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# The equity premium in a small open economy and an application to Israel☆

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ABSTRACT

We show that the preferences suggested by Greenwood, Hercowitz and Huffman (GHH), which are quite common in real business cycle (RBC) models of small open economies, are not suited for reproducing both the business cycle and the equity premium facts of a small open economy. We show that by assuming a moderate degree of a wealth effect on labor supply, together with some limitations on labor supply (in the form of real wage rigidity), we can increase the volatility of the stochastic discount factor (SDF), thereby increasing the equity premium and improving the fit of the business cycle moments. We also find that under the aforementioned assumptions, a shock to the realized return on foreign bonds can help in reproducing the equity premium.



## 1. Introduction

A well-known result in the business cycle-asset pricing literature is that the standard[1] real business cycle (RBC) model is unable to reproduce the equity premium observed in the data.[2] In order to be able to generate a reasonable equity premium, there must be some real frictions in the real business cycle model which make it difficult for the consumer to fully and freely smooth marginal utility of consumption in response to external shocks.[3]

Abel (1990) and Constantinides (1990) have shown that high risk aversion and a high degree of habit formation in consumption can generate an equity premium in an endowment economy. Jermann (1998) extended the results to a production economy with endogenous capital but with constant labor input. The ability of the consumer–producer to freely adjust savings–investment in response to external shocks enables the consumer to smooth the marginal utility of consumption. In order to generate an equity premium in this setup, Jermann added capital adjustment costs to the production process of capital.[4] When one allows labor input to become endogenous in Jermann's standard RBC model, the equity premium disappears. The reason is that the consumer can adjust labor supply, in response to a productivity shock, and so continue smoothing the marginal utility of consumption. Uhlig (2006, 2007) suggested overcoming the obstacle posed by the endogenous supply of labor by adding the assumption of real wage rigidity. Following Blanchard and Gali (2007), he assumed that the real wage is rigid and that the quantity of labor is determined by the demand of firms. Thus, the consumers are "prevented" from using labor supply as an insurance device against external shocks. Uhlig showed that by adding the assumption of wage rigidity, a sizeable equity premium can emerge in an otherwise standard RBC model.[5]

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[1] By "standard" we mean a frictionless, one-agent (homogenous) model such as the one presented by King et al. (1988).

[2] For a survey, see for example, Cochrane (2008).

[3] As is already known (for example Lettau and Uhlig (2002)) and will be discussed below, the shape of the utility function also has an important role in producing an equity premium.

[4] The higher those adjustment costs are, the harder it is for the representative producer–consumer to adjust investment–savings in response to external (productivity) shocks.

[5] There are at least two other ways to overcome the above two problems caused by endogenous labor supply (in a representative agent model). Boldrin et al. (2001) added friction to the labor market by specifying limited sectorial mobility. Jaccard (2010) added internal habit formation in labor to the model. Another way to progress is by expanding the framework to a heterogeneous agent model (see for example De Graeve et al. (2010)). Here we restrict the discussion to a homogenous agent model.

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The aforementioned literature dealt with closed economy models. For an open economy, such as the model of Mendoza (1991) and Schmitt-Grohe and Uribe (2003), another degree of freedom is added: consumers can adjust their external borrowing position. In order to generate an equity premium in such a setup, Jahan-Parvar et al. (2013) added costs for adjusting the external debt position of the consumer. They applied the model to the data of three South American countries (Brazil, Argentina and Chile) and succeeded in matching both the business cycle facts and the equity premium of those countries. To the best of our—and their—knowledge, their paper is the only paper that tries to match business cycle moments and equity premium in a small open economy. The model they used includes GHH[6] preferences that are quite common in models of small open economies. An important characteristic of these preferences is the absence of a wealth effect on labor supply. This helps to reproduce the business cycle moments of an open economy without the need to "add" a real wage rigidity. However, the business cycle facts of the above-mentioned countries differ in at least one respect from the data of a typical small open economy. As can be seen in Table 3 of Jahan-Parvar et al. (2013), for that group of South American countries and during the specific time period of their research,[7] the volatility of investment is quite similar to that of consumption. However, in the Israeli data, as well as in most small open economies,[8] the standard deviation of investment is much larger than that of consumption.[9] As will be shown later in this paper, the GHH utility is not suited to reproduce both the business cycle and the equity premium facts of a "typical" small open economy.

We found that a way to progress is to use the Jaimovich and Rebelo (2009) specification of preferences which adds some degree of wealth effect on labor supply and to add to the model some kind of limitations on labor supply. We used both real wage rigidity, of the kind proposed by Uhlig (2006, 2007), and habits in labor. As we shall see later, the addition of some degree of wealth effect and wage rigidity can improve the model's fit even when we refer only to the business cycle moments, i.e., ignoring the equity premium.

The main contribution of this paper is the finding that the use of Jaimovich–Rebelo (henceforth JR) preferences, considerably improves the results relative to those achieved by using GHH preferences. The reason is that the GHH preferences are characterized by a relatively high degree of substitutability between consumption and leisure which moderates the volatility of the stochastic discount factor (SDF). By adding to labor supply some degree of a wealth effect we can get a significant increase in the volatility of the SDF, and hence an increase in the equity premium and in the volatility of investment.

An intuitive explanation is as follows: Assume a negative technology shock which reduces consumption (and thus increases the marginal utility of consumption) and reduces the demand for labor. In both GHH and JR preferences, consumption and leisure are substitutable. In the GHH case the wealth effect on labor supply is zero—that is, the decline in labor moderates the increase in the marginal utility of consumption to a large degree, such that the consumer is not interested in increasing labor supply. In the case of JR preferences the wealth effect is positive—that is, the consumer wishes to increase labor supply in order to moderate the increase in the marginal utility of consumption. But, because of the existence of wage rigidity, he is prevented from doing so freely and this increases the volatility of the marginal utility of consumption relative to the case of GHH.

Following the relevant literature[10] we start the analysis using three shocks: to productivity, to government expenditure and to the world interest rate. However, an important contribution of our paper is a finding that additional shocks, which are characterized by a dominant wealth effect, might have a large contribution to the reproduction of the equity premium. We further show that in the context of a small open economy, shocks to the real exchange rate might be a prominent example of such kind of shocks.

In the next section we present the model. In Section 3 we present and discuss the data and the calibration of the parameters. In Section 4 we present and discuss the results and Section 5 concludes. Data sources and some technical aspects are presented in the appendix.[11]

## 2. The model

In this section we present a stylized RBC model of a small open economy. We assume three types of agents: households, firms and a government. Households and firms optimize in a competitive market and the government collects a lump sum tax to finance its expenditures. The representative household consumes a final product produced by firms, supplies labor services to firms and invests in capital which is rented to firms. The household also engages in lending (or borrowing) abroad by purchasing a one period riskless international real bond. Households, who also own the firms, receive from them profits, capital rents and wages. We assume that the economy is driven by three shocks: to productivity, to government expenditure and to the world interest rate. Later we shall refer to the possible impacts of a shock to the realized return on the foreign bonds.

### 2.1. Households

Following the relevant literature we assume a small open economy with a large number of identical infinitely lived households.[12] The representative household has the following momentary utility function:

$$U_t = U\left(C_t - \chi^c \widetilde{C}_{t-1}, H_t - \chi^h \widetilde{H}_{t-1}\right) \tag{1}$$

Where: $C_t$ and $H_t$ represent consumption and labor input of the representative household. We assume the existence of external habit formation both in consumption and in labor input. $\widetilde{C}_{t-1}$ and $\widetilde{H}_{t-1}$ represent aggregate consumption and aggregate labor input and $0 < \chi^c < 1$ and $1 < \chi^h < 1$ are parameters representing the degree of habit in consumption and in labor input.

In each period the (representative) household faces a budget constraint that is represented by the following two equations:

$$W_t H_t + V_t^{\,k} K_{t-1} = C_t + [I_t + \Phi(K_t - K_{t-1})] + \Gamma_t + [TB_t + \Theta(D_t - D_o)] \tag{2}$$

$$D_t = R^f_{t-1} D_{t-1} - TB_t \tag{3}$$

The left side of Eq. (2) represents household current income, which is the sum of labor income and capital income, where $W_t$ and $V_t^{\,k}$ represent the wage rate and the rental rate of capital. The right side of the equation represents the uses of that income: consumption ($C_t$), investment in physical capital ($I_t$), lump sum taxes ($\Gamma_t$), investment abroad (the trade balance) ($TB_t$) and two special components: a cost of adjusting capital, $\Phi(K_t - K_{t-1})$, and a cost of adjusting foreign assets ($\Theta(D_t - D_o)$). $K_t$ and $D_t$ are the capital stock and the foreign debt at the end of period $t$ (the beginning of period $t+1$), and $\Phi(.)$ and $\Theta(.)$ are concave cost functions. Eq. (3) represents the evolution of foreign debt, where $R^f_{t-1}$ is the world (gross) interest rate at period $t$, which

[6] This function was first proposed by Greenwood et al. (1988).

[7] Their research covers the period 1993 to 2007.

[8] For example: Canada, Portugal, Finland, Norway, Portugal and Belgium. In these countries the volatility of investments is more than 3 times the volatility of consumption.

[9] In fact, even for these countries, if we look at a longer period then that used by Jahan-Parvar et al. (2013) we see a much more regular behavior of the business cycle moments.

[10] See Jahan-Parvar et al. (2013) and the references there.

[11] Additional technical aspects are included in a technical appendix which can be provided upon request.

[12] In the specification of the model we follow Schmitt-Grohe and Uribe (2003). The assumption of large identical infinitely lived households is made to simplify the model without losing its ability to capture the relevant empirical regularities of the economy.