CIRPÉE
Centre interuniversitaire sur le risque, les politiques économiques et l'emploi

Cahier de recherche/Working Paper **06-32**

Fiscal Policies, External Deficits, and Budget Deficits

Michel Normandin

Septembre/September 2006

Normandin: Department of Economics and CIRPÉE, HEC Montréal, 3000 Chemin de la Côte-Ste-Catherine, Montréal, Québec, Canada H3T 2A7 / Phone number: (514) 340-6841 / Fax: (514) 340-6469
michel.normandin@hec.ca

I thank Mohammed Bouaddi for research assistance. I acknowledge financial support from Social Sciences and Humanities Research Council of Canada.

Abstract:
This paper studies the effects of fiscal policies on external and budget deficits. From a tractable small open-economy, overlapping-generation model, the effects are measured by the responses of the external deficit to an increase in the budget deficit due to a tax-cut. The responses are positively affected by the birth rate and the degree of persistence of the budget deficit. Empirical results for the G7 countries over the post-1975 period reveal that the values of birth rate are small for all, but one, countries ; but the responses of external and budget deficits are substantial and persistent for most countries. In particular, the fiscal policy has the most important effects on the external deficits for Canada, Japan, and the United States ; somewhat smaller impacts for France, Germany, and the United Kingdom ; and negligible effects for Italy.

Keywords: Agents' Superior Information, Birth Rate, Impact and Dynamic Responses, G7 Countries, Orthogonality Restrictions

JEL Classification: E62, F32, F41

1. Introduction

This paper studies the effects of fiscal policies on external and budget deficits. More precisely, our analysis assesses the implications of reducing taxes. Conceptually, a tax-cut clearly leads to an increase of the budget deficit, but has ambiguous effects on the external deficit. For example, this fiscal policy augments the external deficit, as long as there is an increase of consumption (of imported goods) induced by the increase of private after-tax incomes. However, the policy does not alter the external deficit, if private spendings are not affected by changes of means to finance public expenditures.

This controversy has motivated many empirical investigations. Some of these studies have estimated the influence of fiscal policies on external and budet deficits from reduced forms (Bernheim 1987; Roubini 1988; Anderson 1990; Evans 1990). The other analyses have tested the hypothesis that the means of financing public expenditures are neutral, from structural consumption models (Johnson 1986; Katsaitis 1987; Evans 1988; Leiderman and Razin 1988; Enders and Lee 1990; Haug 1990; Evans 1993; Evans and Hasan 1994) and current account specifications (Ahmed 1986, 1987; Hercowitz 1986; Sheffrin and Woo 1990; Otto 1992; Chen and Haug 1993; Ghosh 1995).

Unfortunately, these studies are plagued by severe problems. In particular, estimating reduced forms only allows one to verify the significance of the correlations between variables; it does not reveal the importance of the causal impacts of fiscal policies on the external deficit. Moreover, refuting the neutrality hypothesis from structural equations only implies that governments have the ability to affect the external deficit by changing the timing of taxes; it does not provide information on

the importance of the effects of such a policy.

Recently, Normandin (1999) improves on earlier work by directly gauging the causal effects of fiscal policies on external and budget deficits. From a tractable small open-economy version of Blanchard (1985) overlapping-generation model, these effects are measured by the responses of the external deficit to an increase in the budget deficit due to a tax-cut. These responses increase as the birth rate increases. This occurs because a rise of the birth rate implies that the tax burden can be more easily shifted to future generations, so that current private consumption and external deficit augment. In addition, the responses increase as the persistence of the budget deficit increases. This arises because the persistence implies that an augmentation of the contemporaneous budget deficit signals future rises of this variable, and thus future tax reductions, so that these 'sunny days' lead to an increase of current consumption and external deficit.

This paper extends Normandin (1999) analysis in two crucial dimensions. First, the analysis is enlarged by studying the G7 countries. As a group, these countries account for 55 percent of the overall 1990 real gross domestic product of the 116 countries for which the data are available in the Penn World Tables (Mark 5.6a). This suggests that the inclusion of these countries is important to have a broad international perspective of the effects of fiscal policies on external and budget deficits. This constrasts with Normandin (1999) who considers exclusively Canada and the United States, which account for only 25 percent of the overall economic activity.

Second, the influences of fiscal policies are evaluated from both impact and dynamic responses. The impact responses give information on the instantaneous

effects of a tax-cut. The dynamic responses document the delayed effects of such a policy. Thus, the joint analysis of impact and dynamic responses offers the considerable advantage of providing a complete assessment of the effects of fiscal policies on external and budget deficits through time. This constrasts with Normandin (1999) who focuses only on the impact responses.

Our analysis is performed on quarterly series for the G7 countries over the post-1975 period. Unit root tests reveal that the current account, budget deficit, net output, and nonhuman wealth are first-order integrated time series for almost all countries. Furthermore, cointegration tests indicate that there exists a single cointegration relation between the current account, the budget deficit, and the nonhuman wealth for most countries. It can be shown that these time-series properties provide empirical supports for the tractable small open-economy, overlapping-generation model, as long as the birth rate is strictly positive.

Combining the model with the notion of agents' superior information (relative to the econometrician) allows one to derive testable orthogonality restrictions. Furthermore, these restrictions are exploited to estimate the birth rate. Interestingly, the estimates confirm that the birth rate is always strictly positive. This implies that the neutrality hypothesis is rejected, so that fiscal policies alter the external deficit. Yet, the estimates reveal that the birth rate is numerically small. For example, the values of birth rate can be as low as 0.1 percent (per quarter) for all, but one, countries. This suggests that a tax-cut as only negligible effects on external deficit, unless the budget deficit exhibits a great degree of persistence. This is because the impact and dynamic responses of external deficit correspond to the value of the birth rate, in the absence of persistence.

Finally, combining the model with agents' superior information enables one to derive restricted vectors autoregressions. These processes capture the persistence of budget deficit, and are evaluated at the relevant values of birth rate to estimate the impact and dynamic responses of external and budget deficits following a tax-cut. Interestingly, these responses reveal that the budget deficit is persistently affected by the fiscal policy for all countries. Moreover, the responses indicate that the external deficit substantially and persistently increases for most countries. In particular, these responses often exceed the values of birth rate, to reach 1.36 currency units (e.g. dollars) at impact and 1.08 currency units after 20 quarters following a one-unit-currency tax-cut. Overall, the fiscal policy has the most important effects on the external deficits for Canada, Japan, and the United States; somewhat smaller impacts for France, Germany, and the United Kingdom; and negligible effects for Italy.

This paper is organized as follows. Section 2 presents the theoretical economic environment. Section 3 constructs and describes the data. Section 4 estimates the birth rate. Section 5 estimates the effects of fiscal policies on external and budget deficits. Section 6 concludes.

2. Theoretical Economic Environment

Blanchard (1985) overlapping generations model is amended to obtain a tractable small open economic environment. For this purpose, the behavior of individual and aggregate consumptions, the financing of government expenditures, as well as the determination of the current account and external deficit are derived. In contrast to Normandin (1999), the environment is completely described and fully solved.

2.1 Individual Consumption

In period t, each domestic consumer born at time s solves the following problem:

$$\max_{\{C_{s,t+j}\}} -\frac{1}{2}E_t\sum_{j=0}^{\infty}(C_{s,t+j}-\beta_s)^2(1+r)^{-j}(1-p)^j, \tag{1}$$

$$\text{s.t.} \quad (B_{s,t+1}+F_{s,t+1}) = (1+\eta)(B_{s,t}+F_{s,t}+W_{s,t}-T_{s,t}-C_{s,t}). \tag{2}$$

E_t represents the expectation operator conditional on information available in period t, $C_{s,t}$ is consumption, $W_{s,t}$ is a noninsurable stochastic labor income, $T_{s,t}$ is lump-sum taxes, $B_{s,t}$ is the purchases of one period bonds issued by the domestic government, and $F_{s,t}$ is the purchases of foreign one period bonds.

Also, the term $(1+\eta)$ represents the gross return on individual nonhuman wealth. To interpret this return, it is convenient to postulate the existence of insurance firms which make (receive) every period an annuity payment to (from) each consumer holding positive (negative) nonhuman wealth and inherit this wealth at consumer's death. Under the assumption that these firms face a zero-profit condition, Yaari (1965) shows that $(1+\eta) = (1+r)/(1-p)$. Here, $(1+r)$ corresponds to the gross return on one period bonds, while $(1-p)^{-1}$ is the gross annuity rate.

In addition, β_s is a bliss point, $(1-p)$ is the probability of being alive next period, and p is the birth rate. When $p = 0$, the domestic economy is described by an infinitely-lived representative consumer model. When $p = 1$, the domestic environment is represented by a sequence of static economies, i.e. each cohort is fully replaced in the subsequent period by a different cohort. The parameter p can also be interpreted as a measure of the imperfectness of intergenerational linkages.

More precisely, domestic consumers are altruistic only when p is smaller than the actual domestic birth rate.

Equation (1) describes the preferences of the domestic consumer. These preferences are characterized by a quadratic period utility function. This specification allows one to simplify the exposition. Equation (2) corresponds to the budget constraint. This constraint involves a constant gross return. Again, this permits one to simplify the presentation. The consumer maximizes its utility subject to its budget constraint by choosing a path of expected consumption. The optimal path is given by the Euler equation:

$$E_t C_{s,t+j} = C_{s,t}. \tag{3}$$

This expression stipulates that the temporal trajectory of expected consumption is flat, i.e. consumption is a martingale. Also, the Euler equation (3) and the budget constraint (2) yield the individual consumption function:

$$C_{s,t} = \frac{\eta}{1+\eta}\Big[(B_{s,t} + F_{s,t}) + E_t \sum_{j=0}^{\infty}(W_{s,t+j} - T_{s,t+j})(1+\eta)^{-j}\Big]. \tag{4}$$

The function (4) is static for a sequence of static economies [$p = 1$, so that $(1+\eta) \to \infty$]. In contrast, (4) is dynamic when there is an infinitely-lived representative consumer [$p = 0$, so that $(1+\eta) = (1+r)$].

2.2 Aggregate Consumption

An aggregate variable is defined as $X_t = \sum_{s=-\infty}^{t} P_{s,t} X_{s,t}$. Here, $P_{s,t} = p(1-p)^{(t-s)}$ is the size in period t of the cohort born at time s, p is the number of individuals born each period (i.e. $P_{s,s} = p$), and $P = 1$ is the (normalized) total

population. Following Gali (1990), the aggregation is performed by postulating that individual labor income and taxes are the same for all consumers. That is, $W_{s,t+j} = W_{t+j}$ and $T_{s,t+j} = T_{t+j}$, so that the aggregate labor income and taxes are $W_{t+j} = \sum_{s=-\infty}^{t} P_{s,t} W_{s,t+j}$ and $T_{t+j} = \sum_{s=-\infty}^{t} P_{s,t} T_{s,t+j}$. As in Obstfeld and Rogoff (1995, section 3), it is further assumed that domestic firms do not face capital installation costs and satisfy a zero-profit condition. In this case, aggregate labor income corresponds to the difference between aggregate output and aggregate investment expenditures; that is, $W_t = (Y_t - I_t)$.

Using these notions and the individual consumption function (4) yields the following aggregate consumption function:

$$\begin{aligned} C_t &= \sum_{s=-\infty}^{t} P_{s,t} C_{s,t}, \\ &= \frac{\eta}{1+\eta} \sum_{s=-\infty}^{t} P_{s,t} \Big[(B_{s,t} + F_{s,t}) + E_t \sum_{j=0}^{\infty} (W_{s,t+j} - T_{s,t+j})(1+\eta)^{-j} \Big], \\ &= \frac{\eta}{1+\eta} \Big[(B_t + F_t) + E_t \sum_{j=0}^{\infty} (W_{t+j} - T_{t+j})(1+\eta)^{-j} \Big], \\ &= \frac{\eta}{1+\eta} \Big[(B_t + F_t) + E_t \sum_{j=0}^{\infty} (Y_{t+j} - I_{t+j} - T_{t+j})(1+\eta)^{-j} \Big], \end{aligned} \tag{5}$$

where C_t is the aggregate consumption and $(B_t + F_t)$ is the aggregate nonhuman wealth. The function (5) is static when $p = 1$ [i.e. $(1+\eta) \to \infty$] and dynamic when $p = 0$ [i.e. $(1+\eta) = (1+r)$].

Moreover, using the notion that each consumer has zero nonhuman wealth at birth [i.e. $(B_{t+1,t+1} + F_{t+1,t+1}) = 0$] and the individual budget constraint (2) yields the following aggregate intertemporal budget constraint:

$$
\begin{aligned}
(B_{t+1} + F_{t+1}) &= \sum_{s=-\infty}^{t+1} P_{s,t+1}(B_{s,t+1} + F_{s,t+1}), \\
&= (1-p) \sum_{s=-\infty}^{t} P_{s,t}(B_{s,t+1} + F_{s,t+1}), \\
&= (1-p)(1+\eta) \sum_{s=-\infty}^{t} P_{s,t}(B_{s,t} + F_{s,t} + W_{s,t} - T_{s,t} - C_{s,t}), \\
&= (1+r)(B_t + F_t + W_t - T_t - C_t), \\
&= (1+r)(B_t + F_t + Y_t - I_t - T_t - C_t). \qquad (6)
\end{aligned}
$$

Equation (6) reflects the idea that, in aggregate, the gross return on nonhuman wealth is $(1+r)$, rather than $(1+\eta)$. This is because the annuity payments represent pure transfers among consumers.

2.3 Financing of Government Expenditures

The public sector of the domestic country faces the following intertemporal budget constraint:

$$
\begin{aligned}
(B_{t+1} + B^*_{t+1}) &= (1+r)(B_t + B^*_t + G_t - T_t), \qquad (7) \\
&= (B_t + B^*_t) + (1+r)D_t. \qquad (8)
\end{aligned}
$$

The variable B^*_t is the value of foreign purchases of one period domestic bonds, G_t represents the domestic government stochastic expenditures on goods and services, and $D_t = \frac{r}{1+r}(B_t + B^*_t) + G_t - T_t$ corresponds to the definition of the budget deficit (which includes the service of the debt).

In this context, future aggregate taxes are obtained by applying recursive substitutions on (8):

$$\begin{aligned} T_{t+j} &= \frac{r}{1+r}(B_{t+j} + B^*_{t+j}) + G_{t+j} - D_{t+j}, \\ &= \frac{r}{1+r}\Big[(B_t + B^*_t) + (1+r)\sum_{k=0}^{j-1} D_{t+k}\Big] + G_{t+j} - D_{t+j}, \end{aligned} \tag{9}$$

where $j \geq 1$. Furthermore, the present value of aggregate taxes is given by:

$$\begin{aligned} &\sum_{j=0}^{\infty} T_{t+j}(1+\eta)^j = \frac{r}{1+r}(B_t + B^*_t)\sum_{j=0}^{\infty}(1+\eta)^{-j} \\ &+ \sum_{j=0}^{\infty}(G_{t+j} - D_{t+j})(1+\eta)^{-j} + r\sum_{j=1}^{\infty}(1+\eta)^{-j}\sum_{k=0}^{j-1} D_{t+k}, \\ &= \Big(\frac{r}{1+r}\Big)\Big(\frac{1+\eta}{\eta}\Big)(B_t + B^*_t) + \sum_{j=0}^{\infty}(G_{t+j} - D_{t+j})(1+\eta)^{-j} + r\sum_{j=0}^{\infty} D_{t+j}\sum_{k=j+1}^{\infty}(1+\eta)^{-k}, \\ &= \Big(\frac{r}{1+r}\Big)\Big(\frac{1+\eta}{\eta}\Big)(B_t + B^*_t) + \sum_{j=0}^{\infty}\Big(G_{t+j} + \Big(\frac{r-\eta}{\eta}\Big)D_{t+j}\Big)(1+\eta)^{-j}. \end{aligned} \tag{10}$$

Substituting expression (10) in (5) allows one to rewrite the aggregate consumption function as:

$$\begin{aligned} C_t &= \frac{\eta}{1+\eta}(B_t + F_t) - \frac{r}{1+r}(B_t + B^*_t) + \frac{\eta}{1+\eta}E_t\sum_{j=0}^{\infty}\Big(Q_{t+j} + \Big(\frac{\eta-r}{\eta}\Big)D_{t+j}\Big)(1+\eta)^{-j}, \\ &= \left[\frac{\eta}{1+\eta}(B_t + F_t) - \frac{r}{1+r}(B_t + B^*_t)\right] \\ &+ \left[Q_t + \Big(\frac{\eta-r}{\eta}\Big)D_t\right] - \left[-E_t\sum_{j=1}^{\infty}\Big(\Delta Q_{t+j} + \Big(\frac{\eta-r}{\eta}\Big)\Delta D_{t+j}\Big)(1+\eta)^{-j}\right], \end{aligned} \tag{11}$$

where Δ is the first difference operator, $D_{t+j} = \left(\sum_{k=1}^{j} \Delta D_{t+k} + D_t\right)$, $Q_{t+j} = \left(\sum_{k=1}^{j} \Delta Q_{t+k} + Q_t\right)$, $Q_t = (Y_t - I_t - G_t)$ is the aggregate net output, and $[Q_t + ((\eta - r)/\eta)D_t]$ is the aggregate cash flow. The function (11) states that aggregate consumption is equal to the sum of the aggregate nonhuman income (the first set of brackets) and aggregate cash flow (the second set of brackets), minus the aggregate saving (the third set of brackets). Here, the aggregate saving corresponds to expected future declines in aggregate cash flows. In addition, the measure of cash flow involves the term $((\eta - r)/\eta)$, which is the probability that consumers currently alive will not have to pay the future increases in taxes required to reimburse the contemporanous budget deficit. As before, the function (11) is static for a sequence of static economies [$p = 0$, so that $(1 + \eta) \to \infty$]. In addition, the tax burden is completely shifted to future generations [i.e. $((\eta - r)/\eta) \to 1$]. In contrast, (11) is dynamic when there is an infinitely-lived representative consumer [$p = 0$, so that $(1 + \eta) = (1 + r)$]. In this case, the consumer reimburses entirely the budget deficit [i.e. $((\eta - r)/\eta) = 0$].

Finally, substituting expression (9) in (6) permits one to rewrite the aggregate intertemporal budget constraint as:

$$(B_{t+1} + F_{t+1}) = (1 + r)(B_t + F_t + Q_t + D_t - C_t) - r(B_t + B_t^*). \qquad (12)$$

2.4 Current Account and External Deficit

The external deficit is measured as the negative of the current account. For the domestic economy just described, the current account is defined as:

$$Z_t = [(F_{t+1} - F_t) - (B^*_{t+1} - B^*_t)]/(1+r). \tag{13}$$

Equation (13) corresponds to changes in net foreign asset positions. Also, substituting the aggregate intertemporal budget constraints (6) and (7) in (13) enables one to rewrite the current account as:

$$Z_t = \frac{r}{1+r}(F_t - B^*_t) + Q_t - C_t, \tag{14}$$

where $\frac{r}{1+r}(F_t - B^*_t)$ is the net income on foreign assets. Expression (14) corresponds to the portion of national ressources that is not absorbed by domestic agents.

Moreover, substituting the aggregate consumption function (11) in (14) and (12) yields:

$$\begin{aligned} Z_t = &-\frac{p}{1+r}(B_t + F_t) - \Big(\frac{\eta - r}{\eta}\Big)D_t \\ &- \left[E_t \sum_{j=1}^{\infty}\Big(\Delta Q_{t+j} + \Big(\frac{\eta - r}{\eta}\Big)\Delta D_{t+j}\Big)(1+\eta)^{-j}\right], \end{aligned} \tag{15}$$

and

$$\begin{aligned} (B_{t+1} + F_{t+1}) = &(1-p)(B_t + F_t) + (1+r)\Big(1 - \Big(\frac{\eta - r}{\eta}\Big)\Big)D_t \\ &- (1+r)\left[E_t \sum_{j=1}^{\infty}\Big(\Delta Q_{t+j} + \Big(\frac{\eta - r}{\eta}\Big)\Delta D_{t+j}\Big)(1+\eta)^{-j}\right]. \end{aligned} \tag{16}$$

Expressions (15) and (16) are the rules for the current account and nonhuman wealth. Again, these rules are static for a sequence of static economies [$p = 1$,

so that $((\eta - r)/\eta) \rightarrow 1$ and $(1 + \eta) \rightarrow \infty]$. In this case, a one-currency-unit (e.g. one-dollar) tax-cut does not alter future nonhuman wealth, but implies a one-currency-unit decrease in the contemporanous current account. Consequently, this fiscal policy affects both the external and budget deficits. In contrast, the rules are dynamic when there is an infinitely-lived representative consumer [$p = 0$, so that $((\eta - r)/\eta) = 0$ and $(1 + \eta) = (1 + r)$]. In addition, a one-currency-unit tax-cut leads to a $(1 + r)$-currency-unit increase in future nonhuman wealth, but does not alter the current account. Thus, the fiscal policy only affects the budget deficit.

Finally, the rules (15) and (16) are rearranged as:

$$\hat{Z}_t \equiv Z_t + \frac{p}{1+r}(F_t + B_t) + \Big(\frac{\eta - r}{\eta}\Big) D_t, \tag{17}$$

$$= -E_t \sum_{j=1}^{\infty} \Big(\Delta Q_{t+j} + \Big(\frac{\eta - r}{\eta}\Big) \Delta D_{t+j} \Big) (1+\eta)^{-j}, \tag{18}$$

and

$$(\widehat{B_{t+1} + F_{t+1}}) \equiv (B_{t+1} + F_{t+1}) - (1-p)(B_t + F_t) - (1+r)\Big(1 - \Big(\frac{\eta - r}{\eta}\Big)\Big) D_t, \tag{19}$$

$$= -(1+r) E_t \sum_{j=1}^{\infty} \Big(\Delta Q_{t+j} + \Big(\frac{\eta - r}{\eta}\Big) \Delta D_{t+j} \Big) (1+\eta)^{-j}. \tag{20}$$

Equations (17) and (19) define the adjusted current account, $\hat{Z}_t$, and the adjusted aggregate nonhuman wealth, $(\widehat{B_{t+1} + F_{t+1}})$. Expressions (18) and (20) are the rules for the adjusted variables. When $p < 1$, these rules are purely forward-looking since the adjusted variables are exclusively related to expected changes in future stochastic forcing variables. When $p = 0$, the single forcing variable corresponds to

the aggregate net output. When $0 < p < 1$, the forcing variables also include the budget deficit. Equations (17) and (18) will be central to our analysis of the effects of fiscal policies on external and budget deficits.

3. Data

The quarterly seasonally adjusted measures are constructed for the G7 countries over the post-1975 period. As a group, these countries account for 55 percent of the overall 1990 real gross domestic product of the 116 countries for which the data are available in the Penn World Tables (Mark 5.6a). In contrast, Normandin (1999) considers exclusively Canada and the United States to account for only 25 percent of the overall economic activity.

3.1 Construction of the Data

The individual countries (samples) are Canada (1975-I to 2001-III), France (1975-I to 1998-IV), Germany (1975-I to 1998-IV), Italy (1975-I to 1998-IV), Japan (1977-I to 2001-III), the United Kingdom (1975-I to 1999-IV), and the United States (1975-I to 2001-III). Germany refers to West Germany and Unified Germany for the pre- and post-1990 periods. The measures are mainly computed from the International Financial Statistics (IFS) released by the International Monetary Funds (IMF), as well as the Main Economic Indicators (MEI) and the Quarterly National Accounts (QNA) published by the Organization for Economic Cooperation and Development (OECD).

Current Account and External Deficit

For each country, the current account (Z_t) is constructed as the product

of the nominal current account in US dollars (source: IFS, IMF) and the nominal exchange rate of national currency units per US dollars (source: IFS, IMF), deflated by the all-item consumer price index (CPI) for the baseyear 1995 (source: MEI, OECD). For each country, the published series of current account are not seasonally adjusted. Thus, the current account is regressed (by OLS) on quarter dummies to remove seasonality. The external deficit is measured as the negative of the current account.

Budget Deficit

With the exception of Japan, the budget deficit (D_t) corresponds to the nominal budget deficit in national currency (source: IFS, IMF), normalized by the CPI. Because these data are not seasonally adjusted, the series are regressed on quarter dummies. For Japan, the budget deficit is the sum of the nominal government final consumption expenditures in national currency (source: QNA, OECD) and the nominal debt service in national currency (source: Japan Statistical Yearbook 2002) less the nominal total tax revenues in national currency (source: Revenue Statistics, OEDC), divided by the CPI. The published data on total tax revenues are annual. For this reason, this series is interpolated by using the Quadratic-Match Average Nonparametric Method available in Eviews.

Net Output

For each country, the net output (Q_t) is the difference between the nominal gross domestic product in national currency (source: QNA, OECD) and the sum of the nominal gross fixed capital formation in national currency (source: QNA, OECD) and the nominal government final consumption expenditures in national currency (source: QNA, OECD), divided by the CPI. The published data for Ger-

many are not seasonally adjusted. Hence, the German series are regressed on quarter dummies.

Nonhuman Wealth

For each country, the nonhuman wealth $(B_t + F_t)$ is constructed as the weighted sum of the debt service and the net income on foreign assets. The weight corresponds to $\left(\frac{1+r}{r}\right)$, with the calibration $r = 0.01$ (per quarter). For each country, the net income on foreign assets $\left[\frac{r}{1+r}(F_t - B_t^*)\right]$ is the nominal factor income in national currency (source: Time Series Query, World Bank), deflated by the CPI. Because the data on net factor income are annual, this series is interpolated by using the Quadratic-Match Average algorithm. For Japan, the debt service $\left[\frac{r}{1+r}(B_t + B_t^*)\right]$ is the nominal debt service in national currency (source: Japan Statistical Yearbook 2002), normalized by the CPI. For the other countries, the debt service is the sum of the nominal budget deficit in national currency (source: IFS, IMF) and the nominal total tax revenues in national currency (source: Revenue Statistics, OEDC) less the nominal government final consumption expenditures in national currency (source: QNA, OECD), divided by the CPI. Again, the series on total tax revenues are interpolated and the data on budget deficit are deseasonalized.

3.2 Description of the Data

Figure 1 displays the time series of current account, budget deficit, net output, and nonhuman wealth for each country. Visual inspection suggests that the current accounts and budget deficits exhibit volatilities which increase through time for most countries. Also, the net outputs and nonhuman wealth feature levels that increase through time for most countries. Overall, these characteristics suggest that

the series are first-order integrated.

Consequently, the tests developped by Dickey and Fuller (1979) [DF] and Phillips and Perron (1988) [PP] are performed to verify the presence of unit roots. In their basic form, these tests rely on a regression of the contemporaneous change of a series on the lagged level of this series. The null hypothesis of unit root cannot be rejected if the t-statistic indicates that the coefficient of the regression is not significantly different from zero. In practice, the regression is enriched by following the procedure outlined by Campbell and Perron (1991). For the DF and PP tests, a constant and a linear trend are also included in the regression if the associated estimates are individually significant at the 10 percent level. For the DF test, lagged changes of the series are further incorporated in the regression, where the relevant number (up to 15) of lags is selected by the Akaike information criterion. For the PP test, a triangular Bartlett window with a truncation parameter corresponding to the integer part of $\left[4 \times \left(\frac{T}{100}\right)^{2/9}\right]$ (where T is the sample size) is used to obtain a heteroscedasticity and autocorrelation consistent covariance matrix of the regression estimates (Newey and West 1987).

Table 1 reports the DF and PP tests for the levels of current account, budget deficit, net output, and nonhuman wealth. Interestingly, the DF and PP tests almost always include the same sets of deterministic components. Also, both the DF and PP tests cannot reject the unit root hypothesis for 19 out of the 28 cases. In addition, either the DF or PP test cannot reject the null hypothesis for four series. Finally, both the DF and PP tests reject the presence of unit root for only five cases. These exceptions are the budget deficits for Germany and the United Kingdom, the net output for Italy, and the nonhuman wealth for Japan and the United Kingdom. Overall, these findings indicate that the unit root hypothesis is

reasonable for almost all series.

Table 2 presents the DF and PP tests for the changes of current account, budget deficit, net output, and nonhuman wealth. Again, the DF and PP tests incorporate the same deterministic terms for most of the cases. Moreover, both the DF and PP tests strongly reject the unit root hypothesis for 27 out of the 28 cases. The exception is that the DF test detects a unit root in the change of nonhuman wealth for Canada, while the PP test does not. In sum, these results confirm that the levels of current account, budget deficit, net output, and nonhuman wealth are generally first-order integrated, so that the changes of these series are stationary.

For completeness, the tests developped by Johansen (1991) are performed to verify the presence of cointegration relations between the levels of the series. In their basic form, these tests rely on a vector error correction model (VECM), where a vector containing the contemporaneous changes of the series is related to a vector including the lagged levels of the series. The appropriate number of cointegration relations is detected from statistics related to the trace [Tr] and the maximum eigenvalue [ME] of the coefficient matrix affecting the vector of the lagged levels of the series. In practice, the VECM is enriched by incorporating a vector of constants and vectors of lagged changes of the series. The relevant number (up to 15) of lags is determined by the Akaike information criterion.

Table 3 reports the Tr and ME tests for the cointegration relations between the levels of current account, budget deficit, and nonhuman wealth. Empirically, both the Tr and ME tests reject the no cointegration hypothesis for five out of the seven countries. In addition, either the Tr or ME test reject the null hypothesis for the other two cases. Finally, the Tr or ME test cannot reject the notion that there

is a single cointegration relation for five countries. The exceptions are the United Kingdom with zero or two cointegration relations, and the United States with three cointegration relations. Overall, these findings indicate that the assumption of a single cointegration relation is reasonable for almost all countries.

To summarize, the test results reveal that the current account, budget deficit, net output, and nonhuman wealth are first-order integrated for almost all countries. Furthermore, there exists only one cointegration relation between the current account, the budget deficit, and the nonhuman wealth for most cases. Interestingly, these results provide an empirical support for our tractable theoretical economic environment, as long as the birth rate is strictly positive. Specifically, the environment predicts that the adjusted current account must be stationary. This is because equation (18) states that $\hat{Z}_t$ is a linear combination of ΔQ_t and ΔD_t, where these changes are always stationary. Moreover, equation (17) implies that $\hat{Z}_t = Z_t$ when $p = 0$, such that the current account should be stationary. However, this property never holds in the data, and as such it refutes the case of a null birth rate. Finally, equation (17) states that $\hat{Z}_t = \left[Z_t + \frac{p}{1+r}(F_t + B_t) + \left(\frac{\eta - r}{\eta}\right) D_t\right]$ when $p > 0$, which implies that their is a single cointegration relation between the current account, the budget deficit, and the nonhuman wealth. This property almost always holds in the data, so that it accords with a strictly positive birth rate.

4. Estimation of the Birth Rate

The birth rate is a key ingredient involved in the defintion (17) and the rule (18) of adjusted current account, which are central to the evaluation of the effects of fiscal policies on external and budget deficits. Here, two estimation methods for the birth rate are elaborated and applied. Both procedures exploit certain

orthogonality restrictions. These restrictions can be derived when agents possess a richer information set than the econometrician. In contrast to Normandin (1999), the agents' superior information is fully detailed.

4.1 Agents' Superior Information

It is most plausible that agents' decisions rely on more information than just the history of forcing variables. In this spirit, the law of motion for forcing variables is specified as:

$$\begin{pmatrix} \Delta Q_t \\ \Delta D_t \\ \Delta H_t \end{pmatrix} = \begin{pmatrix} \pi_{11} & \pi_{12} & \pi_{13} \\ \pi_{21} & \pi_{22} & \pi_{23} \\ \pi_{31} & \pi_{32} & \pi_{33} \end{pmatrix} \begin{pmatrix} \Delta Q_{t-1} \\ \Delta D_{t-1} \\ \Delta H_{t-1} \end{pmatrix} + \begin{pmatrix} \nu_{q,t} \\ \nu_{d,t} \\ \nu_{h,t} \end{pmatrix},$$

or more compactly

$$W_t = \Pi_w W_{t-1} + V_t. \tag{21}$$

This law of motion assumes that the appropriate forcing variables are the net output and budget deficit. This is predicted by our theoretical economic environment when the birth rate is positive (see section 2). This is also consistent with the empirical time-series properties (see section 3).

The law of motion stipulates that the information set incorporates, not only past values of forcing variables, but also lagged values of a hidden variable H_t. This variable can be viewed as a composite of several exogenous variables. In addition, the hidden variable contains relevant extra information to improve forecasts of future forcing variables when it Granger-causes changes of net output or of budget deficit ($\pi_{13} \neq 0$ or $\pi_{23} \neq 0$). Finally, it is assumed that the hidden variable

is observed and used by the economic agents, but is unknown or omitted by the econometrician. This implies that the agents' information set is superior to the econometrician's one.

In practice, the presence of the hidden variable makes it difficult to estimate the law of motion (21). Following Boileau and Normandin (2002, 2003), it is possible to use the rule (18) and the law of motion (21) to extract a law of motion that contains only variables that are observed by the econometrician. This occurs because the rule implies that agents fully reveal their expectations of future forcing variables through there forwarg-looking decisions. Then, an adequate law of motion is obtained by replacing the hidden variable by the adjusted current account. This yields a law of motion that is augmented by agents' superior information.

To derive the augmented law of motion, first the agents' expectations constructed from (21) are substituted in the rule (18) to yield:

$$\hat{Z}_t = \varphi_{zw} W_t, \tag{22}$$

where $\varphi_{zw} = -\left[e_1' + \left(\frac{\eta - r}{\eta}\right) e_2'\right] \Pi_w (1+\eta)^{-1} \left[I - \Pi_w (1+\eta)^{-1}\right]$, I is the identity matrix, $e_1 = (\,1 \quad 0 \quad 0\,)'$, $e_2 = (\,0 \quad 1 \quad 0\,)'$, and $e_3 = (\,0 \quad 0 \quad 1\,)'$. Second, the expression (22) is rewritten as:

$$X_{z,t} = \Upsilon_z W_t, \tag{23}$$

where $X_{z,t} = (\,\Delta Q_t \quad \Delta D_t \quad \hat{Z}_t\,)'$ and $\Upsilon_z = (\,e_1' \quad e_2' \quad \varphi_{zw}\,)'$. Third, substituting (21) in (23) permits one to obtain a vector autoregression (VAR) for the adjusted current account:

$$\begin{pmatrix} \Delta Q_t \\ \Delta D_t \\ \hat{Z}_t \end{pmatrix} = \begin{pmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{pmatrix} \begin{pmatrix} \Delta Q_{t-1} \\ \Delta D_{t-1} \\ \hat{Z}_{t-1} \end{pmatrix} + \begin{pmatrix} u_{q,t} \\ u_{d,t} \\ u_{z,t} \end{pmatrix},$$

or

$$X_{z,t} = \Gamma_z X_{z,t-1} + U_{z,t}, \tag{24}$$

where $\Gamma_z = \Upsilon_z \Pi_w \Upsilon_z^{-1}$ and $U_{z,t} = \Upsilon_z V_t$.

Note that the first two equations of (24) form the law of motion for forcing variables augmented by the adjusted current account. In this augmented law of motion, the feedbacks from lagged adjusted current account to contemporanous forcing variables reflect the effects of the lagged hidden variable on current forcing variables: $\gamma_{13} \neq 0$ and $\gamma_{23} \neq 0$ only if $\pi_{13} \neq 0$ and $\pi_{23} \neq 0$. This means that the existence of agents' superior information can be verified by applying Granger-causality tests on (24), since it exclusively contains variables that are in the econometrician's information set. Also, note that the last equation of (24) states that the innovation of adjusted current account is a function of the innovations of forcing and hidden variables: $u_{z,t} = \varphi_{zw} V_t$. This formulation is in accord with the notion that the adjusted current account completely captures the relevant information.

Given that the augmented law of motion contains all the relevant information, it is useful to estimate the unrestricted version of the VAR (24). In particular, this process allows one to derive a restricted VAR that involves the testable restrictions imposed by our theoretical economic environment. To do so, first the expectations constructed from the unrestricted VAR (24) are substituted in the rule (18) to yield:

$$\hat{Z}_t^m = \Theta_{zx} X_{z,t}, \tag{25}$$

where $\Theta_{zx} = -\big[e_1' + \big(\frac{\eta - r}{\eta}\big)e_2'\big]\Gamma_z(1+\eta)^{-1}\big[I - \Gamma_z(1+\eta)^{-1}\big]^{-1}$ is evaluated from the estimates of Γ_z and calibrated values of the birth rate p and the return r. The superscript m indicates that these variables are predicted by the model. Second, the expression (25) is rewritten as:

$$X_{z,t}^m = \Theta_z X_{z,t}, \tag{26}$$

where $X_{z,t}^m = (\,\Delta Q_t \quad \Delta D_t \quad \hat{Z}_t^m\,)'$ and $\Theta_z = (\,e_1' \quad e_2' \quad \Theta_{zx}\,)'$. Third, substituting (24) in (26) produces the restricted VAR for adjusted current account:

$$\begin{pmatrix} \Delta Q_t \\ \Delta D_t \\ \hat{Z}_t^m \end{pmatrix} = \begin{pmatrix} \phi_{11} & \phi_{12} & \phi_{13} \\ \phi_{21} & \phi_{22} & \phi_{23} \\ \phi_{31} & \phi_{32} & \phi_{33} \end{pmatrix} \begin{pmatrix} \Delta Q_{t-1} \\ \Delta D_{t-1} \\ \hat{Z}_{t-1}^m \end{pmatrix} + \begin{pmatrix} u_{q,t} \\ u_{d,t} \\ u_{z,t}^m \end{pmatrix},$$

or

$$X_{z,t}^m = \Phi_z X_{z,t-1}^m + U_{z,t}^m, \tag{27}$$

where $\Phi_z = \Theta_z \Gamma_z \Theta_z^{-1}$ and $U_{z,t}^m = \Theta_z U_{z,t}$.

For completeness, note that a similar procedure can be applied to obtain the restricted VAR for adjusted nonhuman wealth:

$$X_{(b+f),t}^m = \Phi_{(b+f)} X_{(b+f),t-1}^m + U_{(b+f),t}^m, \tag{28}$$

where $X_{(b+f),t}^m = \big(\,\Delta Q_t \quad \Delta D_t \quad \widehat{(B_{t+1} + F_{t+1})^m}\,\big)'$, $\Phi_{(b+f)} = \Theta_{(b+f)}\Gamma_{(b+f)}\Theta_{(b+f)}^{-1}$, $U_{(b+f),t}^m = \Theta_{(b+f)} U_{(b+f),t}$, $\Gamma_{(b+f)}$ and $U_{(b+f),t}$ are the coefficient matrix and the

innovations of the unrestricted VAR, $\Theta_{(b+f)} = (\, e_1' \quad e_2' \quad \Theta_{(b+f),x}\,)'$, and $\Theta_{(b+f),x} = -(1+r)\big[e_1' + \big(\frac{\eta - r}{\eta}\big)e_2'\big]\Gamma_{(b+f)}(1+\eta)^{-1}\big[I - \Gamma_{(b+f)}(1+\eta)^{-1}\big]^{-1}$.

4.2 Orthogonality Restrictions

Under the null hypothesis that the actual and predicted adjusted current accounts are identical:

$$\hat{Z}_t = \hat{Z}_t^m, \tag{29}$$

certain orthogonality restrictions can be derived. To see this, first the expression (29) is rewritten by invoking the defintion $\hat{Z}_t = e_3' X_{z,t}$ and equation (25):

$$\begin{aligned} e_3' &= \Theta_{zx}, \\ &= -\big[e_1' + \big(\frac{\eta - r}{\eta}\big)e_2'\big]\Gamma_z(1+\eta)^{-1}\big[I - \Gamma_z(1+\eta)^{-1}\big]^{-1}, \end{aligned} \tag{30}$$

or

$$e_3'\big[I - \Gamma_z(1+\eta)^{-1}\big] = -\big[e_1' + \big(\frac{\eta - r}{\eta}\big)e_2'\big]\Gamma_z(1+\eta)^{-1}. \tag{31}$$

The equation (31) imposes the three following linear restrictions: $\gamma_{31} = \gamma_{11} + \big(\frac{\eta - r}{\eta}\big)\gamma_{21}$, $\gamma_{32} = \gamma_{12} + \big(\frac{\eta - r}{\eta}\big)\gamma_{22}$, and $\gamma_{33} = \gamma_{13} + \big(\frac{\eta - r}{\eta}\big)\gamma_{23} + (1+\eta)$.

Second, the variable $\epsilon_{z,t}$ is constructed as the following linear combination:

$$\epsilon_{z,t} = \hat{Z}_t - (1+\eta)\hat{Z}_{t-1} - \Delta Q_t - \big(\frac{\eta - r}{\eta}\big)\Delta D_t. \tag{32}$$

This equation is then rewritten by using the first two equations of the unrestricted VAR (24) and the linear restrictions (31) to express the current variables $\hat{Z}_t$, ΔQ_t, and ΔD_t in (32) exclusively in terms of innovations:

$$\epsilon_{z,t} = u_{z,t} - u_{q,t} - \big(\frac{\eta - r}{\eta}\big) u_{d,t}. \tag{33}$$

The expression (33) reveals that the linear restrictions (31) imply that the variable $\epsilon_{z,t}$ is orthogonal to the information dated before period t. Thus, the conditions (31) reflect the orthogonality restrictions.

Formally, the orthogonality restrictions (31) are jointly tested from a $\chi^2(3)$ distributed Wald test statistic. In practice, this statistic is easy to compute because it is numerically identical to the Wald statistic for the test that all the coefficients associated with the regression of $\epsilon_{z,t}$ on $\hat{Z}_{t-1}$, ΔQ_{t-1}, and ΔD_{t-1} are jointly insignificant.

4.3 Estimates of Birth Rate

The orthogonality restrictions (31) are useful to estimate the birth rate. One set of estimates is obtained by testing the restrictions from the following procedure.

Step 1. The variables $\epsilon_{z,t}$ and $\hat{Z}_t$ are constructed by using equations (32) and (17), the observations for Z_t, D_t, Q_t, and $(B_t + F_t)$, as well as the calibration $r = 0.01$ (per quarter) and a given value of birth rate p.

Step 2. The variable $\epsilon_{z,t}$ is regressed by Ordinary Least Squares (OLS) on the lagged variables $\hat{Z}_{t-1}$, ΔQ_{t-1}, and ΔD_{t-1}. Then, the probability value is calculated for the null hypothesis that the regression estimates are jointly insignificant.

Step 3. Steps 1 and 2 are performed for several values of birth rate, where $0 \leq p \leq 1$.

From this procedure, the relevant estimates of birth rate are the values of p for which the orthogonality restrictions hold. In addition, a second set of estimates of birth rate is directly obtained by applying the Generalized Method of Moments (GMM) for the orthogonality condition between $\epsilon_{z,t}$ and a constant, ΔQ_{t-1}, and ΔD_{t-1}, as well as from the calibrated value $r = 0.01$ (per quarter).

Table 4 reports the GMM estimates, $\hat{p}$, as well as the smallest values, $\underline{p}$, and largest values, $\bar{p}$, for which the orthogonality conditions are not rejected at the 1, 5, and 10 percent levels of significance. Figure 2 compares the probability values of the orthogonality test obtained from various values of birth rate to conventional levels of significance.

Empirically, there exist values of p for which the orthogonality conditions hold at the 10 percent level for several countries. However, exceptions are France, Italy, and Japan. Also, some values of p imply that the linear restrictions (31) are not rejected at the 5 percent level for all countries, except France. Interestingly, there exist values of p for which the orthogonality restrictions are never refuted at the 1 percent level, without any exception. For this reason, our analysis relies on these latter values.

It is worth stressing that the values of $\underline{p}$ and $\bar{p}$ are always larger than zero and smaller than one. Under the interpretation that p is the birth rate, these results suggest that none of the selected country can be described by an infinitely-lived respresentative consumer model, nor by a sequence of static economies where each cohort is totally replaced in the subsequent period. Also, the values of $\underline{p}$ are systematically smaller than the birth rate, $\tilde{p}$, of 0.00525 per quarter (or 2.1 percent

per year). Moreover, the values of $\bar{p}$ are always larger than $\tilde{p}$, except for Italy. Note that $\tilde{p}$ represents a meaningful benchmark: it corresponds to the birth rate required to ensure a constant population.

Under the interpretation that p is a measure of the imperfectness of intergenerational linkages, the findings suggest that some newborns are altruistically linked to their parents as long as the relevant values of p are $\underline{\mathrm{p}}$, since these values are smaller than $\tilde{p}$. More precisely, the proportion of these newborns is given by $(\tilde{p} - \underline{\mathrm{p}})/\tilde{p}$, which is substantial for all countries: it corresponds to 80.95%. In contrast, the proportion is only $(\tilde{p} - \bar{p})/\tilde{p} = 4.76\%$ for Italy and 0% for the other countries, when the relevant values of p are assumed to be $\bar{p}$.

Note that the GMM estimates of p are numerically larger than zero and smaller than one. The estimates are not significantly different from zero for all countries, except for Germany and Japan. This means that most economies can be statistically described by an infinitely-lived respresentative consumer model. However, this conclusion is inconsistent with the time-series properties of the current account (see section 3). For this reason, our analysis assumes that the values of p are positive. Also, the GMM estimates are always significantly different from unity. This indicates that none of the country can be characterized by a sequence of static economies. Moreover, the estimates suggest that the proportions of altruistic newborns, $(\tilde{p}-\hat{p})/\tilde{p}$, are 61.90% for the United Kingdom and the United States, 42.86% for France, 23.81% for Canada and Italy, and 0% for Germany and Japan.

The GMM estimates are also numerically larger than the values of $\underline{\mathrm{p}}$ and smaller than those of $\bar{p}$ for all countries, except for France. In fact, the estimates are never significantly different from the values of $\underline{\mathrm{p}}$, with the exception of Japan.

The estimates are significantly different from the values of $\bar{p}$, except for Germany, Italy, and Japan. In our analysis, the values of $\underline{p}$, $\bar{p}$, and $\hat{p}$ are used to verify the robustness of the results.

For completeness, Table 4 indicates that the overidentication restrictions related to the GMM estimates are never rejected, except for France and Japan. This suggests that the orthogonality restrictions statistically hold for most countries, such that the actual and predicted adjusted current account are similar. Also, Table 5 presents the probability values of the test that $\hat{Z}_t$ does not Granger-cause ΔQ_t and ΔD_t (i.e. $\gamma_{13} = 0$ and $\gamma_{23} = 0$). To perform this test, the series $\hat{Z}_t$ is first constructed from equation (17), the values of $\underline{p}$, $\bar{p}$, and $\hat{p}$, as well as the calibration $r = 0.01$ (per quarter). Then, this series is used in the unrestricted VAR (24), which is estimated by OLS. The test results indicate that there are some feedback effects from the lagged adjusted current account to the contemporaneous net ouput for Germany when $p = \underline{p}$; for Japan when $p = \bar{p}$ and $p = \hat{p}$; for the United Kingdom when $p = \underline{p}$, $p = \bar{p}$, and $p = \hat{p}$; as well as for the United States when $p = \hat{p}$. As explained above, these findings are consistent with the presence of agents' superior information. Finally, the Schwarz information creterion reveals that a first-order unrestricted VAR, as stipulated in (24), is appropriate for almost all cases. Exceptions are France when $p = \hat{p}$ and the United States when $p = \bar{p}$, where in both cases a third-order VAR seems slightly preferable.

5. Estimation of the Effects of Fiscal Policies

The effects of fiscal policies are now evaluated. For this purpose, the impact and dynamic responses of external and budget deficits following a one-currency-unit tax-cut are analyzed. In contrast, Normandin (1999) studies only the impact

responses.

5.1 Construction of the Responses

The effects of fiscal policies on external and budget deficits are documented from impact and dynamic responses. Conceptually, these responses are defined as:

$$R_{a,j} = -\Big(\frac{\partial A_{t+j}}{\partial \epsilon_{\tau,t}}\Big) = \Big(\frac{\partial A_{t+j}}{\partial \epsilon_{d,t}}\Big)\lambda. \tag{34}$$

Here, $R_{a,j}$ represents the impact response when $j = 0$ and dynamic responses if $j > 0$, while A_t is a generic variable. For example, the responses of external and budget deficits are obtained by using the definitions $A_t = -Z_t$ and $A_t = D_t$. Also, $\epsilon_{\tau,t}$ and $\epsilon_{d,t}$ correspond to positive shocks of taxes and of budget deficit, whereas λ is a scale parameter.

Equation (34) captures the responses of the variable A_t to an unexpected tax-cut. In addition, expression (34) states that these effects correspond to the responses of A_t to a positive shock of the budget deficit. To see this, note that $\epsilon_{d,t}$ captures the portion of the innovation of the budget deficit $u_{d,t}$ that is orthogonal to the innovations of net output $u_{q,t}$, where the net output is constructed from the government expenditures on goods and services. This ensures that the responses (34) represent the effects of an increase of the budget deficit that is exclusively due to a tax-cut, rather than to an increase of goverment expenditures. Finally, the parameter λ is chosen to scale to unity the impact response of budget deficit following a budget deficit shock. This eases the interpretation of (34), since it is equivalent an experiment where the tax-cut is normalized to one currency unit.

Conceptually, the effects of fiscal policies are evaluated from our theoretical economic environment. In particular, these effects are derived by exploiting the definitions of adjusted current account (17) and nonhuman wealth (19), the rules of these adjusted variables (18) and (20), and the law of motion for forcing variables (21). Synonymously, the dynamic responses are constructed from the definitions (17) and (19), as well as the restricted VARs (27) and (28). Recall that the validity of the linear combinations involved in these definitions is supported by the results of unit root and cointegration tests (see section 3). Likewise, the relevance of the restricted VARs is confirmed by the test results of the orthogonality restrictions (see section 4). In this sense, assessing the effects of fiscal policies from our theoretical economic environment constitutes a relevant empirical exercise.

The responses of the levels of current account and nonhuman wealth are recovered from the definitions (17) and (19):

$$R_{z,j} = R_{\hat{z},j} - \frac{p}{1+r} R_{(b+f),j} - \frac{\eta - r}{\eta} R_{d,j}, \tag{35}$$

and

$$R_{(b+f),(j+1)} = R_{\widehat{(b+f)},(j+1)} + (1-p) R_{(b+f),j} + (1+r)\Big(1 - \Big(\frac{\eta - r}{\eta}\Big)\Big) R_{d,j}. \tag{36}$$

The responses of external deficit is simply the negative of $R_{z,j}$.

Furthermore, the responses of adjusted current account and nonhuman wealth are obtained from the restricted VARs (27) and (28):

$$R_{\hat{z},j} = \big[e_3' \Phi_z^j \Theta_z \Lambda_z e_2\big] \lambda, \tag{37}$$

and

$$R_{\widehat{(b+f)},j+1} = \left[e_3' \Phi^j_{(b+f)} \Theta_{(b+f)} \Lambda_{(b+f)} e_2\right] \lambda. \tag{38}$$

Here, $\Omega_z = E\left(U^m_{z,t} U^{m\,\prime}_{z,t}\right) = \Lambda_z \Lambda_z'$ and $\Omega_{(b+f)} = E\left(U^m_{(b+f),t} U^{m\,\prime}_{(b+f),t}\right) = \Lambda_{(b+f)} \Lambda_{(b+f)}'$, where Λ_z and $\Lambda_{(b+f)}$ are lower triangular matrices with positive elements on their diagonals. These Cholesky decompositions yield orthogonalized shocks.

Finally, the responses of the level of budget deficit is derived from the restricted VAR (27):

$$R_{d,j} = \sum_{\kappa=0}^{j} \left[e_2' \Phi^\kappa_z \Theta_z \Lambda_z e_2\right] \lambda. \tag{39}$$

Expression (39) exploits the notion that the responses of the level of budget deficit corresponds to the accumulation of the responses of the changes of this variable, since $D_{t+j} = \sum_{\kappa=0}^{j} \Delta D_{t+\kappa} + D_{t-1}$ and D_{t-1} is not affected by shocks occuring in period t.

The properties of the responses of external deficit are highlighted by performing the following simulation.

Step 1. The law of motion (21) is specified as:

$$\Pi_w = \begin{pmatrix} \pi_{11} & 0 & \pi_{13} \\ 0 & \pi_{11} & \pi_{13} \\ 0 & 0 & \pi_{11} \end{pmatrix}, \tag{40}$$

and

$$\Omega_w = E\left(V_t V_t'\right) = I. \tag{41}$$

The parameter π_{11} corresponds to the eigenvalues, and thus, captures the degree of persistence of the forcing and hidden variables. Also, π_{13} reflects the degree of additional information used by agents.

Step 2. The restricted VARs for adjusted current account (27) and for adjusted nonhuman wealth (28) are constructed from the specification (40) and (41), for a given calibration of the parameters π_{11} and π_{13}, as well as of the birth rate p and the return $r = 0.01$.

Step 3. The simulated impact and dynamic responses of external deficit is measured by the negative of the responses of current account. To do so, the simulated responses are constructed recursively for $j = 0, 1, \ldots, 20$ from equations (35)–(39) and the notion that $R_{(b+f),0} = 0$, since the nonhuman wealth is a predetermined variable.

Step 4. Steps 1 to 3 are repeated for several calibrated values of p, π_{11}, and π_{13}. In particular, the birth rate is set to approach the cases where the economy is populated by an infinitely-lived representative consumer ($p = 0.001 \approx 0$) and by a sequence of one-period cohorts ($p = 0.999 \approx 1$). Also, the degree of persistence is fixed to capture oscillating ($\pi_{11} = -0.5$), smooth ($\pi_{11} = 0.5$), and nonpersistent ($\pi_{11} = 0.01$) dynamics. Finally, the last parameter is calibrated to take into account the presence ($\pi_{13} = -0.5$ and $\pi_{13} = 0.5$) and absence ($\pi_{13} = 0.01 \approx 0$) of agents' superior information.

Figure 3 displays the simulated responses of external deficit for the different calibrations. These responses exhibit three properties. First, the impact and dynamic responses are systematically larger when the birth rate is larger, for given degrees of persistence and agents' superior information. This arises because an in-

crease in the birth rate implies that the tax burden can be more easily shifted to future generations. In this context, consumers perceive an increase in their cash flows, so that private consumption and external deficit augment. Also, the impact responses always converge to unity when the birth rate tends to one. This occurs because a sequence of static economies implies that the tax burden is completely shifted to future generations [i.e. $(\eta - r)/\eta \to 1$]. Conversely, the impact responses always equal zero when the birth rate is null. This is because consumers currently alive reimburse the budget deficit entirely [i.e. $(\eta - r)/\eta = 0$].

Second, the dynamic responses are always larger when the persistence parameter is larger, for given birth rate and degree of agents' superior information. This occurs because a smooth persistence implies that an increase of the contemporaneous budget deficit signals future rises of this variable, or synonymously, future tax reductions. In this case, consumers expect significant increases in their future cash flow, such that consumption and external deficit increase. To gauge the importance of this notion, it is useful to compare the dynamic responses for the cases where $\pi_{11} = 0.01$ and $\pi_{11} = 0.50$. In the absence of persistence ($\pi_{11} = 0.01$), the dynamic responses are flat and correspond to the value of the birth rate. In the presence of smooth persistence ($\pi_{11} = 0.50$), the dynamic responses sharply increase to reach a value that substantially exceeds that of the birth rate. More precisely, the responses are twice that of the birth rate, within six quarters after the fiscal policy. For example, for a birth rate equal to one, the external deficit rapidly increases by two currency units following an additional currency unit of budget deficit due to a tax-cut.

Finally, the responses do not seem to be affected by the degree of agents' superior information. That is, the responses are insensitive to changes in the value

of π_{13}, for given values of p and π_{11}.

5.2 Estimates of the Responses

To estimate the empirical responses for each country, the following procedure is performed.

Step 1. The variables $\hat{Z}_t$ and $(\widehat{B_{t+1} + F_{t+1}})$ are computed by using equations (17) and (19), the observations for Z_t, D_t, Q_t, and $(B_t + F_t)$, as well as the calibration $r = 0.01$ (per quarter) and a given value of birth rate p.

Step 2. The unrestricted VARs for adjusted current account and nonhuman wealth (24) are estimated by OLS. These processes are used to construct the restricted VARs for adjusted current account (27) and nonhuman wealth (28).

Step 3. The empirical impact and dynamic responses of external deficit are measured by the negative of the responses of current account (35). The empirical impact and dynamic responses of budget deficit are given by (39). These empirical responses are constructed recursively for $j = 0, 1, \ldots, 20$ from (35)–(39) and $R_{(b+f),0} = 0$.

Step 4. Steps 1 to 3 are performed for the GMM estimates of the birth rate, $\hat{p}$, as well as the smallest values, $\underline{p}$, and largest values, $\bar{p}$, for which the orthogonality conditions are not rejected at the 1 percent level of significance.

Figure 4 exhibits the empirical responses of external and budget deficits. Figure 5 presents the probability values that the responses of external deficit are equal to zero, one, and the birth rate. Recall that the impact responses are null and unity when the birth rates are equal to zero and one. Also, the dynamic responses

correspond to the value of the birth rate when there is no persistence.

Empirically, the responses of budget deficit are always numerically close to one and statistically significant. [For briefness, this last result is not reported.] This reveals that fiscal policies persistently affect the budget deficit. In addition, as explained above, the persistence of the budget deficit can lead to a substantial increase of the external deficit, so that the associated dynamic responses exceed the value of the birth rate.

In general, the responses of external deficit are numerically positive. Exceptions are Japan for the first five quarters after the shock when $p = \underline{p}$, and at impact when $p = \bar{p}$ and $p = \hat{p}$; the United Kingdom for the first 13 and 15 quarters when $p = \underline{p}$ and $p = \hat{p}$; and the United States for the second quarter when $p = \underline{p}$ and the first eight quarters when $p = \hat{p}$. Moreover, the responses are most of the time insignificantly different from zero (at the 10 percent level) when $p = \underline{p}$ and $p = \hat{p}$, but are often statistically positive when $p = \bar{p}$. Exceptions are France and Italy where the responses are statistically positive after one quarter when $p = \underline{p}$; Germany and Japan where the responses are significantly larger than zero after 14 and seven quarters when $p = \hat{p}$; as well as Italy and the United States where the responses are never significant when $p = \bar{p}$. Overall, these findings suggest that fiscal policies influence the external deficit, as long as $p = \bar{p}$. This is rationalized by the property stating that the responses increase as the birth rate increases, and the fact that $\bar{p}$ is always larger than $\underline{p}$ and $\hat{p}$.

The responses of external deficit are frequently numerically smaller than unity. Exceptions are Canada for the responses at impact when $p = \bar{p}$ and $p = \hat{p}$; Germany for the first quarter when $p = \bar{p}$; and Japan after 17 quarters when $p = \bar{p}$.

Furthermore, the responses are systematically signifcantly different from one (at the 10 percent level) when $p = \underline{p}$, and are frequently statistically smaller than unity when $p = \bar{p}$ and $p = \hat{p}$. Important exceptions are Canada and Japan where the responses are never significantly different from one when $p = \bar{p}$ and $p = \hat{p}$; and the United States where the responses are always statistically equal to unity when $p = \bar{p}$. Thus, Canada, Japan, and the United States are the countries for which fiscal policies most strongly alter the external deficit, especially when $p = \bar{p}$. Again, this finding is explained by the concept that the responses are larger when the birth rate is larger, and the evidence that $\bar{p}$ is the largest estimate of the birth rate.

Finally, the responses of external deficit are numerically larger than the birth rate. Exceptions are Japan for the first six and two quarters after the shock when $p = \underline{p}$ and $p = \bar{p}$, and at impact when $p = \hat{p}$; the United Kingdom for the first 14 and 16 quarters when $p = \underline{p}$ and $p = \hat{p}$; and the United States for the second quarter when $p = \underline{p}$ and the first nine quarters when $p = \hat{p}$. In addition, the responses are most of the time insignificantly different from the value of the birth rate (at the 10 percent level) when $p = \underline{p}$ and $p = \hat{p}$, but are often statistically larger when $p = \bar{p}$. Exceptions are France and Italy where the responses are statistically larger than the birth rate after five and one quarters when $p = \underline{p}$; Germany and Japan where the responses are significantly larger than the birth rate after 15 and 10 quarters when $p = \hat{p}$; as well as Italy and the United States where the responses are never significantly different from the birth rate when $p = \bar{p}$. As shown above, the property that the responses are larger than the birth rate is due to the great persistence of the forcing variables, and in particular, the budget deficit.

In summary, fiscal policies subtantially and persistently affect the budget deficits of all countries. These policies are also likely to greatly influence the external

deficits for Canada, Japan, and the United States. In particular, the effects of a tax-cut are enhanced by the large degree of persistence of the budget deficits for Canada and Japan. In contrast, a tax-cut has smaller impacts on the external deficits for France and Germany, mild influences for the United Kingdom, and only negligible effects for Italy.

6. Conclusion

This paper studied the effects of fiscal policies on external and budget deficits. To do so, it improves on previous analyses in two crucial dimensions. First, it enlarges the analysis by studying the G7 countries to have a broad international perspective of the effects of fiscal policies on external and budget deficits. Second, it evaluates both impact and dynamic responses to provide a complete assessment of the temporal effects of a tax-cut.

Our analysis is performed on quarterly series for the G7 countries over the post-1975 period. It is shown that the time-series properties of the current account, budget deficit, net output, and nonhuman wealth support the case where the birth rate is strictly positive. Interestingly, the estimates confirm that the birth rate is always strictly positive, but numerically small. Finally, the responses of external and budget deficits are substantial and persistent for most countries. In particular, the fiscal policy has the most important effects on the external deficits for Canada, Japan, and the United States; somewhat smaller impacts for France, Germany, and the United Kingdom; and negligible effects for Italy.

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Table 1. Tests of Unit Root: Levels

Countries	Tests	Variables			
		Z_t	D_t	Q_t	$(B_t + F_t)$
Canada	DF	-1.206^{n}	-2.711^{t}	-3.168^{t}	-2.622^{t}
	PP	-1.859^{n}	-2.781^{t}	3.653^{n}	-2.584^{t}
France	DF	-2.158^{t}	-3.265^{t}	-1.685^{t}	-2.127^{t}
	PP	-3.065^{t}	$-9.429^{t,a}$	-2.387^{t}	-2.150^{t}
Germany	DF	-1.626^{n}	$-4.059^{c,a}$	-1.867^{t}	-2.173^{t}
	PP	$-2.179^{n,b}$	$-8.059^{c,a}$	-2.598^{t}	-2.917^{t}
Italy	DF	-1.681^{n}	-2.461^{c}	$-4.584^{t,a}$	-2.584^{t}
	PP	$-2.259^{n,b}$	-2.461^{c}	$-4.406^{t,a}$	-2.491^{t}
Japan	DF	-3.270^{t}	-0.295^{t}	2.084^{t}	$-9.108^{t,a}$
	PP	-2.035^{c}	-0.498^{t}	-2.027^{c}	$-9.328^{t,a}$
UK	DF	-1.330^{n}	$-3.283^{c,b}$	1.154^{c}	$-4.051^{t,a}$
	PP	-3.353^{t}	$-4.096^{c,a}$	-1.721^{t}	$-2.968^{c,b}$
US	DF	-3.281^{t}	-1.004^{n}	7.715^{n}	-2.481^{t}
	PP	0.024^{n}	$-6.181^{t,a}$	6.341^{n}	0.843^{n}

Note: Entries are the t-statistics of the coefficients associated with the lagged values of the variables. The superscrits are x, y. $x = n, c$, and t when the regression includes no deterministic term, a constant, and a constant as well as a linear trend. $y = a$ and b when the coefficients are significant at the 1 and 5 percent levels. MacKinnon asymptotic critical values at the 1 and 5 percent levels are -2.56 and -1.94 for $x = n$; -3.43 and -2.86 for $x = c$; and -3.96 and -3.41 for $x = t$.

Table 2. Tests of Unit Root: First Differences

Countries	Tests	Variables			
		ΔZ_t	ΔD_t	ΔQ_t	$\Delta(B_t + F_t)$
Canada	DF	$-6.317^{n,a}$	$-6.361^{n,a}$	$-7.315^{c,a}$	-2.622^{c}
	PP	$-12.736^{n,a}$	$-10.946^{n,a}$	$-7.012^{n,a}$	$-10.219^{n,a}$
France	DF	$-15.677^{n,a}$	$-16.155^{n,a}$	$-10.584^{c,a}$	$-10.207^{n,a}$
	PP	$-16.044^{n,a}$	$-32.509^{n,a}$	$-13.489^{c,a}$	$-10.194^{n,a}$
Germany	DF	$-12.710^{n,a}$	$-11.776^{n,a}$	$-4.600^{c,a}$	$-3.058^{n,a}$
	PP	$-12.710^{n,a}$	$-31.582^{n,a}$	$-14.589^{c,a}$	$-13.852^{n,a}$
Italy	DF	$-13.995^{n,a}$	$-6.566^{n,a}$	$-5.839^{c,a}$	$-7.234^{c,a}$
	PP	$-13.850^{n,a}$	$-10.828^{n,a}$	$-15.728^{c,a}$	$-10.134^{c,a}$
Japan	DF	$-3.528^{n,a}$	$-6.200^{t,a}$	$-10.252^{t,a}$	$-5.617^{t,a}$
	PP	$-11.862^{n,a}$	$-5.570^{n,a}$	$-14.438^{t,a}$	$-35.156^{n,a}$
UK	DF	$-9.967^{n,a}$	$-4.200^{n,a}$	$-11.393^{c,a}$	$-5.952^{n,a}$
	PP	$-14.118^{n,a}$	$-17.729^{n,a}$	$-11.453^{c,a}$	$-5.965^{n,a}$
US	DF	$-11.060^{n,a}$	$-14.229^{n,a}$	$-9.048^{c,a}$	$-2.366^{n,b}$
	PP	$-11.076^{n,a}$	$-24.169^{n,a}$	$-9.205^{c,a}$	$-7.922^{n,a}$

Note: Entries are the t-statistics of the coefficients associated with the lagged values of the variables. Δ represents the first difference operator. The superscrits are x, y. $x = n, c$, and t when the regression includes no deterministic term, a constant, and a constant as well as a linear trend. $y = a$ and b when the coefficients are significant at the 1 and 5 percent levels. MacKinnon asymptotic critical values at the 1 and 5 percent levels are -2.56 and -1.94 for $x = n$; -3.43 and -2.86 for $x = c$; and -3.96 and -3.41 for $x = t$.

Table 3. Tests of Cointegration

Countries	Tests	Levels of Significance	
		1	5
Canada	Tr	0	1
	ME	0	0
France	Tr	1	2
	ME	1	2
Germany	Tr	1	1
	ME	1	1
Italy	Tr	1	2
	ME	1	2
Japan	Tr	1	2
	ME	2	2
UK	Tr	2	0
	ME	0	0
US	Tr	3	3
	ME	3	3

Note: Entries are the number of cointegration relations at the 1 and 5 percent levels of significance.

Table 4. Estimates of Birth Rate

Countries	Levels of significance	$\underline{p}$	$\bar{p}$	$\hat{p}$
	1	0.001	0.032	0.004
Canada	5	0.003	0.021	(0.008)
	10	0.006	0.015	[0.142]
	1	0.008	0.017	0.003
France	5	—	—	(0.003)
	10	—	—	[0.008]
	1	0.001	0.010	0.006^b
Germany	5	0.003	0.016	(0.003)
	10	0.004	0.031	[0.260]
	1	0.001	0.005	0.004
Italy	5	0.001	0.001	(0.003)
	10	—	—	[0.684]
	1	0.001	0.037	0.026^a
Japan	5	0.003	0.022	(0.010)
	10	—	—	[0.037]
	1	0.001	0.036	0.002
UK	5	0.001	0.021	(0.002)
	10	0.001	0.014	[0.519]
	1	0.001	0.016	0.002
US	5	0.001	0.008	(0.003)
	10	0.001	0.003	[0.056]

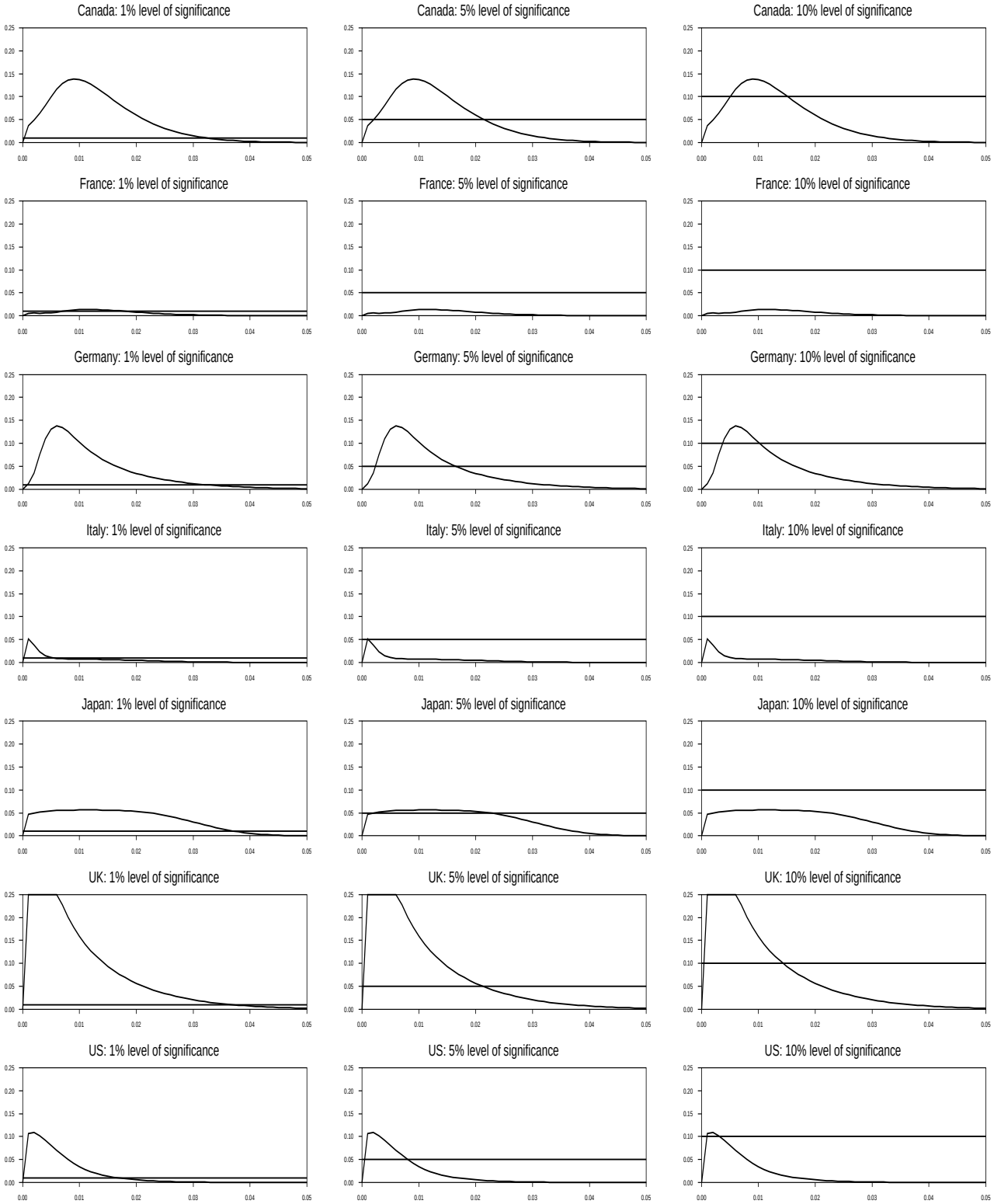
Note: Entries are the estimates of the birth rate. $\underline{p}$ and $\bar{p}$ are the smallest and largest values of the birth rate for which the orthogonality restrictions are not rejected at the 1, 5, and 10 percent levels of significance. $\hat{p}$ represents the GMM estimates of the birth rate. The superscrits a and b indicate that the GMM estimates are significant at the 1 and 5 percent levels. Numbers in parentheses are the standard errors of the GMM estimates. Entries in brackets are the probability values associated with the J-test of overidentification restrictions.

Table 5. Tests of Granger-Causality

Countries	Variables	$\underline{p}$	$\bar{p}$	$\hat{p}$
Canada	ΔQ_t	0.723	0.417	0.511
	ΔD_t	0.709	0.713	0.729
France	ΔQ_t	0.813	0.769	0.948
	ΔD_t	0.997	0.977	0.991
Germany	ΔQ_t	0.092	0.796	0.756
	ΔD_t	0.336	0.438	0.337
Italy	ΔQ_t	0.691	0.909	0.953
	ΔD_t	0.181	0.621	0.565
Japan	ΔQ_t	0.323	0.071	0.065
	ΔD_t	0.587	0.629	0.546
UK	ΔQ_t	0.044	0.002	0.009
	ΔD_t	0.449	0.450	0.401
US	ΔQ_t	0.113	0.953	0.079
	ΔD_t	0.517	0.745	0.546

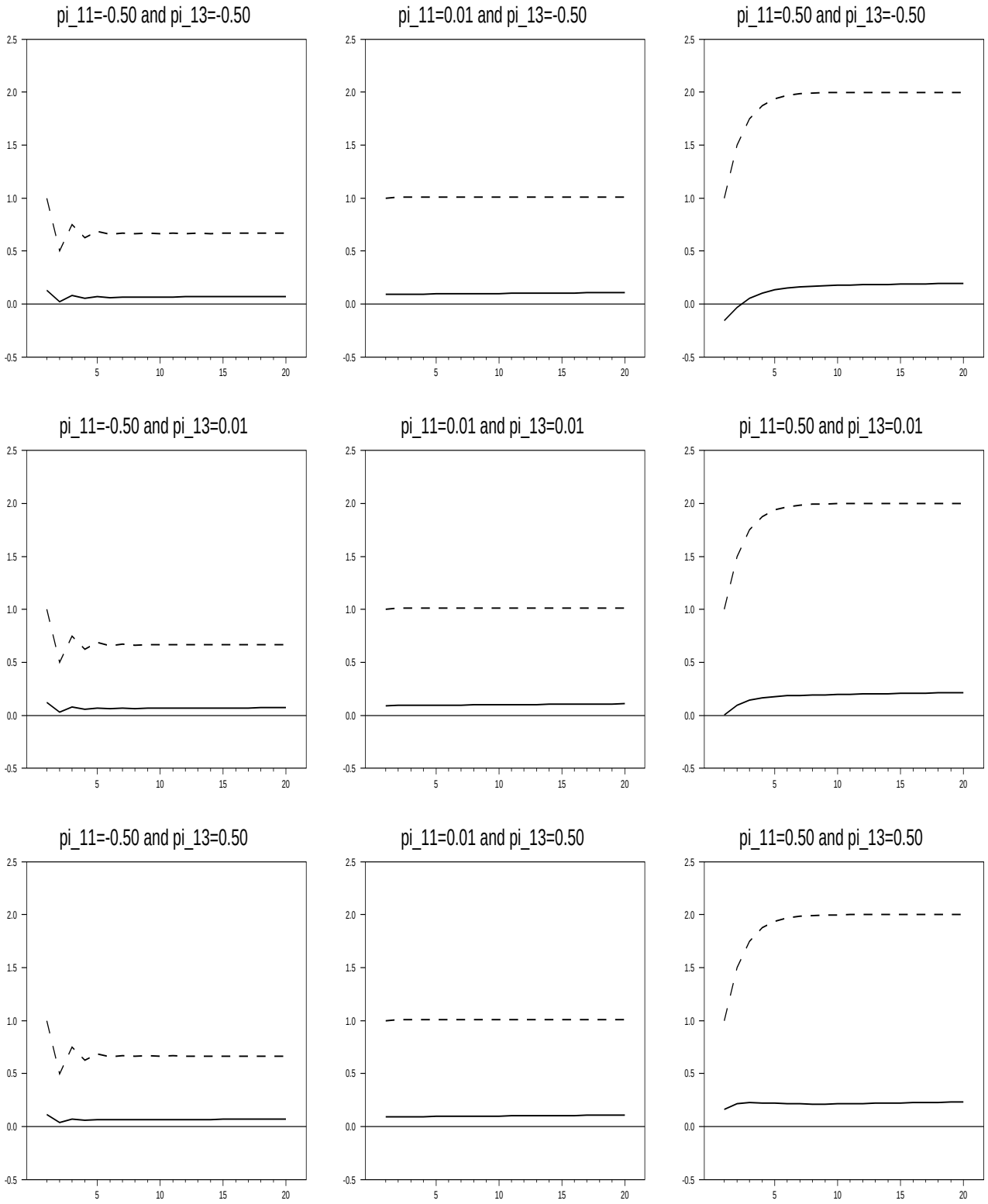
Note: Entries are the probability values associated with the test that the lagged adjusted current account does not affect the current variables. $\underline{p}$ and $\bar{p}$ are the smallest and largest values of the birth rate for which the orthogonality restrictions are not rejected at the 1 percent level of significance, while $\hat{p}$ corresponds to the GMM estimates of the birth rate.

Figure 2: Orthogonality Restrictions



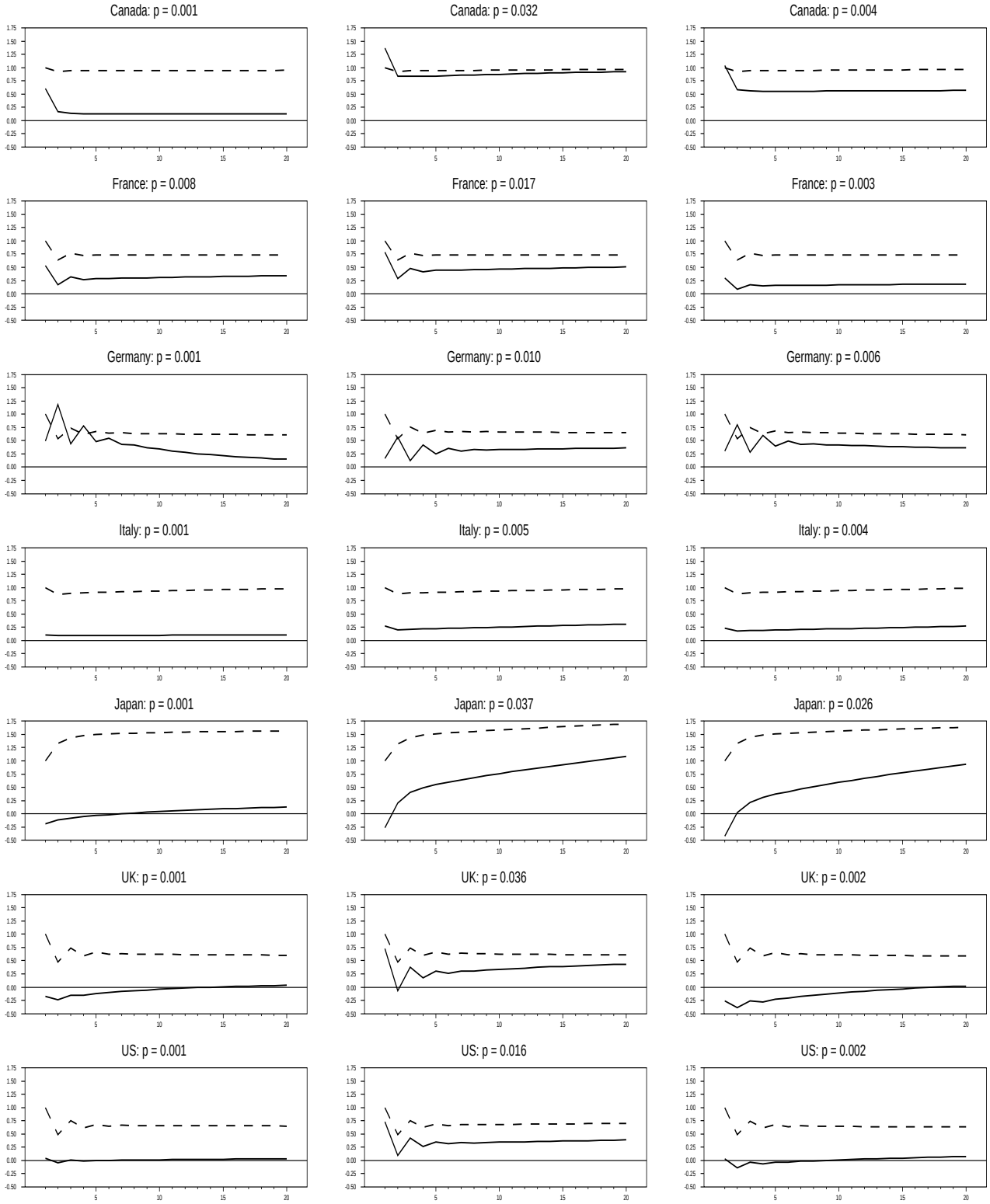
The horizontal lines correspond to the conventional levels of significance.

Figure 3: Simulated Responses



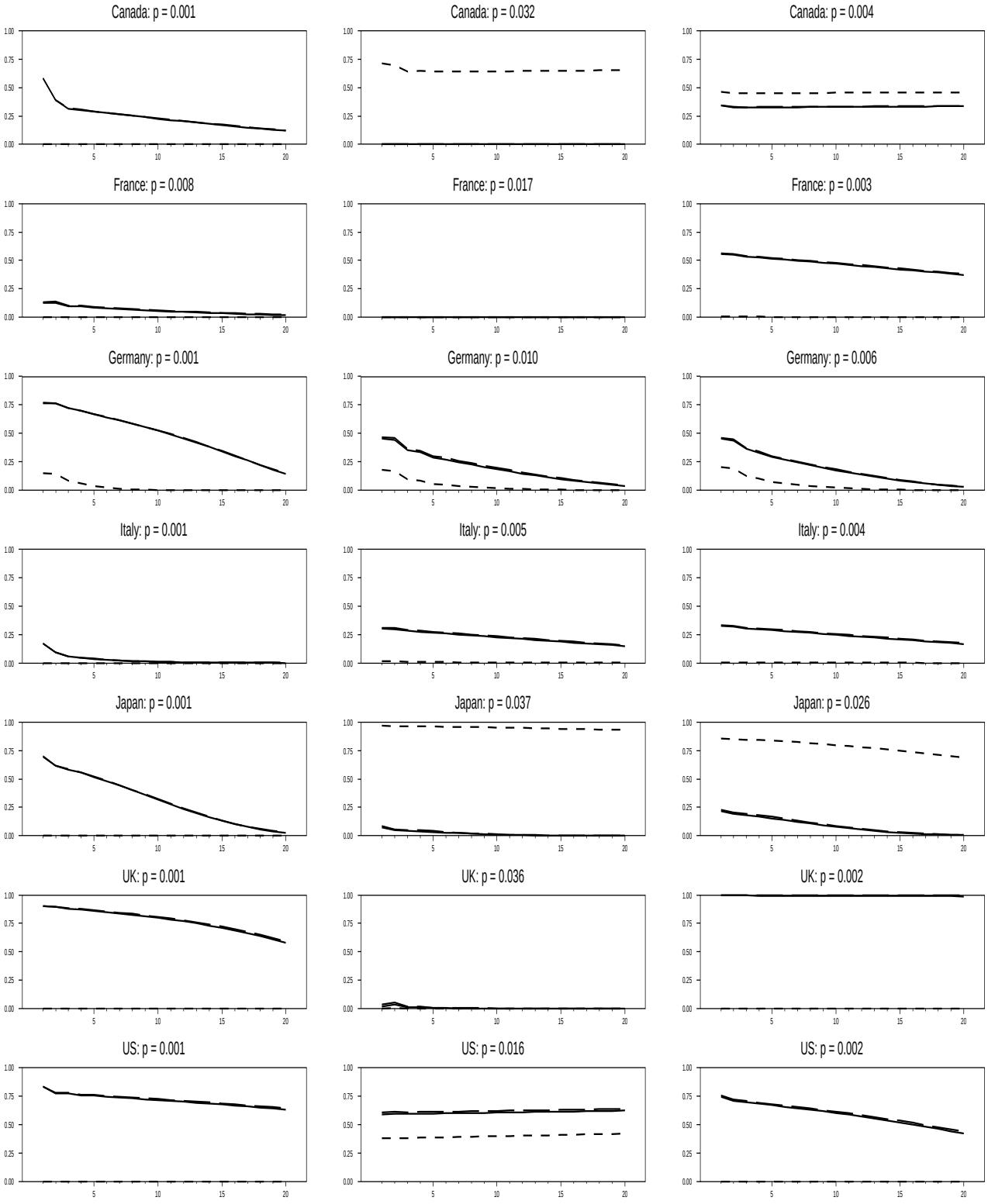
The solid (dashed) lines correspond to the simulated responses of external deficit with $p = 0.001$ ($p = 0.999$).

Figure 4: Empirical Responses



The solid (dashed) lines correspond to the empirical responses of external (budget) deficits.

Figure 5: Probability Values



The solid (dashed) [dotted] lines correspond to the probability values that the responses of external deficit are equal to zero (the birth rate) [one].