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Greek Budget Realities: No Easy Options

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ABSTRACT

As of August 2015, Greece's loan repayments due to external creditors through 2057 summed to €319.5 billion, requiring an average debt payment on a flow basis of 4.1 percent of 2014 Greek GDP. This paper examines the economic impact of increases in distortionary taxes on consumption, capital and labor income as well as reductions in government expenditures sufficient to increase Greece's primary balance by one percent of 2014 GDP – roughly a quarter of Greece's total debt obligations. In the baseline case calibrated to the Greek economy, all of the tax and expenditure policies we consider produce declines in output in both the short- and long-run. Projections of the primary surplus based on static revenue scoring grossly overestimate the amount of actual revenue that Greece would raise due to the endogenous adjustment of capital and labor. Meeting the debt repayment schedule is substantially more costly because Greece is a small economy that is integrated with the larger European economy. Failure to incorporate the impact of capital and labor mobility results in a significant overestimate of future revenue. Delaying the implementation of tax increases or government expenditure cuts can help mitigate the short-run fall in output, but such delays require greater economic hardship in the long run.

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INTRODUCTION

As of August 2015, Greece's loan repayments due to external creditors through 2057 summed to €319.5 billion, requiring an average debt payment on a flow basis of 4.1 percent of 2014 Greek GDP.[1] This paper examines the economic impact of alternative strategies that Greece could implement to generate a sizable primary surplus. To be specific, we consider increases in distortionary taxes on consumption, capital and labor income as well as reductions in government expenditures sufficient to increase Greece's primary balance by one percent of 2014 GDP – roughly a quarter of Greece's total debt obligations. Studying each policy in isolation illustrates the costs and benefits associated with each instrument. In the discussion section below we also consider combinations of policies that could yield the necessary 4.1 percent.[2]

Our analysis yields the following conclusions:

- In the baseline case calibrated to the Greek economy, all of the tax and expenditure policies we consider produce declines in output in both the short- and long-run. The model projection for the near term involves output declines on the order of 1 to 2 percent of 2014 GDP.

- Projections of the primary surplus based on static revenue scoring grossly overestimate the amount of actual revenue that Greece would raise due to the endogenous adjustment of capital and labor.

- Meeting the debt repayment schedule is substantially more costly because Greece is a small economy that is integrated with the larger European economy. Failure to incorporate the impact of capital and labor mobility results in a significant overestimate of future revenue.

- Delaying the implementation of tax increases or government expenditure cuts can help mitigate the short-run fall in output, but such delays require greater economic hardship in the long run.

FRAMEWORK FOR ANALYSIS

The basic model for our analysis includes features of DSGE models commonly used by central banks and macroeconomists to study both short-run business cycle dynamics and long-run adjustment to permanent changes in fiscal policy. At its core, the model closely resembles the framework in Heathcoate and Perri (2002) in which foreign and domestic intermediate goods are combined to create a "final good" that is ultimately used for domestic consumption, investment

[1] Source: Bloomberg. This sum reflects a variety of interest rates, revolving credit agreements, and bond maturities. The IMF's Dissemination Standards Bulletin Board reports budgetary central government debt of €312.8 billion for the second quarter of 2015.

[2] The Memorandum of Understanding between the European Commission, the Greek government and its central bank, agreed to in August 2015, included a commitment on the part of the Greek government to run primary surpluses from 2018 forward of 3.5 percent of (current) GDP.

and government purchases.[3] Greece, the home country, is treated as a small part of a larger European aggregate. Greece faces a downward sloping demand curve for its country-specific export good but the share of Greece in the European economy is so small that events in Greece have no meaningful effect on economic activity in the European aggregate.

Tradeable intermediate goods are produced with capital and labor inputs. Bond markets, asset markets and currency markets are fully integrated. As a member of the euro area, Greece takes the nominal interest rate set by the ECB as given. In the baseline model, labor cannot move across international borders. The assumption of labor immobility is belied by the outflow of labor, particularly skilled workers, from Greece since the onset of the crisis. To capture the effect of labor mobility we consider high labor supply elasticity as a special case. Not surprisingly, when labor responds more elastically to increases in tax distortions, it is much harder to raise revenue and the excess burden of the tax on the labor that remains in Greece is larger.

The Greek government raises revenue through distortionary taxes on capital and labor income and on consumption spending. Part of the revenue is transferred back to households, part is used to finance government spending on final goods, and some is transferred to foreign creditors as debt repayment. We assume that government purchases do not affect the marginal utility of consumption, the marginal disutility of labor or production. The model includes sluggish adjustment in prices and wages and allows for adjustment costs in investment.

We examine the impact on macroeconomic aggregates in response to once-and-for-all-changes in policy over different time intervals and under different specifications of model parameters. Our analysis can be thought of as an extension of the tax experiments considered in Mankiw and Weinzierl (2006), where here we include a richer set of adjustment mechanisms, integrated capital markets and we capture changes in macroeconomic variables along the transition to the post-policy steady state.

Distortionary Labor and Consumption Taxation.

Labor and consumption taxation jointly reduce the incentive to work, depress the supply of labor and reduce consumption. In the absence of wage rigidity, these distortions would enter through the labor supply condition,

$$v'(N_t) = \frac{W_t\left(1-\tau_t^N\right)}{P_t\left(1+\tau_t^C\right)} u'(C_t) \ . \qquad (1)$$

N_t denotes total hours of labor supplied and $v'(N_t)$ is the marginal disutility of labor; C_t is real consumption and $u'(C_t)$ is the marginal utility of consumption. The term $W_t\left(1-\tau_t^N\right)/P_t\left(1+\tau_t^C\right)$ is the after-tax real wage. Increases in the tax rate on labor income τ_t^N or the tax rate on consumption spending τ_t^C reduce labor supply by reducing the real after-tax compensation for work. For the numerical model, we assume the flow utility function takes the

[3] Given space constraints we do not provide a detailed discussion of the model in this paper. We refer the interested reader to House, Proebsting and Tesar [2015, in progress].

form $u(C_t)-v(N_t)=C_t^{1-\frac{1}{\sigma}}-\phi N_t^{1+\frac{1}{\eta}}$. The parameter η is the Frisch labor supply elasticity; higher values of η imply that workers are more responsive to changes in the after-tax real wage. The parameter σ is the intertemporal elasticity of substitution. While the consumption-labor supply choice is distorted by the wedge that jointly reflects the labor and consumption tax, the taxes are not equivalent in their revenue implications and therefore we consider each tax separately.

The labor supply condition (1) embodies a second channel through which changes in government finance influences labor supply. A reduction in consumption, triggered by, for example an increase in government spending, results in an increase in labor supply through a wealth effect. Events or policies that reduce wealth and thus reduce consumption are also predicted to ultimately raise employment by giving workers a greater incentive to work. (This is sometimes referred to as an "impoverishment effect" on labor supply.)

The model we analyze includes both wage and price rigidity and as a consequence, the simple labor supply condition described in (1) does not hold at every moment, though the basic economic intuition discussed above remains intact. To capture the slow adjustment of nominal prices and wages, the model includes Calvo price and wage setting mechanisms following Christiano, *et al*. (2005). The rates at which prices and wages adjust are governed by two Calvo parameters. The Calvo mechanism allows for fully flexible prices and wages as a special case.

Distortionary Capital Taxation.

Capital taxes reduce the after-tax payoff to capital accumulation and thereby reduce the incentive to expand business activity. This effect typically takes some time to materialize. In the short run, the capital stock is already in place and thus the supply of capital is relatively inelastic. In the model, this distortion enters through the investment demand schedule which itself is a combination of two equations

$$Q_t=\beta E_t\left[\sum_{j=1}^{\infty}\beta^j(1-\delta)^j\frac{u'(C_{t+j})}{u'(C_t)}\frac{R_{t+j}\left(1-\tau_{t+j}^K\right)}{P_{t+j}}\right] \tag{2}$$

and

$$\Delta\ln I_t=\frac{1}{\kappa}\ln Q_t+\beta E_t\left[\Delta\ln I_{t+1}\right] \tag{3}$$

The first condition gives the relative value of capital (Tobin's Q) in terms of the discounted stream of real capital payoffs. In the equation, $R_t\left(1-\tau_t^K\right)\big/P_t$ is the real after-tax flow payoff to a unit of capital. The second equation provides a connection between the relative value of capital (Q) and investment. We adopt the approach in Christiano et al. (2005) who use "higher order adjustment costs" to generate additional persistence in investment. The degree of adjustment costs is then governed by a single parameter $\kappa\geq 0$. Expected increases in future capital taxes reduce the relative value of capital through (2) and in turn depress current investment.

In a closed economy, an increase in the capital tax rate would reduce capital investment, but some of the negative impact of the tax increase would be offset by a change in the domestic interest rate. Because Greece is part of a global financial system, Greek savers have the option of substituting away from investing in domestic capital to investing in international bonds. This channel of substitution will increase the long-run elasticity of capital with respect to the tax rate.[4]

Government Solvency Constraint.

In all of the model simulations, we assume that Greece chooses a policy combination that enables it to repay a given amount of money to its creditors. This requires that the policy options satisfy the government's budget constraint

$$\sum_{j=1}^{\infty}\left(\frac{1}{1+i}\right)^{j}\left[P_tG_t+T_t+X_t-\tau_t^K R_tK_t-\tau_t^N W_tN_t-\tau_t^C P_tC_t\right]=0 \qquad (4)$$

where X_t is a nominal repayment commitment, T_t is a nominal lump sum transfer (or tax) and $i_t=i$ is the nominal interest rate.

We take 2014 as the point of departure and consider once-and-for-all changes to economic policy starting in 2015. Our baseline analysis assumes that the debt repayment commitment is not anticipated prior to 2014 – that is, we assume that the indebtedness comes as a surprise to the Greek population.[5] Later we relax this assumption and consider the case where the fiscal policy changes occur with a lag so that households anticipate future changes in policy. In all cases we assume that Greece maintains access to financial markets (i.e. has sufficient credibility with its creditors) to borrow in years when debt payments exceed the fiscal surplus, and saves when the surplus exceeds its scheduled debt payment.[6]

To facilitate comparison across policy experiments, we consider spending reductions or tax increases sufficient to generate an average flow increase in the primary balance of one percent of 2014 GDP. For ease of exposition we will refer to the permanent one percent increase in the primary balance as the *target* primary balance. The target we consider is only a quarter of the amount required to fully meet the scheduled stream of debt payments. Nonetheless, the magnitudes of the tax and expenditure changes needed to generate the target primary balance are already quite large. We do not push the model to generate the full 4 percent increase in the primary balance as a share of 2014 GDP for three reasons. First, we use standard linearization techniques to solve the model, which are appropriate for "small" perturbations in the neighborhood of a stable trend growth path but are increasingly inaccurate for large policy changes that push the economy away from the initial steady state. In principle, a policy tax

[4] Because the final investment good is country specific, physical capital is immobile in the sense that a unit of capital cannot be unbolted from the home factory and put into operation abroad. The capital stock does, however, gradually adjust to changes in the tax rate through the substitution between investment in new domestic capital and international bonds.

[5] To be precise, we assume that the Greek economy begins in an initial steady state. Then, in 2014, Greek taxpayers simultaneously learn both that their debt obligations X are larger than previously believed and learn about the new policies aimed at reducing the debt.

[6] In reality Greece faces a lumpy stream of payments, with large payments due in some years, and smaller payments in others. An interesting question we leave for future study is the case when Greece faces binding credit constraints and must either accumulate balances in advance of large payments or adjust fiscal policy on a year-by-year basis.

change that would satisfy (or attempt to satisfy) the full 4.1 percent increase could push capital and labor taxes into the downward sloping portion of the Laffer curve (see Trabandt and Uhlig (2006) and Mendoza, Tesar and Zhang (2014)). Second, our baseline revenue forecasts are based on a model with zero economic growth. This calibration is in line with both recent experience in Greece as well as forecasts of long-run growth absent significant structural reform (see, e.g., McQuinn and Whelen 2015). Were the Greek economy to return to a positive rate of growth, the policy changes needed to meet the target would be smaller. We return to the issue of economic growth later in the paper. Finally, the actual policy response is likely to be a combination of tax increases and spending cuts, rather than an increase in a single policy instrument.

CALIBRATION

Table 1 lists the parameters used to solve the model and their economic interpretation. The rate of time discount is 0.99, and the intertemporal elasticity of substitution is 0.5. In the baseline case the elasticity of substitution between home and foreign goods is 1.5 (CES preferences over home and foreign goods). We also consider the case in which home and foreign goods are perfect substitutes (the neoclassical model in Table 2). A key parameter in the model is the Frisch labor supply elasticity, which we set to 0.5 in the baseline model (see for instance, Chetty *et al*. (2011)). To proxy for international labor mobility, we assume a very high Frisch elasticity of 10 in one of the model specifications.

Turning to the production side of the model, we assume that the production function is Cobb-Douglas with a labor share of 0.64. We set adjustment costs on investment at 2.5 implying that a one percent increase in Tobin's Q causes a 0.40 percent increase in investment growth (ceteris paribus). We set the Calvo parameters so that wages adjust on average once every 12 months (see e.g., Barattieri *et al*. 2014) and prices adjust on average once every 8 months (see e.g., Nakamura and Steinsson (2008) and Klenow and Kryvtsov (2008)). Greece's share of total GDP in the system is 2 percent, consistent with Greece's GDP share of Europe. The share of imports relative to GDP is 0.21 consistent with the average observed import share from 2000-2013.

The initial stance of fiscal policy reflects the level of taxes and government expenditures observed in Greece in 2014 (or the latest year for which data are available). Estimates of average effective tax rates on labor, capital and consumption are calculated using the methodology developed in Mendoza, Razin and Tesar (1994). They are, respectively, 43, 18 and 16 percent. The bottom section of the table shows macro aggregates as shares of 2014 GDP. The consumption and investment shares are determined by the model, the other ratios are pre-set. We start from a benchmark trade balance to GDP ratio of balanced trade, ignoring Greece's large initial current account deficit. We also set the primary balance to GDP equal to zero, consistent with the data from 2014. Government spending as a share of goods and services is set at 20 percent, slightly higher than the rate observed in 2014 (18 percent). The model generates a consumption share that is lower than that in the data, and an investment share that is too high, largely because it ignores the current account imbalance that supports higher Greek consumption.

TABLE 1: PARAMETERS AND CALIBRATION

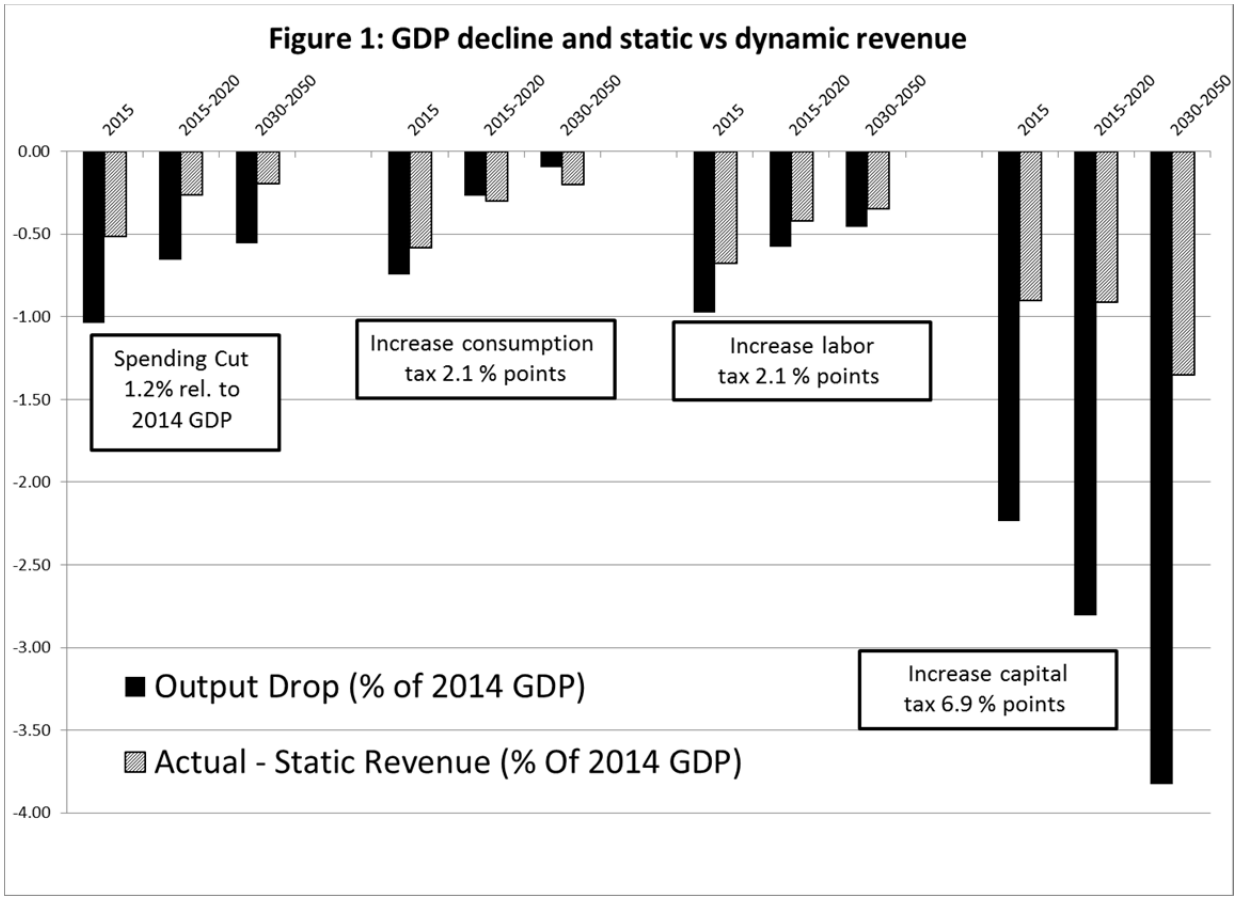
Preferences		
	β (subjective time discount factor)	0.99
	ψ (trade elasticity)	1.50
	σ (intertemporal elast. of sub.)	0.50
	η (Frisch elasticity)	[0.5, 10]
Technology		
	α (labor share)	0.64
	κ (inverse Q elasticity)	2.48
	Duration of price rigidity	8 month avg.
	Duration of wage rigidity	1 year avg.
	Desired price and wage markup	0.10
	Greek share of EU GDP	0.02
	Greek import share	0.21

		DATA	**MODEL**
Initial Effective Tax Rates			
	τ^N (labor income tax rate)	0.43	0.43
	τ^K (capital income tax rate)	0.18	0.18
	τ^C (consumption tax rate)	0.16	0.16
Ratios in 2014[b]			
	CONS/GDP	0.74	0.61
	INV/GDP	0.13	0.19
	Govt. Exp/GDP	0.18	0.20
	Trade Balance/GDP	-0.08	0.00
	Primary Balance/GDP	0.00	0.00

[a] Averages based on data from Eurostat, 2000 – 2013.
[b] Empirical ratios based on 2014 or most recent year available from Eurostat/OECD.

RESULTS

Figure 1 illustrates the change in GDP (black bars) and the difference between the actual and static revenue scores (grey bars) associated with the various policy changes needed to reach the target primary balance in the baseline model. The figure shows the effect of the policy in the short-run (2015), the medium run (2015-2020) and the long run (2030-50). Table 2 reports results for output and employment for each policy change, and compares results across different model specifications.



Decrease in Government Spending

In the baseline model, a decrease in government spending (the first set of bars) results in a one percent decline in GDP in the short run, with slightly smaller average declines over the medium and long runs. If the policymaker had relied on a static score to estimate the impact of the policy, he or she would have assumed that there was no effect of the expenditure cut on revenue and would therefore have underestimated the size of the expenditure cut needed to meet the repayment target. In the dynamic model, however, the decrease in government expenditures reduces aggregate demand for the home good, resulting in declines in labor and capital income, as well as consumption, and therefore a decline in tax revenue. The gap between the static score and the dynamic score is roughly 0.5 percent of 2014 GDP.

If the economy is truly neoclassical (see Table 2), with flexible prices and wages and perfect substitutability between the home and the foreign good (essentially a one-good economy), the

reduction in government spending has no impact on macroeconomic activity beyond the transfer of domestic resources to foreign creditors. In this case, the government reduces its purchases by exactly enough to repay its foreign creditors. Net exports rise by exactly the amount by which government demand falls leaving aggregate demand, and thus economic activity, unchanged. This is not to say that the Greek citizens do not care about this policy change. While GDP and employment are unaffected, welfare decreases to the extent that households value the government services that are now not being provided.

Table 2.

	Government Spending			Consumption Tax Increase			Labor Tax Increase			Capital Tax Increase		
	2015	Short Run 2015-2020	Long Run 2030-2050	2015	Short Run 2015-2020	Long Run 2030-2050	2015	Short Run 2015-2020	Long Run 2030-2050	2015	Short Run 2015-2020	Long Run 2030-2050
BASELINE MODEL												
	Spending by 1.21% of GDP			Tax increase from 16% to 18,2%			Tax increase from 43% to 45%			Tax increase from 18% to 20.3%		
GDP	-1.04	-0.66	-0.55	-0.74	-0.27	-0.10	-0.97	-0.57	-0.46	-2.24	-2.81	-3.83
Employment	-1.05	-0.23	0.06	-0.60	0.34	0.62	-0.96	-0.10	0.18	-1.74	-0.80	0.51
Static Revenue	0.00	0.00	0.00	1.22	1.22	1.22	1.36	1.36	1.36	2.24	2.24	2.24
Actual Revenue	-0.51	-0.26	-0.19	0.64	0.92	1.02	0.68	0.94	1.01	1.34	1.33	0.89
NEOCLASSICAL MODEL												
	Spending by 1% of GDP			Tax increase from 16% to 17.7%			Tax increase from 43% to 44.8%			Tax increase from 18% to 26.6%		
GDP	0.00	0.00	0.00	0.27	0.34	0.47	0.06	0.07	0.10	0.73	-1.70	-6.13
Employment	0.00	0.00	0.00	0.40	0.43	0.47	0.09	0.09	0.10	1.98	1.17	-0.24
Static Revenue	0.00	0.00	0.00	0.98	0.98	0.98	1.12	1.12	1.12	2.79	2.79	2.79
Actual Revenue	0.00	0.00	0.00	0.95	0.97	1.01	0.99	0.99	1.00	2.86	2.06	0.77
STICKY PRICES AND WAGES												
	Spending by 1% of GDP			Tax increase from 16% to 17.7%			Tax increase from 43% to 44.8%			Tax increase from 18% to 26.6%		
GDP	-0.01	0.00	0.00	0.21	0.33	0.47	0.04	0.07	0.11	0.37	-1.79	-6.14
Employment	-0.01	0.00	0.00	0.31	0.41	0.47	0.06	0.09	0.11	1.44	1.05	-0.23
Static Revenue	0.00	0.00	0.00	0.98	0.98	0.98	1.12	1.12	1.12	2.80	2.80	2.80
Actual Revenue	0.00	0.00	0.00	0.93	0.97	1.01	0.98	0.99	1.00	2.77	2.04	0.77
INTL LABOR MOBILITY												
	Spending by 1.3% of GDP			Tax increase from 16% to 18.7%			Tax increase from 43% to 47.3%			Tax increase from 18% to 31.1%		
GDP	-1.50	-1.08	-0.81	-1.45	-1.06	-0.80	-3.12	-3.77	-4.06	-5.26	-8.45	-9.64
Employment	-1.84	-0.84	-0.24	-1.75	-0.81	-0.23	-4.35	-4.79	-4.20	-5.82	-6.92	-2.32
Static Revenue	0.00	0.00	0.00	1.51	1.51	1.51	2.78	2.78	2.78	4.24	4.24	4.24
Actual Revenue	-0.63	-0.39	-0.28	0.70	0.92	1.02	1.28	1.13	0.97	2.64	1.71	0.81

Increases in Labor and Consumption Taxes

Consumption and labor tax rates jointly affect the wedge between the marginal rate of substitution and the marginal product of labor as seen in equation (1). In the baseline model, the increase in the consumption and labor tax rates are about the same size (a 2.1 percentage point increase). The static score understates the drop in revenue by roughly 0.3 percent of 2014 GDP.

The responses of labor and output to the increase in taxes depend on the relative strength of the income and substitution effects on labor supply and on the elasticity of substitution between domestic and foreign goods. For the neoclassical model and the sticky price model, the income and substitution effects on labor supply nearly offset. The tax increase makes households poorer and increases their incentive to work. In our model, the income elasticity of labor supply is given by $-\eta/\sigma$ while the (Frisch) substitution elasticity is η. Since $\sigma = 0.5$ in our baseline

calibration, the income effect dominates the substitution effect and thus labor supply and output ultimately increase. The importance (and realism) of the wealth effect is somewhat controversial. Blundell and MaCurdy (1999) report empirical estimates of income elasticities of labor supply between 0 and -1.00 with typical estimates in the range of -0.1 and -0.2. Our calibration implies an income elasticity of -1.00 (the top of the range reported by Blundell and MaCurdy). Reducing the income elasticity would imply larger short-run output drops than those shown in Figure 1.

In addition to the income and substitution effects on labor supply, the equilibrium also depends heavily on the trade elasticity. In the neoclassical specification and the sticky price specification, this elasticity is infinite. As a consequence, Greece can pay off its nominal obligations simply by working more and selling home goods to its foreign creditors at par. In the baseline specification however, the trade elasticity is only 1.50. This implies that as the supply of Greek goods rises, the price of these goods fa, tempering the payoff to working more. In the baseline model, this trade effect causes employment and output to fall in equilibrium.

Increase in the Capital Tax

The capital tax is the most inefficient in terms of generating revenue per unit of output loss. It also generates the largest gap between actual revenue and the static projection. An increase in the capital tax leads directly (subject to adjustment costs) to a reduction in investment and an associated decline in output and employment. The erosion of the tax base is amplified by the household's ability to substitute away from investment in the home capital good toward investment in the international bond. This erosion of the tax base explains why a much larger tax increase (6.9 percentage points) is needed to meet the revenue target. In the baseline model as well as the neoclassical model, an increase in the capital tax causes capital, labor and output to fall in the long run.

Adding Sticky Prices to the Neoclassical Model.

The third panel reports results for a "Sticky Price" specification. This specification is identical to the Neoclassical specification with the exception that prices and wages adjust slowly to changes in economic activity as they do in our baseline model. Importantly, the Sticky Price specification maintains the assumption that there is an infinite elasticity of substitution between home and foreign goods so this is effectively still a one-good model.

Price and wage rigidity have only modest effects relative to the predictions of the basic Neoclassical model. Virtually all of the differences between the two model specifications are concentrated in the short-run responses and even these differences are relatively small. In the long run, the two models deliver essentially identical predictions. Prices and wages eventually adjust to the policy change at which point the model has returned to the same trajectory as the one for an environment with fully flexible prices.

The responses to the government spending cut are identical with and without sticky prices. Since there was no shift in aggregate demand in the flexible price specification, there was no pressure on prices or wages to begin with. Since aggregate demand is unchanged, adding price and wage rigidity has no effect on the outcome.

International Labor Mobility.

To proxy for labor mobility (see the fourth panel of Table 2), we adopt a high Frisch elasticity of 10 (relative to the baseline elasticity of 0.5) and keep all other parameters set at the values in the baseline case. With labor mobility, changes in the real after-tax wage produce much larger changes in labor supply. In effect, some workers can leave Greece and work abroad and we assume that emigrating workers do not remit their labor earnings so domestic income (GNP) falls one for one with the reduction in labor income. Notice that there is no contradiction with the microeconomic estimates of relatively low Frisch labor supply elasticities in our specification. The workers could all have Frisch elasticities of zero but still be willing to move abroad to avoid enduring the domestic policies that Greece adopts. Relative to the baseline model, an economy with mobile labor requires much greater policy changes to meet the revenue target. To afford a flow payment to foreign creditors of one percent of GDP, government spending has to fall by 1.3 percent and output falls by 1.5 percent in the short run. In the long run output remains below trend by roughly 0.81 percent. Tax policies are similarly contractionary. The labor tax policy causes a long run reduction in output of 4.06 percent while the capital tax approach causes a long-run reduction of more than 9 percent.

DISCUSSION AND CAVEATS

The policy options considered above were each structured to be sufficient to increase the primary balance by one percent of GDP. Greece's actual obligations are closer to 4 percent of GDP on a flow basis. Given the linearity of our model, we can get a rough sense of one policy combination that would come close to fully "resolving" Greece's debt burden by simply summing across the rows of the four policy options. For instance, in the baseline model, a decrease in government spending of 1.21 percent of GDP together with 2.2 percentage point increase in the consumption tax, a 2 percentage point increase in the labor tax and a 7 percentage point increase in the capital tax would raise enough to afford a 4 percent flow payment to Greece's creditors. This would entail a short-run decrease in GDP of approximately 9 percent and a long-run (permanent) decrease of 5 percent. If labor is mobile, the decrease in in long run GDP would be nearly 15 percent!

There are several important real world issues that we have suppressed in our analysis. First is the credibility of the Greek government to future reforms. The policy simulations above illustrate the severity of the adjustments that Greece is facing and it simply might be too much to expect that Greece will have the political will power to follow through with such policy changes. Second is the issue of tax compliance in Greece. The tax changes we outlined above were changes in the effective tax rates not increases in the statutory rates. To the extent that Greek firms and workers can avoid statutory tax increases the required increase in the statutory rates will need to be even greater than the rate increases we analyzed. Finally, in the simulations we considered, Greek workers and firms are surprised by the revelation of the extent of government debt at the same instant that the Greek government sets out on a new policy path. In reality, labor and investment adjustments are already underway in Greece influenced by the expectations of the policy choices that Greece might make.

COSTS AND BENEFITS OF DELAYING AUSTERITY

Given the current weakness of the Greek economy, a natural question is whether the necessary fiscal adjustments should be delayed. Delay would allow prices and wages to adjust in

anticipation of the policy changes, hopefully mitigating the disruptive effects of sluggish nominal adjustments. On the other hand, there is a cost to delay because any interim deficits before the austerity policies are implemented must be financed. In the analysis up to this point, we have implicitly assumed that there is no risk of default and that temporary shortfalls in revenue relative to the target could be financed at the Eurozone (real) interest rate of two percent. The interest rate in the event of a delay would likely include a risk premium. Here we assume that incremental debt due to delay carries an interest rate of 6 percent (a risk premium of 4 percent over the 2 percent baseline rate).

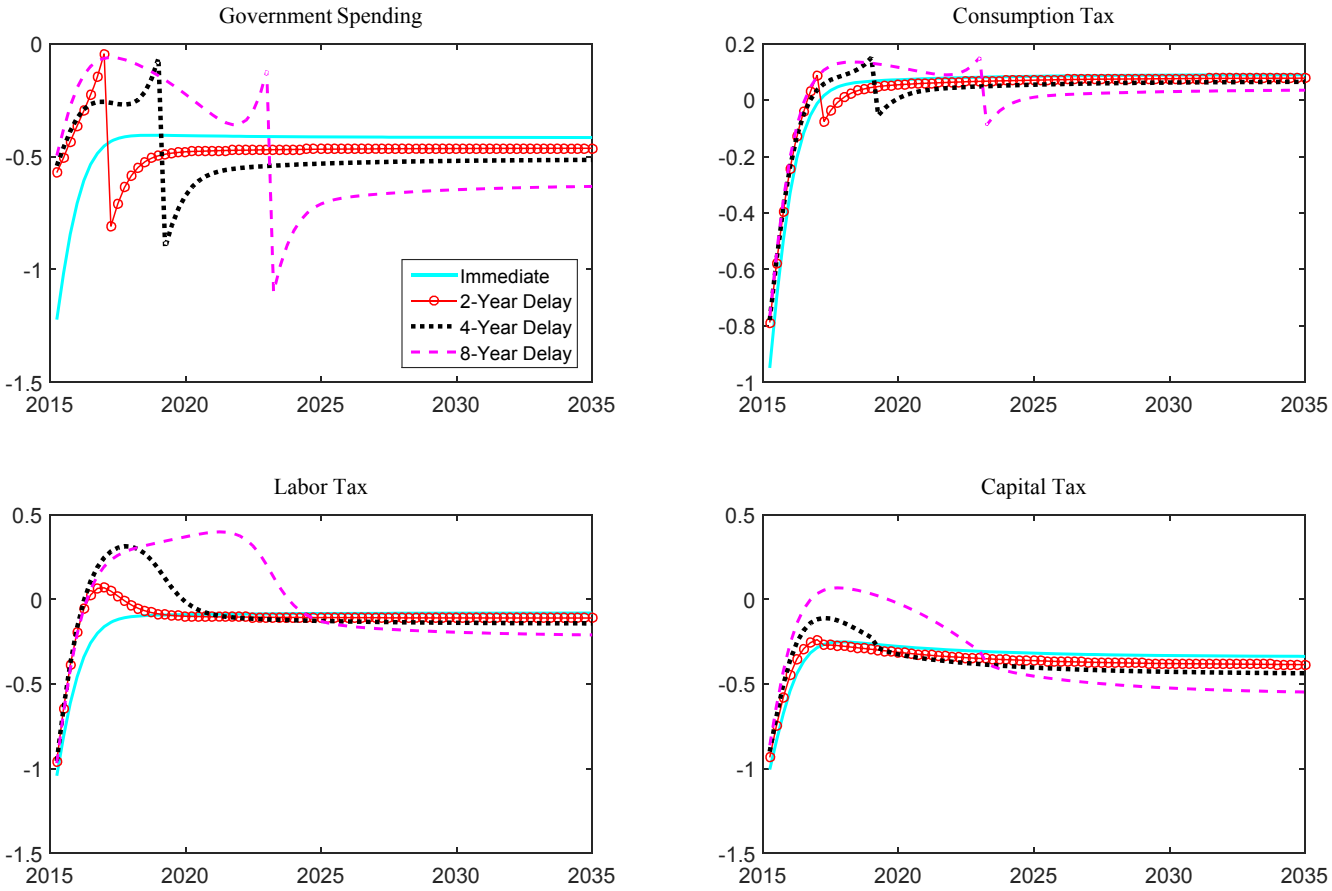
To illustrate the tradeoffs that Greece faces, we use the model to simulate four delay scenarios for the four policy adjustment options discussed above. For each policy adjustment (cutting government spending, raising consumption taxes, raising labor taxes or raising capital taxes), we simulate the response to a policy that goes into effect immediately and compare it to policies with a 2 year delay, a 4 year delay and an 8 year delay. The 4 year delay is similar to the actual recommendation in the Memorandum of Understanding which called for increases in the primary balance of -0.25 percent in 2015, 0.5 percent in 2016, 1.75 percent in 2017 and 3.5 percent thereafter (see European Commission (2015), p. 6). Figure 2 shows the simulated trajectories for Greek GDP under each of these scenarios. The top left panel shows the reactions for cutting government spending.

In all cases, there are clear short-run benefits to delay. Looking at the 2015-2020 period, the delayed policies feature GDP that is roughly 0.5 percent greater than policies that go into effect immediately. The exception seems to be the consumption tax for which the benefits of delay are small in all cases. Unfortunately, there are also clear long-run costs to delay. In every case, output in the long run is lower than otherwise by perhaps as much as 0.25 percent. How the Greek government would weigh these costs and benefits is unclear. It is also unclear what Greece's options for delay really are. If Greece can roll over its debt at a low interest rate then the case for delay becomes stronger. Indeed, if it can roll over debt at below market rates this would be a form of debt forgiveness.

OTHER CONSIDERATIONS

Economic Growth. Our analysis so far has adopted a pessimistic view that Greece will not grow at all in the coming decades. A zero growth rate is consistent with Greece's recent experience (since 2000, real growth has actually been negative) and also with some long term forecasts (see McQuinn and Whelan (2015)). Assuming that Greece will grow over time will allow the government to raise much more revenue for any given change in tax rates. To a rough approximation, if the annual discount rate for Greek debt is r and the long run annual growth rate is g then raising an amount equivalent to a perpetual payment of roughly 1.00 percent of Greece's 2014 GDP would require an adjustment that is only $(r-g)/r$ times as large as the adjustments reported in Table 2. Thus, if the interest rate were indeed 6 percent as we considered in our analysis of the delay scenarios above and the growth rate were roughly 2 percent then the tax changes (and spending cuts) would need be only 2/3 as large as those considered in Table 2. According to the IMF, its revised growth assessment for Greece going forward is approximately 1.5 percent (See IMF 2015) though it still describes this projection as "ambitious."

Figure 2: Delay Scenarios



Notes: The figure reports simulated GDP for different policies and different delay horizons. Each panel in the figure considers a different policy option (the policy instruments are listed above the panels). Each line in a given panel considers a different delay horizon.

Structural Reforms. Part of the August negotiations included specific requirements that Greece undertake a variety of structural reforms to modernize and liberalize labor markets, reform its pension system, reduce government regulation and promote competition in product markets. (See the European Commission 2015). Our analysis assumed that these structural reforms would either not be undertaken or would yield only a limited improvement in the functioning of the Greek economy. If, on the other hand, the proposed structural reforms do result in substantial improvements to economic conditions, this would potentially reduce the fiscal pressure on the Greek economy. Quantifying the anticipated payoffs associated with the proposed structural reforms is extremely difficult. One recent attempt at doing so is McQuinn and Whelan (2015). Those authors use a neoclassical growth model similar to ours together with some plausible assumptions on the effects of major structural reforms to quantify the potential effects of the reforms. Most of the policies considered by McQuinn and Whelan (2015) focus on increasing labor supply either by reducing labor market regulation or by reducing the generosity of state

pension systems. Under the most optimistic scenarios, these reforms could potentially push Greek labor market outcomes toward the labor market performance of the most productive countries in Europe. Were such an improvement to occur it would raise Greek GDP substantially in the long run and raise long-run revenue.

Debt Write-downs and Asset Sales. One final consideration is the reduction of the debt burden by either debt forgiveness or through the sale of Greek assets. Both of these options would work directly to reduce the overall debt burden. Initially, the IMF hoped that Greece could raise perhaps as much as €23 billion through the sale of various state holdings (see IMF 2015). While this sum is less than 10 percent of the overall total amount of debt payments, its effect on the present value of the debt would be substantial. For example, if we discounted future Greek debt payments at a four percent annual rate, asset sales of €23 billion would allow Greece to reduce its annual debt payment from 4.1 percent of GDP to roughly 3.5 percent of GDP.

CONCLUSIONS

This paper provides a number of estimates of the impact of alternative fiscal adjustments that would enable Greece to increase its primary balance on a permanent basis by one percent of 2014 GDP. Under reasonable assumptions we show that a) the required adjustments are very large and very painful, b) they are even larger when one takes into account realistic elasticities of the tax base and c) they are larger still when one takes into account that Greece is a small open economy. There could be some short term benefits from delaying fiscal adjustment, but delay will come at a relatively high price unless Greece's creditors are willing to provide additional finance at a relatively low interest rate. All of these adjustments become less painful under the scenario that the Greek economy returns to a positive growth path. Whether proposed structural reforms can actually produce sustained growth remains to be seen.

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