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The role of capital taxation on the business cycle: the case of Chile, 1960–2019

Rodrigo A. Cerda[1] · **José Tomás Valente**[2]

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Abstract

How relevant could capital income tax be as a growth engine? We analyse the Chilean experience that since the mid-80s has shown significant increase in its growth rate, outperforming most Latin American countries in the same period. This paper analyses the contribution of capital stock to the Chilean business cycle from 1960 to 2019. We do so by constructing a dynamic general equilibrium model in which firms accumulate capital and capital income taxation occurs at both firm and individual levels. In line with previous studies, we find that productivity shocks were an important driver of growth but unlike them, we find that capital income taxation policies also played an important role in explaining the Chilean miracle. The large adjustments in capital stock that Chile experienced are in line with the reasoning that interest rates in small open economies like Chile respond less to increases in capital taxation, and therefore do not diminish the impact of tax reforms.

Keywords Tax policy · TFP · SOE · DSGE

JEL Classification H24 · H25 · N16

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✉ Rodrigo A. Cerda
rcerdan@uc.cl

José Tomás Valente
jtvalent@uc.cl

[1] Facultad de Derecho, Pontificia Universidad Católica de Chile and Centro Latinoamericano de Políticas Económicas y Sociales (Clapes-UC), Santiago, Chile

[2] Centro Latinoamericano de Políticas Económicas y Sociales (Clapes-UC), Santiago, Chile

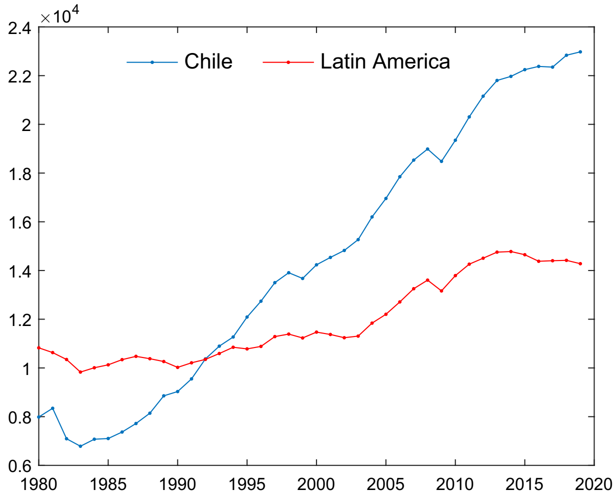

Fig. 1 GDP per capita at constant 2011 PPP prices: 1980–2019. *Sources*: World Economic Outlook, 2019, IMF

1 Introduction

Historical approaches to the Chilean economy at the beginning of the 20th century often placed Chile as a country with frustrated development, marked by geographical and cultural difficulties that made its position behind other countries in the region understandable (see Pinto 1959). During the 1940s and 1950s the Chilean economy grew at about 3.5% per year. In the following decades, there were booms and crises, but on average, the economy kept its pace during the 60s, 70s and early 80s. However, halfway through the 80s, the performance of the Chilean economy improved significantly, averaging 7.2% GDP growth between 1986 and 1997. This period, usually known as the "Chilean golden period" (see Gallego and Loayza 2002), not only increased GDP but also the living standards of the Chilean population: between 1990 and 2013, poverty rate decreased from 38.6 to 7.8%; average years of schooling increased from 9 to 10.8 and the employment rate increased from 47.7 to 53.3%. In terms of per capita income (PPP), the Chilean economy went from US$ 5.846 to US$ 22.469, considerably over-performing its neighbours, as shown in Fig. 1.

What explains the Chilean miracle? Different studies (Beyer and Vergara 2002; Coeymans 1999; Corbo and Gonzalez 2014; Chumacero and Fuentes 2002; De Gregorio 2005; Fuentes et al. 2006; Gallego and Loayza 2002) indicate that the high growth period is mainly explained by a jump in total factor productivity (TFP). For instance, Gallego and Loayza (2002) using growth accounting indicated that "the increase in the GDP growth rate after 1985 was due primarily to a very large expansion of total factor productivity". However, and despite having been a relevant growth driver for decades, there has been much less interest in studying capital accumulation as a growth engine than there has been in studying the TFP. As can be

Table 1 Growth accounting

	Solow decomposition				Growth contributions			
	Capital (%)	Labour (%)	TFP (%)	GDP (%)	Capital (%)	Labour (%)	TFP (%)	GDP (%)
1960–1969	1.6	1.2	2.1	4.9	32.6	24.2	43.2	100
1970–1979	0.9	0.5	0.8	2.2	42.1	23.6	34.4	100
1980–1989	1.1	1.9	0.4	3.4	31.4	55.6	13.0	100
1990–1999	3.2	1.1	2.4	6.7	48.2	15.9	35.9	100
2000–2019	2.3	1.4	0.0	3.7	62.9	37.1	0.0	100
1960–2019	1.8	1.2	1.1	4.2	43.7	28.8	27.4	100

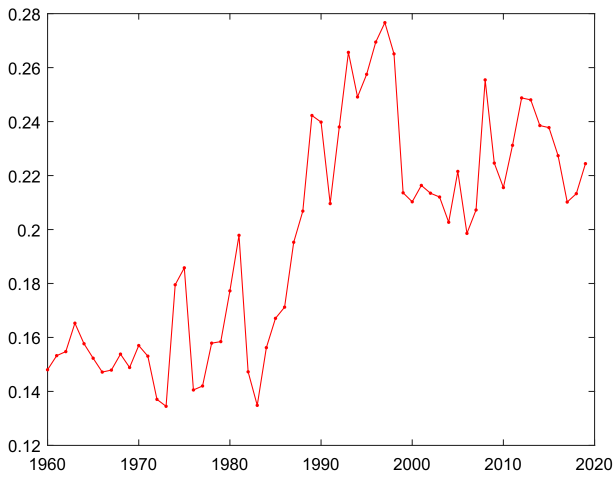

Fig. 2 Investment rate, 1960–2019

seen in Table 1, a simple Solow decomposition[1] shows that during the 70's and 80's, capital stock explained, on average, 37% of GDP growth while during the 90s and 2000s, capital explained 48.2% and 62.9% of total GDP growth, respectively. This increase in the relevance of capital is less surprising after considering the evolution of investment as a fraction of GDP, which fluctuated around 15% between 1920 and 1970, but has risen significantly since 1984, reaching investment rates close to 25% in the 90s and averaging 23% between 1995 and 2019 (see Fig. 2).

In this paper, we plan to closely study the investment dynamics in Chile with special attention on the large increase in capital accumulation observed since the mid-80s. Our hypothesis is that a major factor behind the decline in investment rates and their impressive subsequent recovery was the implementation of a series of tax reforms in Chile during this period. Hence, the moderation of effective taxation on capital income from the mid-80s, brought about by these reforms, strengthened investment rates and capital accumulation, giving way to an exalted economic growth.

Up until 1984, Chile had a tax system which imposed double taxation on firms' profits, in addition to large corporate taxes; but that year, a major tax reform was approved, which eliminated double taxation and lowered corporate taxation from 49 to 10%, among other changes. Basic investment theory (Hall and Jorgenson 1967) would suggest that such a large change in corporate taxation should increase capital demand, probably boosting the economy. For instance, Bond and Xing (2015), using data from 14 OECD countries, report estimates of long run elasticities of capital-output ratio vis-a-vis corporate taxation in the range − 0.3 to − 0.5, suggesting large increases in capital demand resulting from 1984 Chilean tax reform.

[1] Using a capital income share equal to 0.4, as in Corbo and Gonzalez (2014) and Coeymans (1999) among others.

Our paper extends previous studies that argue that fiscal shocks and, in particular, capital taxation, are important for a better understanding of economic fluctuations. There are many studies that focus on the role of distortionary capital taxation: Braun (1994) and McGrattan (1994b) argue that distortionary taxation significantly explain postwar cyclical activity; McGrattan (2012) argues that capital taxation shocks had an important role in explaining the path of economic variables in the 1930s; Kydland and Zarazaga (2016) analyse the slow recovery of the US economy from the 2008–2009 great recession and argue that the expectations of higher taxes account for two-thirds of the investment gap. However, while there are many papers that study the role of capital taxation during recessions in the US, the impact of capital taxation shocks has not been studied extensively for recession episodes in developing economies like Chile.

To understand the role played by capital stock in the Chilean miracle and its relation with taxation, we built a model that merges the small open economy model in Schmitt-Grohe and Uribe (2003) with the production-based asset pricing model in Cochrane (1991) in order to study the general equilibrium effects of distortionary taxation on the firm's investment decision. In our model, taxation on capital income occurs at the firm level and at a personal level in the form of a corporate and dividend tax, respectively. Under this double capital taxation design—which represents the case of many countries—, the timing of taxation differs between firms and individuals because corporate taxation occurs at an accrual base while dividend taxation might occur years later (depending on, when firm owners decide to make cash retirements from the firms). We distinguish between corporate taxation of undistributed profits and dividend taxation to account for this difference in taxation timing.

We argue that the unanticipated changes in the corporate tax rate are greatly responsible for the changes in investment rates in the Chilean economy during the second part of the twentieth century. We find that a model that includes only TPF shocks (baseline model), captures part of the dynamics of investment, failing to account for the total drop during the 70s or failing to explain the sharp rebound of investment after 1985. Conversely, the predictions of the extended model—which includes tax rates—more closely mimic Chilean investment data in magnitude and timing of the movements, including the rebound in investment in the second half of the 80s. Additionally, the extended model also does a better job in replicating the dynamics of consumption and GDP.

Considering the Chilean tax history makes a significant difference in the model's prediction on investment, capital accumulation and GDP, this paper studies the role played by capital accumulation and taxes in Chile's development path, particularly surrounding Chile's golden period. Guiding the construction of our model along the lines of capital tax reforms in Chile, we find that a series of tax reforms that greatly relieved capital income taxation, strengthened investment rates and capital accumulation and gave way to a golden period of growth. We also provide some extensions on how expectations on future tax rates affect investment dynamics and how they help to explain the results.

The paper is developed as follows. Section 2 briefly describes the evolution of the main Chilean economic variables in the second half of the 20th century. Section 3 describes the Chilean tax system and its evolution; it discusses the different taxes and regime changes, by focusing on corporate and personal taxation. Section 4 describes the model used to simulate the impact of taxes on the economy, and it also discusses the simulation method used in the paper (Sect. 4.6). Section 5 describes the data used to calibrate the model while Sect. 6 presents the results. Finally, Sect. 7 concludes.

2 The Chilean economic history

2.1 The economic reforms

Throughout the second half of the twentieth century, Chile underwent a series of important political and economic changes. On November 4th of 1970, Chile elected democratically a left-wing president, whom, after nearly 3 years in office, was overthrown by a military coup which concluded in a 17-year dictatorship.

At the beginning of the 1970s, Chile was practically a closed economy (the average import tariffs reached 105%). Its exports were utterly dependent on copper [80% of exports were copper, see Larraín and Vergara (2000)]. The Chilean model was based on import substitution plus a large public sector with several industries in its hands (the copper industry, public utility services, the banking sector, the leading airline). Besides, the public sector fixed many prices, which caused microeconomic distortions and produced low growth. In the mid-70s, during the military dictatorship, many economic reforms were carried out that profoundly impacted the economy. The main reforms were commercial opening, privatization of companies in state hands, end of financial repression, creation of an individually funded pension system and the consolidation of fiscal policy. These reforms had to pass two crucial tests. The first of these was the effects of the 1982 debt crisis in Latin American countries. Chile had adopted a fixed exchange rate rule in 1979 to reduce inflation, which had shown success between 1980 and 1981, but that made it very vulnerable to the outflow of capital that occurred from all over Latin America as of 1981. Thus, in 1981, Chile had a substantial deficit in its current account. In order to regain balance required a sharp depreciation of its real exchange rate. It was initially carried out via wage adjustments and a sharp increase in unemployment. The Chilean economy contracted 11% in 1982 and 5% in 1983. However, the Chilean economy's growth rates since 1984 possibly validated the reforms (the average growth rate was 6% between 1984 and 1989).

The second important test occurred in the early 90s. A new government took office, whose authorities had been opponents of the military dictatorship, which decided to continue with the economic approach implemented since the mid-70s. In fact, since the early 1990s, another critical reform was carried out that had to do with the new system of public infrastructure concessions. It was based on verifying a significant deficit in public infrastructure, and that the public sector did not have space to promote new investments. A program based on a system of contracts for the construction, operation and transfer of public infrastructure in the hands of private companies, which financed and built the infrastructure and subsequently charged for the use of that public service for some time.

The Chilean economy experienced strong recessions—the strongest in 1975 and 1982, when the output contracted 13% and 14%, respectively. Nevertheless, since the mid-80s the economy experienced unprecedented dynamism in which the investment rate went from 9.2 to 25%. The reforms led an average 7.7% growth between 1991 and 1997, reaching the highest sustained expansion for this economy at least since the early 1940s. After the 1999-Asian crisis, the economy has slowed down and grew by 3.8% between 2000 and 2019.

2.2 The cycle

In this paper, we focus on fluctuations in the Chilean data not directly related to the TFP trend. For this purpose, we remove this trend along with population size effects from the data. We focus on the evolution of the capital stock that accounted for one-third of GDP growth between 1960 and 1980 and more than 45% since 1990. To do so, we initially compute the TFP by using the usual Solow decomposition and assume a Cobb-Douglas production function as follows,

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{1}$$

where Y_t is output, A_t is TFP, K_t is capital, L_t is labour and α is capital's share of income. For our estimation, we set $\alpha = 0.4$ as in Corbo and Gonzalez (2014), among others, and then, we calculated the TFP as a residual. In addition, we decompose TFP as in,

$$A_t = A_t^T \varepsilon_t \tag{2}$$

where A_t^T is the trend[2] of the TFP and ε_t is a stationary shock. The usual resource constraint in an open economy is:

$$C_t + G_t + I_t + TB_t = Y_t \tag{3}$$

where C_t, I_t, G_t, TB_t are consumption, investment, fiscal expenditure and the trade balance. We remove the TFP trend and labour force (F_t), by dividing Eq. 3 by $\left(A_t^{T,(1+\alpha)}F_t\right)$ and we obtain:

$$\begin{aligned}\frac{C_t}{A_t^{T,(1+\alpha)}F_t} + \frac{G_t}{A_t^{T,(1+\alpha)}F_t} + \frac{I_t}{A_t^{T,(1+\alpha)}F_t} + \frac{TB_t}{A_t^{T,(1+\alpha)}F_t} &= \frac{Y_t}{A_t^{T,(1+\alpha)}F_t} \\ &= \left[\frac{A_t}{A_t^T}\right]\left[\frac{K_t}{A_t^T F_t}\right]^{\alpha}\left[\frac{L_t}{F_t}\right]^{1-\alpha}\end{aligned} \tag{4}$$

We then construct normalized variables as in $k_t = {}^{K_t}/_{A_t^T F_t}$, $y_t = {}^{Y_t}/\left(A_t^{T,(1+\alpha)}F_t\right)$, $c_t = {}^{C_t}/\left(A_t^{T,(1+\alpha)}F_t\right)$and $i_t = {}^{I_t}/\left(A_t^{T,(1+\alpha)}F_t\right)$.

2 We model the trend by means of a quadratic time model.

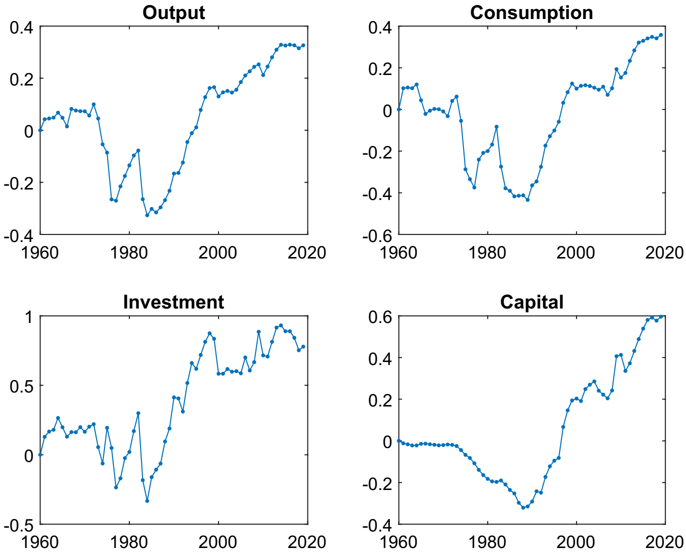

Fig. 3 Detrended series, 1960–2019

Figure 3 shows the evolution from 1960 to 2019 of the four detrended series: output, consumption, investment and capital stock (the data were obtained from Díaz et al. 2010 and updated using official data from the Central Bank of Chile). The variables show no large fluctuations between 1960 and the early 70s, indicating that in that period, they grew at the same pace as the TFP trend and the labour force. However, since the mid-70s, the variables show large fluctuations: detrended GDP decreased by 30% between 1973 and 1983 while detrended consumption dropped by almost 50% in the same period. The drop in detrended investment started earlier and was even larger; the cumulative decrease from the beginning of the 70s to 1983 was 40% vis-à-vis its 1970s detrended mean. However, since 1983, both output and investment began to recover, improvement that allowed investment to reach its 1970s detrended level in the first half of the 1990s and to recover in the early 2000s the detrended level that the output had had before the drop.

As is seen in Fig. 3, by the end of the 2000s, investment was 60% greater than its 1970s detrended level, a quite unique recovery. Other variables also show upward trends but less pronounced recoveries: by the end of the 2000s, output and consumption were 30% larger compared to their 1960s detrended level. In contrast, capital stock by the end of the sample was 60% larger vis-à-vis its initial detrended level.

Table 2 Tax structure in 1973

Tax	Rate
I Profits	
1st category (Corporate Taxation)	
General rate	17%
Publicly held company	35%
Banks and insurance companies	40%
Owner's salary	5.5%
2nd category (Personal Taxation)	
Wages and salaries	Progressive 0-65%
Professional	7%
Professional associations	12%
Board director	30%
Overall	Progressive 0-60%
Additional	40%
Housing	7%
Capital gains	20%
II Property	
Real estate	Multiple taxation
Wealth	Progressive
III Sales and services	
General rate at producers level	17,5%
General rate at retail level	4%
Surcharge on specific products	Varying between 8% and 50%
IV Stamp tax	Wide variety

3 The Chilean tax history

3.1 Tax system pre-1974

By the beginning of the 60s, the Chilean tax system had a double taxation property, as it taxes accrued profits both at the corporate and individual levels (owner taxation), even if profits were not distributed to their owners. The system had a large number of exemptions and special treatments. The tax code contained 108 exemptions for sale taxes and other 173 exemptions in different legal bodies. Lamarca (1981) provides a summary of the basic 1973 tax structure which is reproduced in Table 2. The structure of taxation had many complications; tax bases were heterogeneous and there were different rates for similar bases. In addition, there was a wide range of alternative systems, special sectoral treatments, and there were no adequate mechanisms to account for inflation. With the exception of the payroll tax, which was paid monthly, individual tax and corporate tax were paid with a one year lag, without inflation adjustment. This was an important drawback for tax collection, especially when inflation reached a value of 746% in 1974.

There was a general corporate tax equal to 17%. However, corporations (large firms) were taxed at a higher rate (35%). In addition, banks and insurance companies (i.e. the financial sector) were taxed at an even larger corporate tax (40%). Personal income tax was progressive, nevertheless, the tax scales for labour and capital income differed. In particular, the highest marginal rate applied to wages (second category tax) exceeded the highest marginal rate for capital income.

3.2 1974 tax reform

In 1972, fiscal deficit reached 12.3% of GDP (Díaz et al. 2010), and in 1974, a tax reform was implemented to increase tax revenues. According to Cheyre (1986): "Given the magnitude of the fiscal deficit in that period, it was necessary not only to take measures in order to reduce the level of spending, but it also required significant efforts to achieve greater tax revenues".[3]

The 1974 tax reform was enacted in Law Decree No. 824, and published on 31st December. This legal text entailed substantial changes on individual and corporate taxation, such as adjustments for inflation. The reform repealed alternative corporate tax regimes and taxed all corporations at the same rate. In addition, corporate tax rate dropped from 17 to 15%.[4] and two years later was reduced to 10%.[5] However, the tax system was not integrated, so taxes paid at corporate level could not be used as credit when paying personal taxes. In the case of large firms, previous to the 1974 reform, shareholders were taxed on distributed profits, which induced capitalization of companies by encouraging shareholders to postpone tax payment. However, in the 1974 reform, authorities opted for a tax system in which shareholders were taxed on total accrued profits, and in order to implement the system, an additional tax (40%) was established for large firms. That payment could be used as credit for shareholders when they paid their individual taxes.

Individual taxes aimed to treat individual income on a single base, regardless of their source, with a progressive tax scale being applied on the uniform base, ranging from 0 to 58 percent,[6] while non-residents—foreign companies and natural and legal people without residency in Chile—were taxed at a 40 percent rate.

As a result of the 1974 tax reform, the burden of taxation was high. Consider the following example—the first column of Table 3 is taken from Cheyre (1986)—in which we focus on the case of an individual owning a fraction of a large corporation that has gross profits equals to $100 Chilean pesos. In addition, we make the

[3] The objectives and principles of the reform are summarized in a document by the former Minister (Cauas 1974).

[4] However, a transition period was contemplated in the new legal text. In 1976 and 1977, the tax rate was 20% and 18%, respectively.

[5] Law Decree No 1604, December 1976.

[6] Until March 1974, the top marginal rate of the second category tax was 65%. With the approval of Law Decree N°367, the top marginal rate rose to 80% on a temporary basis until December 31 of 1974. With the enactment of law Decree No. 824 (1st January, 1975), the maximum rate was set at 60%. In 1981, maximum rate was set at 58%. This structure was modified only temporarily between March and December 1982, with the sole purpose of increasing tax revenue.

Table 3 Tax structure in 1983

	100% distribution	Non-distribution	
Gross profits	100	100	(1)
1st category tax	− 10	− 10	(2)
(10% of (1))	90	90	(3)
Additional tax P.H.C	− 36	− 36	(4)
(40% of (3))	54	54	(5)
Dividends	54	0	(5)
Personal tax rate	− 31.3	0	(6)
(58% of (5))			
Tax credit	+ 21.6	0	(7)
(40% of (5))			
Net dividends	44.3	0	(8)
Effective total tax rate	55.7%	46%	

assumption that the taxpayer is at the maximum progressive rate (58%). In the table, we consider two situations: (a) 100% distribution of gross profits to their owners and (b) no distribution of gross profits. The non-distribution situation corresponds to a case in which the after corporate tax profits can be reinvested into the firm, while in the first case, gross profits are withdrawn and thus are not reinvested in the firm. According to Cheyre (1986), the mixture of taxation was designed so that the effective tax rate paid by a firm's owner coincides with the maximum rate paid at the individual level. In fact, as shown in table, if the firm's owner received dividends, the effective tax rate was 55.7%, which is very close to the maximum progressive tax for natural taxpayers (58%). If the firm reinvested gross profits and thus, it did not pay dividend to its owners, taxation was also very high. As shown in column (2) of Table 3, in that case, the effective tax rate was 46%. Thus, there was no large difference on effective tax rates if reinvesting or paying dividends to its owners. As Cerda et al. (2014) points out, the 1983 tax system taxed income excessively, and it had the effect of encouraging the distribution of income by corporations (which threatened reinvestment), and favoured financing through loans at the expense of equity financing.

3.3 1984 tax reform

The Chilean government enacted a new reform to the tax system on 31st January, 1984 (Law No. 18,293). *According to the message on the Bill (Message No. 955, 15 November, 1982)*, the new tax system would primarily intend to increase savings and investment. According to Cuevas (2014), it was " a bill that introduced tax changes designed to encourage private sector savings and investment. With the changes, gross profits were not taxed until they were withdrawn from firms".

In the message of that bill, and referring to the prior tax system, it was held that "the current (1974) structure of income tax, which taxes both earned and received income, not only discourages savings at a personal level, minimizing it globally, but

Table 4 Tax structure with the 1984 reform

	100% distribution	Non-distribution	
Gross profits	100	100	(1)
1st category tax	– 10	– 10	(2)
(10% of (1))	90	90	(3)
Dividends	90	0	(5)
Personal tax rate	– 50	0	(6)
(50% of (1))			
Tax credit	+ 10	0	(7)
(40% of (5))			
Net dividends	50	0	(8)
Effective total tax rate	50%	10%	

it is also a factor that contributes to excessively increase the debt to equity ratio of Chilean companies, with consequent macroeconomic instability that this entails. Moreover, the current income tax system punishes mostly variable return projects, including several in which the country has comparative advantages".

Cerda et al. (2014) explain that in its original version, the bill was structured on a single tax on withdrawals or received income, under which, if the profits were not definitively withdrawn from the company, there was no taxation at all. Thus, taxes on reinvestment of profits would be zero. In the case of foreign corporations, they were taxed when profits were withdrawn or remitted abroad. Corporate taxation was set at 10% of accrued gross profits and taxation was fully imputed allowing the corporate tax to be used as a withholding for personal taxation. This full imputation system avoided double taxation and ensured similar taxes for labour and capital income.[7] The additional tax rate of 40% that affected large corporations was gradually eliminated: a rate of 30% was established for 1984; 15% for 1985 and zero thereafter. The new legislation also included reductions in the personal tax rates and the maximum personal tax rate was set at 50%. Table 4 illustrates how the tax burden differs if profits were withdrawn or if profits were reinvested after 1984. In the first case, the total tax burden was 50% while in the second case, it was just 10%, providing incentives to reinvest.

3.4 Tax reforms in the last 30 years

In the late 1980s, there was some consensus in Chilean economic literature that Chile had a modern tax system. Arellano and Marfán (1987) described the tax system as follows:

[7] It should be noted that exceptionally, and only for 1989, the corporate tax was applied on the basis of received income . As from 1990, with the Law No. 18,985, the corporate tax returned to a regime were accrued profits were the taxable base.

"The current Chilean tax system is a mature system that ensures fiscal revenues, that although lower than in developed countries, is in line—and sometimes surpasses—fiscal revenues of other countries with a similar level of development"

In that context, and due to the need of financing an increase in fiscal expenditure, a new tax reform was enacted in 1990. The 1990 tax reform increased tax revenues by temporarily rising corporate tax from 10 to 15%, until December 1993. In 1994, the government approved the tax increase as permanent until 2001 when it rose to 17%.[8] In addition, in the 1993 and 2001 reforms, the tranches and the marginal rates of personal taxes were changed.[9]

The Chilean tax system has had large and significant changes in the last 50 years. In what follows, we plan to analyse how those changes may have impacted the economy. We use a macroeconomic model with taxes in which agents do not anticipate tax changes to answer that question. The following section explains the model.

4 The model economy

Our theoretical framework includes as a key element the possibility of double taxation, to better represent what occurs in many countries nowadays. To do so, we will allow firms to accumulate capital and decide how much to invest. After the investment decision is made and corporate taxes are paid, dividends will correspond to cash flow residuals. When dividends are received, capital taxation occurs at the personal level. To implement such kind of environment our model merges the small open economy model in Schmitt-Grohe and Uribe (2003) with the production-based asset pricing model in Cochrane (1991), and digress from the literature that assumes that capital is accumulated by individuals and then rented to firms.

4.1 Households

The economy is populated by a large number of identical households with preferences described by the following utility function:

$$\max \sum_{t=0}^{t} \beta^t \frac{\left[c - \frac{n^\theta}{\theta}\right]^{1-\sigma} - 1}{1-\sigma} \tag{5}$$

where c_t denotes consumption and n_t denotes hours worked in period t. The parameter σ is positive while β lies in the interval (0, 1) and $\theta > 1$. In this economy, households make saving decisions while firms make investment decisions. We assume households own shares of a firm that produce final goods and own the capital stock.

[8] In 2010, the government raised temporarily the corporate tax to 20%. However, the corporate tax was established at 20% permanently in 2012. Further, in 2014 with the approval of Law No. 20.780, the corporate tax was increased to 27% within a period of four years.

[9] The tax reforms of 2012 and 2014 also contain changes in personal taxes.

The household supplies n_t hours to the labour market. The period-by-period budget constraint of the household is:

$$\left(1+\tau_t^p\right)c_t+d_t+p_{t+1}s_{t+1}=\left(1+r_{t-1}\right)d_{t-1}+w_tn_t+\left(\left(1-\tau_t^d\right)\pi_t+p_{t+1}\right)s_t \quad (6)$$

where d_t denotes the stock of debt at the end of period t, r_{t-1} denotes the domestic interest rate on bonds held between periods $t-1$ and t, w_t denotes real wage, τ_t^p is the tax on consumption and τ_t^d is the dividend tax. In addition, π_t is the profit generated by the firm, s_t the number of shares of the firm owned by the household and p_t the price of each share. The household takes w_t, π_t, p_t, τ_t^p, τ_t^d and the initial conditions d_{t-1} and s_{t-1} as exogenous. The representative household maximizes expected utility, subject to budget constraint (6) and a no-Ponzi constraint of the form:

$$\lim_{j\to\infty}E_t\frac{d_{t+j}}{\prod_{s=0}^{j}(1+r_s)}\le 0 \quad (7)$$

The optimality conditions can be written as:

$$\frac{\left(\left(1-\tau_{t+1}^d\right)\pi_{t+1}+p_{t+2}\right)}{p_{t+1}}=\left(1+r_t\right) \quad (8)$$

$$\frac{u_c\left(c_t\right)}{\beta u_{c(c_{t+1})}}=\frac{\left(\left(1-\tau_{t+1}^d\right)\pi_{t+1}+p_{t+2}\right)}{p_{t+1}}\frac{(1+\tau_t^p)}{(1+\tau_{t+1}^p)} \quad (9)$$

$$\frac{u_n\left(n_t\right)}{u_c\left(c_t\right)}=\frac{w_t}{(1+\tau_t^p)} \quad (10)$$

Equation 8 is an arbitrage condition that equals the capital market return and the return from the stock holdings. As can be seen on the left hand side of Eq. 8, returns on stock holdings arise from two sources: after tax-dividends and capital gains. Equation 9 is the usual Euler equation that describes the evolution of consumption path over time and condition 10 determines labour supply, given the labour market wage rate.

In order to induce independence on the deterministic steady state from initial conditions, we assume that the country faces a debt-elastic interest-rate premium as in Schmitt-Grohe and Uribe (2003). Specifically, the domestic interest rate faced by domestic agents, r_t, is assumed to be the sum of the world interest rate $r^*>0$, which is constant, and a country premium that increases with the country's level of debt d_t. Formally, r_t is given by:

$$r_t=r_t^*+p\left(d_t\right)=r_t^*+\psi\left(e^{d_t-\bar{d}}-1\right) \quad (11)$$

where $\psi>0$ and $\bar{d}$ are parameters. It follows that Eq. 8 can be written as in:

$$\frac{\left(1-\tau_{t+1}^{d}\right)\pi_{t+1}+p_{t+2}}{p_{t+1}}=1+r_{t}^{*}+\psi\left(e^{d_{t}-\bar{d}}-1\right) \tag{12}$$

4.2 The firm

The firm's aggregate production technology is characterized by a Cobb-Douglas production function that uses capital, k_t and labour, l_t, as inputs.

$$Y_t = A_t k_t^{\alpha} l^{1-\alpha} \tag{13}$$

where $\alpha \in (0, 1)$ represents capital's share of output and A_t is the technology. The capital stock evolves according to the following law of motion:

$$k_{t+1} = (1-\delta)k_t + I_t \tag{14}$$

where $\delta \in [0, 1)$ denotes the depreciation of capital. The firm's objective function is to maximize the present value of dividends. Formally, the firm's optimization problem is given by:

$$\max \sum_{i=t}^{\infty}\left(\prod_{s=t}^{i}\frac{\beta u_c\left(c_s\right)}{u_c\left(c_{s-1}\right)}\right)\left(1-\tau_i^d\right)\pi_i \tag{15}$$

subject to the technological constraint (13) and the law of motion of the capital stock (14). In addition, the firm has a quadratic capital adjustment cost of the form:

$$\boldsymbol{\Phi} = \frac{\Phi}{2}\left(\frac{k_{t+1}}{k_t}-(1-\delta)-\xi\right)^2 k_t \tag{16}$$

where $\Phi > 0$ is a parameter. Note that dividends are given by:

$$\pi_i = \left(1-\tau_i^c\right)\left(Y\left(k_i, n_i\right)-w_i n_i\right)-\left(1-\tau_i^c z\right)I_i-\boldsymbol{\Phi} \tag{17}$$

where τ_t^c is the corporate tax in period t, and z is a parameter related to the present value of depreciation allowances. Hence, dividend is the cash-flow after paying wages, corporate taxes, and the cost of investment—which includes the cash cost of investment plus its adjustment cost. The corporate tax is paid at an accrued base. In our set-up, if the firm decides to reinvest, it pays only the corporate tax while if the firm pays dividends to their owners, the total tax burden is larger and corresponds to $(\tau_i^c + \tau_i^d - \tau_i^c\tau_i^d)$. Thus, the corporate tax is in fact a reinvestment tax. The value of the firm, p_t, equals the present discounted value of future expected profits. Using the Euler equation (9) that can be integrated forward and the firms' optimality conditions, in addition to replacing the expressions for dividends (17) and using the linear homogeneity of the production function, we obtain:

$$p_i = \left(1 - \tau_{i-1}^d\right)\left(1 - \tau_{i-1}^c z\right)k_i + \left(1 - \tau_{i-1}^d\right)\Phi\left(\frac{I_{i-1}}{k_{i-1}} - \xi\right)k_i \tag{18}$$

Thus, the value of the firm depends on the after-tax value of its capital stock (including the adjustment cost).

4.3 The government

We assume there is no debt available for the government and thus, its budget constraint is given by:

$$\tau_t^d \pi_t s_t + \tau_t^c \left(Y\left(k_t, l_t\right) - w_t l_t\right) - \tau_t^c z I_t + \tau_t^p c_t = g_t$$

where g_t is the per capita public spending.

4.4 Market clearing

In equilibrium, the following market clearing conditions must hold:

$$s_t = 1 \tag{19}$$

$$n_t = l_t \tag{20}$$

$$d_{t-1}(1 + r_{t-1}^* + \psi(e^{d_{t-1}-\bar{d}} - 1)) - d_t = Y(k_t, n_t) - c_t - g_t - I_t - \varPhi \tag{21}$$

Equation 19 corresponds to stock holdings: in equilibrium the representative household must hold the total supply of stocks. Equation 20 is the equilibrium in the labour market; the left-hand side is the labour supply while the right-hand side is the labour demand. Finally, Eq. 21 describes the equilibrium in the goods market. It basically states that the net change in the country debt holding must be equal to the excess of aggregate expenditure (which includes the net interest payment on debt) vis-à-vis total income; therefore, it is the usual current account definition.

4.5 Equilibrium

Once we have described the model economy, we may define our equilibrium concept.

Equilibrium. Given an initial capital stock, K_0, debt level, d_{-1} and an exogenous process of fiscal policies $\left\{g_{t,}^0 \tau_t^{0,d}, \tau_t^{0,c}, \tau_t^{0,p}, z_t^0\right\}_{t=0}^{\infty}$, the equilibrium of the economy is characterized by a set of quantities $\left\{c_t, n_t, s_t, I_t, \mathrm{div}_t\right\}_{t=0}^{\infty}$ and a set of prices $\left\{w_t, r_t, p_t\right\}_{t=0}^{\infty}$ satisfying the following conditions:

$$\frac{u_c\left(c_t\right)}{\beta u_{c\left(c_{t+1}\right)}} = \frac{\left(\left(1 - \tau_{t+1}^d\right)\pi_{t+1} + p_{t+2}\right)}{p_{t+1}} \frac{(1 + \tau_t^p)}{(1 + \tau_{t+1}^p)} \tag{22}$$

$$\frac{u_n(n_t)}{u_c(c_t)} = \frac{w_t}{(1+\tau_t^p)} \tag{23}$$

$$\frac{\left(\left(1-\tau_{t+1}^d\right)\pi_{t+1}+p_{t+2}\right)}{p_{t+1}} = \left(1+r_t^* + \psi_1\left(e^{d_t-\bar{d}}-1\right)\right) \tag{24}$$

$$p_t = \left(1-\tau_{t-1}^d\right)\left(1-\tau_{t-1}^c z\right)k_t + \left(1-\tau_{t-1}^d\right)\Phi\left(\frac{I_{t-1}}{k_{t-1}} - -\xi\right)k_t \tag{25}$$

$$d_{t-1}\left(1+r_{t-1}^* + \psi\left(e^{d_{t-1}-\bar{d}}-1\right)\right) - d_t = Y(k_t,n_t) - c_t - g_t - I_t - \boldsymbol{\Phi} \tag{26}$$

plus the transversality condition (7).

4.6 Simulation method

Based on the idea that tax reforms might be unexpected and might surprise economic agents as an identifying assumption, we intend to simulate the impact of previously unexpected tax reforms. The methodology differs from using the complete effective path for taxes and fiscal expenditure in an initial simulation because in that case, agents would know ex-ante the changes in policies and would react changing their optimal decisions. Rather than following that methodology, firstly, we will simulate as if the pre-1974 policies would be kept with no change in our complete simulation horizon. In that case, agents will optimally make decisions based on that set of information. Secondly, we will run an additional simulation in which we change the tax path starting in 1974, and we will take as given decisions pre-1974 obtained in the previous simulation. Thus starting in 1974, agents will solve a new problem using their 1973 stock variables as starting points. We repeat the process sequentially for each year of tax reform.

More formally, our procedure is the following. We suppose our initial period is 1960, i.e. $t = 0$ corresponds to 1960. At that time, we suppose there is an exogenously announced fiscal policy that corresponds to the sequence $\left\{g_{t,}^0 \tau_t^{0,d}, \tau_t^{0,c}, z_t^0\right\}_{t=0}^{\infty}$. We use the supra-index 0 to indicate it is the initial simulation, conditional on the initial fiscal policy. We approximate ∞ by T, where T = 10.000. We suppose in $t = 0$, economic agents take as given the exogenous fiscal sequence $\left\{g_{t,}^0 \tau_t^{0,d}, \tau_t^{0,c}, z_t\right\}_{t=0}^{\infty}$ and solve their problems rationally, satisfy market clearing conditions and the public sector budget constraint—ensuring conditions 22 through 26 hold. The result is the sequence $\left\{c_t^0, n_t^0, w_t^0, p_t^0, div_t^0, d_{t,}^0 k_t^0\right\}_{t=0}^{T}$ that solves the complete time span, assuming an exogenous fiscal sequence.

To deal with a later unexpected change in fiscal policy, we set a new and different fiscal policy starting at time $t = j$, where j is the year of the announcement, and we impose a new fiscal sequence from j onwards $\left\{g_{t,}^j \tau_t^{j,d}, \tau_t^{j,c}, z_t^j\right\}_{t=j}^{T}$. We next simulate

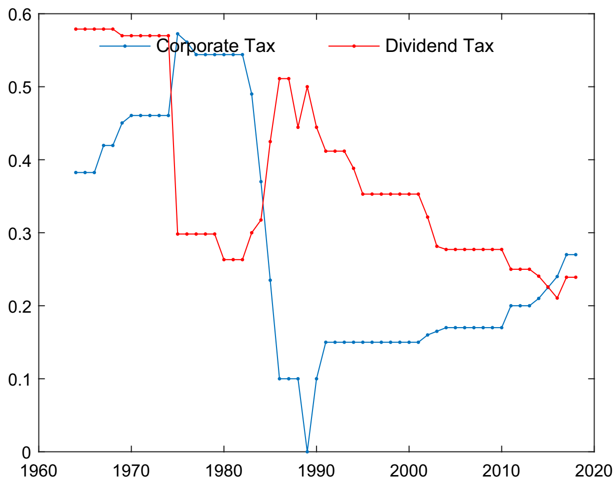

Fig. 4 The evolution of tax rates 1964–2019

using Eqs. 22 through 26 starting at the jth period. To solve the new simulation, we use as starting state variables the values of those variables in the $(j-1)$th year in the former simulation, i.e. $\left\{d_{j-1,}^{j-1} k_{j-2}^{j-1}\right\}$. We repeat that procedure consecutively for changes in the fiscal sequence that correspond to $j = \{1974, 1984, 1990, 1993\}$.

5 Data

5.1 Description

The tax variables in this paper are the reinvestment tax and the dividend tax. We build those series from 1960 to 2019 using the information on the tax code from the National Congress Library. The reinvestment tax rate is built from the different tax levied on corporate profits. It corresponds to the tax rate that the firm pays when it retains \$1 Chilean pesos of profits. Currently, Chile has a unique corporate tax (the so-called first category tax or "impuesto de primera categoría"), but throughout its history, there were at least three additional taxes on non-distributed profits in different periods (from 1960 to 1963, 1968 to 1969 and 1975 to 1985, see the description in Sect. 3). For this reason, we calculate the reinvestment tax rate as follows:

$$t_{\text{rinv}} = 1 - (1 - t_{\text{FC}})(1 - t_A)$$

where t_{rinv} is the reinvestment tax, t_{FC} is the first category tax and t_A is the additional corporate tax when it is applicable. To construct the dividend tax, we took two steps. First, we built a total tax burden variable, and then, we calculate the dividend tax rate as follows:

$$t_{\text{div}} = 1 - \frac{(1 - t_{\text{total}})}{(1 - t_{\text{rinv}})}$$

where t_{div} is the dividend tax, t_{total} is the total tax burden and t_{rinv} is the reinvestment tax. The total tax burden variable corresponds to tax rate on dividend income. As discussed above, before the 1984 tax reform, corporate taxation was independent from the personal income tax so that the total tax burden was calculated as in a classical taxation system, i.e. as an additional tax on the cash flow at the personal level. The 1984 tax reform switched to a full-imputation tax system, i.e. it was allowed to use the corporate tax as a withholding tax for the personal income tax.[10]

Figure 4 illustrates the evolution of the dividend tax (paid by the owners of the firms when they receive dividends) and the evolution of the reinvestment tax rate. Even though the reinvestment tax rate was high at the beginning of the 70s, with the 1974 tax reform, it was further increased, reaching rates over 57% and eventually stabilizing at 54%. By contrast, since the 1984 tax reform, the reinvestment tax rate dropped to its lowest historical level, creating an important difference between the reinvestment rate and the dividend tax. In another hand, the dividend tax was relatively high before 1975, and similar to its 1964–1974 values (around 60%). The 1974 reform decreased the dividend tax to a 30%, which was later reinstated at higher levels of 51% in 1986, and was finally gradually decreased to values close to 35% by the end of 2000s.

The main source for the rest of the Chilean data is Díaz et al. (2010), from which we obtained series for GDP, investment, capital stock, labour force and consumption—both private and public .

5.2 Calibration

The model period is one year. In order to set parameters for the model, we use a combination of parameters that are standard in the literature plus others that have a direct counterpart in the data.

The coefficient of relative risk aversion σ (CRRA) is set to 1.0, as in Cobble and Faúndez (2015). Setting $\sigma = 1$ is consistent with a logarithm utility function, which has been extensively used in the Chilean literature (see Bergoeing et al. 2002, 2005; Céspedes et al. 2012). To fix θ, note that this parameter is directly related to the elasticity of labour supply as $\epsilon_n = \frac{1}{\theta-1}$, where ϵ_n is the labour supply elasticity. According to estimates in Mizala et al. (1998), the elasticity of female and male labour supply in Chile are 1.89 and 1.07, respectively. Using their average of both elasticities, we fix $\theta = 1.5$. In the case of z—that corresponds to the present value share of investment that can be discounted from the tax base—, we use the

[10] The personal income tax is the tax levied on personal earnings including labour and capital income. In Chile, it corresponds to the "Impuesto Global Complementario" (IGC) which taxes the entire personal income base. This is the only progressive tax in Chile. Other taxes are generally flat rates. We use the highest marginal rate of the IGC to construct the time series for the personal income tax. These are available from the tax code—which had obviously changed many times since 1960.

micro-economic estimate in Cerda and Llodrá Vial (2017), and we set z to 0.55. The debt elasticity of the country risk premium ψ is fixed at 0.874, as in García-Cicco et al. (2010)'s estimation for Chile's neighbour: Argentina, using annual data for the period 1900–2005.[11] In this way, the role of debt elasticity of the country premium is not limited to simply induce stationarity, but to act as the reduced form of a financial friction shaping the model's response to aggregate disturbances.[12] We set r^* to 7 percent per year, and we impose the restriction $1 + r^* = \beta^{-1}$ which implies a subjective discount factor, β, of 0.94. A further implication of these restrictions is that the steady state of d_t equals $\bar{d}$. We set the parameter α—the average capital income share—at 0.40 following Corbo and Gonzalez (2014).

The remaining parameters are estimated using Chilean data. The value assigned to the depreciation rate δ is 7%, which is in the middle of the range of values for depreciation rates usually used for Chile. The parameter Φ introduces quadratic capital adjustment cost. This parameter is fixed at 3.5 in order to match the volatility of investment with the one observed in the data. The parameter ξ is set to equal the depreciation rate, this specification ensures that the adjustment costs (for the detrended data) are zero in steady state. Finally, the parameter $\bar{d}$ is set at 0% percent, so that in steady state, there is no debt. This is set to match the observed average trade-balance-to-output ratio for the Chilean economy (over the analysed period, it was near zero).

6 Model predictions

6.1 Basic results

In this section, we report results where we have two scenarios. The baseline scenario excludes tax changes, keeping tax rates at their 1960 level, while the extended scenario includes the tax changes following our simulation model explained in Sect. 4.6. The following figures show predictions of the baseline and the extended model for real investment, real capital, real private consumption and real GDP. We compare both scenarios with actual detrended Chilean data over the period 1960–2019. All series are indexed so that 1960 is the initial value and the respective paths showing deviations from its 1960 detrended value.

Figure 5 shows that the baseline model does not capture the big adjustments in capital accumulations during the 70s, 80s and 90s. One might wonder why does capital decrease in the 70s in the baseline scenario? There is a sequence of transitory

[11] Our specification of the country interest rate premium makes the interest rate a function of the level of debt as opposed to the level of debt relative to trend output. Therefore, to make the comparison possible, the value of ψ of 1.3 used by García-Cicco et al. (2010) must be divided by the level of steady-state output in that model, which equals 1.4865.

[12] Models with imperfect enforcement of international loan contracts a la Eaton and Gersovitz (1981), predict that country premium increases with the level of external indebtedness. In a similar way, models in which international borrowing is limited by collateral constraints imply a shadow interest premium that is increasing in the level of net external debt.

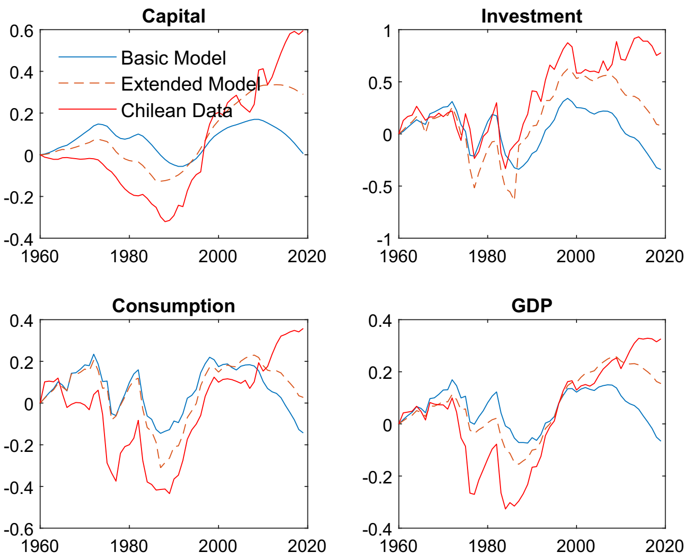

Fig. 5 Basic and extended models

negative shocks in productivity in that period that drive the result. However, those shocks are not enough to explain the behaviour of capital. Conversely, when tax rates are included, the model predicts a fall in the capital stock, and an abrupt rise by the end of the 80's.

The extended model also accurately accounts for the later rebound in capital stock accumulation in the second part of the 80's, where it mimics the behaviour of actual Chilean data quite closely. This rebound is due to the large capital taxation cut: in just 3 years, tax over undistributed profits fell from 49 to 10%. Figure 5 also shows investment for the simulations and the actual detrended Chilean data. The analysis of these series is similar to the one exposed for the capital stock. Temporary productivity shocks explain an important part of the dynamics of investment, but fail to account for the sharp rebound of investment after 1985. On the other hand, the extended model closely follows Chilean investment data in the magnitude as well as timing of the movements, and particularly predicts an impressive rebound in investment in the second half of the 80s, much like that in the Chilean economy. Summing up, the baseline model projects a very small part of the drop in capital stock and fails to account for the later rebound in the capital stock accumulation, and similarly, investment is quite well explained by the extended scenario. This is the main result of the paper, namely that not taking into account the Chilean tax history makes a significant difference in the model's predictions on investment and the capital accumulations path.

In addition, Fig. 5 shows the model's consumption path which was increasing prior to 1974, and later dropped between 1974 and 1977. Both simulated models follow the dynamics of consumption during the period pretty well. Although none of them account for the total consumption drop, they predict a drop in 1974–1975, the

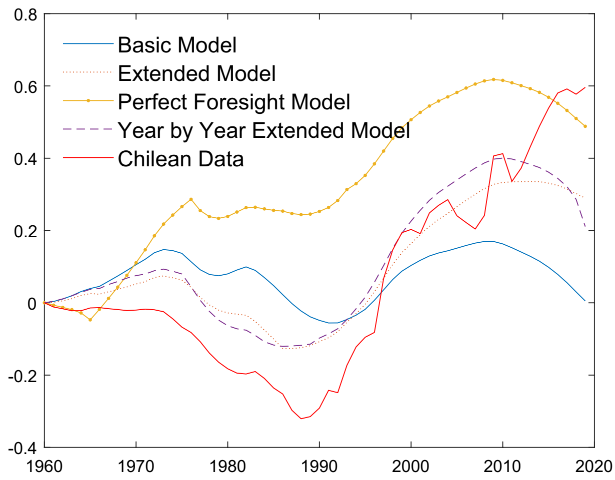

Fig. 6 Perfect Foresight and Year-by-Year models

rebound of 1977, the crisis of 1982 and the final rise in consumption. The extended model does a better job in accounting for the 1982 drop and ends in a higher level than the basic model, following somewhat closer the actual data. Finally, Fig. 5 shows GDP for the predicted models and the Chilean data. The baseline predicts much smoother path compared to the actual data and the extended model. The extended model follows the contractions and the rises in real GDP more closely. Similar to what we saw when we analysed capital stock, the extended model does a better job predicting the timing of the drops and rises, and also better accounts for the large output rise after 1986 while the baseline model does this only partially.

The large adjustments in capital stock that Chile experienced are in line with the reasoning that interest rates in small open economies like Chile respond less to increases in capital taxation, and therefore do not diminish the impact of tax reforms.

6.2 Extensions

So far we have argued that major tax changes are a key factor for explaining capital accumulation dynamics in a small open economy like Chile. In this subsection, we simulate variants of the model to provide intuition and evaluate the robustness of the results. In the first simulation, we include productivity shocks and taxes, but instead of considering only major tax reforms, we include the whole evolution of taxes in the optimization. In this simulation, we assume that households and firms have myopic expectations, and in each period, they fix their expectation concerning taxes at the current tax rates. Thus, when tax rates change in a given year, we assume agents set their expectation of future taxes at that new level. In this case, rather than simulating a sequence of five consecutive tax periods, we simulate a sequence for each year. In that yearly sequence, we take the initial state variables obtained from the previous simulation as given. We call this simulation the "Year by year extended model".

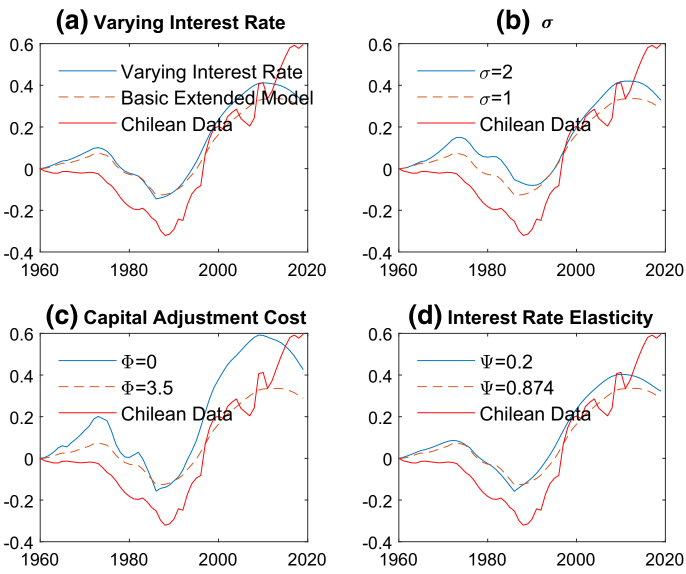

Fig. 7 Extensions

In Fig. 6, we see that the extended model and its variant, the "Year by year extended model", are not very different. The model that includes taxes year by year follows the actual Chilean data a bit more closely, but the magnitude of the output drop and later output rise are very similar. During Chilean history, there were many small tax changes in addition to the three big ones explained in Sect. 3 (1974, 1984 and 1990) that is why this variant of the model provides slighter smoother changes; nevertheless, the main conclusion still holds: considering key features of Chilean tax history makes an important difference in the model's prediction of capital accumulation. In a second extension, we provide a sense of the quantitative impact of another key factor: expectations on future tax rates on undistributed profits and dividends. Up to this moment, our simulations were obtained considering myopic expectations for future taxes. In this second set of simulations, we assume that households and firms know the whole path of future taxes, i.e. they have perfect foresight in taxes. We call it the "perfect foresight model". Figure 6 depicts also the results. The dash-dot line shows the capital accumulation path for the perfect foresight case diverges considerably from the other simulated paths. That result should not be surprising: the intuition is simple, Chilean taxes over undistributed profits decreased over time; therefore, if Chileans knew this path at the beginning of the simulation horizon, their optimal response should have been to accumulate more capital. The result helps to better understand the contributions of expectations in the extended model. An unexpected tax shock is a key factor driving the results and is important for replicating the Chilean capital accumulation path.

Since we are analysing a small open economy, it is important to study if the waves of capital accumulation and de-accumulation are only tightly linked to key reforms in capital income taxation or if there are also other factors, like a varying interest rate that might be affecting the cost of capital. Up to this point, we have assumed a domestic interest rate that is the sum of the world interest rate r^*, which is constant, and a country premium that increases with the country's level of debt d_t. In a third extension, we relax this assumption and introduce variations in the world interest rate. The dotted line in Fig. 7 panel (a) shows the evolution of capital in the basic extended model with taxes—where $r^* = 7\%$—, the red line shows the Chilean data, and finally, the blue line shows the evolution of capital under a varying interest rate that mimics the evolution of the market yield on US Treasury securities at 1 year. As can be seen in figure, by including variations in the international interest rate the simulated capital stock path decreases a bit more during the 80's, as a result of higher interest rates during that period.

We also check the robustness of the results by varying some other key parameters of the model. In particular, we analyse the sensitivity of results to alternative values of the intertemporal elasticity of substitution, the adjustment cost and the interest rate elasticity. In Fig. 7 panel (b), we see the result for an intertemporal elasticity of substitution of 0.5 ($\sigma = 2$), which implies a desire to have less volatile consumption. Under this higher value of σ, we get similar trajectories, but a worst fit for the data, mainly due to an amplification problem. This result goes in line with previous literature and with what was expected for an emerging market, economies that are characterized by more pronounced business cycles and higher consumption and investment volatility (Aguiar and Gopinath 2007). In panel (c), we show the results of decreasing the adjustment cost of the benchmark extended model from $\Phi = 3.5$ to $\Phi = 0$. As can be expected, smaller values of adjustment cost generate greater adjustments in capital stock. Finally, we start from the extended benchmark model but set a smaller interest rate elasticity, which means that the country premium is less sensible to the country's level of debt d_t. As a result, in episodes where the economy has rapid increases on investment financed with debt, we would expect slower increases in the country premium that allow larger increases in investment. This is the result that we observed in panel (d).

7 Conclusion

As in other studies that focus in the US experience (McGrattan 2012; Kydland and Zarazaga 2016; McGrattan 1994a), capital taxation shocks are quite relevant for explaining the economic dynamics of Chile since 1960s. In Chile, the dynamics are quite pronounced after a tax shock. We account for these movements by modelling the tax shocks in a small open economy model, in which the interest rate is much more elastic than in the closed economy model used for developed countries, such us the USA. In fact, when there is a corporate tax shock that depressed capital demand, as the interest rate is very elastic, large part of the tax shock is transmitted to capital quantities producing the large fluctuation in the model, mimicking the observed data. In that sense, this paper shows that a distortionary tax might have a larger impact in small open economies compared to large developed economies, which affect the world interest rate more directly.

Concerning the case of Chile, the question that we have tried to answer is: what explains the "Chilean miracle"? While there has been large interest in studying TPF as the engine of growth during the Chilean miracle, there has been less interest in studying capital accumulation. This is somewhat strange as we show that capital contribution has been a large driver of economic growth over many decades.

In this paper, we looked more carefully at capital dynamics in the Chilean economy during the second part of the 20th century, with special attention to the large increase in investment rate since the mid-80s. This paper challenges the conventional view that fiscal policy played a small role in Chilean growth dynamics. Tax rates on capital changed significantly during the period and, when introduced into the simulation model, imply large drops in investment in the first half of the 70s and explain the large rebound after the mid-eighties.

Our results complement the literature developed in Chari et al. (2007), who propose a methodology to account for fluctuations in business cycles, by using wedges in efficiency, labour and investment. These wedges represent price distortions and generally are modelled using autoregressive processes, and therefore follow random processes. In our case, on the contrary, we focus on the distortion in investment and capital, and we hypothesize that these wedges are the result of changes in capital tax rates. There are some studies such as Lama (2011), which in Latin America emphasizes the relevance of wedges in the labour market. However, our study using longer data, with significant movements in capital tax rates, finds that the investment wedges seem to be very relevant. This is in line with what was found in other studies such as Chakraborty and Otsu (2013) for the case of BRICs economies and also by Simonovska and Soderling (2015) for Chile. In this last paper, although it occupies data of lesser extension than ours, they find that the efficiency wedges , labour and investment are relevant since the beginning of the 2000s.

Our paper complements the conventional view by showing that TPF alone is not able to explain neither the sharp decline of capital stock in the 70s nor the large rise during the 80s. In line with other recent studies (Cerda et al. 2020; Cerda and Llodrá Vial 2017), this study finds that fiscal policy is important for capital accumulation in Chile, and suggests that a promising area for future research is to estimate and quantitatively evaluate the effects that different fiscal policies have had in the development path of emerging market economies.

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