Department of Economics University of Maryland

Economics 325

Intermediate Macroeconomic Analysis

Problem Set 2 – Suggested Solutions

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Fall 2011

Instructions: Written (typed is strongly preferred, but not required) solutions must be submitted no later than 2:00pm on the date listed above.

You must submit your own independently-written solutions. You are permitted (in fact, encouraged) to work in groups to think through issues and ideas, but you must submit your own independently-written solutions. **Groups may be no larger than four students total, and all group members' names must be listed on the first page. Under no circumstances will multiple verbatim identical solutions be considered acceptable. Failure to adhere to these guidelines may result in your problem set not being accepted, and a grade of zero being assigned.**

Your solutions, which likely require some combination of mathematical derivations, economic reasoning, graphical analysis, and pure logic, should be **clearly, logically, and thoroughly presented;** they should not leave the reader (i.e., your TAs and I) guessing about what you actually meant. Your method of argument(s) and approach to problems is as important as, if not more important than, your "final answer." Throughout, your analysis should be based on the frameworks, concepts, and methods we have developed in class.

There are three problems in total, each with multiple subparts.

Problem 1: "The Economic Crisis from a Neoclassical Perspective." (30 points) Read the essay by Ohanian (posted on the course website):

Ohanian, Lee. 2010. "The Economic Crisis from a Neoclassical Perspective." *Journal of Economic Perspectives*, Vol. 24, pp. 45-66.

Use the essay and what we have learned throughout the semester to address the following points clearly and succinctly. Whenever a "model" or "framework" is called for in the analysis below, start from the perspective(s) of one or more of our basic frameworks: consumption-leisure; consumption-savings (in two-period or infinite-period form, it does not matter); the combination of consumption-leisure and consumption-savings (Chapter 5); and supply-and-demand-based firm theory (Chapter 6).

a. **(9 points)** In the section titled "A Diagnostic Approach to the Causes of Recession," Ohanian describes an infinite-horizon version of the frameworks described above. From it, Ohanian obtains his main results (once input with actual data for the U.S. economy and other economies). These results are presented in Table 2. **Briefly describe the concept (i.e., the economics) and mathematics for each of the following:**
   i) the "labor deviation" (sometimes referred to in the related literature as the "labor wedge")
   ii) the "capital deviation" (sometimes referred to in the related literature as the "capital wedge" or "investment wedge")
   iii) the "productivity deviation" (sometimes referred to in the related literature as the "productivity wedge")

Solution: For cases i) and ii), the term "wedge" describes a gap between the MRS for a particular pair of markets and the (essentially) marginal product of output with respect to that market's input good. More formally (and described generally), the consumption-labor MRS is $\frac{u_l(c,l)}{u_c(c,l)}$, and the marginal product of labor is $f_n(k,n)$ (omitting time subscripts for simplicity). The "labor wedge" is thus the τ^n such that $\frac{u_l(c,l)/u_c(c,l)}{f_n(k,n)} = 1-\tau^n$.

Turning to the intertemporal (i.e., capital) market, the consumption-savings MRS is (now requiring time subscripts – and we introduce a subjective discount factor as well, but that isn't crucial for the general idea here) $\frac{u_c(c_t,l_t)}{\beta u_c(c_{t+1},l_{t+1})}$. The marginal product of capital is of course $f_k(k_{t+1},n_{t+1})$. The "capital wedge" – call it τ^k -- is defined analogously as the labor wedge. Technically, the way it is defined is in gross terms, which means the effective marginal product of capital is $1-\delta+f_k(k_{t+1},n_{t+1})$, in which case the capital wedge is the τ^k that solves

$$\frac{u_c(c_t,l_t)}{\beta u_c(c_{t+1},l_{t+1})} \cdot \frac{1}{1-\delta+f_k(k_{t+1},n_{t+1})} = 1-\tau_{t+1}^k,$$

but it was fine if you didn't include the gross term $1-\delta$.

The labor wedge and the capital wedge required you to draw on your knowledge from Chapters 2, 3, 4, and 6.

The "productivity wedge" was something that we have not studied explicitly in class. As explained by Ohanian, it is the gap between total output in the economy in period *t* as produced by $f(k_t, n_t)$, and total absorption, which is just (if we take a closed-economy view) $c_t + inv_t + g_t$. As explained in **BASIC** macroeconomics, these two should be equal. The extent to which they do not line up is the "productivity deviation."

(Previewing growth theory courses, if your interests take you in that direction: the "productivity deviation" is simply the Solow residual (i.e., the TFP measure) except written in a "detrended" way.)

b. **(6 points)** Briefly **(in no more than two sentences/phrases each)** describe why each of the labor wedge, the capital wedge, and the productivity wedge are important **for the purpose of analyzing data from the perspective of our frameworks.** (Note: be clear about **data** vs. **"windows"** through which to view data.)

Solution: As alluded to in the solution above, the wedges are a diagnostic for how far away from the empirical data the basic predictions of the perfectly-competitive model (i.e., the RBC model) are. That is, if the true data (in the three markets – goods markets, labor markets, and financial markets) are what we ultimately aim to explain using something like the RBC model, the wedges give some guide as to what margins are most missing the mark.

c. **(8 points)** Ohanian's results show that the labor wedge was the most important of the three wedges that is reflected in the U.S. data over the period 2007-2009. In principle, there are (both in our frameworks and in the data as viewed from the perspective of our frameworks) **two distinct components** of the labor wedge. **What are the two components of the labor wedge? Describe this carefully and with as much mathematical accuracy as possible.**

ALSO – if all we were looking at was Table 2 (with no other knowledge of Ohanian's or others' analyses), would we be able to decompose the labor wedge into each of these two components? **Briefly explain why or why not.**

Solution: The two components of the labor wedge are one arising on the labor demand side $mpn_t = (1-\tau_t^{LD})w_t$ (in which τ_t^{LD} denotes the demand component of the labor wedge), and one arising on the labor supply side $(1-\tau_t^{LS})w_t = \frac{u_l(c_t, l_t)}{u_c(c_t, l_t)}$ (in which τ_t^{LS} denotes the supply component of the labor wedge).

Combining these wedge components (by eliminating the wage w_t across them) gives

$mpn_t = \frac{1-\tau_t^{LD}}{1-\tau_t^{LS}} \cdot \frac{u_l(c_t, l_t)}{u_c(c_t, l_t)}$, in which we can define $1-\tau_t^n \equiv \frac{1-\tau_t^{LD}}{1-\tau_t^{LS}}$ as the overall labor wedge.

It is τ_t that Ohanian's measurements report, **but** we would **not** be able to decompose it into the "demand" and "supply" components.

d. **(7 points)** Ohanian's result that the labor wedge was the most important of the three wedges during the 2007-2009 recession suggests the need for further development of frameworks for labor-market analysis. Based on the subsection "Understanding Labor Deviations" in Ohanian's essay, briefly **(in no more than two sentences/phrases each**) describe/propose **two** alternative (and sensible!) ways in which the basic models studied in class could be enhanced/enriched to perhaps replicate the observed empirical facts.

Solution: Broadly:

1. Introduce "matching" issues (or something that breaks the extensive margin from total hours, which puts the extensive and intensive margins together)
2. "Skills mismatch" that requires retraining, etc.

Problem 2: Matching in the Labor Market (30 points). Consider the matching function over the number of unemployed individuals (*ue*) and the number of vacant jobs (*vac*)

$$m(ue, vac) = a \cdot ue^{\alpha} vac^{1-\alpha},$$

with $a > 0$ and $\alpha \in (0,1)$. The functional form is Cobb-Douglas, which is the most widely-used form in applied matching analysis. From the perspective of labor-market analysis, the "number of new matches" in a given time period is simply the number of new jobs created in that period.

The early parts of this problem ask you to work theoretically with this matching function; the later parts of this problem ask you to think about some empirical U.S. labor market facts through the lens of this matching function.

Except for part h of this problem, the terms *a* and *α* are to be treated as parameters, not as variables.

a. **(3 points)** Compute the **two** marginal functions, $m_{ue}(.)$ and $m_{vac}(.)$ based on the above. (That is, you are being asked to compute $\frac{dm(ue, vac)}{d(ue)}$ and $\frac{dm(ue, vac)}{d(vac)}$ for the given matching function.)

Solution: The partial derivatives of the matching function are $\frac{\partial m(ue, vac)}{\partial ue} = \alpha \cdot a \cdot ue^{\alpha-1} vac^{1-\alpha}$ and $\frac{\partial m(ue, vac)}{\partial vac} = (1-\alpha) \cdot a \cdot ue^{\alpha} vac^{-\alpha}$.

b. **(3 points)** Define **labor-market tightness** as $\theta \equiv \frac{vac}{ue}$, which measures the **ratio** of vacancies to unemployment. With this definition of θ, rewrite the two marginal functions constructed in part a in terms of **only θ**. (That is, starting from your solution in part a, algebraically rearrange those expressions so that you can express them in terms of **only θ**.)

Solution: With this definition of θ, the two partial derivatives from part a can be written as $\frac{\partial m(.)}{\partial ue} = \alpha \cdot a \cdot \left(\frac{vac}{ue} \right)^{1-\alpha} \equiv \alpha \cdot a \cdot \theta^{1-\alpha}$ and $\frac{\partial m(.)}{\partial vac} = (1-\alpha) \cdot a \cdot \left(\frac{vac}{ue} \right)^{-\alpha} \equiv (1-\alpha) \cdot a \cdot \theta^{-\alpha}$.

c. **(3 points)** Starting from the solution in part b, construct the following measure for the given matching function: $\frac{m_{ue}(.)}{m_{vac}(.)}$. **Given what you constructed,** of what economic variable(s) is this a function? Denote this set of variable(s) by *X*.

Solution: With the partials constructed above, this questions asks you to construct the ratio,

$$\frac{\partial m(.)/\partial ue}{\partial m(.)/\partial vac} = \frac{\alpha \cdot a \cdot \theta^{1-\alpha}}{(1-\alpha)\cdot a \cdot \theta^{-\alpha}} = \left(\frac{\alpha}{1-\alpha}\right)\theta$$

The variable X is thus simply θ (because α is viewed as a constant).

d. **(3 points)** Now construct another labor-market measure starting from the given matching function. Specifically, construct an expression for

$$p^{FILL} = \frac{m(ue, vac)}{vac} = ...$$

where the ellipsis (…) indicate a term that you are to compute given the Cobb-Douglas matching function. **Express this in terms of *only* θ. Given what you constructed, is** $p^{FILL} = m_{ue}(.)$ (from part a)? **Is** $p^{FILL} = m_{vac}(.)$ (from part a)?

Solution: Note that this is **not** a partial derivative that requires construction. With the given matching function, we have $p^{FILL} = \frac{a \cdot ue^{\alpha} vac^{1-\alpha}}{vac} = a \cdot ue^{\alpha} vac^{-\alpha} = a \cdot \left(\frac{vac}{ue}\right)^{-\alpha} = a \cdot \theta^{-\alpha}$. Or, in shorter (summary) form,

$$p^{FILL} = a \cdot \theta^{-\alpha}.$$

Referring back to part a (and actually part b, which is a bit more direct for the purpose of comparison), it is **not** the case that p^{FILL} is either of the partial derivatives of the matching function.

e. **(3 points)** Similar to part d, now construct yet another labor-market measure starting from the given matching function. Specifically, construct an expression for

$$p^{FIND} = \frac{m(ue, vac)}{ue} = ...$$

where the ellipsis (…) indicate a term that you are to compute given the Cobb-Douglas matching function. **Express this in terms of *only* θ. Given what you constructed, is** $p^{FIND} = m_{ue}(.)$ (from part a)? **Is** $p^{FIND} = m_{vac}(.)$ (from part a)?

Solution: Note that this is **not** a partial derivative that requires construction. With the given matching function, we have $p^{FIND} = \frac{a \cdot ue^{\alpha} vac^{1-\alpha}}{ue} = a \cdot ue^{\alpha-1} vac^{1-\alpha} = a \cdot \left(\frac{vac}{ue}\right)^{1-\alpha} = a \cdot \theta^{1-\alpha}$. Or, in shorter (summary) form,

$$p^{FIND} = a \cdot \theta^{1-\alpha}.$$

Referring back to part a (and actually part b, which is a bit more direct for the purpose of comparison), it is **not** the case that p^{FIND} is either of the partial derivatives of the matching function.

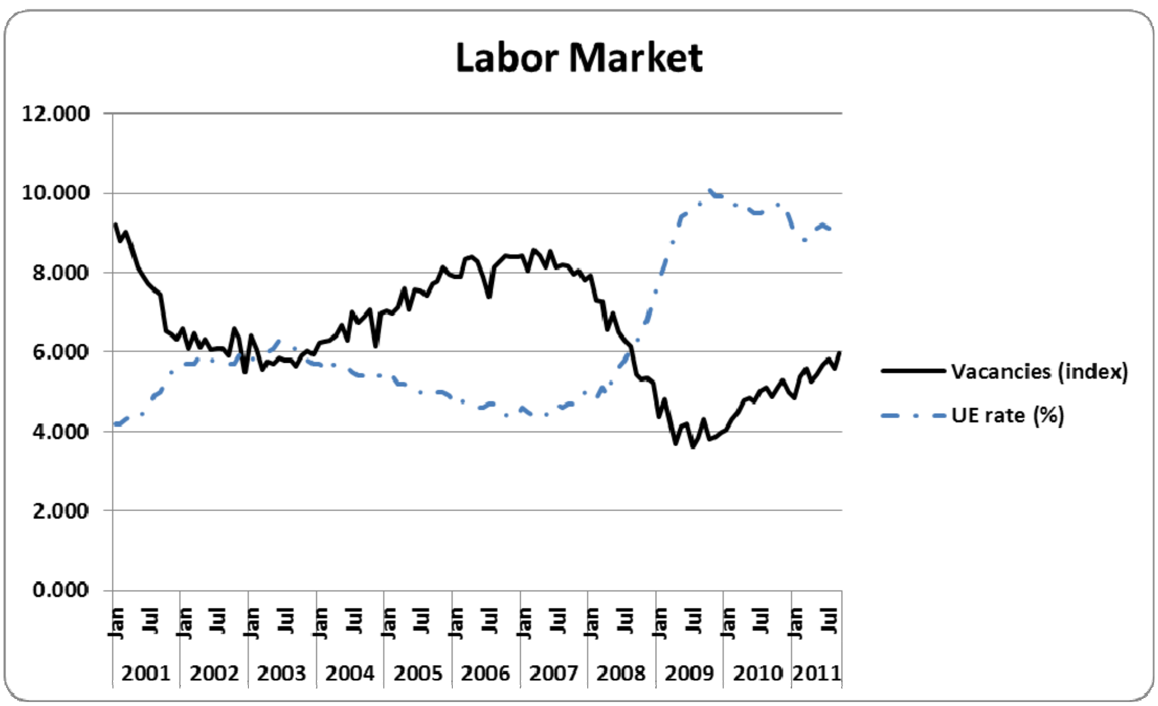
f. **(5 points)** Provide **brief and clear economic interpretation** (i.e., not simply a verbal restatement of the mathematics) of the measures p^{FILL} and p^{FIND} constructed in part d and part e. **ALSO,** referring to the diagram immediately below, describe/discuss how each of p^{FILL} and p^{FIND} moved (increased, decreased, or stayed constant) over the period 2004-2007, **and** over the period 2008-2009. As part of your response, you should also describe how the variable *X* (from part c) moved over each time period.

Solution: Intuitively, p^{FILL} is the probability (in a "large" market) that an advertised job vacancy is filled by an unemployed individual looking for a job; and p^{FIND} is the probability that an unemployed individual looking for a job finds an open job vacancy.

With theta defined as vac/ue, it is clear that theta INCREASED during the period 2004-2007, and theta DECREASED during the period 2008-2009.

The solution in part d shows that p^{FILL} decreases as theta increases. Hence, p^{FILL} decreased during 2004-2007, and increased during 2008-2009.

The solution in part e shows that p^{FIND} increases as theta increases. Hence, p^{FIND} increased during 204-2007, and decreased during 2008-2009.



g. **(6 points)** The diagram above shows the U.S. national unemployment rate (which has been between 9-10 percent over the past roughly two years) and (an index of) the number of job vacancies in the private sector over the past 10 years. (The latter data are obtained from the JOLTS database, a monthly time series available through the Bureau of Labor Statistics at www.bls.gov/jlt.)

Do not try to insert the data in the graph above into the matching function (doing so would require some more statistical data handling). But the data above paint the following portrait to many economists: vacancies have increased notably over the past roughly two years (about a 50 percent increase); but the unemployment rate has only slightly and slowly ticked down (from 10 percent to about 9 percent). Address each of the following points **briefly (in no more than three sentences/phrases) and clearly:**

i) What if there is a “skills mismatch” in the labor market (a commonly-used phrase the past couple of years)? The interpretation of this phrase is that while there may simultaneously be a lot of people looking for jobs and a lot of firms looking to hire workers, perhaps the events of a few years ago fundamentally changed the “type” of workers that firms want to hire; hence, not much hiring is actually happening. (One example is financial sector workers: what if so many financiers are simply “not needed” anymore, and firms want to instead hire more “production workers.”)

ii) What if there is “uncertainty” about future economic events, such as, for example, future economic policy? To make it a bit concrete, suppose firms are concerned about increased taxation of their profits in upcoming quarters or years. Qualitatively, does this “uncertainty” go in the right direction in explaining the somewhat dichotomous movements in vacancies and unemployment?

Solution: [Most reasonable answers that were thought out were accepted.]

h. **(4 points)** The matching model is a fairly universal way to try to organize thinking about issues such as the ones brought up in part g. If we use the Cobb-Douglas matching function as the particular “window” through which to view and try to interpret such explanations, is it possible to **qualitatively** reconcile empirical interpretations such as in part g with the theoretical predictions of the matching function? (Note: for this problem, it may be helpful to think in terms of the **parameters** a and/or α.) **Briefly and clearly explain.**

Solution: The Cobb-Douglas matching function is the one presented at the start of this problem. If a and/or alpha change, **[most reasonable answers that were thought out were accepted.]**

Problem 3: Greece and Long-Run Fiscal (In)Solvency (40 points). The current European economic and sovereign debt crisis has put into sharp focus one of the main challenges of enacting a **single** currency zone (the euro zone, or the euro area, as it is officially called) and hence a **single monetary policy** among (17) sovereign countries, but **without** enacting a **single fiscal policy** across those countries. Consider specifically the case of Greece, which is the most highly indebted country (in terms of percentage of its GDP – the Greek government's debt is roughly 150% of Greek GDP) in the euro area. (Throughout the rest of this problem, the terms "single-currency zone," "euro zone," and "euro area" are used interchangeably.)

In this problem, you will apply the Fiscal Theory of the Price Level (FTPL) studied in Chapter 15 to the analysis of fiscal policy in a single-currency zone. In studying or applying the FTPL, the condition around which the analysis revolves is the present-value (lifetime) consolidated government budget constraint (GBC). Recall that, starting from the beginning of period *t*, the present-value consolidated GBC is

$$\frac{B_{t-1}}{P_t} = \sum_{s=0}^{\infty} \frac{t_{t+s} - g_{t+s}}{\prod_{x=1}^{s}(1+r_{t+x-1})} + \sum_{s=0}^{\infty} \frac{sr_{t+s}}{\prod_{x=1}^{s}(1+r_{t+x-1})},$$

in which all of the notation is just as in Chapter 15.

You are given three numerical values. First, suppose that B_{t-1} = €340 billion (which roughly corresponds to what the Greek government's total nominal debt is at present). Second, assume that $\boldsymbol{t_t - g_t}$ **= – €20 billion (note the minus sign** – this value roughly corresponds to Greece's fiscal balance in the third quarter of 2011). Third, the Greek nominal price level **in period *t*-1 is $\boldsymbol{P_{t-1}}$ = 1** (which is a normalization).

Due to its high indebtedness, Greece was under the spectre of default and possible exit from the single-currency zone. To avoid these dramatic adverse consequences, Greece was compelled (by other European governments) to make strict fiscal adjustments as well as other reforms to stabilize the rapid increase in government debt.

Note: in some of the analysis below, you will need to make use of the **geometric summation** result from basic mathematics. A brief description of the geometric summation result: suppose that a variable *x* is successively raised to higher and higher powers, and the infinite sequence of these terms is summed together, as in

$$x^0 + x^1 + x^2 + x^3 + x^4 + ...$$
$$= \sum_{s=0}^{\infty} x^s$$

(in which the second line compactly expresses the infinite summation using the summation notation Σ). This sum can be computed in a simple way according to

$$\sum_{s=0}^{\infty} x^s = \frac{1}{1-x}.$$

This expression is the geometric summation result (which you studied in a pre-calculus or basic calculus course), which you will need to apply in some of the analysis below.

General Solution: In much of the analysis below, you needed to apply the geometric summation result. This result applies here because all of the economic terms (specifically, $t - g$ and sr) in the present value GBC do **not** depend on the index of summation s and thus can be pulled outside the summation operator. In other words, this is essentially a steady-state analysis. The present value GBC can thus be simplified to

$$B_{t-1} = (t-g)\sum_{s=0}^{\infty}\frac{1}{(1+r)^s} + sr\sum_{s=0}^{\infty}\frac{1}{(1+r)^s},$$

which can be simplified even further. The two key observations you had to make were the following. First, the term $\frac{1}{(1+r)^s}$ can be expressed as $\left(\frac{1}{1+r}\right)^s$ by the rules of exponents. Second, in terms of the general form of the geometric summation given above, the variable "x" corresponds to the term $\frac{1}{1+r}$. Applying the geometric summation result, we have

$$\sum_{s=0}^{\infty}\left(\frac{1}{1+r}\right)^s = \frac{1}{1-\frac{1}{1+r}} = \frac{1}{\frac{1+r-1}{1+r}} = \frac{1}{\frac{r}{1+r}} = \frac{1+r}{r}.$$

With this, the present value GBC is expressed as

$$B_{t-1} = \left(\frac{1+r}{r}\right)(t-g) + \left(\frac{1+r}{r}\right)sr,$$

or, equivalently,

$$B_{t-1} = \left(\frac{1+r}{r}\right)(t-g+sr).$$

The entire analysis is then based on either of these last two representations of the present-value GBC, which from here we will refer to as the PVGBC.

a. **(4 points)** In a single-currency zone (such as the euro area), monetary policy is carried out by a "common" central bank (which is the European Central Bank in the euro area). A consequence of this is that individual countries – in particular, Greece – **cannot** print their own money (despite the fact that there **is** a Bank of Greece). What is the implication of this for **Greece's** seignorage revenue? **And,** how would this impact Greece's present-value GBC? Explain as clearly as possible, including, if needed, any mathematical analysis.

Solution: Not being allowed to print nominal money means $M_t - M_{t-1} = 0$ in every period *t*, which in turn means (by definition) that seignorage revenue is $sr_t = \frac{M_t - M_{t-1}}{P_t} = 0$ in every period. Thus, the present-value GBC (PVGBC) is simply

$$\frac{B_{t-1}}{P_t} = \sum_{s=0}^{\infty} \frac{t_{t+s} - g_{t+s}}{\prod_{x=1}^{s}(1+r_{t+x-1})}.$$

The real value of government liabilities thus has to be financed by pure fiscal surpluses.

b. **(6 points)** Suppose that Greece commits to stay in the single-currency zone and to carry out all necessary fiscal adjustments to ensure its present-value GBC is satisfied. Suppose that the real interest rate is constant in every period at five percent (*r* = 0.05) and that the nominal price level in period *t* will remain $P_t = 1$ (note this is the period-*t* price level, not the period *t*-1 price level).[1] Suppose Greece carries out its fiscal adjustments in period *t*, **and** (to simplify things a bit) Greece will keep the new fiscal surplus (or fiscal deficit) **constant** at that level in **all** subsequent time periods. **What is the numerical value of the fiscal surplus (or fiscal deficit) in order to ensure that the present-value consolidated GBC from part a is satisfied? That is, what is the numerical value of (*t* – *g*)? Be clear about the sign and the numerical magnitude of (*t* – *g*).** Present your economic and/or mathematical logic; and provide brief economic explanation.

Solution: Using the given numerical values in the PVGBC,

$$\frac{340 \text{ billion}}{1} = \frac{B_{t-1}}{P_t} = \left(\frac{1+0.05}{0.05}\right)(t-g),$$

from which it obviously follows that $(t-g) = 16.19 \text{ billion}$. Intuitively, if the entire debt has to be repaid using a constant fiscal surplus (and zero seignorage) over time, that surplus has to \$16.19 billion in every time period.

c. **(6 points)** Re-do the analysis in part b, assuming instead that *r* = 0.025. **Compare the conclusion here with the conclusion in part b,** providing brief economic explanation for why the conclusions do or do not differ.

Solution: Using the given numerical values in the PVGBC,

$$\frac{340 \text{ billion}}{1} = \frac{B_{t-1}}{P_t} = \left(\frac{1+0.025}{0.025}\right)(t-g),$$

[1] And note that what is relevant here is the **real** interest rate, **not** the **nominal** interest rate, which had shot up in Greece to about 25% in October 2011. The reason why **real** interest rates, not nominal rates, matter most directly is that markets' expectations of inflation for Greece (if Greece did indeed exit from the euro zone) was near 20%.

from which it obviously follows that $(t-g)=8.29 \text{ billion}$. Intuitively, if the entire debt has to be repaid using a constant fiscal surplus (and zero seignorage) over time, that surplus has to $8.29 billion in every time period. The required surplus in this case is smaller than in part b because of the lower interest rate, which in turn implies **smaller interest payments on the debt** that has to be repaid.

d. **(6 points)** Under a more realistic view, suppose that Greece still commits to stay in the single-currency zone and to make some, but not all, of the required fiscal adjustments that you computed in part b (perhaps because of "political constraints" that we are leaving outside the analysis). To make it concrete, suppose that Greece is able to run a fiscal surplus of only **€5 billion** in every period (i.e., $t - g$ = €5 in every time period). If the real interest rate is five percent (r = 0.05), compute the **numerical value of P_t** to ensure that the present-value consolidated GBC is satisfied. **Be clear about your logic and computation to arrive at the result;** and provide brief economic explanation.

Solution: Using the given numerical values in the PVGBC,

$$\frac{340 \text{ billion}}{P_t}=\frac{B_{t-1}}{P_t}=\left(\frac{1+0.05}{0.05}\right)\cdot 5,$$

which now has to be solved for P_t. Solving this for P_t, we have

$$P_t=\frac{B_{t-1}}{\left(\frac{1+0.05}{0.05}\right)\cdot 5}$$

or P_t = 3.24. Intuitively, if the fiscal surplus cannot be as large as computed in part b and the nominal government debt is fixed at B_{t-1} = 340 (and sr = 0 always), then the only way for the PVGBC to be satisfied is for the price level to adjust (higher) in the short run. This makes the **real** value of the government debt to be **smaller** than B_{t-1} = 340.

e. (6 points) Re-do the analysis in part d, assuming instead that r = 0.025. **Compare the conclusion here with the conclusion in part d,** providing brief economic explanation for why the conclusions do or do not differ.

Solution: Using the given numerical values in the PVGBC,

$$\frac{340 \text{ billion}}{P_t}=\frac{B_{t-1}}{P_t}=\left(\frac{1+0.025}{0.025}\right)\cdot 5,$$

which now has to be solved for P_t. Solving this for P_t, we have

$$P_t = \frac{B_{t-1}}{\left(\frac{1+0.025}{0.025}\right)\cdot 5}$$

or P_t = 1.66. Intuitively, if the fiscal surplus cannot be as large as computed in part c and the nominal government debt is fixed at B_{t-1} = 340 (and *sr* = 0 always), then the only way for the PVGBC to be satisfied is for the price level to adjust (higher) in the short run. This makes the **real** value of the government debt to be **smaller** than B_{t-1} = 340, but not as small as in the case computed in part d.

f. **(12 points)** Assume that Greece decides (against the collective wisdom of other European governments) to **leave** the single-currency zone. Once having left the euro zone, instead of making a serious fiscal adjustment, Greece prefers to cover its debt burden through seignorage revenue, while keeping the fiscal balance **unchanged (in every time period into the future) at *t* – *g* = – €20 billion** (note the minus sign). Suppose that the required seignorage revenue is kept at the same level in **all** subsequent years, and assume that *r* = 0.05 **(which suppose cannot be affected by monetary policy)**. **Address the following three questions:**

i) How much (per-period) seignorage revenue would Greece need to generate in order to keep its prices at *P* = 1 in period *t* and for every period beyond *t*?

ii) What are the implications of this particular monetary and fiscal (and, ultimately, political) policy on Greece's own future (i.e., period *t* and beyond) inflation rate?

iii) What is the theoretical difference between the analysis in this question and the analysis conducted in parts b and c, **and** with the analysis conducted in parts d and e?

Solution: If the fiscal balance is kept at a **deficit** (of 20 billion euro), then the per-period seignorage revenue needed to balance the PVGBC **and** keep *P* = 1 in every period requires computing seignorage revenue from

$$\frac{340 \text{ billion}}{P_t} = \frac{B_{t-1}}{P_t} = \left(\frac{1+0.05}{0.05}\right)\cdot(-20+sr)$$

(note the -20 on the right-hand side is the per-period fiscal deficit). Solving this for *sr* gives

$$sr = \left(\frac{0.05}{1+0.05}\right)\frac{B_{t-1}}{P_t} - (t-g),$$

or *sr* = 36.19 in every period, which answers part i).

If Greece does actually implement and stick with this policy, then inflation will always be zero (i.e., *P* = 1 for every period into the future), which answers part ii). **BUT** (and this is the key part of the question – although, indeed, this was told to you at the start of the sub-question) Greece is now printing its own currency because it has left the euro currency.

Finally, the analytical difference is simply that we are now allowing for the possibility that seignorage revenue will be generated by Greece due to its creation of its money, which answers part iii).