Sports and (real) business cycles

M. Alper Çenesiz\textsuperscript{a} and Christian Pierdzioch\textsuperscript{b,*}
\textsuperscript{a}CEF.UP, Faculdade de Economia, Universidade do Porto, 4200-464 Porto, Portugal
\textsuperscript{b}Department of Economics, Helmut Schmidt University, 22043 Hamburg, Germany

We extend a basic real business cycle model to incorporate households doing sports. Households decide on spending time at the workplace and spending time on doing sports. Sports acts as an investment in health and, thereby, affects total factor productivity. We study the implications of sports for the propagation of technology shocks and for the volatility and persistence of output at business cycle frequencies.

Keywords: sports; business cycles; technology shocks; output volatility; persistence

JEL Classification: E32; I10; J22

I. Introduction

We study the implications of sports for business-cycle fluctuations using a basic real business cycle model in which households choose between spending time at the workplace and spending time on doing sports. Households not only receive a flow of utility from doing sports, but doing sports also acts as an investment in health. Doing sports, thereby, affects total factor productivity (TFP) and changes the propagation of technology shocks, affecting the volatility and persistence of business-cycle fluctuations.

Results of empirical research document the non-negligible macroeconomic effects of sports-related activities. Accounting for direct and indirect effects of sports-related economic activities, Dimitrov \textit{et al.} (2006) estimate that in EU-15 countries in 2003 sports-related activities accounted for 14.3 million jobs, a purchasing power of €373 billion and an economic value-added of €389 billion. Other researchers have studied empirically the macroeconomic effects of sports mega-events like the Olympic games. See Rose and Spiegel (2011), among others.

As in macroeconomic research on home production, we model sports as a home-production activity

\textsuperscript{*}Corresponding author. E-mail: c.pierdzioch@hsu-hh.de

\textsuperscript{1}Sports-related activities in a broader sense include, for example, maintaining sports facilities, sports-related services, production and merchandising of sporting goods, sports media, sports-related tourism, etc.

\textsuperscript{2}Other researchers have studied empirically the macroeconomic effects of sports mega-events like the Olympic games. See Rose and Spiegel (2011), among others.

\textsuperscript{3}For classic contributions to this research, see Benhabib \textit{et al.} (1991) and Greenwood and Hercowitz (1991).
that contributes to household health, where health affects TFP. As in the household production model developed by Fisher (2007), we assume that household health is a complement to business capital and labour in market production. In analogy to Fisher’s ‘household capital complementarity hypothesis’, the mechanism at work in our model can be described in terms of a ‘sports-health capital complementarity hypothesis’.

Results of empirical research suggest that health is countercyclical. Ruhm (2000) finds for US data that changes in total mortality are procyclical, that is, stronger economic conditions tend to increase mortality at business-cycle frequencies. He further finds that a stronger economy leads to increases in smoking and obesity and less physical activity, where the effects of stronger economic conditions on health seem to persist over time (Ruhm, 2003). Our model is consistent with this empirical evidence as it implies countercyclical dynamics of sports and health.

II. The Model

An infinitely-lived rational representative household maximizes expected lifetime utility given by

\[ E_t \left[ \sum_{i=0}^{\infty} \beta^i (\log c_{t+i} + \gamma \log s_{t+i}) \right], \]

(1)

where \( 0 < \beta < 1 \) denotes the discount factor, \( \gamma > 0 \) denotes the relative weight of sports in the utility, \( E_t \) denotes the conditional-expectations operator, \( c_t \) denotes consumption and \( s_t \) denotes the fraction of time spent on doing sports. We abstract from other leisure-time activities, and we normalize total time net of other leisure-time activities to unity. The household maximizes lifetime utility subject to

\[ c_t + i_t \leq w_t n_t + r_t k_t, \]

(2)

where \( i_t \) denotes investment, \( w_t \) denotes the wage, \( n_t = 1 - s_t \) denotes hours worked, \( r_t \) denotes the rental rate on capital and \( k_t \) denotes the capital stock. Consumption and investment goods are perfect substitutes. The dynamics of capital are given by

\[ k_{t+1} = i_t + (1 - \delta_k) k_t, \]

(3)

where \( 0 < \delta_k < 1 \) is the rate of depreciation of capital.

An implicit assumption underlying Equation 2 is that the household does not need to buy specific sports equipment for doing sports, and that the household is not a member of a sports club and, thus, does not pay any member fees for doing sports. We, thus, focus on the economic effects of sports like walking and running that are time consuming but do not require the consumption of specific sports equipment.\(^5\)

Doing sports affects household health, which is the first channel through which sports affects business-cycle fluctuations in our model. Specifically, we assume that the dynamics of household health are given by

\[ h_t = s_t + (1 - \delta_h) h_{t-1}, \]

(4)

where \( 0 < \delta_h < 1 \) is the rate of depreciation of household health. According to Equation 4, household health gradually deteriorates if the household does not do any sports.\(^6\) Sports, thus, can be viewed as a home-production activity. It is different from the typical home-production good though because the dual nature of sports implies that it yields a flow of utility and, at the same time, is an investment in household health. As a result, sports as a home-production activity produces endogenous persistence because doing sports affects current and future household health. The relative strengths of the effect on current and future household health depend upon the magnitude of the depreciation rate, \( \delta_h \), of household health.

A second channel through which sports affects business-cycle fluctuations is through the household’s optimal choice between consumption and sports:

\(^4\)The functional form of the utility is standard in the real business cycle literature. For a classic study, see Long, Jr. and Plosser (1983) or Hansen (1985).

\(^5\)We could include sports equipment in the model if \( c_t \) is interpreted as a basket of goods defined over conventional consumption goods and sports equipment. As long as the model does not feature a separate sports-business sector, modelling such a basket of goods would only add a further decision variable to the model without affecting its basic properties.

\(^6\)Eber (2003) suggests a quadratic function to model the contemporaneous link between household health and sports in order to capture the idea that this link may turn negative if sports exceeds a critical threshold. For recent research on the link between sports and health, see Schnohr et al. (2003) and Blair et al. (2004), among others.
See, for example, Hansen (1985), who employs similar values.

The optimal choice of consumption is governed by a standard Euler equation:

$$\frac{y_t}{s_t} = \frac{w_t}{c_t}$$

Equation 2 is based on the assumption that households own firms. Firms act in competitive goods and labour markets. The production function is given by

$$y_t = \tilde{A}_t k_t^\alpha n_t^{1-\alpha},$$

where $0 < 1 - \alpha < 1$ denotes the labour share of output. The term $\tilde{A}_t$ denotes TFP, which is assumed exogenous to firms to keep the model as close as possible to the standard real business cycle model. The first-order optimality conditions for firms are

$$\alpha \frac{y_t}{k_t} = r_t,$$

$$\delta \frac{y_t}{n_t} = w_t.$$

TFP consists of two components:

$$\tilde{A}_t = A_t \left( \frac{h_t}{n_t} \right)^\zeta$$

where $\zeta > 0$ denotes the elasticity of TFP with respect to household health. The first component, $A_t$, denotes a technology shift variable that stochastically fluctuates according to an autoregressive process of order 1:

$$\log A_{t+1} = \rho \log A_t + \epsilon_{t+1}$$

We then vary the sports-related parameters, $\gamma$, $\zeta$ and $\delta_h$, to study how sports affects business-cycle fluctuations.

Figure 1 shows the impulse response functions for our model (solid lines) and for a standard real business cycle model (dashed lines). A positive technology shock increases output. Because the demand for capital and labour increases, the interest rate and the wage and, thus, investment and hours worked increase. Because the household works more hours, the time available for sports decreases. Households do less sports and household health decreases. The countercyclical dynamics of household health lower TFP and dampen the effect of a technology shock on output, while the persistence of household health implies that the effect of a technology shock on output gets more persistent.

Figure 2 summarizes the implications of our model for the volatility, $\sigma(y)$, and persistence, $\rho(\gamma, y_{t-1})$, of output. We measure volatility in terms of the SD and persistence in terms of the coefficient of first-order autocorrelation. In the upper row of the figure, we plot the volatility and persistence of output as a function of $\zeta$, which measures the elasticity of TFP with respect to household health, and $\gamma$, which measures the relative weight of the intratemporal allocation of time between work and sports changes household health which, in turn, alters TFP. Because a positive technology shock raises the opportunity costs of doing sports, such a shock leads to lower health, mitigating the effect of the shock on output. At the same time, the persistence of fluctuations in household health transmits onto the persistence of TFP.

Equations 3–11 along with the aggregate resource constraint, $c_t + i_t = y_t$, and the time constraint, $l = n_t + s_t$, determine the recursive competitive equilibrium values of $\{c_t, i_t, s_t, y_t, k_{t+1}, h_t, r_t, n_t, w_t, A_t, A_t\}$. We compute the recursive competitive equilibrium by loglinearizing the model around its nonstochastic steady state.

### III. Simulation Results

In order to simulate our model, we assume $\beta = 0.99$, $\delta_k = 0.024$, $\alpha = 0.36$, $\sigma = 0.72\%$ and $\rho = 0.95$.  

The real business cycle model obtains for $\zeta = 0$. In order to make the results comparable across models, we set TFP in the nonstochastic steady state of the basic real business cycle model equal to the value of TFP in our model.
sports in utility. A larger value of ζ implies a stronger effect of health on productivity. A larger value of γ implies that the household prefers doing more sports. In the lower row, we plot the volatility and persistence of output as a function of both the depreciation rate, δₜ, of health and γ. Several results emerge.

A larger value of the elasticity of TFP with respect to household health lowers output volatility. As this elasticity increases, the impact of health on TFP gets larger. Because health is countercyclical, a larger value of the elasticity of TFP with respect to household health dampens the overall effect of a technology shock on output.
The elasticity parameter, $\zeta$, plays a key role for the effect of the $\gamma$ on output volatility. If the elasticity parameter is small (large), output volatility increases (decreases) in $\gamma$. An increase in $\gamma$ reduces the steady-state value of hours worked and, thus, amplifies the fluctuations of hours worked relative to its steady-state value. This effect leads to an increase in output volatility. If, however, the elasticity of TFP with respect to household health gets larger, the impact of fluctuations in hours worked on output relative to fluctuations in health gets less important, lowering output volatility. It, thus, remains an empirical question how output volatility changes as households spent more time on doing sports in the nonstochastic steady state.

Increasing the elasticity of TFP with respect to household health lowers the persistence of output. A larger value of the elasticity parameter, $\zeta$, dampens the response of output to a technology shock and implies that output returns quickly to its steady-state value. As a result, persistence decreases. A larger value of $\gamma$, in turn, increases persistence as the elasticity parameter, $\zeta$, also increases because the relative contribution of fluctuations in health to fluctuations in output increases, leading to an increase in the amplitude of output fluctuations.

As the depreciation rate, $\delta_h$, of household health increases, output volatility decreases. For small values of the depreciation rate, the dynamics of household health are mainly determined by past household health, implying that a variation in sports has a small impact on household health. Accordingly, household health shows rather smooth dynamics, implying that a technology shock strongly transmits onto output. As a result, output volatility is relatively large. As the depreciation rate of health increases, the effect of current sports on health becomes stronger and household health shows a stronger countercyclical variation. Output volatility, thus, decreases as the depreciation rate of household health increases.

Output persistence is a nonlinear function of the depreciation rate, $\delta_h$, of household health. When the depreciation rate is small, household health shows rather smooth dynamics. Its countercyclical effect on output is small. Hence, on impact, output exhibits a relatively strong jump in the wake of a technology shock, though it also dies out faster. As the depreciation rate increases, household health shows strong countercyclical dynamics and the impact effect of a technology shock on output gets weaker. At the same time, a larger depreciation rate leverages the dynamics of household health due to variations in sports. It, thus, takes longer for household health to revert to its steady-state value, and this persistence transmits onto the persistence of output.

IV. Concluding Remarks

Our simple model should be interpreted as a first step to develop a deeper understanding of the link between sports and business cycle dynamics. While our simple model renders it possible to study some fundamental channels through which sports may affect business cycle dynamics, a natural next step is to extend the model to incorporate other features that are standard in the business-cycle literature. For example, time-to-build considerations can be used to model time lags between sports and household health. Moreover, sports is not the only leisure-time activity of households, implying that the model should be extended to model how households allocate their leisure time between sports and other activities. Finally, it would be interesting to add to our model a sports-business sector and to inspect the cyclical dynamics of its output.

Acknowledgements

Part of this article was written while Alper Çenesiz visited the Helmut Schmidt University (HSU). The hospitality of the HSU is gratefully acknowledged. The authors declare no conflict of interest.

Funding

Alper Çenesiz gratefully acknowledges the financial support by Portuguese Public Funds through FCT (Fundaçô para a Ciência e a Tecnologia) in the framework of the project PEst-OE/EGE/UI4105/2014.

References


