as it sees fit.[6] Deviations from a full tax-smoothing rule may thus be an indirect way of resisting spending pressures.

We formalize this idea by incorporating into an otherwise standard optimal fiscal policy model (à la Lucas and Stokey, 1983) a political distortion that makes it costly to run budget surpluses due to the pressures they create to increase public spending.[7] Given this political distortion, a government that faces large (and perfectly anticipated) fluctuations in the tax base will choose to lower taxes in good times to fend off spending pressures. However, since reducing taxes in good times imposes intertemporal distortions, it will not be optimal for the government to resist all increases in public spending. Hence, an optimal policy

[4] Unfortunately, there is no readily available data on conventional tax *rates*. Casual empiricism, however, strongly suggests that tax rates are indeed procyclical in developing countries. The cases of Argentina and Mexico in 1995 provide a striking illustration. In the midst of a severe recession, both countries implemented major fiscal adjustments involving large increases in tax rates (together, of course, with substantial cuts in public spending). In the case of Mexico, the value-added tax rate was increased from 10% to 15%. On the other hand, during the economic boom in Argentina in 1991–1994, tax rates were reduced with the explicit purpose of avoiding large surpluses (further details are provided in Section 3).

[5] As analyzed in detail in Section 3, commodity booms offer a laboratory-type experiment to analyze the spending pressures that arise when government's coffers are quickly filled.

[6] This view was repeatedly stated by Domingo Cavallo who, as finance minister of Argentina during 1991–1996, presided over a far-reaching stabilization and reform program.

[7] It should be noted that our main purpose is *not* to model this political distortion, but rather to take it as *given* and analyze its public finance implications. The political distortion itself may be viewed as a reduced form arising from a political economy model. One possible rationalization is given by Tornell and Lane (1999), who show that, as a result of a common pool problem, positive terms of trade shock may lead to a more than proportional change in fiscal appropriations (see also Tornell and Lane, 1998; Lane and Tornell, 1998). A related mechanism is emphasized by Velasco (1999) in the context of a model in which interest groups can successfully lobby the fiscal authority and thus induce inefficiently high levels of government spending (see Alesina and Perotti, 1994 for a review of the political economy of budget deficits in relation to OECD countries).

response to positive shocks in the tax base will involve both decreasing tax rates and raising spending. The opposite is true when the economy is hit by negative shocks to the tax base. In other words, our model predicts that, given this political distortion, optimal fiscal policy is procyclical.[8]

How de we interpret, in light of our model, the differences in fiscal policy between G7 countries, non-G7 industrial countries, and developing countries? We argue that these differences reflect the fact that the tax base fluctuates the most in developing countries and the least in the G7 countries, with non-G7 industrial countries falling somewhere in the middle. In fact, as documented below, the variability of the tax base (i.e., output or consumption) in developing countries is between two and four times higher than in G7 countries. In terms of the model, if fluctuations in the tax base are small, spending pressures will not play much of a role and full tax smoothing will hold as an approximation. In contrast, when fluctuations in the tax base (and hence in the budget surplus) are large, political pressures become harder to resist and will have a major impact on fiscal policy. This implies that the larger the variability of the tax base, the more procyclical fiscal policy will be.

Two additional implications of the model are worth stressing. First, the procyclical response of fiscal policy leads to fluctuations in consumption and output. Policy-induced volatility thus reinforces the volatility of the underlying economic environment. In this context, it would be incorrect to blame policymakers for unstable macroeconomic policies. Our model suggests that the root of unstable policies may lie, not in policymakers' inability to set the "correct" policies, but rather in the political economy of fiscal arrangements. Second, during recessions, it might appear as though the economy is not borrowing enough, which may be construed as evidence of lack of access to international credit markets (i.e., credit rationing). In the model, however, it is the inability of the government to generate large-enough surpluses during expansions that forces it to borrow less during recessions–relative to a full tax-smoothing rule–in order to satisfy its solvency constraint.

Our explanation contrasts with the received wisdom on this issue (see Aizenman et al., 2000; Gavin and Perotti, 1997a,b), which holds that procyclical fiscal policy is mainly explained by the fact that countries may be cut off from international credit markets in bad times.[9] While this explanation has obvious merits, it is not without problems. At a theoretical level, if the government knows that it will lose access to international credit markets during bad times, it is not clear why it would not build a buffer stock that would prevent the borrowing constraint from binding in bad times. At an empirical level, the fact that procyclical fiscal policy is also present in many OECD countries with full access to

[8] For the sake of brevity, we only present a real model of optimal taxation. Section 8 discusses how adding money to the model by assuming that it reduces transactions costs, together with positive collection costs, should deliver the same results (and for the same intuitive reasons).

[9] Persson (1997) advocates a third explanation based on the effects of realized inflation on real government expenditures. This could explain why budget surpluses are particularly high during recessions, which are also periods of high inflation. Persson et al. (1996) argue that this channel is particularly important in the case of Sweden.

capital markets suggests that, at the very least, lack of access to capital markets does not constitute the whole story (see Lane, 2003).[10]

Sorting out the empirical relevance of these contrasting explanations for procyclical fiscal policy could have important implications from a public policy perspective. While the credit rationing explanation would focus on the need to ensure–through various financial mechanisms–that countries have access to liquidity in bad times, our explanation suggests that emphasis ought to be placed in reforming domestic fiscal institutions to ensure that fiscal surpluses are saved in good times. In this sense, therefore, our analysis reinforces the public policy implications of the works by Lane and Tornell (1998) and Tornell and Lane (1998, 1999), which also point to the importance of implementing the appropriate fiscal allocations mechanisms.

The paper proceeds as follows. Section 2 documents the business cycle properties of fiscal variables for a large sample of industrial and developing countries. Section 3 illustrates the outbreak of political pressures to spend in good times during episodes in which fiscal revenues increase dramatically (i.e., commodity booms). Section 4 presents a real model of optimal taxation with consumption taxes, which incorporates a political distortion. Section 5 shows the conditions under which, in the absence of the political distortion, full tax smoothing is optimal. We use this case as our benchmark. Section 6 contains the main results of the paper: we show that exogenous shocks to non-tax revenues and to the tax base lead to an optimal procyclical fiscal policy. Section 7 shows analogous results obtained for labor income taxation. Section 8 interprets the evidence described in Section 2 in terms of the model. Finally, Section 9 concludes.

2. Business cycle properties of fiscal policy

How is fiscal policy conducted over the business cycle? To answer this question, this section reviews the most salient features of the business cycle properties of fiscal variables for a group of 56 countries, which comprises 20 industrial countries and 36 developing countries. These properties refer to moments of Hodrick–Prescott filtered variables. We focus on volatility, as measured by the standard deviation, and comovement, as measured by correlations, for a set of common macro and fiscal variables to compare the experience of developing countries with that of industrial countries. We use annual data from the IMF's International Finance Statistics and Government Finance Statistics and the Inter-American Development Bank (IADB).[11]

Table 1 indicates that, on average, output is twice as volatile in developing countries as in the industrial countries, while private consumption is about three times as volatile.[12] Furthermore, consumption is 70% more volatile than output in developing countries. Such variability in consumption is important because tax systems in developing countries

[10] In the case of developing countries–and as discussed further in Section 8–imperfections in capital markets that generate a positive correlation between the level of public debt (as a proportion of GDP) and the risk premium on public debt will further contribute to fiscal procyclicality through similar mechanisms as those emphasized in this paper.

[11] The choice of annual frequency is due to the lack of quarterly data for several variables in developing countries.

[12] The difference in the average volatilities is significant at the 1% level for output and 5% for consumption.

Table 1
Business cycle properties of fiscal variables

Country	Number of countries	S.D.		Correlations with output			
		Output	Private consumption	Private consumption	Government consumption	Revenues	Inflation tax
Industrial countries	20	2.18	2.85	0.79	0.17** (2.47)	0.38*** (5.61)	0.23*** (4.76)
G7	6	2.05	2.26	0.87	−0.02 (−0.28)	0.31** (3.20)	0.25*** (4.85)
Other industrial	14	2.24	3.10	0.75	0.25** (2.95)	0.39*** (4.59)	0.22*** (3.33)
Developing countries	36	4.47	7.62	0.60	0.53*** (15.40)	0.53*** (14.33)	−0.09* (−1.86)
Latin America	17	4.54	7.41	0.64	0.53*** (9.79)	0.49*** (10.71)	−0.19** (−2.86)
Africa	11	4.00	8.46	0.48	0.54*** (9.60)	0.55*** (8.19)	−0.10 (−1.41)
Other developing	8	4.96	6.91	0.69	0.52*** (6.59)	0.62*** (5.72)	0.10 (0.77)
All sample	56	3.65	5.92	0.69	0.40*** (10.01)	0.47*** (13.44)	0.02 (0.53)

All variables (except for the inflation tax) are expressed in real terms. The inflation tax is defined as the inflation rate over one plus the inflation rate. Statistics are based on Hodrick–Prescott filtered data. The sample period is 1970–1994.

Data are annual from IFS and GFS of the IMF, except for Argentina, Bolivia, Brazil, Dominican Republic, and Peru, which are from the IADB's internal database. *t*-statistics are in parentheses.

* Indicates significance at the 10% level.

** Indicates significance at the 5% level.

*** Indicates significance at the 1% level.

are often based on consumption taxes, rather than on income taxes as in industrial countries. The evidence thus suggests that tax bases are considerably more volatile in developing countries than in industrial countries. As will become clear below, this higher variability will play an important role in our model's predictions.

Table 1 also presents evidence on the comovement between (the cyclical components of) output and the most relevant fiscal variables. The main findings are as follows. First, fiscal revenues are procyclical (i.e., the correlation between output and revenues is positive) in both developing and industrial countries. In both cases, the correlation coefficient is statistically different from zero at the 1% level. Of course, this comes as no surprise since any standard optimal tax-smoothing model would imply procyclical tax *revenues* (as opposed to tax *rates*) in response to shocks to the tax base.

Second, the only group in which government consumption is not correlated with output over the business cycle is the G7 countries. In every other group, this correlation is positive and statistically different from zero. In the non-G7 industrial countries, government consumption is procyclical, with the correlation coefficient being 0.25. In developing countries, government consumption is *highly* procyclical (the correlation coefficient is 0.53), reflecting a positive correlation in every single one of the 36 developing countries in our sample (see Table A1).

To test whether average correlations between government consumption and output differ within and across regions, we perform a series of F-tests. First, the hypothesis that average correlations across developing country regions are the same cannot be rejected, suggesting that the procyclicality of government consumption is a pervasive phenomenon in the developing world. Second, the hypothesis that average correlations for developing countries and industrial countries are equal is rejected at the 1% level. Even the behavior within the industrialized world is not homogenous. In fact, the hypothesis that average correlations for G7 and non-G7 industrial countries are equal is rejected at the 10% level. In sum, these results clearly indicate that the procyclical behavior of government consumption is a widespread phenomenon, which is certainly not confined to Latin America as documented in Gavin et al. (1996) and Gavin and Perotti (1997a). This is the first puzzle in search of an explanation.

Third, the inflation tax rate is countercyclical in industrial countries (i.e., the inflation tax increases during expansions and falls during recessions).[13] The correlation coefficient between the inflation tax and output is positive (0.23) and significantly different from zero at the 1% level. The opposite is true for developing countries. The correlation coefficient between the inflation tax and output for developing countries is negative (-0.09) and significantly different from zero at the 10% level. In fact, F-tests (not reported) indicate that the hypothesis that the average correlations for industrial and developing countries are the same is rejected at the 1% level. This procyclical behavior of tax rates constitutes the second puzzle in search for an explanation.[14]

[13] The inflation tax rate is defined as $\pi/1+\pi$, where π is the inflation rate. Hence, the inflation tax rate is bounded between zero and one (as long, of course, as the inflation rate is non-negative).

[14] Again, we take the behavior of the inflation tax rate as also capturing the behavior of other conventional taxes. (Data on tax *rates* are extremely difficult to come by on any consistent basis.) Indeed, abundant casual evidence suggests that governments in developing countries increase tax rates in bad times.

In sum, the cyclical behavior of fiscal policy in developing countries (in terms of government consumption and tax rates), and even in some industrial countries, is puzzling both in terms of the existing body of theory and when compared to the G7 countries.[15] This evidence raises the question of whether one can construct a neoclassical optimal fiscal policy model, which delivers procyclical fiscal behavior as an optimal response to exogenous shocks. The model developed in Section 4 yields such an optimal fiscal policy as a result of the interaction between a variable tax base and political distortions. Before proceeding to the model, and as a way to motivate the role of political factors, Section 3 analyzes evidence from commodity booms episodes, which suggests that revenue booms give rise to political pressures for additional spending.

3. Revenue booms, government spending, and politics

Political pressures for additional spending in good times will play a critical role in the setup of our model. From a formal point of view, the model will take as given such political pressures since the focus is on explaining deviations from Barro-type tax-smoothing policies by a benevolent fiscal authority. This section motivates our emphasis on political factors by first discussing the reaction of government spending to extraordinary increases in revenues due to rises in commodity prices. The magnitude of the resulting windfall gains is such that these episodes constitute almost laboratory-type experiments for the analysis of the emergence of spending pressures when fiscal resources are abundant. It then discusses the role of political factors in accounting for these spending pressures.

3.1. Revenue booms and government spending

A first experiment is provided by the oil shock of 1974. As illustrated in Table 2, which is based on Gelb (1989), the average windfall gain during 1974–1978 was 21.7% of GDP.[16] Notice first that, on average, only 17.9% of the windfall gain was saved. In other words, 82.1% of the windfall was spent. Remarkably, most of these resources were spent by the government (75.9% of the windfall gain) and only 6.2% by the private sector, as Table 2 indicates. Since, on average, around four fifths of the windfall gain accrued to the government, the private sector saved 70% of the windfall income gain, while the public sector saved only 5% of its windfall revenue gain. Put differently, the very low propensity to save out of what turned out to be a temporary shock was due mainly to the public sector's spending spree. A closer look at the fiscal accounts (Table 3) reveals that the government's marginal propensity to spend out of the windfall increase in revenues is high in every single country, ranging from 0.77 in Venezuela to 0.99 in Nigeria.[17]

[15] See Kaminsky et al. (2004) for further evidence using a more comprehensive database, different measures of government spending, and various detrending methods.

[16] The windfall gain is computed as the value effect (i.e., price times oil sales) of the change in oil prices.

[17] Not taking into account the case of Ecuador, where revenues actually fell.

Table 2
Oil boom and aggregate expenditures, 1974–1978

	Windfall gain								
	% GDP	% of Windfall gain							
		Total (1)+(2)+(3)	Spent						Saved (3)
			Private expenditures			Public expenditures			
			Consumption	Investment	Total (1)	Consumption	Investment	Total (2)	
Algeria	27.1	100.0	13.3	NA	13.3	5.2	97.4	102.6	−15.9
Ecuador	16.7	100.0	−5.4	22.8	17.4	32.9	28.7	61.7	21.0
Indonesia	16.0	100.0	13.1	−10.6	2.5	15.0	49.4	64.4	33.1
Iran	36.9	100.0	−19.0	18.2	−0.8	27.6	27.1	54.7	46.1
Nigeria	22.8	100.0	12.7	−28.9	−16.2	18.4	85.5	103.9	12.3
Venezuela	10.7	100.0	17.8	30.8	48.6	15.0	45.8	60.7	−9.3
Average	21.7	100.0	2.0	5.1	6.2	19.4	56.5	75.9	17.9

Source: Based on Gelb (1989).

As indicated in Table 2, a large fraction of the increase in government expenditures takes the form of public investment. In practice, however, most of the increases in public investment, although officially recorded as such, are actually government consumption. In a report titled "Ungenerous Endowments," *The Economist* (1995) describes the use of proceeds from commodity booms as follows:

> All too often the proceeds of recent commodity windfalls have accrued to governments, either through taxes or because they nationalised the companies involved. Naturally enough, the governments then instituted lavish spending programmes... Public spending is not always bad; indeed the right kind of public investment can be an important engine of economic growth. Inevitably, however, many of the public spending programmes put in place by countries enjoying a resource boom have not been of this kind. Economists who have sought to measure the effectiveness of such spending, for instance after the 1973 oil shock, have found that it often yielded minimal, zero or, in a few cases, even negative rates of return.

Given the low return of public investment associated with commodity booms, most of it should be viewed as falling essentially into the same category as government consumption since non-productive investment will not generate future consumption.[18] While it is inherently difficult to establish how large is the proportion of non-productive investment during these commodity booms, estimates from Nigeria put it as high as 75% (*The Economist* (1995)). In this light, the increase in non-productive government expenditures resulting from a revenue bonanza is simply staggering.

A similar pattern of booming government revenues and expenditures was observed during the coffee boom of 1976–1978. Due to a severe frost in Brazil, the average

[18] At a more general level, Isham and Kaufmann (1998) calculate economic rates of return from a set of 1276 public and private investment projects under monitoring by the World Bank. They find that when public investment exceeds 10% of GDP, it has an adverse effect on the return of individuals projects.

Table 3
Oil boom and fiscal response, 1974–1978 (% GDP)

	Total revenues		Total expenditures		Marginal propensity to spend out of revenues
	1970–1972	1974–1978	1970–1972	1974–1978	
Algeria	32.6	59.9	40.2	71.5	0.97
Ecuador	14.2	12.9	14.1	14.4	NA
Indonesia	15.6	23.1	18.7	25.0	0.90
Iran	31.7	71.1	37.7	71.6	0.85
Nigeria	12.3	27.7	10.8	24.2	0.99
Venezuela	25.2	42.1	24.8	32.0	0.77
Average	21.9	39.5	24.4	39.8	0.91

Source: Based on Gelb (1989).
The marginal propensity to consume out of revenues is defined as the ratio of the change in total expenditures to the change in total revenues. "NA" means not applicable.

price of coffee in 1977 was three times as high as the 1975 average. Furthermore, given the cause of the price increase, it was evident to all players involved that the price boom would be temporary. Little et al. (1993) studied the effects of this coffee boom in five developing countries: Cameroon, Colombia, Costa Rica, Cote d'Ivoire, and Kenya. The extent to which the windfall gains accrued to producers or the government varied greatly across countries. For example, in Costa Rica and Kenya, where the whole price rise accrued to producers, the rise in fiscal revenues came about through other channels, such as export taxes. In spite of these differences, "government revenues in four of the five countries doubled from 1975 to 1978 [and] [i]t did not take long for government expenditures to catch up with, and overtake, revenue (Little et al., 1993, pp. 40–41). As in the case of the oil boom, most of the increases in government expenditures showed up as investment. For instance, in Cote d'Ivoire, the "government reacted to the coffee and cocoa boom of the mid-1970s by increasing its capital expenditures from 8 percent of GDP in 1975 to 22 percent in 1977. Private investment remained relatively stable during that period, at about 13 to 15 percent of GDP" (Chamley and Ghanen, 1994, p. 305).

3.2. Political factors

The evidence presented so far–which suggests that governments embark on a spending spree when faced with a windfall gain in revenues–is clearly at odds with standard optimal fiscal policy prescriptions. It is hard to think of economic reasons that should lead a government to increase its consumption so dramatically, as opposed to saving most of the windfall for a rainy day. Furthermore, such government behavior is in stark contrast to that of the private sector, which appears to save the bulk of these large windfalls as standard intertemporal models would predict.

In our view, this puzzling behavior can be traced back to the size of the fluctuations in fiscal revenues. Given such large fluctuations in fiscal revenues, smoothing both tax rates and government consumption à la Barro would imply running extremely large budget surpluses in good times. In practice, however, the ability to run such large budget surpluses during good times appears to be severely hampered by political pressures. While always present, these political pressures are particularly evident during times of plenty. In the words of *The Economist* (1995):

> The trouble is that the lure of those fat rents can be hard to resist. The upshot is routinely an outbreak of competitive rent-seeking. The power centres in any resource-rich country soon notice that the profits from capturing a slice of the rent from natural resources beat those of any possible alternatives; and they act accordingly. Behind the economic jargon is a simple enough proposition: give a group of people a big pot of money and they will spend their time arguing how to share it out... Experience bears this out. In Mexico in the 1970s, politicians and firms battled over the state's oil revenues. So it was in Venezuela, Nigeria, and several other big oil exporting countries. Nor is the experience restricted to oil exporters. Other resource-rich countries have blown the proceeds of their wealth in competitive rent-seeking: Australia and Brazil are outstanding examples.

In the same vein, Little et al. (1993), based on a detailed study of 18 developing countries from 1974 to 1989, conclude that economic booms leading to large increases in government revenues typically weaken treasury control and that "[m]ost governments, democratic and authoritarian alike, are preoccupied with the short-run and find it hard to resist spending a windfall in revenues" (pp. 378–379). Examples of spending binges and loss of fiscal control in the aftermath of positive terms of trade shocks include Indonesia after the first oil shock, Mexico and Nigeria after the second oil shock, and Kenya during the coffee boom of the mid-1970s. They argue that "when funds are readily available, and known by all to be available, it requires exceptionally strong traditions and strong-willed financial officials backed by their political leaders to maintain fiscal discipline..." (p. 379).

Although commodity booms in developing countries offer a unique opportunity to look through a magnifying glass at the outbreak of political pressures in times of plenty, such pressures are certainly not limited to periods of commodity booms. For instance, after the launching of an exchange rate-based stabilization plan in 1991, Argentina went through a rapid economic expansion during 1991–1994. The resulting increase in tax revenues led to a substantial increase in government spending. At the same time, there was an active policy of reducing labor tax rates to prevent the fiscal surplus from rising too much. The rationale–as stated publicly, time and again, by the Minister of Finance, Domingo Cavallo–was that if the fiscal surplus were allowed to rise, political pressures would eat it away. Hence, the argument went, the surplus would be put to better use if it were handed back to the private sector through lower tax rates.[19]

Finally, some indirect evidence in favor of the notion that the abundance of resources stimulates spending pressures is given by the widespread practice on the part of finance ministers to purposely underestimate fiscal revenues in order to avert spending pressures. In fact, econometric evidence for 12 Latin American countries suggests that, in volatile

[19] In a 1999 interview (*Ambito Financiero*, January 5, 1999), Cavallo argued against raising taxes to reduce the current fiscal deficit because "[w]hen the federal government and the provinces get... more revenues, they stop worrying about containing public spending... It makes more sense to generate some fiscal deficit but reduce taxes, as we did, for example, [in 1994 and 1996] [b]ecause... it puts pressure on those who manage public spending to prevent it from getting out of control..." (authors' translation).

economies, the treasury systematically underestimates fiscal revenues in order to prevent overspending (see Aizenman and Hausmann, 2000). The underlying logic is that spending agencies react asymmetrically when their allocated funds differ from realized expenditures. When there is a shortfall of funds, these agencies will always request additional funds from the treasury. In contrast, when there is an excess of funds, these agencies will typically spend the extra funds. This asymmetry introduces an overspending bias, which the treasury attempts to curb by reducing the estimated revenues and, accordingly, the initial budget allocations.

In summary, three key stylized facts emerge from this section. First, the fluctuations in government revenues observed in economies that depend on volatile sources of revenue may be extremely large. Second, large temporary rises in government revenue result in correspondingly large increases in government consumption (i.e., actual government consumption plus non-productive public investment). Third, political factors–in particular the emergence of political pressures for additional spending during revenue bonanzas– appear to be of central importance in understanding the apparent inability of governments to save in good times. These stylized facts, together with the evidence presented in Section 2, suggest that high variability of fiscal revenues, combined with increased spending pressures in good times, may be key in explaining the procyclical nature of fiscal policy. These ideas are formalized in Section 4's model.

4. The model

This section develops a simple perfect-foresight real model of optimal fiscal policy, which will be used in later sections to illustrate our main points.[20] The analysis will first focus on the case of consumption taxes and then show that all results go through for the case of labor income taxation.

4.1. The household's problem

Consider a small open economy inhabited by a large number of identical, infinitely lived consumers, who are blessed with perfect foresight. The economy is perfectly integrated with the rest of the world in both goods and capital markets. The (constant) world real interest rate is denoted by r. There exists only one (tradable and non-storable) consumption good in the world.

Production of the only good in period t, y_t, takes place through a linear technology:

$$y_t = \alpha_t \ell_t, \tag{1}$$

where ℓ_t denotes labor supplied in period t and α_t is a productivity shock.

[20] To make our points as clearly as possible, we will focus on perfect-foresight equilibrium paths. This allows us to isolate variability in fiscal variables, which is due solely to anticipated changes in fiscal revenues. In a stochastic version of this model, such changes would be reinforced by revisions to permanent revenues associated with unexpected shocks.

Let f_t denote net foreign assets held by the representative consumer at the end of period t. The consumer's flow budget constraint is thus:

$$f_t = (1+r)f_{t-1} + y_t - (1+\theta_t)c_t, \tag{2}$$

where c_t is consumption in period t and θ_t is the consumption tax rate.[21] Assuming away Ponzi games–and using Eq. (1)–the flow constraint (2) implies that the household's lifetime expenditure is constrained only by its initial assets and the present discounted value of the output path:

$$(1+r)f_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t \alpha_t \ell_t = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t c_t(1+\theta_t). \tag{3}$$

The representative household's lifetime utility is given by:

$$\sum_{t=0}^{\infty}\beta^t[q_t u(c_t) - (1-q_t)v(\ell_t)], \tag{4}$$

where $\beta \in (0,1)$ is the constant subjective discount factor, q_t is a preference shock, and $u(.)$ and $v(.)$ satisfy $u'(.)>0$, $v'(.)>0$, $u''(.)<0$, and $v''(.)>0$.

The consumer's problem consists in choosing a sequence $\{c_t,\ell_t\}_{t=0}^{\infty}$ that maximizes Eq. (4) subject to Eq. (3), for a given path of $\{q_t,\theta_t,\alpha_t\}_{t=0}^{\infty}$ and given values of f_{-1} and r.[22] In addition to Eq. (3), the first-order conditions for this problem are:

$$q_t u'(c_t) = \lambda(1+\theta_t), \tag{5}$$

$$(1-q_t)v'(\ell_t) = \lambda\alpha_t, \tag{6}$$

for $t=0,1,\ldots$, where λ is the Lagrange multiplier associated with constraint (3). Eq. (5) states that, at an optimum, the marginal utility of consumption is proportional to the effective price of consumption, $1+\theta_t$. Similarly, Eq. (6) indicates that, at an optimum, the marginal disutility of labor is proportional to the marginal productivity of labor.[23]

As in any optimal fiscal policy problem, the allocation chosen by the government must be implementable as a competitive equilibrium. Hence, the household's optimality conditions will restrict the set of allocations that the government can choose from. There are two such "implementability" conditions. The first, intratemporal, is the equilibrium price function, $y^{\theta}(c_t,\ell_t)$, which expresses the consumption tax as a function of consumption and labor (as follows from Eqs. (5) and (6)):

$$\theta_t \equiv y^{\theta}(c_t,\ell_t) = \frac{\alpha_t q_t u'(c_t)}{(1-q_t)v'(\ell_t)} - 1. \tag{7}$$

The second, intertemporal condition, is given by Eq. (6).

[21] As documented by Easterly and Rebelo (1993), developing countries tend to rely more heavily on trade taxes (which are equivalent in this framework to consumption taxes), whereas developed countries rely primarily on income taxes.

[22] As usual, and to eliminate inessential dynamics, it will be assumed that $\beta = 1/(1+r)$.

[23] Naturally, in a decentralized competitive equilibrium, the real wage would equal α_t.

4.2. The government's problem

Consider now the policy problem faced by the government. In each period t, the government must finance government consumption, g_t, with either contemporaneous revenues, or by borrowing in international capital markets. The government has two sources of revenues: it levies a consumption tax whose proceeds are given by $\theta_t c_t$, and owns a flow endowment of a tradable natural resource, whose value in each period t (in terms of the consumption good) is given by z_t. The government's flow budget constraint is thus:

$$b_t = (1+r)b_{t-1} + \theta_t c_t + z_t - g_t, \tag{8}$$

where b_t denotes the government's holdings of net foreign assets at the end of period t. In what follows, $T_t(=\theta_t c_t)$ will denote consumption tax revenues and $R_t(=T_t+z_t)$ total revenues. Assuming away Ponzi games, the corresponding intertemporal budget constraint is given by:

$$(1+r)b_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t(\theta_t c_t + z_t) = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t g_t. \tag{9}$$

Combining the consumer's and the government's intertemporal budget constraints (Eqs. (3) and (9)) yields the economy's resource constraint (where $w(\equiv f+b)$ denotes the economy's net foreign assets):

$$(1+r)w_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t(\alpha_t \ell_t + z_t) = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t (c_t + g_t). \tag{10}$$

4.2.1. Government spending rule

Our model departs from the standard optimal fiscal model à la Lucas and Stokey (1983) by assuming that government spending consists of both an exogenous component, $\bar{g}$, and an endogenous component.[24] The endogenous component is assumed to be a non-negative, increasing and convex function of the primary surplus. Formally:

$$g_t = \bar{g} + f(PS_t), \tag{11}$$

where the function f(PS) satisfies:

$$f'(.)>0, \quad f''(.)>0, \tag{12}$$

and the primary surplus, PS_t, is defined as:

$$PS_t \equiv \theta_t c_t + z_t - g_t. \tag{13}$$

This specification includes as a special case (i.e., $f(\text{PS})\equiv 0$) the standard optimal fiscal policy problem in which government spending is taken as exogenous. We will

[24] The exogenous component is assumed to be constant over time for expositional convenience and implies no loss of generality.

refer to this case as the "Barro case" (after Barro, 1979) and use it as a benchmark.[25]

We view the spending rule (Eq. (11)) as reflecting a political distortion which characterizes the workings of actual economies. In a world with no political distortions, spending decisions would be made based solely on an evaluation of social costs and benefits, and would thus be independent of the business cycle (in terms of our model, they would be captured by the term $\bar{g}$). In actuality, however, decisions on public spending are heavily influenced by political pressures from various groups such as Congress, lobbyists, public sector workers' unions, government agencies, and states or provinces (see, e.g., Olson, 1971). While such pressures are, to a greater or lesser extent, always present, they are more difficult to resist in good times than in bad times, as argued at length in Section 3. As a matter of political expediency, it is easier for a finance minister to dismiss spending pressures in times of deficit by simply pointing to the lack of resources. In contrast, when fiscal resources are abundant, spending pressures multiply and typically force the finance minister into yielding to some of the demands.

Before proceeding, some remarks on the formal specification of our government spending function are warranted. While the assumption that spending pressures are an increasing function of available fiscal resources (as reflected in a higher primary balance) seems quite plausible, it might be less obvious why spending pressures may increase at an increasing rate. This assumption, however, is not implausible either. As argued in Section 3, spending pressures seem to multiply in response to revenue booms. Having said that, the convexity of the $f(.)$ function is not necessary for our results to go through. If government consumption is included in the utility function (i.e., government consumption is a substitute for private consumption in utility terms, along the lines of Barro, 1981), a linear $f(.)$ is all that is needed for the same results to be obtained, as shown in Appendix E.

4.2.2. Ramsey allocations

The government's optimization problem consists in choosing $\{c_t, \ell_t, g_t, \lambda\}$ to maximize Eq. (4) subject to Eqs. (6), (9), (10), and (11), with θ_t given by Eq. (7) and PS_t by Eq. (13).[26] The solution to the government's problem yields a system of equations, which characterizes the perfect-foresight equilibrium path of $\{c_t, \ell_t, g_t\}_{t=0}^{\infty}$ for given paths of $\{z_t, q_t, \alpha_t\}_{t=0}^{\infty}$ (see Appendix B). The optimal paths of c_t and ℓ_t determine the optimal path of θ_t through the equilibrium price function (7).

To gain some insights, consider Eq. (B1) of the solution system (see Appendix B), reproduced here for convenience:

$$q_t u'(c_t) = \mu - \frac{\partial \left[y^{\theta}(c_t, \ell_t) c_t \right]}{\partial c_t} \left[\frac{\gamma + \mu}{1 + f'(PS_t)} - \mu \right], \tag{14}$$

[25] Notice that, in the Barro case, the government does not choose government spending since it becomes exogenous. Or, which is formally equivalent, it chooses government spending subject to the constraint that it be equal to $\bar{g}$.

[26] Notice that the government must choose a constant value of λ to ensure that the optimal path of ℓ_t satisfies the implementability condition (6).

where

$$\frac{\partial\left[y^{\theta}(c_t,\ell_t)c_t\right]}{\partial c_t}=\frac{\alpha_t q_t u'(c_t)}{(1-q_t)v'(\ell_t)}\left[1-\frac{1}{\eta^c(c_t)}\right]-1, \tag{15}$$

$$\eta^c(c_t)\equiv-\frac{\partial c_t}{\partial(1+\theta_t)}\frac{1+\theta_t}{c_t}=\frac{-u'(c_t)}{c_t u''(c_t)}, \tag{16}$$

and γ and μ denote the multipliers associated with constraints (9) and (10), respectively. Eq. (16) defines the (absolute value of the) price elasticity of consumption. Eq. (14) states that, at the optimum, the government equates the marginal utility of consumption, $q_t u'(c_t)$, to its marginal cost. The latter is given by the marginal value of a unit of resources, μ, minus the marginal value of the induced change in consumption tax revenues, given by the second term on the right-hand side of Eq. (14). Put differently, since an additional unit of consumption brings additional revenues, the marginal cost of consumption for the government is less than the marginal resource cost.

Eq. (14) also makes clear the role of the political distortion. Other things being equal, an additional unit of consumption leads to higher revenues and hence a higher primary surplus. By increasing $f'(\mathrm{PS}_t)$ (recall that $f(\mathrm{PS}_t)$ is convex), the higher primary surplus increases the fraction of additional revenues that will be lost to wasteful government spending. If $f(\mathrm{PS})\equiv 0$, the marginal value of the induced change in revenues is simply $\gamma\frac{\partial\left[y^{\theta}(c_t,\ell_t)c_t\right]}{\partial c_t}$, which implies that there is no "leakage" of additional revenues through higher government spending.

The ensuing analysis will characterize the perfect-foresight equilibrium paths of the endogenous variables for non-constant paths of the forcing processes. Thus, in our framework, volatility will be viewed as perfectly anticipated fluctuations in the paths of $\{z_t, q_t, \alpha_t\}$. Shocks to z are meant to capture exogenous shocks to revenues, such as an increase in the world price of a primary commodity produced by a state-owned company. Shocks to q affect consumption directly and will therefore be viewed as shocks to the tax base.

5. The Barro case

As a benchmark, it will prove useful to consider the particular case of Eq. (11) in which $f(\mathrm{PS}_t)\equiv 0$. This is the standard case addressed in the optimal fiscal policy literature (see, for instance, Barro, 1979; Lucas and Stokey, 1983), in which the path of government spending is taken as exogenous. Our purpose in this section is to establish conditions under which full tax smoothing prevails. By doing so, we will ensure that deviations from the full tax-smoothing policy in the general case (i.e., when $f(\mathrm{PS})$ satisfies Eq. (12)) will be due solely to the political distortion introduced by the spending rule (Eq. (11)).

5.1. Full tax smoothing

Our first result establishes sufficient conditions for optimal tax smoothing.

Proposition 1 (*Barro rule*). *Suppose that* $f(PS_t)\equiv 0$. *If the price elasticity of consumption,* $\eta_c(c_t)$, *is constant, then along a perfect-foresight equilibrium path,* $\{\theta_t\}_{t=0}^{\infty}=\theta$, *for any given paths of* $\{z_t\}_{t=0}^{\infty}$, $\{q_t\}_{t=0}^{\infty}$, *and* $\{\alpha\}_{t=0}^{\infty}$.[27]

Proof. Set $f'(\mathrm{PS}_t)=0$ in Eq. (14) and use Eqs. (5), (6), and (7) to solve for θ:

$$\theta_t = \frac{\mu - \lambda + \frac{\gamma}{\eta^c(c_t)}}{\lambda + \gamma\left[1 - \frac{1}{\eta^c(c_t)}\right]}. \tag{17}$$

If $\eta^c(c_t)$ is constant, then Eq. (17) implies that θ_t is constant along a perfect-foresight equilibrium path. □

A class of utility functions that satisfies the condition that $\eta^c(c_t)$ be constant is

$$u(c_t) = \frac{c_t^{1-\frac{1}{\rho}} - 1}{1 - \frac{1}{\rho}}, \qquad \rho>0, \tag{18}$$

in which case $\eta^c(c_t)=\rho$. In what follows, we will work with the isoelastic family given by Eq. (18) to ensure that full tax smoothing holds in the Barro case and, therefore, that any deviations from the tax-smoothing rule will be due to the introduction of political distortions.

5.2. Characterization of optimal policies

We will now fully characterize the perfect-foresight equilibrium outcome in the Barro case for a non-constant path of z_t and q_t.

Proposition 2 (*z-Shocks in Barro case*). *Suppose that* $\alpha_t=\alpha$ *and* $q_t=q$, *for all* $t\geq 0$. *Consider a perfect-foresight equilibrium path for an arbitrary path* $\{z_t\}_{t=0}^{\infty}$. *If, along such a path,* $z_{t+1}>z_t$ *for some t, then* $c_{t+1}=c_t$, $\ell_{t+1}=\ell_t$, $\theta_{t+1}=\theta_t$, $T_{t+1}=T_t$, $R_{t+1}>R_t$, *and* $PS_{t+1}>PS_t$.[28]

Proof. The results follow directly from Eqs. (C9)–(C14) in Appendix C. □

A positive shock to revenues gets fully reflected in a higher primary surplus. Tax rates remain constant and, since there is no change in consumption, so do tax revenues. The volatility of total revenues has no impact on consumption and labor.

Proposition 3 (*q-Shocks in Barro case*). *Suppose that* $z_t=z$ *and* $\alpha_t=\alpha$ *for all* $t\geq 0$. *Consider a perfect-foresight equilibrium path for an arbitrary path* $\{q_t\}_{t=0}^{\infty}$. *If, along such a path,* $q_{t+1}>q_t$ *for some t, then* $c_{t+1}>c_t$, $\ell_{t+1}>\ell_t$, $\theta_{t+1}=\theta_t$, $T_{t+1}>T_t$, $R_{t+1}>R_t$, *and* $PS_{t+1}>PS_t$.

Proof. The results follow directly from Eqs. (C9)–(C14) in Appendix C. □

[27] Naturally, throughout our analysis we will implicitly restrict our attention to sequences of $\{z_t\}_{t=0}^{\infty}$ and $\{\alpha\}_{t=0}^{\infty}$ which lead to a finite present discounted value of resources, so that intertemporal constraints are well defined.

[28] Of course, all propositions continue to be valid if–where applicable–inequalities are reversed.

By increasing the marginal utility of current consumption relative to both current leisure and future consumption, a higher q leads to higher consumption. A higher q should therefore be viewed as a positive shock to the tax base. Since the tax rate does not change, tax revenues increase proportionately with the increase in the tax base and are reflected one-to-one in a higher primary surplus. Furthermore, fluctuations in consumption and output only reflect the volatility of the environment (i.e., q-shocks).

In terms of the evidence reviewed in Section 2, the main implications for optimal fiscal policy that follow from the Barro rule are the following: (i) the comovement between the tax rate and the tax base should be zero; (ii) the comovement between government spending and the tax base should also be zero;[29] and (iii) the primary surplus moves one-to-one with the increase in tax revenues. As discussed in Section 2, these implications do not appear to fit the data. Introducing a political distortion will enable us to account for the observed empirical regularities.

6. The *f*-case: the role of political distortions

Consider now the case in which *f*(PS) satisfies the conditions in Eq. (12).

Proposition 4 (*z-Shocks in the f-case*). *Suppose that* $\alpha_t = \alpha$ *and* $q_t = q$, *for all* $t \geq 0$. *Consider a perfect-foresight equilibrium path for an arbitrary path* $\{z_t\}_{t=0}^{\infty}$. *If, along such a path,* $z_{t+1} > z_t$ *for some t, then* $c_{t+1} > c_t$, $\ell_{t+1} = \ell_t$, $g_{t+1} > g_t$, $\theta_{t+1} < \theta_t$, $T_{t+1} < T_t$, $R_{t+1} > R_t$, *and* $PS_{t+1} > PS_t$.

Proof. See Appendix D. □

This proposition shows that when z increases along a perfect-foresight path, the government finds it optimal to reduce tax rates and increase government spending. The optimal fiscal policy is thus procyclical: in good times (i.e., high z), the government increases public spending and lowers taxes; in bad times (i.e., low z), it reduces public spending and raises taxes. Moreover, the procyclicality of tax rates induces fluctuations in consumption, which rises in good times and falls in bad times. Such volatility in consumption, which is absent in the Barro case, is therefore not related to the underlying volatility of the environment, but to the government's policy response.

Why is procyclical fiscal policy optimal? Suppose that, in response to a temporarily higher z, the government did not change taxes (as in the Barro case). Then the higher revenues would lead to a higher primary surplus and hence, by increasing government spending, to lower *net* tax revenues (recall the discussion

[29] This implication is trivially true in this case because the path of government spending is exogenous and flat over time. However, the same implication follows if the level of public spending enters separably into the utility function and is optimally chosen by the government. In that case, the (endogenously determined) level of g is constant over time (see Appendix E).

following Eq. (14)). Therefore, the government reduces tax rates in an attempt to reduce the higher primary surplus and thus fend off spending pressures. However, the government will not find it optimal to fully offset the higher revenues by lowering taxes to the point of leaving the primary surplus unchanged. The reason is that the government must balance the trade-off between additional government spending and the inter-temporal distortion implied by a non-constant path of taxes. The government thus absorbs a fraction of the positive shock in the form of higher spending. Since government spending increases and tax rates decline, the primary surplus rises by less than it would in the Barro case.

Three important remarks are called for concerning the nature of the result in Proposition (4). First, it should be clear that the procyclicality in government spending does not directly follow from the political pressures captured in *f*(.). To see this, consider for a moment the case in which the government could resort to lump-sum taxes. In this case, as can be easily shown, the government would optimally choose to fully offset the effect of a higher z on the primary surplus by reducing lump sum taxes. As a result, government spending would remain unchanged in response to an increase in z. Hence, the critical factor in explaining procyclical fiscal policy in our model is the interaction between political distortions and distortionary taxation in the presence of variable government revenues.

Second, our result does not hinge on government consumption providing no social benefits. The same result is obtained in the alternative specification analyzed in Appendix E, in which government consumption yields direct utility to the household and *f*(.), is a *linear* function. In this case, the higher primary surplus is still costly because, by increasing government consumption, it reduces at the margin the value of additional government consumption (due to diminishing marginal utility of government consumption).

Third, an additional (distortionary) tax would not change our results either. An example of this would be to add money into the model so that the government can also resort to the inflation tax. In that case, it can be shown that (if the government finds it optimal to use the inflation tax to begin with) it is optimal for the government to reduce *both* the consumption tax and the inflation tax in response to an increase in z. An additional distortionary tax simply provides the government with another means for reducing the higher primary surplus.

Consider now the optimal policy response to q-shocks, which capture shocks to the tax base.

Proposition 5 (q-*Shocks in the f-case*). *Suppose that* $z_t = z$ *and* $\alpha_t = \alpha$ *for all* $t \geq 0$. *Consider a perfect-foresight equilibrium path for an arbitrary path* $\{q_t\}_{t=0}^{\infty}$. *If, along such a path,* $q_{t+1} > q_t$, *then* $c_{t+1} > c_t$, $\ell_{t+1} > \ell_t$, $g_{t+1} > g_t$, $\theta_{t+1} < \theta_t$, $T_{t+1} > T_t$, $R_{t+1} > R_t$, *and* $PS_{t+1} > PS_t$.

Proof. See Appendix D. □

A rise in q leads to higher consumption and output. As in the case of an exogenous increase in revenues, the government responds to an increase in the tax base by lowering tax rates and increasing government spending. Such procyclical fiscal policy response exacerbates the fluctuations in consumption induced by the q-shock. Therefore, fluctuations in consumption do not only reflect the volatility of the environment but also the procyclical policy response to shocks. Political distortions, by inducing a procyclical fiscal policy, lead to larger economic fluctuations.

For further reference, note that, in terms of the evidence reviewed in Section 2, the predictions of the model are the following: (i) the comovement between the tax rate and the tax base should be negative; (ii) the comovement between government spending and the tax base should be positive; and (iii) the primary surplus should increase by less than tax revenues.

Finally, it is worth stressing that, in this model, the procyclicality of fiscal policy does not originate in any sort of credit rationing during bad times on the part of international credit markets. Rather, it is the inability of the government to generate large budget surpluses in good times that leads to less borrowing in bad times relative to the amount of borrowing that would have taken place in the absence of political distortions. Hence, in the context of our model, it would be misleading to conclude that credit rationing by international markets in bad times is the driving force behind the existence of procyclical fiscal behavior in developing countries. This difference in emphasis has important public policy implications. In the credit rationing interpretation, policy efforts should be directed at removing those international credit markets distortions that may lie behind the rationing behavior in bad times. In our interpretation, policy efforts should be directed at implementing domestic institutional arrangements, which ensure that government surpluses are saved in good times.

7. Labor income taxation

We now address the case of labor income taxation and derive the preference specification under which the same results obtain. Specifically, we show that when the utility function is defined in terms of labor and the subutility function for labor is isoelastic, full tax smoothing is optimal in the Barro case and procyclical fiscal policy is optimal in the general case.

Formally, the household's and the government's intertemporal budget constraints become, respectively:

$$(1+r)f_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)(1-\tau_t)\alpha_t\ell_t = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t c_t, \tag{19}$$

$$(1+r)b_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t(\tau_t\alpha_t\ell_t + z_t) = \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^t g_t, \tag{20}$$

where τ_t denotes the labor income tax.

Proceeding in the same way as above, the household's problem is first solved to derive the restrictions imposed by a competitive equilibrium. Such implementability conditions are then taken into account in the government's problem. Combining the first-order conditions for ℓ_t and g_t from the government's problem, we obtain:

$$\frac{(1-q_t)v'(\ell_t)}{\alpha_t} = \mu + \frac{\partial[y^\tau(c_t,\ell_t)\ell_t]}{\partial \ell_t}\left[\frac{\gamma+\mu}{1+f'(PS_t)} - \mu\right], \tag{21}$$

where

$$\frac{\partial[y^\tau(c_t,\ell_t)\ell_t]}{\partial \ell_t} = 1 - \frac{(1-q_t)v'(\ell_t)}{\alpha_t q_t u'(c_t)}\left[1+\frac{1}{\eta^\ell(\ell_t)}\right], \tag{22}$$

$$\eta^\ell(\ell_t) \equiv \frac{\partial \ell_t}{\partial \alpha_t(1-\tau_t)} \frac{\alpha_t(1-\tau_t)}{\ell_t} = \frac{v'(\ell_t)}{\ell_t v''(\ell_t)}. \tag{23}$$

The equilibrium price function is denoted by $y^\tau(c_t,\ell_t)$ and the labor supply elasticity with respect to the after-tax real wage is denoted by $\eta^\ell(\ell_t)$.

As in the consumption tax case, we now establish sufficient conditions for optimal tax smoothing.

Proposition 6 (*Barro rule*). *Suppose that $f(PS_t) \equiv 0$. If the labor supply elasticity, $\eta^\ell(\ell_t)$, is constant, then along a perfect-foresight equilibrium path, $\{\tau_t\}_{t=0}^\infty = \tau$, for any given paths of $\{z_t\}_{t=0}^\infty$, $\{q_t\}_{t=0}^\infty$, and $\{\alpha_t\}_{t=0}^\infty$.*

Proof. Set $f'(\mathrm{PS}_t)=0$ in Eq. (21) and use the consumer's first-order conditions and Eq. (22) to solve for τ:

$$\tau_t = \frac{\lambda - \mu + \frac{\gamma}{\eta^\ell(\ell_t)}}{\lambda + \gamma\left[1+\frac{1}{\eta^\ell(\ell_t)}\right]}. \tag{24}$$

If $\eta^\ell(\ell_t)$ is constant, then Eq. (24) implies that τ_t is constant along a perfect-foresight equilibrium path. □

A class of utility functions that satisfies the condition that $\eta^\ell(\ell_t)$ be constant is:

$$v(\ell_t) = \frac{\ell_t^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}}, \qquad \sigma > 0, \tag{25}$$

in which case $\eta^\ell(\ell_t)=\sigma$.[30]

Using Eq. (25), a set of propositions analogous to the consumption tax case can be derived for a non-constant path of z_t and q_t. Given the symmetry between consumption and labor in our formulation, full-tax smoothing obtained in the Barro case and fiscal policy is procyclical in the general case (i.e., labor taxes fall and government spending increases in good times).

[30] Notice that specifying the utility function in terms of leisure (as opposed to labor) would not necessarily deliver full tax smoothing. The reason is that if the utility function were defined as $u(c) + \frac{(1-\ell_t)^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}}$, the labor supply elasticity would not be constant.

We now consider shocks to the marginal productivity of labor (α). Since labor supply will change in response to fluctuations in α, these fluctuations constitute shocks to the tax base.[31]

Proposition 7 (α-*Shocks*). *Suppose that* $z_t = z$ *and* $q_t = q$ *for all* $t \geq 0$. *Consider a perfect-foresight equilibrium path for an arbitrary path* $\{\alpha_t\}_{t=0}^{\infty}$. *Suppose that, along such a path,* $\alpha_{t+1} > \alpha_t$.

(i) *If* $f(PS) \equiv 0$ *(the Barro case),* $c_{t+1} = c_t$, $\ell_{t+1} > \ell_t$, $\tau_{t+1} = \tau_t$, $T_{t+1} > T_t$, $R_{t+1} > R_t$, *and* $PS_{t+1} > PS_t$.

(ii) *If* $f(PS)$ *satisfies Eq.* (12), *then* $c_{t+1} = c_t$, $\ell_{t+1} > \ell_t$, $g_{t+1} > g_t$, $\tau_{t+1} < \tau_t$, $T_{t+1} > T_t$, $R_{t+1} > R_t$, *and* $PS_{t+1} > PS_t$.

Proof. Proceeding analogously to the consumption tax case (see Appendices B and C), all the results follow. □

We have thus shown that, in the presence of a political distortion, a procyclical fiscal policy is optimal regardless of whether the tax system is income-based or consumption-based. In this context, therefore, the differences in the conduct of fiscal policy over the cycle observed in industrial and developing countries cannot be attributed to differences in the tax systems.

8. Interpreting the evidence

The evidence in Section 2 shows that, for the G7 countries, the Barro rule seems to hold as a first approximation. In sharp contrast, fiscal policy in developing countries appears to be highly procyclical. How do we interpret such contrasting behavior of fiscal policy in light of our model?

It would be tempting to interpret the evidence for the G7 countries as being consistent with the absence of political distortions (the Barro case), and the evidence for developing countries as being consistent with the presence of political distortions, which put pressure on public spending in good times (the "*f*-case"). We would, however, argue against such interpretation since there is no reason to believe that the activity of political lobbying is limited to developing countries.

A second explanation could exploit the differences in tax systems: the G7 tax system is, by and large, income-based, while in many developing countries, the tax system is consumption-based. Any story along those lines, however, would be inconsistent with the model since the optimality of procyclical fiscal policy was shown not to depend on whether consumption or labor income taxes are used to finance public spending.

A third explanation–and the one that we favor–is based on the relative variability of the tax base in the G7 countries and developing countries. As shown in Section 2,

[31] In the consumption tax case, α-shocks have no impact on the tax base due to the separability of the utility function.

the variability of the tax base in developing countries is more than twice as high (and more than three times as high if we took consumption as the relevant tax base) as that of the relevant tax base in the G7 countries (i.e., output). In the model, to the extent that fluctuations in the tax base are small (i.e., fluctuations in the forcing processes are small), then political pressures to spend will be relatively unimportant because the budget surplus will deviate little from its average value (formally, the economy will be operating in a relatively flat portion of the *f*-curve). The Barro rule will thus hold as an approximation. In contrast, when fluctuations in the tax base are large, which implies generating large budget surpluses in good times, political pressures will be particularly acute. To avoid "excessive" spending induced by such pressures, policymakers will engage in a strongly procyclical fiscal policy. The inability to generate large-enough surpluses in good times implies that fiscal policy will be highly contractionary in bad times. Hence, the larger are the fluctuations in the tax base, the more procyclical will fiscal policy be because it becomes increasingly costly to generate in good times the budget surpluses that would be necessary to achieve full tax smoothing.

Such an interpretation of the evidence is consistent with the scatter plots presented in Figs. 1 and 2. Fig. 1 illustrates that higher volatility (as measured by the standard deviation of output) is associated with a larger degree of procyclicality in government consumption (as measured by the correlation between the cyclical components of government purchases and output). Fig. 2 shows that higher output volatility is associated with a larger degree of procyclicality in the inflation tax rate (as measured by the correlation between the cyclical

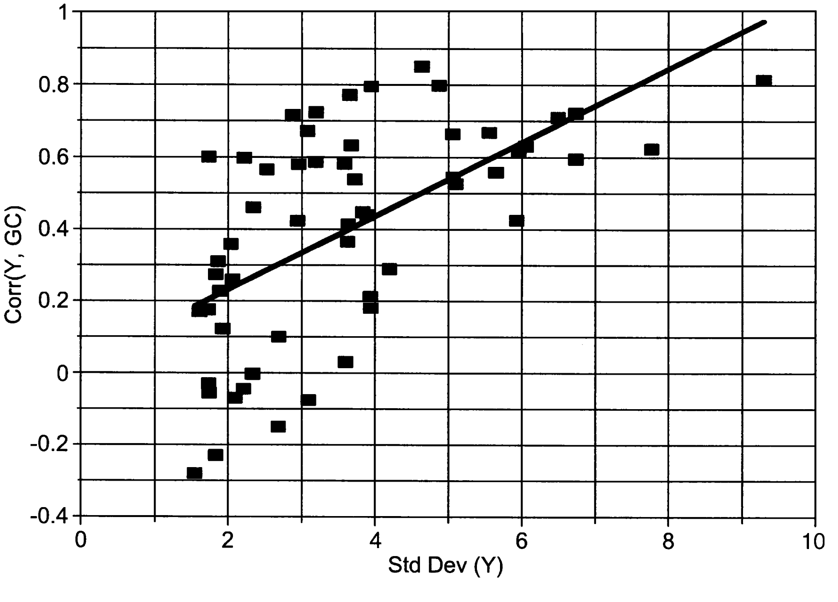

Fig. 1. Volatility and procyclicality: Government consumption. The regression line is given by $y=0.03+0.10x$; *t*-statistic of coefficient=5.48; $R^2=0.36$.

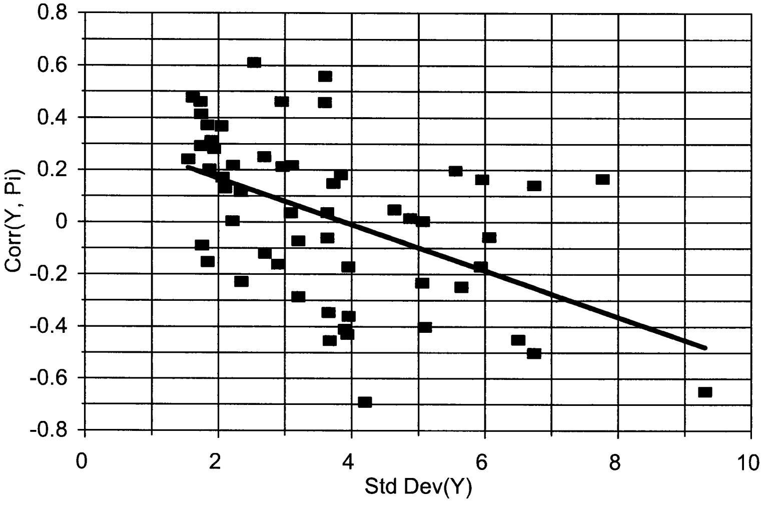

Fig. 2. Volatility and procyclicality: Inflation tax. The regression line is given by $y=3.71-2.73x$; t-statistic of coefficient$=-4.15$; $R^2=0.24$.

components of the inflation tax rate and output). This supports the idea that the main driving force behind the degree of procyclicality of fiscal policy is the magnitude of the underlying variability of the tax base rather than the degree of a country's economic development.[32]

An additional channel that may explain differences in procyclicality across countries is that, for a given variability of the tax base, countries may differ in the intensity of the political pressures for additional spending that they face in good times, as reflected in a "steeper" slope of the *f*-function. Based on a sample of 26 Latin American countries, Stein et al. (1999) find evidence that, after controlling for the volatility of the tax base, a higher level of political fragmentation leads to a more procyclical response of government spending. Such finding would be consistent with models in which a larger degree of political polarization and instability leads to a more inefficient tax system, as in Cukierman et al. (1992). More generally, any political economy model in which fragmentation and polarization result in more fiscal pressures would, in the context of our model, be reflected in more fiscal procyclicality. In particular, models built around the notion that different government units (i.e., ministries, provinces) fight for resources without taking into account the effects of their actions on the overall level of resources–such as Aizenman (1992) and Tornell and Lane (1999)–would clearly predict that a larger degree of political polarization would lead to even greater fiscal pressures. In practice, therefore, political instability and/or fragmentation should certainly be viewed as a contributing factor to greater fiscal procyclicality.

[32] Of course, correlation does not imply causality and, hence, causation could run in the opposite direction. In terms of Fig. 1, for instance, discretionary changes in fiscal policy could lead to changes in economic activity and hence in the tax base. At this level of empiricism, we clearly cannot discard this possibility.

While we have not explicitly introduced money into our model, we could easily do that by assuming that money reduces transactions costs. In such a model, collection costs associated with conventional taxes would lead to an optimal use of the inflation tax (see Aizenman, 1987; Bordo and Végh, 2002). In the presence of a political distortion, the fiscal authority would then find it optimal in good times to reduce both conventional taxes and the inflation tax. Moreover, the higher the level of collection costs, the more will the fiscal authority rely on the inflation tax and hence the larger will be the changes in the inflation tax in response to shocks to non-tax revenues. In other words, high collection costs–a distinguishing feature of most developing countries–should lead to a large procyclicality in the inflation tax. Higher collection costs should also lead to more procyclical government spending since varying tax rates to fend off spending pressures should prove more costly.

Finally, we should notice that even though we have chosen to downplay the role of capital market imperfections in order to highlight the role of political distortions, there is no doubt that, in practice, such imperfections abound and would only reinforce the procyclicality generated by political distortions. Specifically, consider any capital market imperfection that generates a positive association between the ratio of public debt to GDP and the risk premium (as in Aizenman et al., 2000). If the risk premium carried by public debt is higher in bad times, then borrowing in bad times becomes more costly, which would induce policymakers to raise taxes and reduce government consumption, further fueling the procyclicality of fiscal policy (see Bordo and Végh, 2002). The opposite would be true in good times: a lower risk premium would encourage more borrowing, more government spending, and lower taxes. In other words, a positive association between public debt and the risk premium would increase the dependence of current fiscal decisions on flow measures of government income (which is consistent with a broad interpretation of our f-function). In addition, there are two other capital markets imperfections analyzed in the literature that would reinforce procyclical fiscal policy. The first one is the so-called "original sin" (i.e., the inability of developing countries to issue debt in their own currency) (see Eichengreen et al., 2003). Since bad times are associated with real depreciation of the domestic currency, the effective debt burden increases in bad times, which would provide further impetus to procyclical fiscal policy. The second imperfection is incomplete asset markets. As shown by Riascos and Végh (2003), introducing incomplete markets into an otherwise frictionless neo-classical model would induce fiscal procyclicality as a second-best response.

9. Conclusions

While fiscal policy in the G7 countries appears to follow Barro's optimal smoothing rules, fiscal policy in developing countries is highly procyclical. To explain this contrasting behavior, we have developed an optimal fiscal policy model that incorporates a political distortion, which makes it costly to run budget surpluses due to the pressures that abundant fiscal resources create to increase public spending. Specifically, we assume that there exists an endogenous component of government spending, which is a positive function of the budget surplus (i.e., large surpluses give rise to spending pressures). Given this political distortion, a government that faces large (and perfectly anticipated) fluctuations in the tax base will choose to lower (increase) taxes and increase (lower) government spending in good times (bad times). In other words, our model predicts that, in the presence of this political distortion, optimal fiscal policy is procyclical.

The explanation for procyclicality offered in this paper contrasts sharply with the prevailing orthodoxy. The standard explanation for procyclical fiscal policy in developing countries relies on imperfect access during bad times to international credit markets. The idea is that countries hit by an adverse shock lose access to international credit at the time when it is most needed. From a public policy point of view, this interpretation calls for ensuring that developing countries–in particular those countries whose fundamentals are sound–retain access to international credit markets in bad times. In the aftermath of the global financial turmoil that followed the Russian crisis in the summer of 1998, several mechanisms have been proposed to achieve this objective, such as coordinated action between multilateral financial organizations and the private sector, and contingent credit lines to be activated during bad times.

In our model, on the other hand, the procyclicality of fiscal policy does not originate in any international credit rationing during bad times. Rather, it is the inability of the government to generate large-enough surpluses during expansions that forces it to borrow less during recessions–relative to a full tax-smoothing rule–in order to satisfy its solvency constraint. In this interpretation, the policy implications differ from those outlined above by shifting the emphasis from external financial constraints to domestic fiscal institutions. More specifically, the focus of public policy should be on designing fiscal arrangements aimed at ensuring that fiscal surpluses generated in good times are saved for a rainy day. For example, von Hagen and Harden (1995) and Eichengreen et al. (1996) have proposed a "national fiscal council," an autonomous government institution–akin to an independent central bank–that would set the optimal amount of borrowing over the cycle.

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Appendix A. Business cycle properties of fiscal variables for individual countries

This appendix reports for individual countries the aggregate statistics reported in Table 1 in the text (see Table A1).

Table A1
Business cycle properties for individual countries

Country	Standard Deviation		Correlations with output (*Y*)			
	Y	PC	PC	GC	*R*	P_i
G7						
Canada	2.34	2.63	0.91	0.00	0.47	0.12
France	1.55	1.19	0.85	−0.28	0.41	0.24
Italy	1.90	1.81	0.95	0.23	0.06	0.31
Japan	1.74	1.96	0.81	0.18	0.21	0.46
United Kingdom	2.69	3.27	0.87	−0.15	0.07	0.25
United States	2.10	2.70	0.85	−0.07	0.66	0.13
Average	2.05	2.26	0.87	−0.02	0.31	0.25
Other OECD						
Australia	1.74	1.28	0.50	−0.03	0.32	0.41
Austria	1.62	1.36	0.84	0.17	0.61	0.48
Belgium	1.84	2.31	0.84	0.27	0.56	0.37
Denmark	1.84	3.20	0.79	−0.23	0.84	−0.15
Greece	2.21	5.64	0.59	−0.04	0.25	0.01
Iceland	2.89	4.41	0.78	0.72	0.62	−0.16
Ireland	2.04	4.31	0.75	0.36	−0.16	0.37
The Netherlands	1.74	2.64	0.82	0.60	0.48	0.29
New Zealand	3.10	2.97	0.80	−0.08	0.53	0.22
Norway	1.75	2.47	0.69	−0.06	0.05	−0.09
Portugal	3.09	4.77	0.47	0.67	−0.22	0.04
Spain	2.95	3.47	0.96	0.42	0.69	0.46
Sweden	1.94	2.62	0.74	0.12	0.58	0.28
Switzerland	2.54	1.92	0.91	0.57	0.31	0.61
Average	2.24	3.10	0.75	0.25	0.39	0.22
Latin America						
Argentina	4.20	5.70	0.54	0.29	0.33	−0.69
Bolivia	3.90	5.50	0.51	0.44	0.40	−0.41
Brazil	3.95	5.18	0.16	0.18	0.22	−0.17
Chile	6.74	9.10	0.88	0.59	0.68	−0.50
Colombia	1.86	2.20	0.69	0.31	0.46	0.20
Costa Rica	3.96	7.67	0.86	0.80	0.42	−0.36
Dominican Republic	2.70	5.10	0.26	0.10	0.50	−0.12
El Salvador	5.96	6.14	0.89	0.62	0.67	0.17
Guatemala	3.64	2.54	0.90	0.41	0.36	−0.06
Guyana	6.06	32.63	0.46	0.63	0.57	−0.06
Honduras	3.63	2.69	0.70	0.37	0.78	0.04
Mexico	3.66	6.28	0.93	0.77	0.61	−0.35
Panama	5.57	6.05	0.27	0.67	0.77	0.20
Paraguay	5.06	3.59	0.60	0.66	0.48	−0.23
Peru	6.50	11.90	0.84	0.71	0.50	−0.45

Table A1 (*continued*)

Country	Standard Deviation		Correlations with output (*Y*)			
	Y	PC	PC	GC	*R*	P_i
Latin America						
Uruguay	5.10	7.78	0.90	0.53	0.51	−0.40
Venezuela	4.64	5.93	0.46	0.85	0.05	0.05
Average	4.54	7.41	0.64	0.53	0.49	−0.19
Africa						
Burundi	3.94	7.50	0.29	0.21	0.30	−0.43
Botswana	6.74	12.90	0.37	0.72	0.69	0.14
Ethiopia	3.68	8.43	0.44	0.63	0.70	−0.45
Ghana	5.07	10.50	0.73	0.54	0.13	0.00
Kenya	3.20	7.38	0.56	0.72	0.84	−0.29
Madagascar	3.20	6.52	0.40	0.59	NA	−0.07
Mauritius	4.88	9.38	0.64	0.80	0.74	0.02
Morocco	2.97	2.53	0.20	0.58	0.44	0.21
Nigeria	5.94	12.23	0.40	0.43	0.56	−0.17
South Africa	2.06	3.26	0.73	0.26	0.53	0.17
Tanzania	2.35	12.47	0.56	0.46	0.58	−0.23
Average	4.00	8.46	0.48	0.54	0.55	−0.10
Other developing						
Indonesia	7.77	3.84	0.18	0.62	0.06	0.17
Israel	9.30	14.98	0.89	0.81	0.81	−0.65
Jordan	5.65	11.00	0.71	0.56	NA	−0.25
Korea	2.22	6.56	0.62	0.60	0.75	0.22
Malaysia	3.73	4.19	0.77	0.54	0.64	0.15
Singapore	3.59	6.61	0.87	0.58	0.77	0.46
Syrian Arab Republic	3.60	4.36	0.62	0.03	0.42	0.56
Thailand	3.84	3.76	0.87	0.45	0.88	0.18
Average	4.96	6.91	0.69	0.52	0.62	0.10

Statistics are based on Hodrick–Prescott filtered data. The sample period is 1970–1994.
Variables are: *Y*, real output; PC, real private consumption; GC, real government consumption; *R*, real total revenue, P_i, inflation tax as defined in the text. Data are annual from the IFS and GFS of the IMF, except for Argentina, Bolivia, Brazil, Dominican Republic, and Peru, which are from the IADB's internal database.

Appendix B. The Ramsey system

The following system, which results from the Ramsey problem outlined in the text, characterizes the economy's perfect-foresight equilibrium path for any given paths $\{z_t\}_{t=0}^{\infty}$, $\{q_t\}_{t=0}^{\infty}$, and $\{\alpha_t\}_{t=0}^{\infty}$:

$$q_t u'(c_t) = \mu - \frac{\partial\left[y^{\theta}(c_t, \ell_t)c_t\right]}{\partial c_t}\left[\frac{\gamma+\mu}{1+f'(PS_t)} - \mu\right], \tag{B1}$$

$$(1-q_t)v'(\ell_t) = \alpha_t\mu + c_t\frac{\partial y^{\theta}(c_t, \ell_t)}{\partial \ell_t}\left(\frac{\gamma+\mu}{1+f'(PS_t)} - \mu\right) + \delta_t(1-q_t)\frac{v''(\ell_t)}{\alpha_t}, \tag{B2}$$

$$\Omega_t = \frac{\gamma+\mu}{1+f'(PS_t)}, \tag{B3}$$

$$\sum_{0}^{\infty} \beta^t \delta_t = 0, \tag{B4}$$

$$(1+r)b_{-1} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t (\theta_t c_t + z_t - g_t) = 0, \tag{B5}$$

$$(1+r)w_{-1} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t (\alpha_t \ell_t + z_t - c_t - g_t) = 0, \tag{B6}$$

$$g_t = \bar{g} + f(PS_t), \tag{B7}$$

$$q_t u'(c_t) = \lambda(1+\theta_t), \tag{B8}$$

$$(1-q_t)v'(\ell_t) = \lambda\alpha_t, \tag{B9}$$

$$PS_t \equiv \theta_t c_t + z_t - g_t, \tag{B10}$$

where $\frac{\partial y^\theta(c_t,\ell_t)}{\partial \ell_t}$ and $\frac{\partial \left[y^\theta(c_t,\ell_t)c_t\right]}{\partial c_t}$ are given by Eqs. (7) and (15), respectively, and γ, μ, Ω_t, and δ_t denote the multipliers associated with constraints (9)–(11) and (6), respectively. The solution to this system yields optimal paths for $\{c_t,\ell_t,g_t,\Omega_t,\delta_t,\theta_t,\mathrm{PS}_t\}_{t=0}^{\infty}$ and optimal constant values for γ, μ, and λ.

Appendix C. The Barro system

This appendix characterizes the perfect-foresight equilibrium paths for the Barro case (i.e., the case corresponding to $f(.)\equiv 0$) for any arbitrary paths $\{z_t\}_{t=0}^{\infty}$, $\{q_t\}_{t=0}^{\infty}$, and $\{\alpha_t\}_{t=0}^{\infty}$. The subutility function for consumption takes the isoelastic form given by Eq. (18).

C.1. The system

The perfect-foresight equilibrium path is fully described by the following system of eight equations:

$$\theta_t = \frac{\mu - \lambda + \frac{\gamma}{\rho}}{\lambda + \gamma\left(1 - \frac{1}{\rho}\right)}, \tag{C1}$$

$$(1-q_t)v'(\ell_t) = \alpha_t\mu + \gamma c_t \frac{\partial y^\theta(c_t,\ell_t)}{\partial \ell_t} + \delta_t(1-q_t)\frac{v''(\ell_t)}{\alpha_t}, \tag{C2}$$

$$\sum_{0}^{\infty} \beta^t \delta_t = 0, \tag{C3}$$

$$(1+r)b_{-1} + \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t (\theta_t c_t + z_t - \bar{g}) = 0, \tag{C4}$$

$$(1+r)w_{-1} + \sum_{t=0}^{\infty}\left(\frac{1}{1+r}\right)^{t}(\alpha_t \ell_t + z_t - c_t - \bar{g}) = 0, \tag{C5}$$

$$q_t c_t^{-\frac{1}{\rho}} = \lambda(1+\theta_t), \tag{C6}$$

$$(1-q_t)v'(\ell_t) = \lambda\alpha_t, \tag{C7}$$

$$PS_t \equiv \theta_t c_t + z_t - \bar{g}. \tag{C8}$$

C.2. Equilibrium paths

From Eqs. (C1), and (C7), respectively, it follows that:

$$\theta_t = \tilde{\theta}(\lambda, \mu, \gamma), \tag{C9}$$

$$\ell_t = \tilde{\ell}\left(\lambda; \underset{+}{q_t}\, \underset{+}{\alpha_t}\right), \tag{C10}$$

where a sign below a forcing variable indicates the sign of the "partial derivative" (i.e., how, say, ℓ_t changes relative to ℓ_{t-1} when q_t increases relative to q_{t-1}).

Eqs. (C6) and (C9) imply that:

$$c_t = \tilde{c}\left(\lambda, \mu, \gamma; \underset{+}{q_t}\right). \tag{C11}$$

From Eqs. (C8), (C9), and (C11), it follows that:

$$PS_t = \widetilde{PS}\left(\lambda, \mu, \gamma; \underset{+}{q_t}, \underset{+}{z_t}\right). \tag{C12}$$

Finally, from Eqs. (C9) and (C11):

$$T_t \equiv \theta_t c_t = \tilde{T}\left(\lambda, \mu, \gamma; \underset{+}{q_t}\right), \tag{C13}$$

$$R_t \equiv \theta_t c_t + z_t = \tilde{R}\left(\lambda, \mu, \gamma; \underset{+}{q_t}, \underset{+}{z_t}\right). \tag{C14}$$

Appendix D. The *f*-system

In this case, the system describing a perfect-foresight equilibrium path consists of 10 equations. Substitute Eq. (B8) into Eq. (B1) and solve for θ_t from Eq. (B1), taking into account Eq. (18), to obtain:

$$\theta_t = \frac{\mu - \lambda + \frac{1}{\rho}\left[\frac{\gamma+\mu}{1+f'(PS_t)} - \mu\right]}{\lambda + \left(1-\frac{1}{\rho}\right)\left[\frac{\gamma+\mu}{1+f'(PS_t)} - \mu\right]}. \tag{D1}$$

The rest of the system is given by Eqs. (B2)–(B10).

In order to prove Propositions (4) and (5), we first need to state an assumption and then establish two facts.

Assumption 1. At an optimum, $\frac{\partial\left[y^{\theta}(c_t,\ell_t)c_t\right]}{\partial c_t}=\theta\left(1-\frac{1}{\rho}\right)-\frac{1}{\rho}<0$. Notice that this is a statement about the Laffer curve. Indeed, taking into account Eqs. (18) and (B8), it is easy to show that the tax rate that maximizes tax revenues is given by $\theta=1/(\rho-1)$. We are therefore assuming that the Ramsey planner is operating along the upward sloping part of the Laffer curve. Alternatively, one can simply assume that $\rho<1$.

Fact 1. Along a perfect-foresight equilibrium path, θ and PS move in opposite directions. To see this, totally differentiate Eq. (D1) and substitute for λ from Eq. (D1) to obtain:

$$\frac{\mathrm{d}\theta}{\mathrm{d}PS}=\frac{f''(PS)(\gamma+\mu)^2}{(1+\theta)\left[\lambda+\left(1-\frac{1}{\rho}\right)\left(\frac{\gamma+\mu}{1+f'(PS_t)}-\mu\right)\right]^2[1+f'(PS)]^3}\left[\theta\left(1-\frac{1}{\rho}\right)-\frac{1}{\rho}\right]<0,$$

where the rightmost inequality follows from Assumption (1).

Fact 2. Along a perfect-foresight path, consumption tax revenues are an increasing function of both θ and q. To see this, note, using Eqs. (18) and (B8), that $(\widehat{\theta c})=\rho\hat{q}+(\hat{\theta}/(1+\theta))(1+\theta-\rho\theta)$. Since, by Assumption (1), $1+\theta-\rho\theta>0$, the claim holds.

Proof of Proposition 4. We first show that if, along a perfect-foresight equilibrium path, $z_{t+1}>z_t$, then $\theta_{t+1}<\theta_t$. The proof proceeds by contradiction:

(i) Suppose $\theta_{t+1}=\theta_t$. Then, by Fact (1), $\text{PS}_{t+1}=\text{PS}_t$. This implies, by Eq. (B7), that $g_{t+1}=g_t$. In addition, by Eq. (B8), $\theta_{t+1}=\theta_t$ implies that $c_{t+1}=c_t$ and therefore $\theta_{t+1}c_{t+1}=\theta_t c_t$. Since $\theta_{t+1}c_{t+1}=\theta_t c_t$, $z_{t+1}>z_t$, and $g_{t+1}=g_t$, then, by Eq. (B10), $\text{PS}_{t+1}>\text{PS}_t$, which is a contradiction.

(ii) Suppose $\theta_{t+1}>\theta_t$. Then, by Fact (1), $\text{PS}_{t+1}<\text{PS}_t$. This implies, by Eq. (B7), that $g_{t+1}<g_t$. In addition, $\theta_{t+1}>\theta_t$ implies that $\theta_{t+1}c_{t+1}>\theta_t c_t$ by Fact (2). Since $\theta_{t+1}c_{t+1}>\theta_t c_t$, $z_{t+1}>z_t$ and $g_{t+1}=g_t$, then, by Eq. (B10), $\text{PS}_{t+1}>\text{PS}_t$, which is a contradiction.

We have thus shown that when $z_{t+1}>z_t$, then $\theta_{t+1}<\theta_t$. By Fact (1), $\text{PS}_{t+1}>\text{PS}_t$. Then, by Eq. (B7), it follows that $g_{t+1}>g_t$. Since $\theta_{t+1}<\theta_t$, then by Eq. (B8), $c_{t+1}>c_t$. Since $\theta_{t+1}<\theta_t$, by Fact (2), $\theta_{t+1}c_{t+1}<\theta_t c_t$. Since $z_{t+1}>z_t$, $\text{PS}_{t+1}>\text{PS}_t$, and $g_{t+1}>g_t$, then $R_{t+1}>R_t$. Finally, since $q_{t+1}=q_t$ and $\alpha_{t+1}=\alpha_t$, then, by Eq. (B9), $\ell_{t+1}=\ell_t$. □

Proof of Proposition 5. We first show that if, along a perfect-foresight equilibrium path, $q_{t+1}>q_t$, then $\theta_{t+1}<\theta_t$. The proof proceeds by contradiction:

(i) Suppose $\theta_{t+1}=\theta_t$. Then, by Fact (1), $\text{PS}_{t+1}=\text{PS}_t$. This implies, by Eq. (B7), that $g_{t+1}=g_t$. In addition, by Eq. (B8), $q_{t+1}>q_t$ implies that $c_{t+1}>c_t$ and therefore $\theta_{t+1}c_{t+1}>\theta_t c_t$. Since $\theta_{t+1}c_{t+1}>\theta_t c_t$ and $g_{t+1}=g_t$, then, by Eq. (B10), $\text{PS}_{t+1}>\text{PS}_t$, which is a contradiction.

(ii) Suppose $\theta_{t+1}>\theta_t$. Then, by Fact (1), $\text{PS}_{t+1}<\text{PS}_t$. This implies, by Eq. (B7), that $g_{t+1}<g_t$. In addition, since $q_{t+1}>q_t$ and $\theta_{t+1}>\theta_t$, then, by Fact (2), $\theta_{t+1}c_{t+1}>\theta_t c_t$.

Since $\theta_{t+1}c_{t+1} > \theta_t c_t$ and $g_{t+1} < g_t$, then, by Eq. (B10), $\text{PS}_{t+1} > \text{PS}_t$, which is a contradiction.

We have thus shown that when $q_{t+1} > q_t$, then $\theta_{t+1} < \theta_t$. By Fact (1), $\text{PS}_{t+1} > \text{PS}_t$. Then, by Eq. (B7), $g_{t+1} > g_t$. Since $\text{PS}_{t+1} > \text{PS}_t$ and $g_{t+1} > g_t$, it follows from Eq. (B10) that $\theta_{t+1}c_{t+1} > \theta_t c_t$. Since $q_{t+1} > q_t$ and $\theta_{t+1} < \theta_t$, then by Eq. (B8), $c_{t+1} > c_t$. Finally, since $q_{t+1} > q_t$, then by Eq. (B9), $\ell_{t+1} > \ell_t$. □

Appendix E. Government spending in the utility function

This appendix shows that our main result that the optimal fiscal policy is procyclical in the presence of variable fiscal revenues is also obtained in a model in which government consumption enters into the utility function and $f(.)$, is a linear function (i.e., $f'(.)$ is a positive constant). Suppose that the utility function is now given by:

$$\sum_{t=0}^{\infty} \beta^t [q_t u(c_t) - (1 - q_t) v(\ell_t) + h(g_t)], \tag{E1}$$

where $u(c)$ takes the isoelastic form given by Eq. (18) and $h(g)$ is a strictly increasing and strictly concave function. The household maximizes Eq. (E1), taking g_t as given, subject to Eq. (3). The household's first-order conditions remain unchanged and are given by Eqs. (5) and (6).

The government's problem consists in maximizing Eq. (E1) subject to the same constraints as before, given by Eqs. (6), (9), (10), and (11), with θ_t given by Eq. (7) and PS_t by Eq. (13). The resulting system is the same as in the f-case above (given by Eqs. (B1)–(B10)), except for Eqs. (B1) and (B3), which are replaced by, respectively:

$$\theta_t = \frac{\mu - \lambda + \frac{1}{\rho} A(g_t)}{\lambda + \left(1 - \frac{1}{\rho}\right) A(g_t)}, \tag{E2}$$

$$\Omega_t = \frac{\gamma + \mu - h'(g_t)}{1 + f'(PS_t)}, \tag{E3}$$

where

$$A(g_t) \equiv \frac{\gamma + \mu}{1 + f'(PS_t)} - \mu + \frac{f'(PS_t)}{1 + f'(PS_t)} h'(g_t), \tag{E4}$$

$$A'(g_t) \equiv \frac{f'(PS_t)}{1 + f'(PS_t)} h''(g_t) < 0, \tag{E5}$$

and $f'(\text{PS}_t)$ is some positive constant.

In this formulation, the Barro case corresponds to the case in which $\Omega_t \equiv 0$ for all t (i.e., the government does not face constraint (11)) and $f(.) \equiv 0$. In this case, as can be easily shown, the system remains the same as in the Barro case described in Appendix C with an additional equation given by $z'(g_t) = \gamma + \mu$. This equation implies that g_t is constant along a perfect-foresight equilibrium path regardless of the path of the forcing variables z_t, q_t, and α_t. Hence, Propositions (2) and (3) hold in this case as well with the added implication that the path of g_t is endogenously determined and remains flat over time.

To show the main results, we need to proceed in the same way as before. We first show the following:

Fact 3. Along a perfect-foresight equilibrium path, there exists a negative relationship between θ and g. To this effect, totally differentiate Eq. (E2) to obtain:

$$\frac{d\theta}{dg} = \frac{-A'(g_t)}{(1+\theta)\left[\lambda + \left(1-\frac{1}{\rho}\right)A(g_t)\right]^2}\left[\frac{\gamma+\mu}{1+f'(PS_t)} + z'(g_t)\frac{f'(PS_t)}{1+f'(PS_t)}\right] \times \left[\theta\left(1-\frac{1}{\rho}\right) - \frac{1}{\rho}\right] < 0,$$

where the rightmost inequality follows from Assumption (1) above and the fact that $A'(g_t) < 0$.

Proposition 8. *Suppose that $\alpha_t = \alpha$ and $q_t = q$, for all $t \geq 0$. Consider a perfect-foresight equilibrium path for an arbitrary path $\{z_t\}_{t=0}^{\infty}$. If , along such a path, $z_{t+1} > z_t$ for some t, then $c_{t+1} > c_t$, $\ell_{t+1} = \ell_t$, $g_{t+1} > g_t$, $\theta_{t+1} < \theta_t$, $T_{t+1} < T_t$, $R_{t+1} > R_t$, and $PS_{t+1} > PS_t$.*

Proof. We first show that if, along a perfect-foresight equilibrium path, $z_{t+1} > z_t$, then $\theta_{t+1} < \theta_t$. The proof proceeds by contradiction:

(i) Suppose $\theta_{t+1} = \theta_t$. Then, by Fact (3), $g_{t+1} = g_t$. This implies, by Eq. (B7), that $PS_{t+1} = PS_t$. In addition, by Eq. (B8), $\theta_{t+1} = \theta_t$ implies that $c_{t+1} = c_t$ and therefore $\theta_{t+1}c_{t+1} = \theta_t c_t$. Since $\theta_{t+1}c_{t+1} = \theta_t c_t$, $z_{t+1} > z_t$, and $g_{t+1} = g_t$, then, by Eq. (B10), $PS_{t+1} > PS_t$, which is a contradiction.
(ii) Suppose $\theta_{t+1} > \theta_t$. Then, by Fact (3), $g_{t+1} < g_t$. This implies, by Eq. (B7), that $PS_{t+1} < PS_t$. In addition, $\theta_{t+1} > \theta_t$ implies that $\theta_{t+1}c_{t+1} > \theta_t c_t$ by Fact (2). Since $\theta_{t+1}c_{t+1} > \theta_t c_t$, $z_{t+1} > z_t$, and $g_{t+1} < g_t$, then, by Eq. (B10), $PS_{t+1} > PS_t$, which is a contradiction.

We have thus shown that when $z_{t+1} > z_t$, then $\theta_{t+1} < \theta_t$. By Fact (3), $g_{t+1} > g_t$. Then, by Eq. (B7), it follows that $PS_{t+1} > PS_t$. Since $\theta_{t+1} < \theta_t$, then by Eq. (B8), $c_{t+1} > c_t$. Since $\theta_{t+1} < \theta_t$, by Fact (2), $\theta_{t+1}c_{t+1} < \theta_t c_t$. Since $z_{t+1} > z_t$, $PS_{t+1} > PS_t$, and $g_{t+1} > g_t$, then $R_{t+1} > R_t$. □

Proposition 9. *Suppose that $z_t = z$ and $\alpha_t = \alpha$ for all $t \geq 0$. Consider a perfect-foresight equilibrium path for an arbitrary path $\{q_t\}_{t=0}^{\infty}$. If, along such a path, $q_{t+1} > q_t$ for some t, then $c_{t+1} > c_t$, $\ell_{t+1} > \ell_t$, $g_{t+1} > g_t$, $\theta_{t+1} < \theta_t$, $T_{t+1} > T_t$, $R_{t+1} > R_t$, and $PS_{t+1} > PS_t$.*

Proof. We first show that if, along a perfect-foresight equilibrium path, $q_{t+1} > q_t$, then $\theta_{t+1} < \theta_t$. The proof proceeds by contradiction:

(i) Suppose $\theta_{t+1} = \theta_t$. Then, by Fact (3), $g_{t+1} = g_t$. This implies, by Eq. (B7), that $\mathrm{PS}_{t+1} = \mathrm{PS}_t$. In addition, by Eq. (B8), $q_{t+1} > q_t$ implies that $c_{t+1} > c_t$ and therefore $\theta_{t+1}c_{t+1} > \theta_t c_t$. Since $\theta_{t+1}c_{t+1} > \theta_t c_t$ and $g_{t+1} = g_t$, then, by Eq. (B10), $\mathrm{PS}_{t+1} > \mathrm{PS}_t$, which is a contradiction.

(ii) Suppose $\theta_{t+1} > \theta_t$. Then, by Fact (3), $g_{t+1} < g_t$. This implies, by Eq. (B7), that $\mathrm{PS}_{t+1} < \mathrm{PS}_t$. In addition, since $q_{t+1} > q_t$ and $\theta_{t+1} > \theta_t$, then by Fact (2), $\theta_{t+1}c_{t+1} > \theta_t c_t$. Since $\theta_{t+1}c_{t+1} > \theta_t c_t$ and $g_{t+1} < g_t$, then, by Eq. (B10), $\mathrm{PS}_{t+1} > \mathrm{PS}_t$, which is a contradiction.

We have thus shown that when $q_{t+1} > q_t$, then $\theta_{t+1} < \theta_t$. By Fact (3), $g_{t+1} > g_t$. Then, by Eq. (B7), $\mathrm{PS}_{t+1} > \mathrm{PS}_t$. Since $\mathrm{PS}_{t+1} > \mathrm{PS}_t$ and $g_{t+1} > g_t$, it follows from Eq. (B10) that $\theta_{t+1}c_{t+1} > \theta_t c_t$. Since $q_{t+1} > q_t$ and $\theta_{t+1} < \theta_t$, then by Eq. (B8), $c_{t+1} > c_t$. Finally, since $q_{t+1} > q_t$, $\ell_{t+1} > \ell_t$. □

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