ARC Centre of Excellence in Population Ageing Research

Working Paper 2022/05

Dividend Imputation, Investment and Capital Accumulation in Open Economies

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March 2022

Abstract

A dividend imputation system is designed to address double taxation of capital income by allowing companies to pass on profit taxes paid at the corporate level to shareholders in form of franking tax credits. In this paper, we study implications of dividend imputation in a small open economy model with firm heterogeneity and an internationally integrated capital market. Our analysis indicates that dividend imputation has opposing effects on investment and capital accumulation. On one hand, it mitigates the adverse effects of double taxation and induces more saving and investment; on other hand, it raises the cost of investment for firms that are not fully imputed, which subsequently results in less investment. Moreover, different tax treatments for resident and foreign investors amplify frictions in reallocation of capital across firms, which prevents inflows of foreign capital from fully offsetting the shortage of domestic savings. International investors are not marginal investors in our small open economy setting. Overall, the net effect on capital accumulation is analytically ambiguous, depending on which force is dominant. Our quantitative results indicate that the positive force is dominant and removing dividend imputation leads to decreases in domestic savings, aggregate capital and output. Interestingly, the overall welfare effect is positive as low income households benefit more from additional government transfers, while tax burdens are shifted towards high income households and foreign investors.

JEL Classification: D21, E62, H21, H22, H25

Keywords: Double taxation; Franking tax credit; Fiscal policy; Firm heterogeneity; Overlapping generations; Open economy; Dynamic general equilibrium; Welfare.

*We appreciate useful comments from Alan Woodland, Peter Swan, Robert Gregory, Tim Kam, Maria Racionero and participants of Seminars at Jinan University and Australian National University.

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1 Introduction

In the United States and many other countries, corporations are considered separate legal entities from their shareholders. As such, corporate profits are taxed twice, firstly, at the corporate level as profit taxes, and secondly, when realized by shareholders as dividend and capital gains taxes. This is known as the double taxation of corporate profits. In such "classical" income tax system, this double taxation of capital income likely results in adverse effects on investment, capital accumulation and growth (e.g., see Judd (1985), Chamley (1986), Gordon (1986) and Gordon (1992)). The US has addressed the double taxation issues by lowering tax rates on dividends and capital gains as well as corporate profits.[1] Conversely, few other countries, including Australia, Canada, Chile, Korea and New Zealand, take a different approach by allowing the tax paid at the corporate level to be attributed, or imputed, to shareholders in form of franking tax credits.

Under a tax system with dividend imputation benefits, shareholders are allowed to use franking tax credits to reduce the personal income tax payable. In theory, governments can completely eliminate double taxation by fully refunding profit taxes paid by firms to households. In practice, a proportion of profit tax available as franking tax credits varies from country to country, i.e., either full or partial imputation. Only in few countries like Australia and New Zealand is the full amount of the corporate tax paid distributed as a franking tax credit, i.e., full imputation.[2] Franking credits can only be distributed proportional to dividend payments. Franking tax credits are usually restricted to local investors who are considered residents for tax purposes. Foreign investors might be able to claim some franking credits, but do not receive payouts as tax-resident investors.

Previous studies in the macroeconomics and public finance literature mainly focus on the effects of capital income taxation in an economy where a "classical" tax system is modeled (e.g., see Conesa, Kitao and Krueger (2009) and Gourio and Miao (2010)). Very little is known about to what extent dividend imputation can ameliorate the adverse effects of double taxation and implications for investment, capital accumulation and the macroeconomy. This paper attempts to fill that gap.

To do so we build a dynamic general equilibrium, small-open economy model with a continuum of domestic firms, overlapping generations of households as consumers and local/home investors, foreign investors and a government. Our model has fundamental features of a heterogeneous firms model of Gourio and Miao (2010) and an overlapping generations model of Conesa, Kitao

[1] The American solution to the double taxation issue includes relatively lower tax rates on capital income at the shareholder side. In particular, the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA), a.k.a Bush tax cut, reduced the tax rates on dividends and capital gains to an uniform rate of 15 percent. The 2017 Tax Cuts and Jobs Act (TCJA), a.k.a Trump tax cut, provided large corporate income tax cuts for corporate businesses from 35 to 21 percent.

[2] Canada and Korea have a partial imputation system. Germany had a dividend imputation system until 2000 and France until 2004. Swan (2019) argues that Australia's dividend imputation system achieves the goal of a zero, or close to zero, marginal tax rate on capital.

and Krueger (2009). More specifically, the firm sector includes a large number of firms who undergo idiosyncratic productivity shocks and, while ex-ante identical, are ex-post heterogeneous. Firms act inline with their owners incentives and internalize their owners tax treatments. Firms are subjected to non-negative dividend and non-negative equity issuance constraints. There is a domestic capital market where firm's equity is sold to domestic and foreign investors. Assumingly, a competitive bidding mechanism drives equity prices up to their highest valuation. The foreign investors are free to purchase equity of domestic firms when the expected return meets the rate available internationally. The household sector consists of households with differences in age and labor productivity. The households choose supply labor, consumption and saving to maximize their lifetime utilities. The domestic households are local tax residents who are subjected to the national income tax code and are generally eligible to claim franking credits. The foreign investors are subject to different tax treatments and are generally ineligible for franking credit deductions. The markets are incomplete, with domestic firms subject to financial constraints and capital adjustment costs, and households subject to borrowing constraints and no annuities.

We first explore the impacts of dividend tax and imputation on firm's investment and finance. The previous literature documents two opposing views on the impacts of dividend taxation on investment. Under the "traditional" view, new equity is the marginal source of funds (i.e., external funds) and higher dividend taxes lower the return on this investment and thereby reduce investment. Under the "new" view the marginal source of funds for investment is retained earnings (i.e., internal funds), here dividend tax does not change the marginal cost benefit relationship for investment. Empirical evidence on these two views is inconclusive. Auerbach and Hassett (2003) found different firms behave empirically consistent with both views in US data. Gourio and Miao (2010) show that firms behave consistent with both views in a heterogeneous firm model. In the model of Gourio and Miao (2010), there are three financing regimes with different marginal sources of investment finance: equity issuance regime, liquidity constrained regime and dividend distribution regime. Similar to Gourio and Miao (2010) we find that these three regimes exist in our small open economy model with heterogeneous firms.

Specifically, firms in the equity issuance regime rely on new equity as the marginal source of investment finance; meanwhile, firms in the liquidity constrained regime the cost of firm's investment is equal to after tax profits. Firms in the dividend distribution regime use internal funds for finance investment. However, due to a dividend imputation system the dividend distribution regime are further divided into three sub-regimes according to imputation status: partially imputed, fully imputed and fully franked. In the partially imputed regime, franking credits are limited by dividends paid; meanwhile, in the fully franked regime firms distribute the full value of franking credits which is equal to corporate tax paid. In the fully imputed regime, franking credits are constrained by corporate tax paid. Overall, there are five regimes by financial and imputation status in our framework. At any point in time, heterogeneous firms facing different financial constraints fall in one of these five regimes and react differently to dividend taxation.

There are two interesting results. First, dividend imputation has two opposing effects on investment and capital allocation. By mitigating double taxation on capital, dividend imputation raises the expected return on capital, which induces firms in all regimes to invest more. On other hand, dividend imputation raises the value of dividends and the cost of investment for firms in the partially imputed and fully franked regimes, which subsequently reduces their investment. The net effect of dividend imputation on investment is ambiguous, depending which force is dominant. Second, foreign financial capital is an imperfect substitute for domestic saving in our small open economy model, where capital is freely moved across borders. A conventional result that foreign capital is the marginal source of investment funds does not generally hold when firms are heterogeneous. Foreigners are active in the domestic equity market until they are indifferent between owning additional assets that generate internationally comparable returns. Favorable franking credit treatments for dividend paying firms and tax-resident investors create return differentials between dividend and non-dividend paying firms, and between foreign and domestic-owned firms. As a result, some equities in the domestic capital market do not generate a sufficient return that meets foreign investor's required return. This tax wedge induces foreign investors to invest in a subset of domestic firms that generate an internationally comparable return. In equilibrium, frictions in the capital markets amplifies misallocation of capital across firms and lowers aggregate productivity.

We next simulate the effects of dividend imputation in a full dynamic general equilibrium model. Our quantitative results suggest removing dividend imputation for resident investors reduces the effective rate of return and dampens households' incentives to save and invest, which leads to a reduction in domestic savings. There is a decline in resident owned firms. Foreign investors own more firms; however, the total value of foreign owned equity is broadly unchanged. That is, inflow of foreign capital is not enough to fully offset reduction in supply of domestic savings. The tax wedges and frictions in the capital market prevent foreign capital to be a perfect substitute for domestic savings in a heterogeneous firm setting. After all, removing dividend imputation leads to lower investment, capital accumulation and output. Thus, the classic result that foreign investors are marginal investors in open economies with free capital mobility does not hold in our model.

In addition, we consider an experiment in which the government offsets the adverse effects of removing dividend imputation by reducing the dividend tax rate to the capital gains tax rate for residents. Cutting the dividend tax reduces frictions in reallocation of capital across firms, which results in an increase in total factor productivity and output. However, it is not large enough to fully offset the reduction in output due to removing dividend imputation. Overall, output is still lower. Adjustments in investment and net exports keep aggregate consumption to stay at similar level.

In quantitative analysis the ownership distribution reflects the investors relative tax treatments. Small changes in policy settings can drive large changes in the ownership distribution as small policy changes can flip relative valuations. As such, the impacts of small policy changes can depend to a large degree the initial ownership distribution and, therefore, on initial policy settings. In the analysis investors take advantage of comparative tax advantages related through inter-temporal trade of equities. Hence, even with a narrow distribution of productivity shocks we get firm heterogeneity and trade in equities as firms cater to their owners' tax treatments.

Related literature. Our paper is primarily connected to three strands of the literature: capital income taxation in open economies, analysis of dividend and capital gains taxes in heterogeneous firm models, and analysis of capital income taxation in overlapping generations models.

There is a large literature on capital income taxation in open economies (e.g., Diamond and Mirrlees (1971), Feldstein and Horioka (1980), Gordon (1986), Gordon (1992) and Auerbach and Devereux (2013)). In particular, Diamond and Mirrlees (1971) show that capital income should not be taxed at the source in small open economy. Gordon (1986) also argues that it is efficient for small open economies to forgo the taxing of corporate profit to maximize welfare. Gordon (1992) argues that capital taxes have survived due the tax-crediting conventions, that is credits that foreigners receive in their home countries for capital taxes paid on foreign capital income. Auerbach and Devereux (2013) using a model with a multinational producing and selling in two countries with three sources of rent to show source based taxation distorts production and consumption. They find a destination-based cash-flow tax does not distort behavior but is incident residents. Our paper contributes to this literature a new small open economy model with heterogeneous firms. Our modeling innovation enables us to have new insights into taxation of savings, investment and international capital flows.

Our model builds on the work of Gourio and Miao (2010), Gourio and Miao (2011) and Anagnostopoulos, Atesagaoglu and Carceles-Poveda (2021). That heterogeneous firm literature shows that how capital taxes affect aggregate capital stock and allocation of capital across firms. Anagnostopoulos, Atesagaoglu and Carceles-Poveda (2021) in particular quantify the aggregate and distributional consequences of replacing corporate profit taxes with taxes on dividends and capital gains. As emphasized by Hsieh and Klenow (2009), the distribution of capital across firms is important for aggregate productivity and output. Chen, Qi and Schlagenhauf (2018) allow for ownership structure and find reducing corporate tax improves capital allocation. We extend these previous studies and include dividend imputation and open macroeconomy settings with resident and foreign investors. Our overlapping generations structure of household sector also enable us to shed lights on inter- and intra-distributional consequences.

Since Auerbach and Kotlikoff (1987) there has been a large macroeconomic and public finance literature analyzing tax policy, using overlapping generations models. Our choice to include overlapping generations of households is motivated by Erosa and Gervais (2002) and Conesa, Kitao and Krueger (2009) who demonstrate that lifecycle structure of households is important for understanding lifecycle behaviors and optimal capital taxation. Finally, while partially calibrated to Australia, our paper contributes to the analysis of effects of fiscal policy in Australia (e.g. see Tran and Wende (2021) and Kudrna, Tran and Woodland (2022)). We connect that macro/public finance literature to the macro/finance literature using heterogeneous firm models.

The paper is structured as follows. Section 2 describes the model and Section 3 analyses the firms' optimal choices. Section 4 provides details on the model calibration. In Section 5 presents the quantitative analysis of the core imputation scenarios. Sections 6 provide sensitivity analysis and extension. Section 7 concludes. The Appendix contains additional tables and figures related to the calibration and quantitative analysis.

2 Model

The model is a discrete time dynamic general equilibrium model, which consists of overlapping generations of households, a continuum of perfectly competitive firms, foreign investors and a government with full commitment technology.

2.1 Household

The household sector consist of overlapping generations with different skill types.

Demographics. The model is populated by households of different ages between 20 and 100, $j \in \mathbb{J} =[20, ..., 100]$, and three different skill types $i \in \mathbb{I} =[1, 2, 3]$. In each period a continuum of households aged 20 enters the model and live at most 100 years. They face a stochastic probability of death every period with the age-dependent survival probability given by sp_j at age j. The unconditional probability of surviving from age 20 to age j, is given by $S_j = \prod_{s=21}^{j} sp_s$. The size of a new cohort entering the economy and the overall population both grow at the rate g^n. $M_{t,j,i}$ denotes the size of the cohort of skill type i in age j at time t, which evolves according to $M_{t+1,j+1,i} = sp_{j+1}M_{t,j,i} = M_{t,j+1,i}(1 + g^n)$.

Preferences. Households maximize expected lifetime utility which is the sum of current and discounted future intra-temporal utility adjusted for the chance of death

$$U_{t,j,i} = \sum_{j'=j}^{100} S_j \hat{\beta}^{j'-j} u\left(c_{t+j'-j,j',i}, l_{t+j'-j,j',i}\right),$$

where $\hat{\beta}$ is the time discount factor and S_j is the unconditional probability of survival.

All households have identical intra-temporal preferences over consumption, $c_{t,j,i} \geq 0$, and leisure, $0 \leq l_{t,j,i} \leq 1$. The intra-temporal utility is assumed to have the form

$$u\left(c_{t,j,i}, l_{t,j,i}\right) = \frac{\left(c_{t,j,i}^{\gamma} l_{t,j,i}^{1-\gamma}\right)^{1-\sigma^h}}{1-\sigma^h},$$

where σ^h is a parameter governing inter-temporal elasticity of substitution and γ is the consumption share of utility.

Endowments. Households differ by skill type and age in our model. New households enter the model with a specific income type that determines their labor productivity over their life. Labor efficiency, denoted by $e_{j,i}$, is type and age dependent but time-invariant. In each period, households are endowed with one unit of time that can be allocated to labor market and leisure activities. As such, the agents before tax labor income is given by $w_t\left(1-l_{t,j,i}\right)e_{j,i}$ where w_t is the market wage rate in period t.

Household optimization. A household begins with zero assets and chooses consumption, labor supply and asset holdings to maximize its utility over its lifetime. The households can buy a share of equity, $\theta_{i,j,t}(k_{t+1}, z_t)$, of the continuum of firms where firms are denoted by their next period capital k_{t+1} and their productivity z_t. Firms are either wholly owned by residents or foreigners. The household's equity carried over from the previous period is valued at the price of the firm before issuance, $\tilde{p}_t(k_t, z_t)$, while the household buys equity for the next period at the post issuance price $p_t(k_{t+1}, z_t)$. This is the only way households are able to save for future consumption. We do not consider an option for households to buy assets in foreign countries or buy domestic bonds. The households face borrowing constraints and can not short sell equity, $\theta_{t,j,i} \geq 0$.

There are several sources of income. The household receives labor income, $w_t(1-l_{t,j,i})e_{j,i}$ and equity pays dividends $d_t(k_t, z_t)$. Firms also distribute franking credits, $FC_t(k_t, z_t)$, for the corporate tax they pay and the $\chi^{FC,h}$ parameter determines the degree to which households are able the claim franking credits. Additionally the household receives accidental bequests, $bq_{t,i}$, and government transfers $tr_{t,j,i}$. The household pays labor income tax, dividend income tax, capital gains tax and interest income tax a rates τ_t^l, $\tau_t^{d,h}$, $\tau_t^{g,h}$ and $\tau_t^{i,h}$ respectively. Capital gains is paid on an accrual basis the difference between the price paid for equity and the before issuance equity price. Capital gains tax is a symmetric in that losses are refunded.

The household's income is used to fund consumption and asset purchases where a consumption tax is levied on consumption. As such the households resource constraint is given by

$$
\begin{aligned}
(1+\tau^c)c_{t,j,i} + \int p_t\theta_{t,j,i}d\mu_t &= (1-\tau^l)w_t(1-l_{t,j,i})e_{j,i} + tr_{t,j,i} + bq_{t,i} \\
&+ \int \left(\tilde{p}_t + (1-\tau^{d,h})\left(d_t + \chi^{FC,h}FC_t\right) - \tau^{g,h}\left(\tilde{p}_t - p_{t-1}\right)\right)\theta_{t-1,j-1,i}d\mu,
\end{aligned}
\tag{1}
$$

where $\mu(k_t, z_t)$ is the distribution of firms over capital and productivity.

The domestic expected rate of return on equity is given by

$$
\frac{E_t\left[(1-\tau^{d,h})(d_{t+1}+FC_{t+1}) + (1-\tau^{g,h})(\tilde{p}_{t+1}-p_t)\right]}{p_t}. \tag{2}
$$

However, a domestic rate of return on equity, r_t^h, prevails on all equity bought by resident households. This rate of return is determined by the equity of the marginal firm bought by households.

Any other equity bought by households has it's price bid up so that it's expected return equals r_t^h. Households do not necessarily buy equity in all firms and as such there can exist firms with an expected return below r_t^h. Equity not bought by households has a lower expected return than prevailing domestic rate. Consistent with the domestic rate of return, the price households are willing to pay for equity is given by

$$p_t^h = \frac{E_t\left[(1-\tau^{d,h})(d_{t+1} + \chi^{FC,h} FC_{t+1}) + (1-\tau^{g,h})(\tilde{p}_{t+1})\right]}{r_{t+1}^h + (1-\tau^{g,h})}. \tag{3}$$

In order to simplify the model we assume that all households hold the same share of each firm. As such each households holds an equal share of each firm with $\theta_{t,j,i}(k_{t+1}, z_t) = \theta_{t,j,i}\mathbf{1}_{\Omega(k_{t+1},z_t)=h}$. Here $\mathbf{1}_{\Omega(k_{t+1},z_t)=h}$ is an indicator function of whether there is any resident ownership of the firm at the end of the period t. This allows us to further simplify the household problem. We write the households problem in terms holdings of the representative asset $A_{t,j,i}$ where the resource constraint is given by

$$(1-\tau^c)c_{t,j,i} + a_{t+1,j+1,i} = (1-\tau^n)w_t(1-l_{t,j,i})e_{j,i} + (1+r_t^h)a_{t,j,i} + tr_{t,j,i} + bq_{t,i}. \tag{4}$$

In the above expression the assets owned by each households are given by

$$a_{t+1,j+1,i} = \theta_{t+1,j+1,i}\int p_t \mathbf{1}_{\Omega(k_{t+1},z_t)=h} d\mu_t. \tag{5}$$

As there is no aggregate uncertainty, the return the portfolio of assets equals the expected return.

The household's utility maximization problem can be written in terms of a dynamic programming problem as

$$V_j(a_{t,j,i}) = \max_{\{C_{t,j,i}, l_{t,j,i}, a_{t+1,j+1,i}\}} \left\{u\left(c_{t,j,i}, l_{t,j,i}\right) + \hat{\beta} s p_{j+1} V_{j+1}\left(a_{t+1,j+1,i}\right)\right\} \tag{6}$$

subject to the household's budget constraint given in equation (4), the credit constraint, $a_{t+1,j+1,i} \geq 0$, and the non-negativity of leisure and consumption $c_{t,j,i} > 0$ and $1 \geq l_{t,j,i} > 0$.

2.2 Market structure and foreign investors

In our small open economy model, financial capital is freely mobile across borders. Foreign investors invest in the local equity market as long as their after tax expected return equals to the world interest rate r. Foreign investors are classified as non-residents for income tax purpose. Dividend withholding tax is levied on dividends received by foreign investors at a rate $\tau^{d,f}$. The degree to which foreigners are able to claim franking credits is determined by $\chi^{FC,f}$. We allow for a capital gains tax to be levied on foreign investors an accrual basis at a rate $\tau^{g,f}$. A typical foreign investor's after tax expected return is given by

$$\frac{E_t\left[(1-\tau^{d,f})(d_{t+1}+\chi^{FC,f}FC_{t+1})+(1-\tau^{g,f})(\tilde{p}_{t+1}-p_t))\right]}{p_t}. \tag{7}$$

The equity price foreign investors are willing to pay for equity is given

$$p_t^f = E_t\left[\frac{(1-\tau^{d,f})(d_{t+1}+\chi^{FC,f}FC_{t+1})+\tilde{p}_{t+1}(1-\tau^{g,f})}{1+r-\tau^{g,f}}\right]. \tag{8}$$

Foreign investors compete freely with local domestic households as resident investors in the capital market. All investors can fully observe firm investment and therefore know next period capital. However, they are uncertain about future firm-specific productivity. Residency matters for tax liabilities and firm valuations. Foreign and resident investors might have different valuations of firms because they receive different tax treatments in terms of tax credits and liabilities. As a result, Foreign and resident investors' expectations of the after tax return to holding equities can diverge and drive different valuations. We assume a competitive bidding process among investors forces equity prices up to their valuations. Let $p_t^h(k_{t+1},z_t)$ and $p_t^f(k_{t+1},z_t)$ demote the maximum price resident and foreigners, respectively, are willing to pay for equity in for firm with next period capital k_{t+1} and productivity z_t, as given in equations (3) and (8).

Equities are traded at the end of each period and are sold to the highest bidder. Essentially, the price of equity is given by the maximum of each group's valuation expressed as

$$p_t(k_{t+1},z_t) = \max\left\{p_t^h(k_{t+1},z_t), p_t^f(k_{t+1},z_t)\right\}. \tag{9}$$

Thus, the tax residency rule with different tax treatments for foreign investors affects valuation of firms in the domestic capital market, which in return influences firms' investment and financial decisions. We next detail the firm sector and optimization problems.

2.3 Firms

The production sector consists of a continuum of ex-ante identical firms that under-go idiosyncratic productivity shocks at the start of each period. The firms are owned by either resident or foreign investors. The firms own capital and choose investment, dividends, equity and labor demand to maximize the return to their owners. Firms differ ex-post in terms of the histories of ownership, productivity shocks and their capital levels. A Markov productivity processes ensures the current state of each firm is captured by current ownership, capital and productivity.

Technology. The firms produce output, y_t, by combining capital, k_t, and labor, n_t, in a decreasing returns to scale Cobb-Douglas production function that also depends on the firm's productivity level, z_t. Output before adjustment costs, y^*, is given by

$$y^*_t\left(k_t, n_t; z_t\right) = z_t k_t^{\alpha_k} n_t^{\alpha_n}.$$

The quadratic capital adjustment cost can be deducted directly from output. The final good price is normalized to 1. Firm's revenue is given by

$$y_t\left(k_t, n_t\right) = y^*_t\left(k_t, n_t; z_t\right) - 0.5\psi\left(\frac{i_t}{k_t} - \delta\right)^2 k_t, \tag{10}$$

where i_t is investment and δ is the depreciation rate.[3]

The firms productivity level evolves according to a Markov process given by

$$\ln z_t = \rho \ln z_{t-1} + \epsilon_t,$$

where ρ is the persistence of the Markov process and the shocks, ϵ_t, are normally distributed with mean zero and standard deviation σ, $\epsilon_t \in \mathcal{N}(0, \sigma^2)$.

Capital is accumulated according to the law of motion

$$k_{t+1} = (1-\delta)k_t + i_t. \tag{11}$$

Corporate finance. The firm is owned by equity holders, these are either residents or foreign investor. There are two channels to finance the firm's investment plan: internal finance from earnings after wages and taxes or external finance by issuing new equity, s_t. While firms can distribute earnings through dividends, d_t, they can not raise revenue by paying out negative dividends. The dividend paying constraint is given by

$$d_t \geq 0. \tag{12}$$

While firms can raise revenue through equity issuance, they are not able to return revenue to equity-holders through equity buy-backs. The equity issuance constraint is given by

$$s_t \geq 0. \tag{13}$$

Further, we do not allow the firm to simultaneously pay out dividends and issue equity. Hence, at all times either issuance, dividends or both must be equal to zero. The financial regime constraint is given by

$$d_t s_t = 0. \tag{14}$$

Any new shares issued by the firm are bought by the same group that buys the share at the end of the period. The value of a firm's equity after issuance p_t is given by the value bought from

[3]The assumption that adjustment cost lowers firm's output is important for taxable revenue. This representation is also useful when we decompose changes in output later.

previous share holders $\tilde{p}_t$ plus the value bought through new issuance s_t, as given by

$$p_t = s_t + \tilde{p}_t. \tag{15}$$

Corporate tax and deductions. We model main features of a corporate tax system with dividend imputation. Firms are required to pay corporate taxes on their income which is revenue minus wages, $\tau^k (y_t - w_t n_t)$. Investment and capital depreciation are tax deductible. The value of investment expensing deductions is given by $\chi^I i_t$, where $\chi^I \in [0,1]$ is the deductible fraction of the investment cost. The value of depreciation deductions is equal to $\chi^\delta \delta k_t$, where $\chi^\delta \in [0,1]$ is the deductible fraction of depreciation cost.[4] The corporate tax base after deductions, π^τ, is given by

$$\pi_t^\tau = y(k_t, n_t) - w_t n_t - \chi^I i_t - \chi^\delta \delta k_t. \tag{16}$$

The corporate tax system does not allow for negative corporate tax payments. To capture the non-negativity constraint on corporate tax we define the corporate tax rate function $\tau^k(\pi^\tau)$ as a function of a firm's tax base, π^τ, with the function equal to the corporate tax rate when a firms' tax base is positive and zero otherwise.

$$\tau^k(\pi^\tau) = \begin{cases} \tau^k & \text{if } \pi_t^\tau \geq 0 \\ 0 & \text{if } \pi_t^\tau < 0. \end{cases} \tag{17}$$

The corporate tax paid by each firm, tax_t^k, is given by

$$tax_t^k = \tau^k \pi_t^\tau. \tag{18}$$

Resident investors, i.e., local households, receive a tax credit for the tax paid by firms in which they own equity, known as franking credits (FC) or dividend imputation. By definition franking credits are only received relative to the company income tax paid. The tax-paying franking credit constraint is given by

$$FC_t \leq tax_t^k. \tag{19}$$

In addition, franking credits can only be distributed proportional to the dividend tax paid.[5] This results in another constraint, namely dividend-paying franking credit constraint, as

$$FC_t \leq \frac{\tau^k}{(1-\tau^k)} d_t. \tag{20}$$

[4] Immediate expensing and depreciation deductions are effectively a tax credit for gross investment. For example, in Judd (1987) firms receive an investment tax credit $\theta^{\text{Judd}}(i+\delta k)$. When $\chi^I = \chi^\delta = \theta^{\text{Judd}}/\tau^k$ we have an investment tax credit in our model equal to that in Judd (1987).

[5] The franking credit limit can be found here https://www.ato.gov.au/Business/Imputation/Paying-dividends-and-other-distributions/Allocating-franking-credits/#Calculatingthemaximumfrankingcredit1

The value of franking credits are required to be positive, i.e. $FC_t \geq 0$. The final value of franking credits is given by

$$FC_t = \max\left\{0, \min\left\{tax_t^k,\ \frac{\tau^k}{(1-\tau^k)}d_t)\right\}\right\}. \tag{21}$$

Firm optimization. Firms are owned by either resident households (home/resident investor) or overseas agents (foreign investor). Let $o_t = \{\text{h,f}\}$ denote a firm's ownership status. The set of a typical firm's state variables at the beginning of the period includes capital k_t, productivity shock z_t and ownership o_t. Firms make decisions on investment i_t, dividend payment d_t, equity issuance s_t, labor demand n_t and new ownership o'_{t+1} to maximize the returns of their shareholders.

Given foreigner's and resident's after tax returns given in equations (7) and (2), the maximization problem for firms can be written as

$$V_t(k_t, z_t, o_t) = \max_{i_t, d_t, s_t, n_t, o'_{t+1}} \left(1-\tau^{d,o}\right)\left(d_t + \chi^{FC,o} FC_t\right) + (1-\tau^{g,o})\tilde{p}_t(k_{t+1}), \tag{22}$$

where $\chi^{FC,o} \in [0,1]$ is the degree to which shareholders are able to claim franking credits. Writing this in terms of the post issuance equity price, the value of issuance s_t, and the set of state variables $x_t = \{k_t, z_t, o_t\}$ we have

$$V_t(k_t, z_t, o_t) = \max_{i_t, d_t, s_t, n_t, o'_{t+1}} \left(1-\tau^{d,o}\right)\left(d_t + \chi^{FC,o} FC_t\right) + \left(1-\tau^{g,o}\right)\left(s_t + p_t(k_{t+1})\right). \tag{23}$$

As discussed before, a firm's equity price determined by the maximum willing to pay by either residents or foreigners as given in equation (9). Combining the equity price expression with the price residents and foreigners are willing to pay for equity, from equations (3) and (8), the firms' problems can be written in Bellman equation from as

$$\begin{aligned} V_t(x_t) = \max_{i_t, d_t, s_t, n_t} \Bigg(& \left(1-\tau^{d,o_t}\right)\left(d_t + \chi^{FC,o_t} FC_t\right) + (1-\tau^{g,o_t})s_t \\ & + \left(1-\tau^{g,o_t}\right) \max_{o'_{t+1}} \left(\frac{E_t\left[V(x_{t+1}, o'_{t+1})\right]}{r^{o'}_{t+1} + 1 - \tau^{g,o'_{t+1}}} \right) \Bigg). \end{aligned} \tag{24}$$

For convenience, here and in future usage, $\{x_{t+1}, o'_{t+1}\}$ denotes $\{k_{t+1}, z_{t+1}, o'_{t+1}\}$.

The firms' maximization problems are subject to the resource constraint given by

$$d_t + s_t = y(k_t, n_t, z_t) - w_t n_t - i_t - tax^k. \tag{25}$$

The firms' problems are further subject to the constraints regarding output, capital accumulation, taxation, dividends, issuance and franking credits given in equations (10), (11), (18), (12), (13), (14) and (21).

The firms' problems specify a set of optimal decision rules for labor demand, investment, next period capital, equity issuance, dividends and ownership.

$$
\begin{aligned}
n_t^* = n(x_t),\ i_t^* = i(x_t),\ k_{t+1}^* = g(x_t),& \\
s_t^* = s(x_t),\ d_t^* = d(x_t).& \qquad (26)
\end{aligned}
$$

Ownership outcomes are decided in the asset market. As such, the ownership decision rule is given by

$$
o_{t+1}^* = \underset{o}{max}(p_t^o(k_{t+1}^*, z_t)) = \Omega(k_{t+1}^*, z_t) = \Omega(g(x_t), z_t) = \Omega(x_t). \qquad (27)
$$

Firm distribution and aggregation. The idiosyncratic productivity shocks imply that firms vary in terms of both their capital k_t, productivity z_t, and ownership o_t. The distribution of firms over ownership, capital and productivity is denoted by $\mu_t(k, z, o)$ and where the law of motion for the distribution is given by

$$
\mu_{t+1}(K \times Z \times O) = \sum_o \int \mathbf{1}_{\Omega(x)\in O} \mathbf{1}_{g(x)\in K} \mathrm{Q(z,Z)}\mu_t(\mathrm{dx,o}). \qquad (28)
$$

For convenience, here and in future usage, $\{dx, o\}$ denotes $\{dk, dz, o\}$. Further, $Q(z_t, z_{t+1})$ is the transition function for the Markov process, $\mathbf{1}$ is an indicator function and $\Omega(x)$ and $g(x)$ are next period ownership and the optimal choices for next period capital as given in equations (26) and (27).

Given this distribution of firms it is straight forward to calculate aggregate labor demand,

$$
N_t^d = \sum_o \int n_t(x)\mu_t(dx, o), \qquad (29)
$$

aggregate output,

$$
Y_t = \sum_o \int y_t(x)\mu_t(dx, o), \qquad (30)
$$

aggregate investment,

$$
I_t = \sum_o \int i_t(x)\mu_t(dx, o), \qquad (31)
$$

aggregate issuance,

$$
S_t = \sum_o \int s_t(x)\mu_t(dx, o), \qquad (32)
$$

aggregate dividends,

$$
D_t = \sum_o \int d_t(x)\mu_t(dx, o). \qquad (33)
$$

start of period total value of asset owned by investor group o,

$$\tilde{P}_t^o = \sum_o \int \tilde{p}_t(x)\mu_t(dx, o). \tag{34}$$

and end of period total value of assets bought by investor group o,

$$P_t^{o'} = \sum_o \int \mathbf{1}_{\Omega(x)=o'} p_t(x)\mu_t(dx, o). \tag{35}$$

2.4 Government

The government collects revenue from taxing household and firm incomes and household consumption to finance government purchases and transfers.

Taxes. The government raises revenues from corporate tax, labor income tax, dividend tax, interest income tax, capital gains tax and a consumption tax. The firm pays corporate tax on its gross income with deductions. The full range of deductions is described in the firm section (2.3). Total revenue from the corporate tax is given by

$$TAX_t^k = \sum_o \int tax^k(x)\mu_t(dx, o). \tag{36}$$

The revenue from labor income tax is given by

$$TAX_t^n = \tau^n w_t N_t, \tag{37}$$

where N_t is aggregate labor supply. Tax levied on dividends, through the personal income tax system on resident's and the dividend withholding tax system from foreigners, is given by

$$TAX_t^d = \sum_o \int \tau^{d,o} d_t(x) - (1 - \tau^{d,o})\chi^{FC,o} FC_t(x)\mu_t(dx, o). \tag{38}$$

Capital gains tax revenue is levied on the difference between the start of period pre-issuance value, in Equation (34), and the previous end of period value of equity owned, in equation (35), and is given by

$$TAX_t^g = \sum_o \tau^{g,o} \left(\tilde{P}_t^o - P_{t-1}^o \right). \tag{39}$$

The government revenue from consumption tax, TAX_t^c, is given by

$$TAX_t^c = \tau_t^c C_t, \tag{40}$$

where C_t is total private consumption. Hence, the total tax revenue is a sum of three tax revenues:

$$TAX_t = TAX_t^k + TAX_t^n + TAX_t^d + TAX_t^g + TAX_t^c. \tag{41}$$

Expenditures. The government has two spending programs: the purchase of goods for government consumption, G_t, and government transfers, T_t. Government transfers encompass pension payments and other social security transfers. The total amount of government transfers, T_t, is the sum of transfers to all households

$$T_t = \sum_{j\in\mathbb{J}}\sum_{i\in\mathbb{I}} M_{t,j,i} tr_{t,j,i}. \tag{42}$$

Budget balancing rule. How the government balances its budget depends on the scenario. In the baseline the government's budget is balanced in every year and the government starts with zero debt. Nonetheless, in scenario where the government borrows or lends it does so from foreign investors at international rate of return r. As such the evolution of government bonds, B_t, is given by

$$B_{t+1} = TAX_t - G_t - T_t - (1+r)\, B_t. \tag{43}$$

The rate of return on government bonds is the risk free rate of return. In this case the government's budget is balanced by ensuring the net present value of revenue equals that of spending.

$$\sum_{t=0}^{\infty} \frac{TAX_t}{(1+r)^t} = \sum_{t=0}^{\infty} \frac{G_t + T_t}{(1+r)^t}. \tag{44}$$

2.5 Competitive equilibrium

The solution to the model is given by prices and quantities that are consistent with the solutions to the household's and firms' problems and the government's budget constraint.

For a given model calibration an equilibrium is defined by a set of household decisions for consumption, labor supply and equity and bonds holdings $\{c_{j,i},\ l_{j,i}, a_{j,i}\}_{j\in\mathbb{J},i\in\mathbb{I}}$; a set of firm decisions including labor demand, capital stock, investment, dividends payments and equity issuance and debt $\{n_t(x), k_t(x), i_t(x), d_t(x), s_t(x)\}\ _{x\in\mathbb{X}}$; asset market outcomes consistent the firm decisions $\{\Omega(x), p(x)\}_{x\in\mathbb{X}}$; with a set of relative prices for wages, domestic rate of return and assets prices $\{w_t, r_t\}$; accidental bequests $\{bq_i\}_{i\in\mathbb{I}}$; government policy settings $\{\tau^n, \tau^k,\ \tau^{d,h}, \tau^{d,f}, \tau^{g,h}, \tau^{g,f}, \tau^i, \tau^c, \chi^\delta,\ \chi^I, tr_{i,j,t}, G_t\}_{j\in\mathbb{J},i\in\mathbb{I}}$ such that the following hold:

(i) the choice of leisure, asset accumulation and consumption are consistent with solutions to the household's problem given in equation (6),

(ii) the choice of investment, capital stock, dividends and equity issuance are consistent with the solution firm's problem given in equations (52),

(iii) the price of each firm, the dividends it pays out and its equity issuance, is consistent with the residents and foreigners valuations and asset market outcomes in equations (3), (8) and (9),

(iv) the government's budget balances as given by equations (36), (37), (38), (39), (40), (41) and (44),

(v) the sum of individual consumption, labor supply, share holdings, debts holdings and asset holdings equals aggregate consumption, labor demand, share issuance, debt and value of firms and debt,

$$\sum_{i \in \mathbb{I}, j \in \mathbb{J}} c_{i,j,t} M_{i,j,t} = C_t, \tag{45}$$

$$\sum_{i \in \mathbb{I}, j \in \mathbb{J}} \epsilon_{i,j,t}(1 - l_{i,j,t}) M_{i,j,t} = N_t, \tag{46}$$

$$\sum_{i \in \mathbb{I}, j \in \mathbb{J}} \theta_{i,j,t} M_{i,j,t} = 1, \tag{47}$$

$$\sum_{i \in \mathbb{I}, j \in \mathbb{J}} a_{i,j+1,t+1} M_{i,j,t} = p_t^h, \tag{48}$$

(vi) the sum of output, labor demand, investment and adjustment costs from the continuum of firms equals aggregate output, labor demand and investment as in equations (29), (30) and (33),

(vii) the value of and the return on the representative asset is consistent with the value of and returns on individual firms as given in equations (5) and (2),

(viii) the aggregate resource constraint holds, with aggregate output equaling the sum of aggregate household consumption, government consumption, aggregate investment and net exports

$$Y_t = C_t + G_t + I_t + NX_t, \tag{49}$$

(iix) net exports are consistent with the balance of payments, that is net exports plus net foreign income equals the net value of assets acquired by foreigners

$$NX_t = \int (1 - \tau^{d,f}) d_t(x, f) \mu_t(dx, f) - \tau^{g,f} \left(\tilde{P}_t^f - P_{t-1}^f \right) + P_t^f - \tilde{P}_t^f, \tag{50}$$

(ix) bequests are equal to the deceased's assets, including returns, evenly distributed among the remaining agents of that type as given by

$$bq_{t,j,i} = \frac{\sum_{j \in \mathbb{J}} (M_{t-1,j,i} - M_{t,j+1,i}) (p_t^a + r_t^a) a_{t,j+1,i}}{\sum_{j \in \mathbb{J}} M_{t,j,i}}, \tag{51}$$

(x) the law of motion for the distribution of firms given by equation (28) is satisfied.

3 Analysis of a single firm's decision

In this section we discuss how the incentives faced by investors and the constraints on firms determine their investment and financial decisions.

3.1 Firm's optimization problem

To simplify the exposition we transform the firm's problem from equation (24). We first replace the maximum of foreigners' and residents' willingness to pay for the asset with the argument of the maximization, o^*. We then divide through by the 1 minus the current capital gains tax rate to get

$$V_t(x_t) = \max_{i_t,\, d_t,\, s_t,\, n_t} \left(\frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}}(d_t + \chi^{FC,o_t} FC_t) + s_t + E_t\left[\frac{V(x_{t+1}, o^*_{t+1})}{1 + r^{o^*_t}_{t+1}/(1-\tau^{g,o^*_t})} \right] \right). \tag{52}$$

Here $\frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}}$ is the value of a unit of dividends to shareholders relative to a unit of equity. This the value of dividends to a firm relative to the firm's own value. To solve for the firm's optimal decisions we set up the Lagrangian as below.[6]

$$\begin{aligned}
\mathcal{L} =& E_0 \sum_{t=0}^{\infty} \frac{1}{\prod_{s=1}^{t} 1 + r^{o^*_s}_s/(1-\tau^{g,o^*_s})} \Bigg[\frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}}(d_t + \chi^{FC,o_t} FC_t) + s_t \\
& - \lambda_t \Bigg(\left(1-\tau^k(\pi^\tau)\right) \left(z_t n_t^{\alpha^n} k_t^{\alpha^k} - \frac{\psi}{2}\left(\frac{i_t}{k_t} - \delta\right)^2 k_t - w_t n_t \right) \\
& + \tau^k(\pi^\tau)(\chi^\delta \delta k_t + \chi^I i_t) - i_t - d_t - s_t \Bigg) \\
& - \frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}} \lambda_t^{FCd} \left(FC_t - \frac{\tau^k}{1-\tau^k} d_t \right) \\
& - \frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}} \lambda_t^{FC\tau} \left(FC_t - \tau^k(\pi^\tau) \left(z_t n_t^{\alpha^n} k_t^{\alpha^k} - \frac{\psi}{2}\left(\frac{i_t}{k_t} - \delta\right)^2 k_t - w_t n_t - \chi^\delta \delta k_t - \chi^I i_t \right) \right) \\
& - q_t\left((1-\delta)k_t + i_t - k_{t+1}\right) + \lambda_t^d (d_t) - \lambda_t^s (s_t) - \lambda_t^{ds} (d_t s_t) \Bigg],
\end{aligned} \tag{53}$$

where λ_t, λ_t^{FCd}, $\lambda_t^{FC\tau}$, q_t, λ_t^d, λ_t^s, and λ_t^{ds} are the Lagrange multipliers associated with 7 constraints: resource constraint, franking credit constraint from dividend payment, franking credit constraint

[6] Even though current ownership is given and not the argument of a maximization problem, we denote the firms current ownership o_0 by o_0^* in the Lagrangian for compactness.

from corporate tax payment, law of motion for capital, dividend constraint, issuance constraint, and financial regime constraint, respectively.[7]

To understand investments decision we first turn to the first order conditions for future capital and investment given by

$$
\begin{aligned}
\partial k_{t+1} : q_t =& E\Bigg[\frac{1}{1+r^{o^*}_{t+1}/(1-\tau^{g,o^*_{t+1}})}\Bigg((1-\delta)q_{t+1} + \lambda_{t+1}\left(\alpha^k z_{t+1} n^{\alpha^n}_{t+1} k^{\alpha^k-1}_{t+1} + \frac{\psi}{2}\left(\frac{i^2_{t+1}}{k^2_{t+1}} - \delta^2\right)\right) \\
&- \tau^k(\pi^\tau_{t+1})\left(\lambda_{t+1} - \frac{1-\tau^{d,o_{t+1}}}{1-\tau^{g,o_{t+1}}}\lambda^{FC\tau}_{t+1}\right)\left(\alpha^k z_{t+1} n^{\alpha^n}_{t+1} k^{\alpha^k-1}_{t+1} + \frac{\psi}{2}\left(\frac{i^2_{t+1}}{k^2_{t+1}} - \delta^2\right) - \chi^\delta \delta\right)\Bigg)\Bigg],
\end{aligned}
$$

and

$$
\partial i_t : q_t = \lambda_t\left(1 + \psi\left(\frac{i_t}{k_t} - \delta\right)\right) - \tau^k(\pi^\tau)\left(\lambda_t - \frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}}\lambda^{FC\tau}_t\right)\left(\chi^I + \psi\left(\frac{i_t}{k_t} - \delta\right)\right).
$$

We combine the above expressions and solve forward to get

$$
\begin{aligned}
&\lambda_t\left(1 + \psi\left(\frac{i_t}{k_t} - \delta\right)\right) - \tau^k(\pi^\tau)\left(\lambda_t - \frac{1-\tau^{d,o_t}}{1-\tau^{g,o_t}}\lambda^{FC\tau}_t\right)\left(\chi^I + \psi\left(\frac{i_t}{k_t} - \delta\right)\right) \\
&= \sum_{j=1}^{\infty} E\Bigg[\frac{(1-\delta)^{j-1}}{\prod_{s=1}^{j} 1 + r^{o^*}_{t+s}/(1-\tau^{g,o^*_{t+s}})}\Bigg(\lambda_{t+j}\left(\alpha^k z_{t+j} n^{\alpha^n}_{t+j} k^{\alpha^k-1}_{t+j} + \frac{\psi}{2}\left(\frac{i^2_{t+1}}{k^2_{t+1}} - \delta^2\right)\right) \\
&- \tau^k(\pi^\tau)\left(\lambda_{t+j} - \frac{1-\tau^{d,o_{t+j}}}{1-\tau^{g,o_{t+j}}}\lambda^{FC\tau}_{t+j}\right)\left(\alpha^k z_{t+j} n^{\alpha^n}_{t+j} k^{\alpha^k-1}_{t+j} + \frac{\psi}{2}\left(\frac{i^2_{t+1}}{k^2_{t+1}} - \delta^2\right) - \chi^\delta \delta\right)\Bigg)\Bigg]. \qquad (54)
\end{aligned}
$$

In this expression the left hand side (LHS) gives the marginal cost of capital, while the right hand side (RHS) shows the marginal benefit of capital. This expression shows that investment depends not only on current taxes but the series of expected taxes going forward. The value of the various Lagrange multipliers depend on which constraints bind. We characterize firms into different regimes by the degree to which different constraints bind. It is worth noting expected future ownership, future taxes, and the value of constraints are in part endogenous as firms investment decisions can affect these outcomes.

3.2 Investment and financial decisions

3.2.1 Investment financing

We study how firms would optimally finance their investment, taking the financial constraints as given. Similar to Gourio and Miao (2010), firms are classified into one of three financial regimes in

[7] Neither the capital taxes nor the constraints influence the labor decision. That is, as in standard models, optimal labor demand is occurs when the marginal product of labor equals the wage, from the first order condition $0 = (\lambda_{t+1} - \left(1 - \tau^{d,o^*_t}\right)\lambda^{FC\tau}_{t+1})(\alpha^n z_t n_t^{\alpha^n - 1} k_t^{\alpha^k} - w_t)$.

our model: equity issuance, liquidity constrained and dividend distribution/paying. In the equity issuance regime, firms undertake investment that is greater than after tax profits; they, therefore, rely on new equity to partially finance their investment plan (i.e., external and internal finance). On other hand, firms in liquidity constrained regime undertake investment that is identical to the value of after tax profits (i.e., internal finance). Finally, firms in the dividend distribution regime invest less than their after tax profits (i.e., internal finance) and distribute the rest of profits to shareholders (i.e., dividend distribution).

To understand the how taxes affect investment in each regime we examine the value of paying dividends and the cost of issuing equity. The value of dividends is derived from the FOC for dividends

$$\frac{\left(1-\tau^{d,o_t^*}\right)\left(1-\frac{\tau^k\left(1-\tau^{d,o_t^*}\right)}{1-\tau^k}\lambda_t^{FCd}\right)}{1-\tau^{g,o_t^*}}+\lambda_t^d-\lambda_t^{ds}s_t=\lambda_t. \tag{55}$$

For dividends to be paid the dividend constraint cannot bind and the financial regime constraint implies issuance must be zero, which implies $\lambda_t^d-\lambda_t^{ds}s_t=0$. As a result, the marginal value of the firms resources, λ_t, equals the relative value of dividends,

$$\lambda_t=\frac{\left[1-\overbrace{\left(\tau^{d,o_t}-\frac{\tau^k\left(1-\tau^{d,o}\right)}{1-\tau^k}\lambda_t^{FCd}\right)}^{=\tilde{\tau}^{d,o}}\right]}{\left(1-\tau^{g,o_t^*}\right)}.$$

Let $\tilde{\tau}^{d,o}$ denote the effective tax rate on dividends as

$$\tilde{\tau}^{d,o}=\tau^{d,o_t}-\frac{\tau^k\left(1-\tau^{d,o}\right)}{1-\tau^k}\lambda_t^{FCd}. \tag{56}$$

The value of the dividend franking credit constraint, λ_t^{FCd}, is described below. The relative cost of issuing equity to the firm can be seen from the FOC for issuance

$$1-\lambda_t^s-\lambda_t^{ds}d_t=\lambda_t. \tag{57}$$

For equity to be issued the issuance constraint can not bind and financial regime constraint implies dividends must be zero giving $\lambda_t^s+\lambda_t^{ds}d_t=0$. In this case, the value of the multiplier for the resource constraint equals the relative cost of issuing equity, i.e. $\lambda=1$.

Similar to Gourio and Miao (2010), the firm's financial regime determines the impacts of the taxes on a firm's resource constraint and thereby the marginal cost of capital in our framework. Therefore, we examine how firms behave within each financial regime separately.

- **Equity issuance regime** In the equity issuance regime, the cost of a unit of the firm's resources, λ, is 1. Hence, in this regime neither current dividend nor capital gains tax rate affect the marginal cost of capital. From equation (54), conditional on firms expecting to be in this regime in the future, the future expected dividend tax rate does not impact the firm's investment decisions. However, higher future capital gains tax rates reduce the value of future capital and decrease investment. This, in turn, means fewer firms will be in the issuance regime.

- **Liquidity constrained regime** In this regime firms invest all their after tax profits. The marginal value of capital is not high enough to induce firms to invest more via issuing equity, but too high to reduce investment and pay dividends. Taxes determine which firms fall into this regime. The larger the gap between the effective dividend tax rate and the capital gains tax rate the more firms shift into this regime. When the capital gains tax rates is above the effective dividend tax rate there are no firms in this regime.

- **Dividend distribution regime** For firms in the dividend paying regime the value of the resource constraint equals the value of dividends to the firms. The higher the current effective dividend tax rate the lower the value of dividends. Higher dividend or lower capital gains tax rates decrease the marginal cost of capital. Similarly, higher future dividend or lower capital gains tax rates also decrease the marginal value of capital. In this regime, a higher current effective dividend tax rate will raise investment, while a higher expected effective dividend tax rate will lower investment, holding other things unchanged. From equation (54), future capital gains tax both raises the relative value of future dividends but also the effective discount rate, from these offsetting factors the relative value to the firm dominates and higher future capital gains taxes raises investment, in a partial analysis . For a firm currently in the dividend paying regime and expecting this regime continue with the same owners, the resource constraint value terms in equation (54) cancel out and dividend taxes do not affect investment decision, while capital gains tax raises the effective discount rate and thereby lowers investment. However, even if firms expect to stay in dividend issuance regime they may expect to switch ownership. An expectation of switching to lower dividend tax owners in the future would cause greater investment than if current higher tax rate ownership was expected to continue. So even under the "new" view of firm financing, investors differing dividend tax rates can affect investment decisions.

3.2.2 Dividend imputation and financial regimes

The dividend franking credit constraint influences firms' investment decisions as firm's effective dividend tax rate depends on it. Intuitively, firms' investment decisions are affected by franking payment. To understand the value of the Lagrange multiplier of the dividend franking credit constraint we study the first order condition for franking credits given below

$$\chi^{FC,o_t} = \lambda_t^{FC\tau} + \lambda_t^{FCd}. \tag{58}$$

The two franking constraints only impact a firm's marginal cost of capital if the firm is dividend paying and owned by investors that are able to utilize franking credits, $\chi^{FC,o_t} > 0$. The dividend franking credit constraint only impacts marginal cost or value of capital through the resource constraint and only when firms are dividend issuing, as in equation (55). The tax franking credit constraint can only bind if dividends are positive.

We find dividend paying firms will be in one of three franking regimes. Figure 1 summarizes 5 financial regimes in our setting.

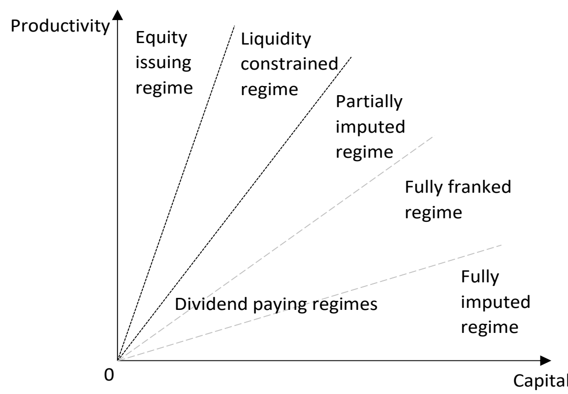

Figure 1: **Financial and imputation regimes.** There are three sub-regimes for the firms that are in the dividend paying regime.

Each franking regime has different impact the marginal cost of capital and we examine them separately.

- **Partially imputed regime:** In this regime, franking credits are limited by the dividends paid and the dividend-paying franking constraint binds, i.e., $FC_t = \frac{\tau^k}{(1-\tau^k)} d_t < tax_t^k$. From equation (58), in this regime the Lagrange multiplier on the dividend franking credit constraint equals the deductibility rate and the multiplier on the tax franking credit constraint is zero, $\lambda_t^{FCd} = \chi^{FC,o_t}$ and $\lambda_t^{FC\tau} = 0$. For these firms each unit of dividends relaxes the franking credit constraint by $\frac{\tau^k}{1-\tau^k}$ units. This additional value associated with dividends lowers the effective dividend tax rate thereby raising the marginal cost of capital. Firms in this regime tend to have less capital as they pay fewer dividends.[8]

[8] $\chi^{FC,o} \in [0, 1]$ is the degree to which shareholders are able to claim franking credits. When $\chi^{FC,o} = 1$ shareholders can claim 100 percent of their franking credits and $\lambda_t^{FCd} = 1$.

- **Fully franked regime:** In this regime both dividend-paying and tax-paying franking credit constraints bind, i.e., $F_tC = tax_t^k = \frac{\tau^k}{(1-\tau^k)}d_t$. According to Equation (59), this is a case when the non-deductible cost of investment equals the value of deductible depreciation. In Figure 2 there is a level of capital where firms are in the fully franked regime. However, the incentives provided by franking credits will cause firms with a range of capital levels to choose investment consistent with the fully franked regime. Without the franking credit constraint firms generally decrease investment as capital increases. However, for firms in the fully franked regime the value of dividend franking credit constraint also declines with capital. As a result, the effective value of dividends declines with capital and investment increases consistent with equation (59). For the fully franking firms both the Lagrange multipliers franking credit constraints are greater than zero, $\lambda_t^{FCd} > 0$, $\lambda_t^{FC\tau} > 0$.

- **Fully imputed regime:** In this regime, the tax-paying franking constraint binds, so that franking credits are constrained by the tax paid, i.e., $FC_t = tax_t^k < \frac{\tau^k}{(1-\tau^k)}d_t$. In this regime the Lagrange multiplier on tax franking credit constraint is equal to the deductibility rate and the multiplier on the dividends franking credit constraint is zero, $\lambda_t^{FC\tau} = \chi^{FC,o_t}$ and $\lambda_t^{FCd} = 0$. For these firms franking credits do not add additional value to current dividends. In this regime franking credits have limited impact the marginal cost of capital. The impact comes through changes in tax revenue from the capital adjustment costs or investment deductibility. Firms in this regime have the most capital as they pay sufficient dividends that tax constrains franking credits.

When investors are able to claim the full value of franking credits, imputation offsets the impact of corporate tax on marginal value of capital for all franking regimes. This is can be seen by showing

$$\lambda - \tau^k \left(\lambda - \frac{1-\tau^d}{1-\tau^g} \lambda^{FC\tau} \right) = \frac{1-\tau^d}{1-\tau^g} \left(1 - \tau^k \left(1 - \chi^{FC} \right) \right).$$

Hence, in equation (54) when franking credits are fully claimable, $\chi^{FC} = 1$, imputation reduces the marginal effective corporate tax rate to at least zero. In the partially imputed regime, and to lesser extent the fully franked regime, depreciation deductions cause imputation to more than offset the impact of the corporate tax on the marginal value of capital. The contribution of the depreciation deduction to the marginal future value of capital is given by $\tau^k(\pi^\tau) \left(\lambda - \frac{1-\tau^d}{1-\tau^g} \lambda^{FC\tau} \right) \chi^\delta \delta$. In the fully imputed regime with full imputation this term is equal to zero. In the partial imputed regime with fully imputation this term equals $\frac{1-\tau^{d,o}}{1-\tau^{g,o}} \frac{\tau^k}{1-\tau^k}$. Depreciation deductions reduce tax paid but in the partially imputed regime reducing tax paid does not result in reducing franking credits. Hence, depreciation deductions result in the negative effective corporate tax rate in the marginal value of capital for partially imputed firms.

3.2.3 Corporate tax rate constraint

We discuss the role of the discontinuity in the corporate tax rate, equation (17). This can impact investment through its impact on both the marginal cost of capital and the marginal value of capital. Corporate tax lowers the marginal value of capital on the RHS of equation (54). However, limiting negative future tax payments further reduces the value of capital. This lowers current investment.

To the extent the constraint on corporate tax binds in the current period this can both raise and lower investment. When investment is tax deductible, $\chi^I > 0$, this lowers the cost of investment. However when the tax constraint is binding firms may undertake investment up to the value deductible because additional investment would be at a higher marginal cost. Further, corporate tax is paid on output after capital adjustment costs, essentially adjustment costs are deductible. This effective deductibility and the constraint on corporate tax can cause a discontinuity in the relationship between a firm's investment and current capital. For certain low capital firms this adjustment cost can be larger than output, in this case the adjustment cost would not be fully deducted thereby reducing investment. Above a certain level of capital firms divest capital. Part of the cost to the firm of divesting capital is the adjustment cost. When a firm pays corporate tax, part of the adjustment is passed to the government. When the constraint on corporate tax binds these adjustment costs are not passed to the government. This increases the cost of divestment to firms and therefore firms invest more (divest less).

3.2.4 A graphic illustration of a special case

We consider a special case where the tax rates on capital gains and dividends are zero and there are no franking credits. This case provides a useful illustration of where various constraints bind and how these interact with firm incentives. Figure 2 shows which constraints bind relative to capital for a given level of productivity. As shown, output and profit increase with firm size in terms of physical capital. Profits after tax, corporate tax before deductions and depreciation, as well levels of equity issuance, dividends and investment are varied with capital stock. Initially, investment increases with capital as higher levels of capital reduce adjustment costs. As capital increases further the marginal product of capital declines and the incentive to invest decreases.

The financing constraints, in equations (12), (12) and (14), state that additional revenue can only be raised through issuance while firm revenue can only be paid out as dividends. That is, for investment to be greater than after tax profits equity must issued and conversely dividends must be paid. In Figure 2, there exists a level capital where the cost of investment equals after tax profits and issuance and dividends are both zero. As discussed below, firms of a range of capital values may choose this under certain tax settings.

Franking credits are constrained by both corporate tax paid and dividends distributed, as detailed in equation (21). As mentioned above, low capital firms pay no dividends and beyond a

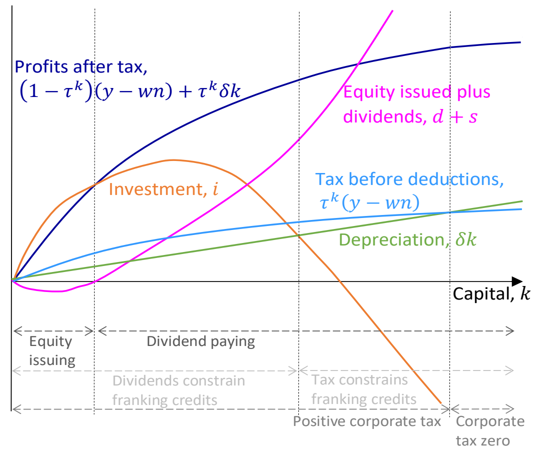

Figure 2: **Firms optimal decisions relative to current capital.** Illustration of a firm's optimal choice of profits, equity issued, dividends and investment against current capital for a fixed productivity level. The illustration assumes no capital gains or dividend taxes, depreciation is fully deductible while investment is not. The illustration shows the ranges over which different constraints bind.

certain level of capital firms begin paying dividends. As such dividends must constrain franking credits for low capital firms. Dividends increase with capital at a faster rate than corporate tax and therefore there comes a level of capital where dividends no longer constraint franking credits and tax paid does. We find this level of capital by finding the point where both constraints bind as below.

$$\begin{aligned} tax_t^k &= \tau^k/(1-\tau^k)d_t \\ \implies (1-\chi^I)i_t &= \chi^\delta \delta k_t \\ \implies i_t &= \frac{\chi^\delta \delta}{1-\chi^I}k_t. \end{aligned} \tag{59}$$

This implies that franking credits are constrained by dividends when the non-deductible cost of investment is greater than deductible depreciation. Conversely, franking credits are constrained by tax paid when the non-deductible cost of investment is less than deductible depreciation. This point is show in Figure 2 where the orange investment line intersects the green depreciation line.

Lastly, the corporate tax payment is constrained to be positive as detailed in equation (18). The constraint binds when taxable revenue is less than wages plus investment and depreciation deductions as given by

$$y_t < w_t n_t + \chi^I i_t + \chi^\delta \delta k_t.$$

This corporate tax constraint can be seen binding from the capital level where the green depreciation line intersects the light blue tax before deductions line in Figure 2. The constraint causes after tax profits to be lower than otherwise beyond this point.

4 Parameterization and calibration

This section describes how model parameters are calibrated. The model is calibrated in line with the literature for both similar heterogeneous firm and overlapping generation models. The households parameters are calibrated in line with overlapping generations models of Australia. The government policy parameters are calibrated broadly in line with current policy settings. The frequency of the model is annual.

4.1 Household

The population dynamics are calibrated to match the Australian Bureau of Statistics' (ABS) release 3222.0 Population Projections. The population dynamics are set to match the evolution of the cohort of persons aged 20 in 2013-14. Defining $Pop_{20,2014}$ to be the population of persons aged 20 at 1 June 2014 the conditional survival probability is calculated as $sp^*_{21} = Pop_{21,2015}/Pop_{20,2014}$. Due to positive net migration the projected size of some age cohorts increases but we set the conditional survival probability to a maximum value of one.

The three skill levels are defined by three education levels. Let $\mathcal{P}_i$ denote the share of the population with skill type i. The share of the population with skill type i at age j is given by $M_{j,i} = \mathcal{P}_i \frac{S_j(1+g^n)^{j-20}}{\sum_{j=20}^{100} S_j(1+g^n)^{j-20}}$. The growth in the population is also calibrated to the ABS's release 3222.0 Population Projections. Growth in the population of persons aged 20 and over is projected to average 1.7 percent from now to 2050 and we use this value for g^n.

The household calibration in part follows Tran and Wende (2021), the consumption share of utility γ is set to 0.25 so that the share of hours spent at work in the model matches HILDA data. The inter-temporal elasticity $1/\sigma$ is set to 0.4 as in Kudrna, Tran and Woodland (2015). The households' discount rates β are set to 0.978 so that the foreigners own 30 per cent of assets as in Cao et al. (2015). The labor efficiency endowments are estimated from HILDA data. The skill type levels are matched to education levels as reported in HILDA, low skill are defined as up to the completion of secondary education, medium skill household have completed vocational training and high skill households have completed a tertiary degree. The shares from in HILDA give the populations shares of the skill types in our calibration. A second order polynomial is fit to the observed data to smooth it. Further, labor productivity is linearly reduced from the fit value produced for age 60 to zero at age 71. This linear trend to zero is imposed so that the model matches the observed hours worked later in life. Further, the decline in labor productivity we impose between ages 60 and 71 partially address the upwards bias in observed labor productivity the occurs to due to retirement.

4.2 Firm

Due to limited data there is no estimate of the productivity shock process of Australian firms. We assume that Australian firms face a similar productivity shock as in the US. We use the estimate from Gourio and Miao (2010) who used the COMPUSTAT database. In our sensitivity analysis, we use different assumptions for the productivity shock process in Australia.

The exponent on labor is set so the labor produces 65 per cent of output as is broadly observed in US data, $\alpha_l = 0.65$. The exponent of capital, the investment adjustment cost parameter, the technology shock persistence and standard deviation are based on firm level data from the . The depreciation rate is set so the investment to capital ratio matches that observed US macroeconomic data.

The international required rate of return is set to 3 per cent. The domestic expected rate of return is determined in equilibrium.

4.3 Government

Tax rates are set to match both current Australian rates and to balance the government's budget in the baseline. The corporate tax rate τ^k, the resident's dividend tax rate $\tau^{d,h}$ and the capital gains tax rate $\tau^{g,h}$, are set to 30, 30 and 15 per cent, respectively. Foreigner's dividend tax rate $\tau^{d,h}$ is set to 10 per cent while we assume there is no tax on foreigners capital gains. The dividends withholding tax rate for foreign investors in Australia is 30 per cent however Australia has a large number of tax treaties that significantly reduce this rate hence we use 10 per cent in the model.[9] The consumption tax rate, τ^c, is set to 4.86 percent to match the consumption tax revenue as a share of GDP and the labor income tax rate, τ^n, is set 32.3 per cent to balance the government's budget in the baseline. In the baseline depreciation is fully deductible, $\chi^\delta = 1$, while investment is not deductible $\chi^I = 0$.

Government purchases of goods are set to 19.2 per cent of GDP based on historical data. Government transfers represent a range of transfers include the pension and other transfers and are calibrated to 5 per cent of GDP and broadly match.

4.4 Benchmark model

In this section we detail the distribution of firms and their optimal decisions that result from initial policy settings applied to the model described in above. A comprehensive set of summary statistics of the initial steady state are contained in Table 10 in the appendix.[10]

[9] See, for example, Australia's tax treaty with the US which limits dividend withholding tax to 5 or 15 per cent depending on the investor http://www.austlii.edu.au/au/other/dfat/treaties/2003/14.html

[10] Capital gains tax revenue is negative in the model. In the model we do not include inflation or aggregate productivity increases and we do not limit capital gains tax deductions to be only claimable against positive capital gains payments. This results in negative capital gains tax revenue.

Distribution of firms by finance regime and ownership. As discussed in section 3.2, firms will be in one of the five regimes. Table 1 details the distribution of firms by regime and firm ownership. The distribution is provided for the mass of firms and also the shares of output, investment and capital. The model is calibrated so that 70 per cent of firms, by asset value, are bought at the end of each period by residents and 30 per cent by foreigners. However residents own closer to 50 per cent of the unit mass of firms as foreigners generally own lower productivity, and thereby lower value firms. Foreigner investors buy lower productivity but higher capital firms. As such, foreign owned firms are divesting on average. As foreign owned firms are lower productivity they account for only 13 per cent of output. 58 per cent of investment is undertaken by equity issuing firms, 5 per cent by liquidity constrained firms, and 47 per cent by resident owned firms that are in either the partially imputed or fully franked regimes.

		Equity issuing	Liquidity constrained	Partially imputed	Fully franked	Fully imputed	Total
Mass of firms	resident	15	0	2	25	11	54
	foreign	8	12	0	0	26	46
Capital (K)	resident	10	0	6	35	16	67
	foreign	2	4	1	0	26	33
Output (Y)	resident	24	0	17	35	10	87
	foreign	2	3	1	0	8	13

Table 1: **Mass of firms, capital and output by financial regime and ownership**.

Asset purchases by resident and foreign investors. As described before, residents and foreigners face different tax rates, face different expected after tax rates of return across firms, and therefore buy different firms. These valuations and purchase decision depend purely on next period capital and current productivity. Figure 3 shows the end of period ownership of firms by current productivity and next period capital. Foreigners place relatively higher value on, and therefore buy, firms with higher capital stock and lower productivity. Much of the value of the high capital low productivity firms is tied to selling their capital rather than their production. Franking credits can only be generated with tax paid on output. Hence these firms have relatively little value in terms of franking credits and are less valued by residents. Resident investors value fully franking firms more than foreign investors as foreigners are not able to use franking credits. In figure 3 one can also see that foreigners are outbid for higher productivity firms with low capital. These firms are likely to reinvest most of their profits and therefore generate return through capital gains. While foreigners have a lower capital gains tax rate, residents have a sufficiently low discount rate to outbid foreigners for these firms.

Investment and financing policy. Figures 4 and 5 show the optimal financial and investment decision of firms by current capital for different productivity levels and ownership. The figures show the importance of the various constraints.

In figures 4 and 5 we can see low capital firms make the same issuance and investment decision

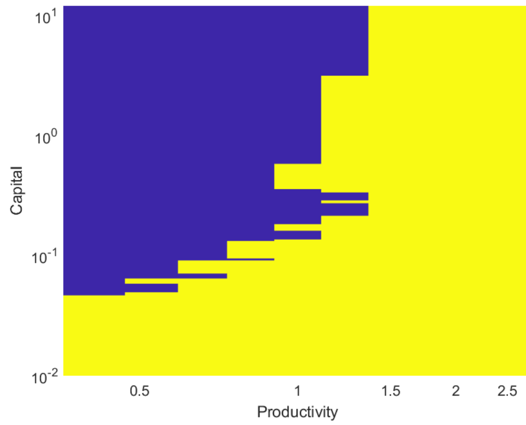

Figure 3: **The end-of-period ownership of firms by next period capital (k_{t+1}) and current productivity z_t.** Note that, Blue indicates foreign ownership and Yellow indicates domestic ownership.

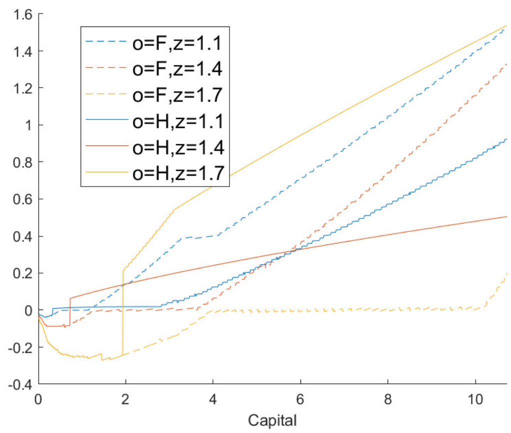

Figure 4: **Sum of dividends and issuance against firm's current capital by firm productivity and ownership.** Note that, H and F refer to domestic and foreign ownership while z is the productivity level.

regardless of ownership. This is because these low capital firms are in the equity issuance regime where current dividend and capital gains tax rates do not affect the decision of firms, as discussed in section 3.2. Instead the decisions of firms in the issuance regime depend on the expected tax rates in the next period. End of period ownership of firms, and therefore expected next period tax rates, depends solely on current productivity and next period capital. As such, the expected next period tax rates will be the same even though current tax rates differ.

In figure 4 we can see that at above a certain level of capital domestically owned firms jump to the dividend paying regime. The jump in dividends occurs due to the higher value of dividends to residents given the franking credits that accompany them. The corresponding drop in investment can be seen in figure 5. The drop in investment occurs at a higher capital stock for higher productivity firms due to their higher capital valuation.

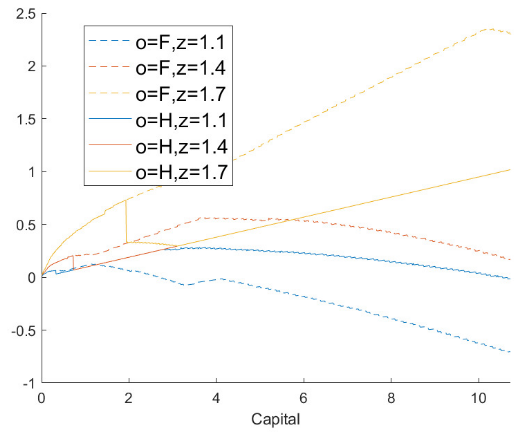

Figure 5: **Investment schedule over current capital (k_t) by firm productivity and ownership.** Note that, H and F refer to domestic and foreign ownership while z is the firm-specific productivity level.

In figure 5 firms in the fully franked regimes can be seen as those with investment along a straight line from the origin where investment replaces depreciated capital. As discussed in section 3.2, in the fully franked regime both the tax and dividend franking credit constraints bind. In this regime firms undertake investment so that the after tax cost of investment equals the value of depreciation deductions as in equation (59). For firms with productivity $z = 1.1$ or $z = 1.4$, those firms with capital above the issuing regime immediately enter the fully franked regime. However, for firms with productivity $z = 1.7$, firms with capital just above the issuance regime are in the partially imputed regime. These firms do not pay sufficient dividends to distribute franking credits up to the full value of tax paid due to the high value of capital for these firms. As capital increases the value of investment declines and $z = 1.7$ productivity firms enter the fully franked regime. Figure 5 shows that above a certain level of capital the $z = 1.1$ productivity firms are in the fully imputed regime. The capital axis of figure 5 does not go sufficiently high to show $z = 1.4$ or $z = 1.7$ productivity firms in the fully imputed regime.

In figure 4 we can see foreign owned firms in the liquidity constrained regime where these firms neither issue equity or pay dividends. As discussed in section 3.2, for firms in the liquidity constrained regime the value of additional investment is below the cost of issuing more equity but above the value of dividends.

Figure 4 shows that above a certain level of capital investment by foreign owned firms is lower than that of otherwise identical resident owned firms. This is in contrast to ownership not impacting investments for the lowest capital firms and investment being lower by domestic firms once they enter the dividend paying regime. However, foreigners face a lower relative dividend tax rate. When dividends do not generate franking credits these dividends are less valued on residents. As such, resident owned firms undertake more investment. Additionally, foreigners buy firms that are expected to sell capital, as is discussed below. This can be seen for the $z = 1.1$ productivity firms where foreigner owned firms divest and resident owned firms are investing. Resident owned firms maintain the capital level knowing they will be sold to foreigners who value the capital more highly as they can sell it while paying lower dividend taxes.

Lastly, in figure 5 we can see that for the $z = 1.1$ productivity foreign owned firms the constraint on corporate tax causes non-smoothness in the relationship between investment and current at capital levels between 3 and 4 units. In this case, capital adjustment costs affect output and therefore the corporate tax rate. As discussed in section 3.2, when a firm is divesting capital part of the cost is borne in adjustment costs. When a firm pays corporate tax, part of the adjustment cost is passed to the government. As such a lower corporate tax rate reduces the value of divestment to firms and therefore firms divest less when the corporate tax constraint begins to bind.

5 Quantitative analysis

In this section, we apply the calibrated model to study the quantitative importance of dividend imputation. Our analysis is undertaken under several policy reform scenarios that include (i) removing resident franking credits, (ii) removing resident franking credits and reducing dividend tax rate to the current rate for foreign investors and (iii) remove different tax treatments for resident and foreign investors. We do so by simulating the long run impact of changing policy settings, in all scenarios the government budget is balanced by lump sum transfers that are equal across households

5.1 No resident franking credit (NRF)

We begin with a policy scenario where residents are not able to claim franking credits ($\chi^{FC,h} = 0$), i.e., No Resident Franking credits (NRF). In this policy setting the benefits of dividend imputation to mitigate the double capital taxation for resident investors is eliminated. The households as local resident investors now face higher dividend and capital gains tax rates, compared to foreign investors.

Investment and ownership. The new tax policy affects households' incentives to save and invest as well as firms' financial and investment decisions. Removing dividend imputation amplifies the adverse effects of double taxation and lowers the effective rate of return in the domestic capital market, which induces households to save less. In addition, it reduces the value of dividend paying firms to resident investors. As such, residents re-optimize their equity bidding decisions and switch to purchasing lower productivity firms as they are more likely to receive positive productivity shocks and therefore generate more capital gains. Figure 6 shows changes in the distribution of firm ownership after the policy change. As in green transition (F2H) in Figure 6, there is a shift in firm ownership from foreigners to residents. As resident investors are not competing hard for some dividend paying firms, foreigner investors can purchase more firms that tend to generate more

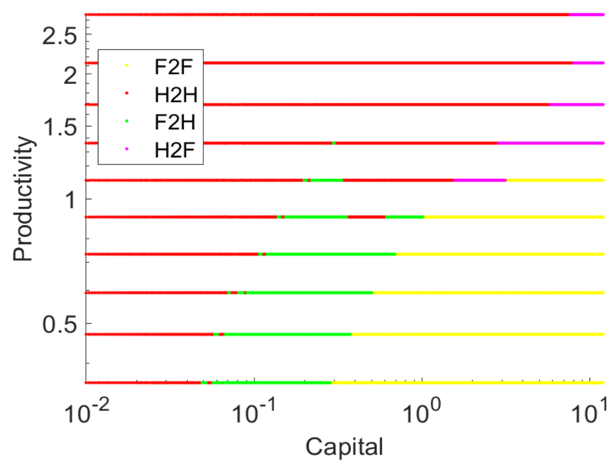

Figure 6: **Changes in firm ownership under No Resident Franking (NRF) scenario.** Change in end-of-period ownership by current productivity (z_t) and next period capital (k_{t+1}). Yellow indicates firms that remain foreign owned (F2F); Red indicates resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to resident ownership (F2H).

dividends, particularly those with high capital and high productivity, where there is less scope for capital gains. As seen in magenta transition (H2F) in Figure 6, there is a shift from domestic foreign ownership.

Changes in the ownership of firms and firms' investment decisions determine aggregate capital stock and the allocation of capital. Removing franking credits deductibility decreases investment for a large number of firms as it lowers the future value of capital to the extent that firms expected to be resident owned and dividend paying in the future. However, this policy change also raises investment for certain firms as it reduces the value of dividends and the cost of investment for firms in the partially imputed and fully franked regimes, as discussed in the section 3.2. Overall, the final effects on investment and aggregate capital are analytically ambiguous, depending on which force is dominant.

Aggregates. Table 2 reports changes in output, investment, consumption, next exports, government revenue and equity value. Our quantitative results indicate that removing dividend imputation lead to decreases in investment, aggregate capital and output.

The changes in the distribution of ownership, value of firms and expected returns are reflected in the changes in the value of equity holdings. Equity values changes are decomposed into volume of physical capital owned and price changes. Equity price changes capture both movements in the price of certain equities and also changes in the distribution of ownership in terms of size and productivity of firms bought. In this scenario the value of foreign equity holdings is broadly unaffected with the increase of the underlying capital owned by foreigners offset by the fall in equity values. That is, equity prices fall so that the return meets foreigners' required return.

It is worth highlight that taxing dividend income affects investment in our small open economy model. This result implies foreign capital is not a perfect substitute for domestic capital. This is

Output: total	-2.0	Government revenue (GR)	1.5
+ Output: resident capital	-4.8	+ GR: corporate tax	0.1
+ Output: foreign capital	2.9	+ GR: residents' dividend tax	-2.4
+ Output: labor	-0.9	+ GR: residents' franking refund	2.3
+ Output: TFP	0.2	+ GR: residents' capital gains tax	1.2
+ Output: adjustment costs	0.5	+ GR: foreigners' dividend tax	0.5
Investment	-1.1	+ GR: foreigners' franking refund	0.0
Consumption	-1.0	+ GR: foreigners' capital gains tax	0.0
Net exports	0.0	+ GR: consumption tax	-0.0
Welfare (W): aggregate	0.2	+ GR: labor tax	-0.3
+ W: low income	0.6	Equity value (EV): total	-24.4
+ W: middle income	0.3	+ EV: resident owned	-25.7
+ W: high income	-0.2	+ EV: foreign owned	1.3
+ W: wages	-0.8	+ EV: residents' capital volume	-47.0
+ W: capital returns	-0.3	+ EV: foreigners' capital volume	24.7
+ W: bequests	-0.2	+ EV: residents' equity price	21.3
+ W: government transfers	1.5	+ EV: foreigners' equity price	-23.4

Table 2: **The aggregate and welfare effects under No Resident Franking (NRF) scenario.** Note that, changes are reported in percentage changes of initial output. W stands for welfare which is measured in terms of compensating variation; GR is government revenue; and EV is equity value.

different from the classic result in standard open economy models with perfect capital mobility, where the total stock of capital is not affected by domestic savings. In this heterogeneous firm setting, different tax treatments for resident and foreign investors amplify frictions in reallocation of capital across firms, which subsequently prevents inflows of foreign capital from fully offsetting the shortage of domestic savings. That is, while foreign capital is perfectly mobile the ownership structure and different returns available to the investors across firms lead to an imperfect substitution between domestic and foreign capital. International investors are not marginal investors in our small open economy setting.

The overall decrease in investment and thereby capital drives the decrease in output. The change in output is decomposed into into factors of production being labor, and resident and foreign owned capital, total factor productivity (TFP) that results from the allocation of capital across firms, and potential output lost to adjustment costs.Firms that increase investment, those that were in the partially imputed and fully franked regimes, tend to be higher productivity. The increase in investment by these firms, and the decrease by other firms, raises TFP marginally. Increases in TFP are reflected in the increased correlation between firm's capital and productivity, as shown in table 12 in the Appendix.[11]

The changes in output have impacted government revenue with changes in firms' financial

[11] The decomposition is based on an aggregate production function which uses aggregate output, aggregate capital of resident and foreign owned firms, aggregate labor, aggregate capital adjustment cost to calculate the level of TFP, Z, given in $Y = ZN^{\alpha^N}(K^h + K^f)^{\alpha^K} - AC$. This decomposition fails to capture the degree to which residents or foreigners own capital in more or less productive firms.

decisions, the ownership distribution and tax rates being more important. This means changes in one tax can have large impacts on other tax bases, as shown in Table 2. Note that, dividend tax is decomposed into revenue directly collected from dividends and franking credit refunds. The additional revenue from cutting franking credits is fully offset by lost dividend tax revenue. However, the net revenue impact is still positive due to additional capital gains tax revenue from residents and increased foreign dividend revenue.

Welfare. We measure welfare by compensating variation which is calculated for each income group and is also decomposed by each variable exogenous to the households budget constraint given by equation (4).[12] Nonetheless, the welfare impacts calculated here can not be used to understand the efficiency of the taxes as we only examine long run impacts and not the transition. [13]

The changes in output, government revenue, and equity prices explain wages, government transfers and households' returns and, in turn, drive the welfare impacts. Aggregate welfare is higher despite aggregate consumption falling. The welfare increase is tilted towards lower income households as they are more beneficial from additional lump-sum transfers and less negatively affected by lower wages and rates of return. The welfare increase is in part due to shifting the burden of taxation to investors, who are high income households and foreigners. There are increases in tax revenues from reducing residents' franking refund and collecting more foreign capital incomes, which subsequently boosts lump-sum transfers and welfare.

5.2 No residents franking credits plus lower dividend tax rate (NRFLD)

We examine the degree to which a lower dividend tax rate offsets removing franking credits. We halve the residents' dividend tax rate to be equal to their capital capital tax rate to remove the distortion caused by the difference between these taxes with the updated policy settings being: $\chi^{FC,h} = 0$, $\tau^{d,h} = 0.15$. We name this experiment No Residents Franking credits and Lower Dividend rate (NRFLD) scenario.

Investment and ownership. Figure 7 below and Table 12 in the Appendix report changes in the distribution of firm ownership. Removing resident's franking credit deductibility and lowering their statutory dividend tax rate nevertheless raises their effective dividend tax rate, given in equation (56), for many firms. However, the effective dividend tax rate decreases for some of the firms that were previously in the fully imputed regime. Therefore, residents switch to purchasing these firms that are in the fully imputed regime. The expected increase in return on these equities raises the domestic rate of return. Conversely, foreigners, who have a lower capital gains tax rate than dividend rate, switch to purchasing equities expected to generate capital gains. As such,

[12] Averaging across the income group does not equal the aggregate because of their unequal population weights. Low, middle and high income households are 23, 50 and 26 per cent of the population respectively. The exogenous variables of the households budget constraint are: wages w, capital return r^h, bequests bq, and government transfers tr.

[13] Tran and Wende (2021) show that aggregated welfare impacts are similar to those calculated with a lump sum redistributive authority.

foreigners buy higher productivity lower capital firms while residents buy higher capital and lower productivity firms.

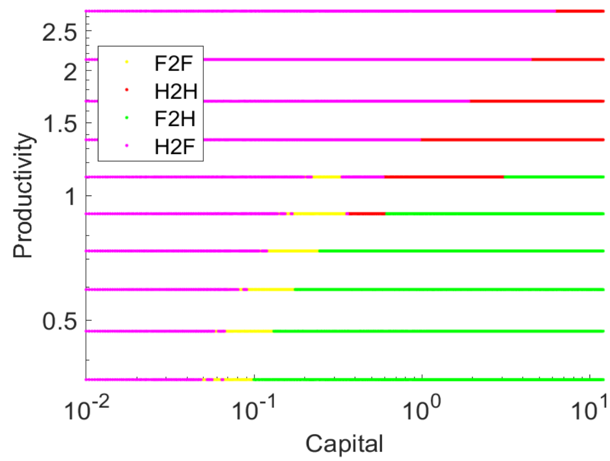

Figure 7: **Changes in firm ownership under No Residents Franking credits and Lower Dividend Rate (NRFLD) scenario.** Change in end of period ownership by current productivity and next period capital. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to resident ownership (F2H).

As seen in Figure 7, the green transition (F2H) shows a shift from foreign to resident ownership, while the magenta transition (H2F) shows a shift from resident to foreign ownership. There is a much greater change in the ownership distribution in this NRFLD scenario than in the previous NRF scenario.

Aggregates. Table 3 reports changes in the key aggregate variables for the NRFLD scenario in comparison with the NRF scenario.

The policy changes lower the value of capital to the extent that firms expect to be in a future state where the resident effective dividend tax rate has increased. This reduces investment and the aggregate capital stock. In fact, aggregate capital falls by more in the NRFLD scenario than in the NRF scenario, despite resident's dividend tax rate being lower. That is, resident's now primarily own the firms that are divesting and these firms divest more. Residents' capital gains and dividend tax rates are equal and therefore value dividends funded by divestment relatively more than foreigners. Further, foreigners have a higher discount rate and pay less for the capital gains generating firms residents previously bought. This further lowers the expected value of capital in divesting firms. The capital stock is lower but the distribution shifts away from divesting low productivity firms to higher productivity firms which raises TFP. This shows that both the policy setting and also the distribution of firms' ownership influence firms' investment decisions, as discussed in Section 3.2.

Residents' equity holdings decrease marginally, despite an increase in their rate of return, as their wage income and ability to save over their lifetimes decreases. Foreigners are willing to pay less for the firms resident's previously bought and therefore the value of their equity holding falls.

	NRF	NRFLD		NRF	NRFLD
Output: total	-2.0	-1.9	Government revenue (GR)	1.5	0.6
+ Output: resident capital	-4.8	2.7	+ GR: corporate tax	0.1	0.0
+ Output: foreign capital	2.9	-5.5	+ GR: res. dividend tax	-2.4	-0.4
+ Output: labor	-0.9	-0.4	+ GR: res. franking refund	2.3	2.3
+ Output: TFP	0.2	2.0	+ GR: res. capital gains tax	1.2	-0.7
+ Output: adjustment costs	0.5	-0.6	+ GR: for. dividend tax	0.5	-0.5
Investment	-1.1	-1.6	+ GR: for. franking refund	0.0	0.0
Consumption	-1.0	-0.0	+ GR: for. capital gains tax	0.0	0.0
Net exports	0.0	-0.3	+ GR: consumption tax	-0.0	-0.0
Welfare (W): aggregate	0.2	0.2	+ GR: labor tax	-0.3	-0.1
+ W: low income	0.6	0.3	Equity Value (EV): total	-24	-10
+ W: middle income	0.3	0.3	+ EV: resident owned	-26	-1.3
+ W: high income	-0.2	0.2	+ EV: foreign owned	1.3	-8.9
+ W: wages	-0.8	-0.4	+ EV: res. capital volume	-47	26
+ W: capital returns	-0.3	0.1	+ EV: for. capital volume	25	-46
+ W: bequests	-0.2	-0.0	+ EV: res. equity price	21	-27
+ W: government transfers	1.5	0.6	+ EV: for. equity price	-23	37

Table 3: **The aggregate and welfare effects under No Resident Franking and Lower Dividend Tax (NRFLD) scenario.** Note that, changes are presented in percentage changes of initial output. To easy comparison, we report the NRF case in the second column. W is welfare; GR is government revenue; EV is equity value.

While the output changes in the NRFLD and NRF scenarios are similar, the revenue increase in the NRFLD scenario is around a third of that in the NRL scenario. This is despite there being less of a reduction in resident's dividend tax revenue. In the NRFLD scenario revenue from residents' capital gains and foreigners' dividends decreases while these streams increase in the NRF scenario.

The increase in TFP in the NRFLD scenario means that while capital is lower than the NRF scenario, output is higher, as shown in Table 3. Labor supply falls less in the NRFLD scenario, as wages are higher. However, potential output lost to capital adjustment costs increases as firms both divest and invest more.

Welfare. While the aggregate welfare changes are similar in the NRF and NRFLD scenarios, the impacts across income groups are more even in the NRFLD scenario. In the NRFLD case the welfare increase is partly explained by the increased TFP rather than being driven by increased transfers. Further, in the NRFLD scenario the wage and rate of return effects are somewhat offsetting.

5.3 Equal tax treatments

We examine the degree to which dividend imputation reduces the negative impact of double taxation of capital when both residents and foreigners are subject to the same tax treatment.

We consider two policy equal tax treatment scenarios. We first apply the equal tax treatments for all foreign and resident investors (i.e., $\chi^{FC,h} = \chi^{FC,f} = 1$, $\tau^{d,h} = \tau^{d,f} = 0.3$ and $\tau^{g,h} = \tau^{g,f} = 0.15$). In this Equal Treatment (ET) scenario, foreign investors are allowed to get franking credits while they are required to pay higher dividend and capital gains tax rates that residents pay. We next remove franking credits deductibility for both residents nor foreigners in the Equal Treatment with No Franking credits (ETNF) scenario, i.e., $\chi^{FC,h} = \chi^{FC,f} = 0$, $\tau^{d,h} = \tau^{d,f} = 0.3$ and $\tau^{g,h} = \tau^{g,f} = 0.15$. The ET is useful to understand the degree resident capital is a substitute for foreign capital when taxes on foreigners are changed. Meanwhile, the impact of imputation is better understood by comparing the ET and ETNF scenarios. Table 12 present changes in the key aggregate variables for these two policy reform scenarios.

	ET	ETNF		ET	ETNF
Output: total	-2.5	-6.4	Government revenue (GR)	0.3	2.2
+ Output: res. capital	5.0	5.2	+ GR: corporate tax	0.0	0.1
+ Output: for. capital	-6.9	-11	+ GR: res. dividend tax	0.9	0.6
+ Output: labor	-0.6	-2.0	+ GR: res. franking refund	0.1	2.3
+ Output: TFP	-0.3	0.2	+ GR: res. capital gains tax	-0.1	0.3
+ Output: adj. costs	0.4	0.9	+ GR: for. dividend tax	0.0	-0.5
Investment	-1.1	-3.1	+ GR: for. franking refund	-0.3	0.0
Consumption	0.3	-0.7	+ GR: for. capital gains tax	-0.1	-0.0
Net exports	-1.7	-2.7	+ GR: consumption tax	0.0	-0.0
Welfare (W): aggregate	-0.3	-0.1	+ GR: labor tax	-0.3	-0.8
+ W: low income	-0.3	0.2	Equity Value (EV): total	-35	-84
+ W: middle income	-0.3	-0.1	+ EV: resident owned	23	4.5
+ W: high income	-0.3	-0.6	+ EV: foreign owned	-58	-89
+ W: wages	-1.3	-2.8	+ EV: res.: capital volume	49	49
+ W: capital returns	0.5	0.5	+ EV: for.: capital volume	-59	-88
+ W: bequests	0.2	0.0	+ EV: res.: equity price	-26	-44
+ W: gov. transfers	0.3	2.2	+ EV: for.: equity price	1.2	-0.2

Table 4: **The aggregate and welfare effects under Equal Tax Treatments (ET) and ET with No Franking Credit (ETNF) scenarios.** Note that, changes are reported in percentage changes of initial output. W stands for welfare; GR is government revenue; EV is equity value. res. stands for residents and for. stands for foreigners.

Aggregates. In both the ET and ETNF scenarios residents and foreigners have the same tax treatment and therefore value all firms equally. As such, the ownership shares are constant across capital stock and productivity. In the ET scenario foreigners own 13 per cent of firms. That is, across firms foreign owned firms produce 13 per cent of output, undertake 13 per cent of investment, and hold 13 per cent of capital as shown in Table 12. In the ETNF scenario foreigners own 2 per cent of all firms.

With equal taxes residents receive the foreign required rate of return. Hence, residents' expected return does not change between the ET and ETNF scenarios. Further, with equal taxes foreigners can be thought of as supplying the gap between domestic saving and the total value of equity. That is, the rate of return and the total value of equity do not change with foreigners' share of equity. This is in contrast to the case with differential tax treatment where returns and equity prices have to change for foreigners to buy more or less equity.

Applying residents' tax treatment to foreigners lowers the value of physical capital and reduces investment, as shown in Table 4.

Under initial policy setting foreigners buy firms expected to be in the fully imputed regime. Reducing the value of dividends for these firms reduces their divestment marginally and reduces the value of expected future value of capital for all firms. Further, as the value of equity previously bought by foreigners falls, resident's expected return increases which raises the required return for all resident owned firms. This further reduces total investment and capital.

Removing imputation for both investors reduces the value of dividends of firms in the partially imputed and fully franked firms. This further reduces the value of physical capital and therefore total investment. It does raise investment by some firms in the partially imputed and fully franked regimes. As such, total physical capital is lower in the ETNF then the ET scenario but TFP is marginally higher.

In the ET scenario increased resident saving makes up around half of the fall in foreign owned equity. In the ETNF scenario resident saving is broadly unchanged relative to initial policy settings with the response to the higher rate of return offset by reduced income to save from lower wages.

In both the ET and ETNF scenarios tax revenue from foreigners declines despite the scenario primarily raising tax rates for foreigners. Total revenue is broadly unchanged in the ET scenario but rises under the ETNF scenario driven by reduced franking refunds for residents.

Welfare. Welfare in both scenarios is lower than under initial policy settings but is higher in the ETNF scenario. In increased revenue, and to a degree the higher TFP, explains the higher welfare in the ETNF scenario relative to the ET case.

6 Sensitivity analysis and extension

6.1 Importance of firm heterogeneity

A key feature of the model is the heterogeneity of firms. This degree of heterogeneity is in part determined by the variance of the firms' productivity process. To show the importance of the firm heterogeneity we run the previous scenarios under two sensitivities: the standard deviation of firm production shocks, σ, reduced to half (PS2) and reduced to a tenth (PS10). Table 5 shows the headline impacts of the scenarios with different level of firm heterogeneity while Tables 13 and 14 provide additional details for these sensitivities.

As productivity distribution narrows firms concentrate in fewer financial regimes. Under initial policy settings in the baseline calibration around 35 per cent of firms are in the equity issuing or

		NRF	NRFLD	ET	ETNF
Output	Baseline	-2.1	-1.9	-2.6	-6.8
	PS2	-1.1	-1.6	-1.3	-5.7
	PS10	-0.0	-0.5	0.3	-4.7
Government revenue	Baseline	1.5	0.6	0.3	2.3
	PS2	1.7	0.9	0.1	2.4
	PS10	1.2	0.5	-0.1	2.3
Welfare: Aggregate	Baseline	0.2	0.2	-0.3	-0.2
	PS2	1.2	0.5	-0.3	1.0
	PS10	0.6	-0.4	-0.6	0.3

Table 5: **The aggregate and welfare effects of policy changes with different standard deviations of firm productivity shocks.** Note that, changes are reported in percentage changes of initial output. PS2 stands for reduction on the standard deviation of firm productivity shocks by half, while PS10 stands for a reduction in the standard deviation of firm productivity shocks to a tenth. NRF is the No Resident Franking scenario, NRFLD is the No Residents Franking credits and Lower Dividend rate scenario, ET is the Equal Treatment scenario and ETNF is Equal Treatment and No Franking scenario.

liquidity constrained regimes, this falls to just over 20 per cent in PS2, and there are no firms in these regimes in the PS10, as can be seen in Tables 15 and 16 in the appendix. In PS10, under initial policy settings, resident owned firms are exclusively in the fully franked regime to fully take advantage of franking credits. In this case residents buy higher productivity and higher capital firms while foreigners buy lower productivity and lower capital firms to receive capital gains.

Not only do firms congregate in particular financial regimes, the regimes are highly responsive to policy setting. In PS10, removing resident's franking credit causes resident owned firms to take all returns as capital gains by reinvesting all profits as in the liquidity constrained regime. At the same time all foreign owned firms are in the full imputed regime. Conversely, in PS10 under the NRFLD scenario, where foreigners have the lower relative capital gains tax rate, foreign owned firms are all in the liquidity constrained regime and reinvest all firm revenue to generate capital gains. In this case, the majority of resident owned firms are in the fully imputed regime. Under the ET settings, where residents have equal tax treatment and equal access to franking credits, in PS10 almost all firms are in the fully franked regime and undertake investment equal to depreciation. As such, there is almost zero correlation between firms productivity and capital. Maintaining equal tax treatment but removing the incentives provided by franking credits, as under ETNF, firms are either in the partially imputed or fully imputed regimes and the correlation between capital and productivity returns.

Narrowing the distribution of firms does remove the impact of dividend taxes. In a model with a single investor and no dividend imputation, if all firms were dividend issuing and investment internally financed, dividend taxes would not impact investment or the capital stock and the "new" view of dividend taxation would prevail. However, in this model, even with a narrow distribution of capital, investors and firms respond to relative tax rates across investors including dividend rate and the imputation rate.

With less firm heterogeneity, foreign and domestic capital become closer substitutes. In PS10, under the NRF, NRFLD and ET scenarios the reductions in capital from one investor are almost completely offset by the other investor, shown in Table 14.

As the distribution of productivity shock narrows, labor supply changes and capital changes drive output. That is, capital allocation and TFP become less important. With small shocks, the policy settings can have a large impact on the correlation between a firm's capital and productivity but the distribution of capital and productivity are both narrow.

As capital from both investors become closer substitutes, the domestic return becomes more responsive and has a larger impact on welfare. That said, government transfers and wages drive most of the long run welfare changes.

6.2 Role of initial policy settings

The marginal distortion from a particular tax depends on the full suite of policy settings. In our framework, policy settings change both the firm ownership distribution and how firms deliver returns. This increases the importance of initial policy settings to the impact of incremental policy change. To demonstrate this we show the impact of small tax policy changes at different initial policy settings. We focus on the residents' dividend tax rate and their franking credit deduction.

Figure 9 shows the impact of a 3 per cent decrease in the resident's dividend tax rate over a range of initial policy settings. Cutting resident's dividend tax rate increases the value of capital for resident owned, dividend paying firms. This increases the value of investment for all firms to the extent they expect to be resident owned and paying dividends in the future. For resident owned firms the rate cut also increases the value of paying out dividends and the cost of investment in the current period. However, the relationship between output change and the initial policy setting is clearly non-linear.

There are three main factors that determine the impact of dividend rate cuts on output. Firstly, increased resident ownership of dividend paying firms means reductions of residents' dividend tax rate have larger impacts on the value of future capital and investment. The resident owned share of dividend paying firms decreases with their dividend tax rate. As such, the impact on output decreases as the initial rate increases. Generally, this effect dominates and the impact on output decreases for higher initial resident's dividend tax rates. To this end, at dividend tax rates above 55 per cent small changes to the rate do not change output, revenue or welfare. At these rates resident owned firms do not pay dividends and instead reinvest all profits to generate capital gains.

Secondly, as noted above, cutting the tax rate can decrease investment by certain firms. When there are very few resident owned dividend paying firms this effect dominates and tax cuts decrease output. This is seen at initial resident's dividend tax rates between 48 and 54 per cent, here dividend tax rate cuts primarily result in resident owned firms paying out some dividends and investing less.

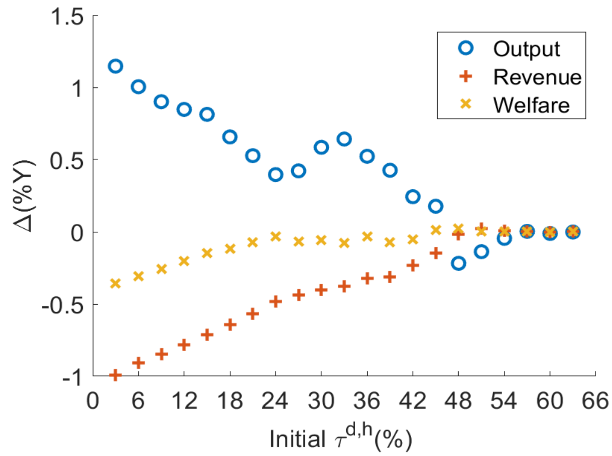

Figure 8: **The aggregate and welfare effects of reducing resident's dividend tax rate by initial policy setting.** Changes in key variables that result from lowering resident's dividend tax rate by 3 per cent by initial policy setting. The figure shows the change in the variables as a percent of output in the baseline.

Lastly, changing resident dividend tax rate can change their expected rate of return. To the extent that tax cuts increase residents' expected rate of return this increases the discount rate of resident owned firms which in itself lowers investment, capital and output. This effect partly offsets the direct effect of the tax cut. The change in the resident's expected return is non-linear with the initial tax rate. In particular, at resident's dividend tax rates between 24 per cent 33 per cent there is a large switch in the distribution of ownership . At these tax rates the relative valuation, between residents and foreigners, for different firms are closer. Hence larger changes in residents' expected rate of return are required to ensure equilibrium between their savings and their equity purchases. As such, small reductions to residents' dividend tax rate from initial rates between 24 per cent 33 are accompanied by larger increases in residents' expected return and smaller increase in the total capital stock and output.

Cuts to residents' dividend tax rate when the initial rate is below 24 percent result in declines in tax revenue from resident's dividends. Above an initial rate of 24 per cent, cuts result in increased revenue from this source due to the increase in dividend payments to residents. At all initial rates, cutting the rate lowers overall revenue as the declines in other revenue streams offset increases in revenue from residents' dividends. At lower initial tax rates, tax from foreign investors declines as they are crowded out and franking credit refunds increases as residents receive more dividends.

The negative welfare impact of cutting resident dividend tax rate is driven by changes in government revenue.

Figure 9 shows the impact of reducing resident's franking credit deductibility by 20 per cent over a range of initial policy settings.

As discussed in the NRF scenario in Section 5.1, reducing the resident's franking credit deduction decreases investment by the majority of firms but increases investment by some resident

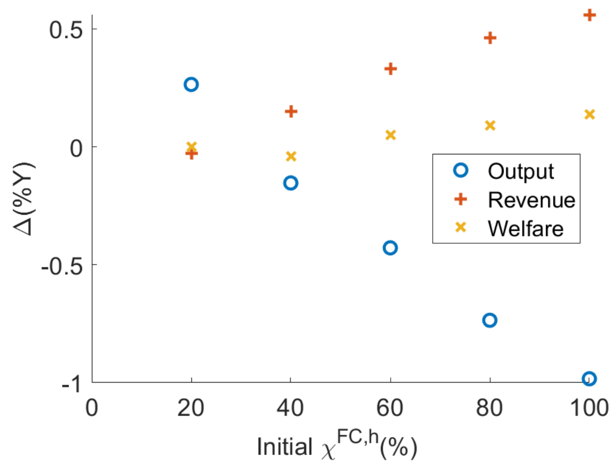

Figure 9: **The aggregate and welfare effects of reducing resident's franking credit deductibility tax rate by initial policy setting.** Changes in key variables that result from lowering resident's franking credit deductibility by 20 per cent against initial policy setting. The figure shows the change in the variables as a percent of output in the baseline.

owned firms in the partially imputed and fully franked regimes. Further, as the resident's franking credit deduction is decreased, they switch to purchasing firms expected to generate returns through capital gains. These include low productivity firms that are likely to receive positive productivity shocks. Foreigners purchase fewer low productivity firms and instead purchase more firms expected to be in the partially imputed and fully franked regimes. Reductions in franking credit deductibility reduce the domestic expected rate of return and the discount rate of resident owned firms, which was already lower than that of foreigners. At higher initial rates of resident's franking credit deductibility, reducing the deduction lowers investment as the effect of the lower future value of capital dominates. At lower rates of resident's franking credit deductibility, as there are fewer resident owned firms expected to be in the partially imputed or fully franked regimes. As such, at lower rates additional reductions have limited impact on the value of capital. Instead, the low productivity firms that residents now buy divest less. They do so as they have both a lower discount rate and higher dividend tax rates than when they were foreign owned. Hence at low levels of resident's franking deductibility, further reductions increase the overall capital stock and output. While aggregate capital stock drives the change in output, reduced adjustment costs and higher TFP raise output when the deductibility is reduced.

Reducing resident franking deductions raises net revenue for all but the lowest initial deductibility rates. At lower rates of deductibility further cuts result in less of saving and fewer franking deductions, as fewer residents harness the deductions. Further, at lower rates of deductibility, there are larger declines in resident dividend tax revenue.

Again, the long run welfare impacts are driven by the changes in government transfers. As the government revenue gains welfare decline with the deductibility, so does the welfare change.

6.3 Extensions

The model described in Section 2 allows many options for taxing capital incomes. While we have investigated the impacts of imputation in this framework, broader questions around the relative efficiency of different taxes in the framework are remain. While we only examine long run impacts of policy changes and therefore can not answer question about tax efficiency, we can compare the long run impacts of each capital tax policy options. That is, to can we model the long run impact of changing each capital tax to better understand the different distortions from each of the capital tax levers.

The scenarios we simulate are setting residents' dividend (RD) tax rate to zero, $\tau^{d,h} = 0$; setting resident's franking (RF) deductibility set to zero, $\chi^{FC,h} = 0$; setting resident's capital gains (RG) tax rate to zero, $\tau^{g,h} = 0$; settings foreigner's dividend (FD) tax rate set to zero, $\tau^{d,f} = 0$; setting foreigners' franking (FF) deductibility set to one, $\chi^{FC,f} = 1$; setting foreigner's capital gains (FG) tax rate to their dividend rate, $\tau^{g,f} = 0.1$; setting the corporate (CT) tax rate set to zero, $\tau^{k} = 0$; setting depreciation deductibility (DD) to zero, $\chi^{\delta} = 0$; allowing investment deductibility (ID), $\chi^{I} = 0, \chi^{\delta} = 0$. In each scenario the government's budget is balanced by lump sum transfers that are equal across households.

Table 6 shows change in net revenue, output and welfare relative in initial GDP under the different policy scenarios with a more comprehensive set of impacts in Table 17 in the appendix.

Scenario	**RD**	**RF**	**RG**	**FD**	**FF**	**FG**	**CT**	**DD**	**ID**
Output	7.3	-2	-0.9	0.5	2.6	-0.7	7.6	-8.4	5.8
Government revenue	-6.8	1.5	0.4	-0.4	-0.8	-0.2	-2.2	1.2	-1.4
Welfare: Aggregate	-1.6	0.2	0.2	0.0	-0.1	-0.0	0.9	-2.6	1.3

Table 6: **The aggregate and welfare effects of changing capital taxes in percentage changes of initial output.** Note that, RD: resident's dividend tax rate set to zero ($\tau^{d,h} = 0$); RF: resident's franking deductibility set to zero ($\chi^{FC,h} = 0$); RG: resident's capital gains tax rate set to zero ($\tau^{g,h} = 0$); FD: foreigner's dividend tax rate set to zero ($\tau^{d,f} = 0$); FF: foreigners' franking deductibility set to one ($\chi^{FC,f} = 1$); FG: foreigner's capital gains tax rate set to their dividend rate, ($\tau^{g,f} = 0.1$); CT: corporate tax rate set to zero ($\tau^{k} = 0$); DD: depreciation deductibility set to zero ($\chi^{\delta} = 0$); and ID: investment deductibility set to one ($\chi^{I} = 0$ and $\chi^{\delta} = 0$).

The net revenue impacts of the scenarios are substantially different. Firstly, the RF and D scenarios reduce tax deductions and therefore raise revenue. Further, the capital gains tax scenario also results in a revenue increase as capital gains tax revenue is negative under the initial policy settings. However, part of the differences in the revenue impacts are due to differences in the size of the tax bases.[14] This makes it difficult to compare the relative distortions from the different taxes.

To better compare the distortions from the different taxes we normalize the impacts by changes

[14]The size of the tax bases are shown in Table 10 in the Appendix.

in net government revenue, effectively this gives the average excess burden of each tax. Table 7 shows the change in output and welfare normalized for the net revenue change.[15]

Scenario	**RD**	**RF**	**RG**	**FD**	**FF**	**FG**	**CT**	**DD**	**ID**
Output	1.1	1.4	2.4	1.2	3.2	-3.5	3.4	6.9	4.3
Government revenue	-1	-1	-1	-1	-1	-1	-1	-1	-1
Welfare: Aggregate	-0.2	-0.2	-0.5	0.1	-0.2	-0.1	0.4	2.1	1.0

Table 7: **The aggregate and welfare effects of changing capital taxes in percentage changes of initial output.** Note that, RD: resident's dividend tax rate set to zero ($\tau^{d,h} = 0$); RF: resident's franking deductibility set to zero ($\chi^{FC,h} = 0$); RG: resident's capital gains tax rate set to zero ($\tau^{g,h} = 0$); FD: foreigner's dividend tax rate set to zero ($\tau^{d,f} = 0$); FF: foreigners' franking deductibility set to one ($\chi^{FC,f} = 1$); FG: foreigner's capital gains tax rate set to their dividend rate, ($\tau^{g,f} = 0.1$); CT: corporate tax rate set to zero ($\tau^{k} = 0$); DD: depreciation deductibility set to zero ($\chi^{\delta} = 0$); and ID: investment deductibility set to one ($\chi^{I} = 0$ and $\chi^{\delta} = 0$).

While many factors drive the difference in the scenarios we note some key takeaways. Firstly, even in a model where resident and foreign capital are imperfect substitutes, taxes on foreign capital incomes are more distorting to the capital stock and output than taxes on residents. This can be seen in the output changes in the FD, FF, FG and CT scenarios.

Secondly, the dividend and capital gains tax rates have larger impacts on the allocation of capital and thereby total factor productivity. Imputation creates a relatively smaller distortion to the allocation of capital across firms.

Lastly, we note that the revenue normalized long run impacts of the DD and ID scenarios exaggerate their impacts. The revenue changes under these policy changes are larger during the transition and these are not captured in this analysis.

7 Conclusion

Our contribution is twofold. First, we formulate a new small-open macroeconomy model where there heterogeneous firms, overlapping generations of households, home and foreign investors, and fiscal policy. This new analytical framework allows us to better capture the way that taxation of savings and capital income drives differences in the marginal cost of investment across firms, which subsequently influences home and foreign investors's investment behaviors. Second, we are the first who formally analyze the macroeconomic and welfare effects of dividend imputation as an alternative solution to the double taxation issue. We analytically show how dividend imputation affects investment. We show that dividend imputation mitigates the double taxation of capital income, that induces more investment; on other hand, it however raises the marginal cost of investment for firms that are partially imputed or fully franked, that then reduces investment. The overall effect is theoretically ambiguous.

[15] Table 18 in the appendix provides a comprehensive set of normalized impacts.

Our quantitative analysis indicates that the positive force is dominant. That is, the presence of a dividend imputation system positively affects domestic saving, aggregate capital and output. Our analysis also highlights the role of differential tax treatment of tax residents and non-residents. That is, the differential tax treatment drive foreign investors' investment incentives and the distribution of firm ownership, which sequentially determines the impacts of capital income taxation in the context of an open economy model. Interestingly, even with perfectly foreign capital mobility assumption, foreign financial capital is not a perfect substitute for domestic saving in our setting where tax distortions and financial frictions distort the allocation of capital across firms.

In the current paper we assume away some modeling features that might be important for the basis of policy formation. Firstly, we only consider long run impacts and are, therefore, not able to consider the short- and medium-run impacts of the various policy changes. We abstract from the full complexity of an income tax code such as an accrual basis for capital gains taxation. We do not allow for firm entry and exit and the distribution of firms does not approximate a Zipf distribution. We also abstract from debt financing and share buying backs option. We leave these potential extensions for future research.

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Appendix

A Calibration and initial steady state

Parameters:		Explanation/Source:
- Periods working	$J_1 = 45$	
- Periods retired	$J_2 = 35$	
- labor productivity by skill	$\{e_j\}_{j=1}^{J_1}$	Calculated from HILDA data
- Markov productivity process persistence	$\rho = 0.767$	Gourio and Miao (2010)
- Productivity shocks standard deviations	$\sigma = 0.211$	Gourio and Miao (2010)
- World interest rate	$r^f = 0.03$	Gourio and Miao (2010)
- Labor income share	$\alpha_n = 0.65$	Gourio and Miao (2010)
- Capital income share	$\alpha_k = 0.311$	Gourio and Miao (2010)
- Capital depreciation	$\delta = 0.095$	Gourio and Miao (2010)
- Corporate tax	$\tau^k = 0.3$	Headline rate
- Resident's dividend tax	$\tau^{d,h} = 0.3$	Approximate average rate
- Resident's franking credit deductibility	$\chi^{FC,h} = 1$	Headline rate
- Resident's capital gains tax	$\tau^{g,h} = 0.15$	Half of dividend rate
- Foreigner's dividend tax	$\tau^{d,f} = 0.1$	Approximate average rate
- Foreigner's franking credit deductibility	$\chi^{FC,f} = 0$	Headline rate
- Foreigner's capital gains tax	$\tau^{g,f} = 0$	Half of dividend rate
- Investment tax credit share	$\chi^I = 0$	Headline rate
- Depreciation deduction share	$\chi^d = 1$	Headline rate

Table 8: **External parameters.**

Parameters:		Explanation/Source:
- Relative risk aversion	$\sigma^h = 2.5$	from previous studies
- Preference on consumption/leisure	$\gamma = 0.25$	to match labor supply
- Discount factor	$\beta = 0.960$	to match 30% foreign ownership
- Capital adjustment cost	$\psi = 1.08$	Gourio and Miao (2010)
- Labor income tax	$\tau^n = 0.17$	Balance initial government budget
- Consumption tax	$\tau^c = 0.062$	to match to consumption tax to GDP
- Residual Government spending	$G/Y = 0.115$	match to government spending to GDP

Table 9: **Internal parameters used to match a set of target moments in the data.**

Value:	**Variable:**	**Per cent of output(Y):**
Labor income	NW	67
Consumption	C	67
Investment	I	19
Government spending	G	12
Net exports	NX	2.8
Capital adjustment cost	AC	3.6
Government Transfers	T	8.2
Corporate tax	TAX^k	5.4
Residents dividend tax	$\tau^{d,h} d_t^h$	2.7
Residents franking refund	$(1 - \tau^{d,h})FC$	2.3
Residents capital gains tax	$TAX_t^{g,h}$	-0.5
Foreign dividend tax	$TAX_t^{d,f}$	0.5
Consumption tax	TAX^c	3.2
Labor tax	TAX^n	11
Residents dividends	d_t^h	8.9
Residents issuance	$-s_t^h$	4.9
Residents franking credits	FC	3.3
Foreign dividends	d_t^f	5.1
Foreign issuance	$-s_t^f$	0.5

Table 10: **Initial steady state values as share of output.**

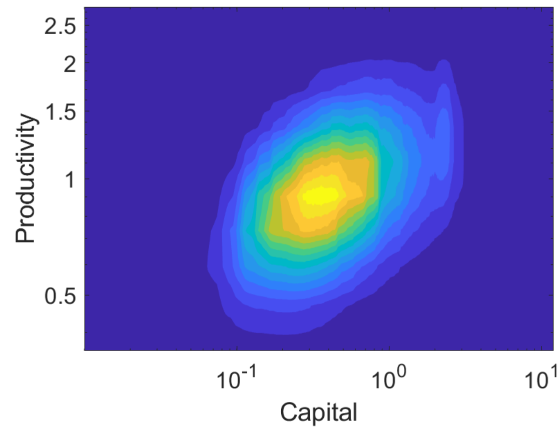

Figure 10: **Mass of firms by capital and productivity.**

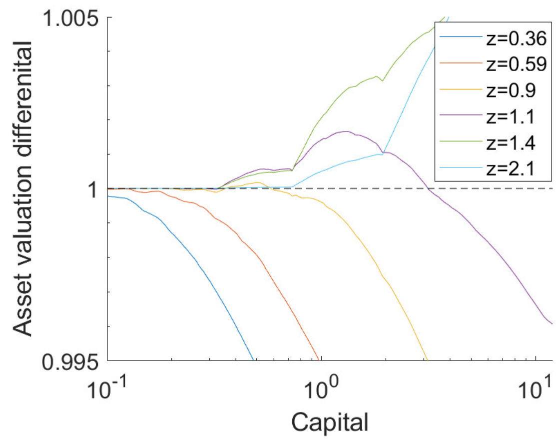

Figure 11: **Resident's asset valuation relative to foreign valuation.** Asset valuation differentialp^h/p^f plotted against capital for different productivity values in the baseline model.

B Quantitative analysis: Additional tables and figures

	NRF	NRFLD	ET	ETNF
Output: Y	-2.1	-1.9	-2.6	-6.8
+ Output: Resident capital K^h	-4.9	2.7	5.1	5.5
+ Output: Foreign capital K^h	3	-5.6	-7.1	-12
+ Output: labor N	-0.9	-0.4	-0.7	-2.2
+ Output: TFP Z	0.2	2.1	-0.3	0.2
+ Output: Adjustment costs AC	0.5	-0.6	0.4	1
Investment	-1.1	-1.6	-1.1	-3.3
Consumption	-1	-0.0	0.3	-0.7
Net exports	0.0	-0.3	-1.8	-2.8
Welfare: Aggregate	0.2	0.2	-0.3	-0.2
+ Welfare: Low income	0.6	0.3	-0.3	0.2
+ Welfare: Middle income	0.3	0.3	-0.3	-0.1
+ Welfare: High income	-0.3	0.2	-0.3	-0.7
+ Welfare: Wages w	-0.8	-0.4	-1.3	-3
+ Welfare: Capital returns r^h	-0.3	0.1	0.6	0.6
+ Welfare: Bequests BQ	-0.2	-0.0	0.2	0.0
+ Welfare: Government transfers T	1.5	0.6	0.3	2.3
Revenue: Total	1.5	0.6	0.3	2.3
+ Corporate tax TAK^k	0.1	0.0	0.0	0.1
+ Residents' dividend tax $\tau^{d,h}d^h$	-2.4	-0.4	0.9	0.7
+ Residents' franking refund $(1-\tau^{d,h})\chi^{FC,h}FC^h$	2.3	2.4	0.1	2.5
+ Residents' capital gains tax	1.2	-0.7	-0.1	0.4
+ Foreigners' dividend tax $\tau^{d,f}d^f$	0.6	-0.5	0.0	-0.5
+ Foreigners' franking refund $(1-\tau^{d,f})\chi^{FC,f}FC^f$	0.0	0.0	-0.3	0.0
+ Foreigners' capital gains tax	0.0	0.0	-0.1	-0.0
+ Consumption tax	-0.0	-0.0	0.0	-0.0
+ Labor tax	-0.3	-0.1	-0.3	-0.8
Equity Value: Total	-25	-10	-36	-90
+ Equity Value: Resident owned	-26	-1	23	5
+ Equity Value: Foreign owned	1	-9	-59	-95
+ Equity Value: Resident capital volume	-48	27	50	52
+ Equity Value: Foreign capital volume	25	-47	-60	-94
+ Equity Value: Resident equity price	22	-28	-27	-47
+ Equity Value: Foreign equity price	-24	38	1	-0.2

Table 11: **Impacts of policy changes.** Note that, changes are in percentage of initial output. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET: Equal Treatment scenario and ETNF: Equal Treatment and No Franking scenario.

			Initial	NRF	NRFLD	ET	ETNF
Mass of firms	Resident	EI	15	20	10	21	15
		LC	0	45	0	0	43
		PI	2	0	5	2	4
		FF	25	0	0	27	0
		FI	11	15	43	37	37
	Foreign	EI	8	0	27	3	0
		LC	12	1	13	0	1
		PI	0	2	0	0	0
		FF	0	0	0	4	0
		FI	26	17	2	5	1
Capital	Resident	EI	10	10	12	10	6
		LC	0	33	0	0	30
		PI	6	1	13	5	11
		FF	35	0	0	34	0
		FI	16	11	57	38	51
	Foreign	EI	2	0	12	1	0
		LC	4	2	5	0	1
		PI	1	7	0	1	0
		FF	0	0	0	5	0
		FI	26	36	1	6	1
Investment	Resident	EI	52	41	42	45	27
		LC	0	56	0	0	64
		PI	12	2	26	12	22
		FF	35	0	0	34	0
		FI	6	1	-24	-4	-15
	Foreign	EI	6	1	49	7	0
		LC	5	5	6	0	1
		PI	1	13	0	2	0
		FF	0	0	0	5	0
		FI	-16	-19	0	-1	-0
Output	Resident	EI	24	21	21	20	14
		LC	0	35	0	0	39
		PI	17	2	24	16	19
		FF	35	0	0	35	0
		FI	10	4	32	16	27
	Foreign	EI	2	0	20	3	0
		LC	3	3	3	0	1
		PI	1	13	0	2	0
		FF	0	0	0	5	0
		FI	8	22	0	2	0
Coefficient of variance: capital			1.29	1.30	1.40	1.28	1.39
Correlation: capital, productivity			0.36	0.37	0.40	0.35	0.35

Table 12: **Distribution of firms by ownership and financial regime**. Note that, EI is Equity issuing; LC is Liquidity constrained; PI is Partially imputed; FF is Fully franked; and FI is Fully imputed. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET: Equal Treatment scenario and ETNF: Equal Treatment and No Franking scenario.

C Sensitivity analysis and extensions: Additional results

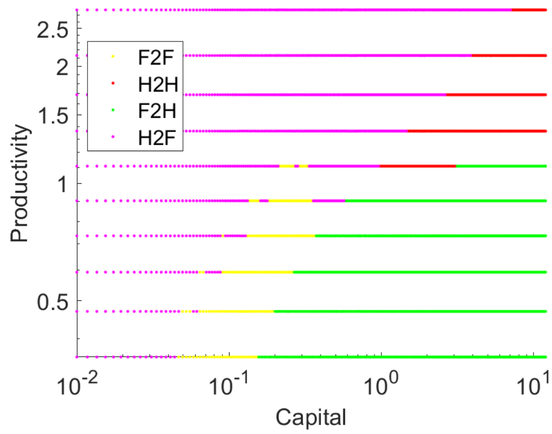

Figure 12: **Changes in firm ownership after cutting residents' dividend tax rate.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

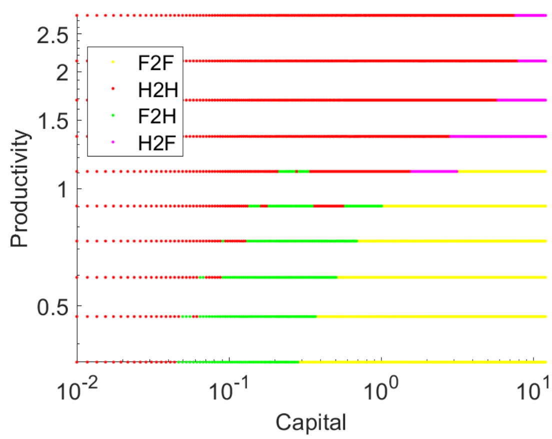

Figure 13: **Changes in firm ownership after removing resident's franking credit deduction.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

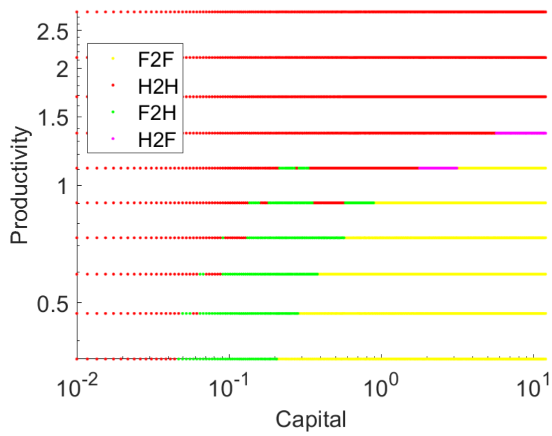

Figure 14: **Changes in firm ownership after cutting residents' capital gains tax rate.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

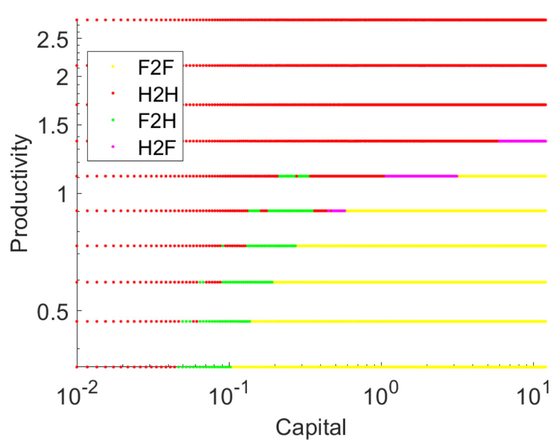

Figure 15: **Changes in firm ownership from cutting foreigner's dividend tax rate.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

	NRF	NRFLD	ET	ETNF
Output: Y	-1.1	-1.6	-1.3	-5.7
+ Output: Resident capital K^h	-3.2	-0.4	2.1	4
+ Output: Foreign capital K^h	2.2	-1.6	-2.9	-8.7
+ Output: Labor N	-0.8	-0.5	-0.3	-2
+ Output: TFP Z	1	1.7	-0.4	1.2
+ Output: Adjustment costs AC	-0.4	-0.7	0.2	-0.2
Investment	-0.6	-1.4	-0.5	-3
Consumption	-0.5	-0.3	0.0	-0.2
Net exports	0.1	0.1	-0.8	-2.5
Government revenue	1.7	0.9	0.1	2.4
+ Corporate tax TAK^k	-0.0	0.1	0.0	0.2
+ Residents' dividend tax $\tau^{d,h}d^h$	-2.2	-0.7	-0.0	0.4
+ Residents' franking refund $(1-\tau^{d,h})FC^h$	2.4	2.4	0.3	2.4
+ Residents' capital gains tax	1	-0.5	0.2	0.3
+ Foreigners' dividend tax $\tau^{d,f}d^f$	0.6	-0.2	0.4	-0.1
+ Foreigners' franking refund $(1-\tau^{d,f})FC^f$	0.0	0.0	-0.6	0.0
+ Foreigners' capital gains tax	0.0	0.0	-0.0	-0.0
+ Consumption tax	-0.0	-0.0	0.0	-0.0
+ Labor tax	-0.1	-0.1	-0.2	-0.7
Equity Value: Total	-32	-12	-17	-90
+ Equity Value: Resident owned	-35	-17	10	-7.2
+ Equity Value: Foreign owned	2.8	4.2	-28	-82
+ Equity Value: Resident capital volume	-32	-4.1	21	39
+ Equity Value: Foreign capital volume	21	-15	-28	-81
+ Equity Value: Resident equity price	-2.5	-13	-11	-47
+ Equity Value: Foreign equity price	-19	20	0.3	-1.9
Welfare: Aggregate	1.2	0.5	-0.3	1.0
+ Welfare: Low income	1.4	0.7	-0.3	1.3
+ Welfare: Middle income	1.3	0.6	-0.3	1.1
+ Welfare: High income	0.9	0.3	-0.3	0.6
+ Welfare: Wages w	0.3	-0.1	-0.7	-1.6
+ Welfare: capital returns r^h	-0.5	-0.2	0.2	0.2
+ Welfare: Bequests BQ	-0.3	-0.1	0.1	-0.1
+ Welfare: Government transfers T	1.7	0.9	0.1	2.4

Table 13: **Impacts of policy changes with standard deviation of firm productivity shocks, σ, reduced by half.** Note that, changes are in percentage of initial output. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET: Equal Treatment scenario and ETNF: Equal Treatment and No Franking scenario.

	NRF	NRFLD	ET	ETNF
Output: Y	-0.0	-0.5	0.3	-4.7
+ Output: Resident capital K^h	-4.2	-4.1	-2.8	-0.5
+ Output: Foreign capital K^h	4.7	3.7	2.8	-2.8
+ Output: Labor N	-0.3	-0.0	0.3	-1.5
+ Output: TFP Z	0.1	0.1	-0.0	0.1
+ Output: Adjustment costs AC	-0.3	-0.2	0.0	-0.0
Investment	0.3	-0.3	0.0	-2.2
Consumption	-1.4	-1.6	-0.9	-1.5
Net exports	1.1	1.4	1.1	-1.0
Government revenue (GR)	1.2	0.5	-0.1	2.3
+ Corporate tax TAK^k	-0.1	-0.0	0.0	0.2
+ Residents' dividend tax $\tau^{d,h}d^h$	-2.1	-0.7	-0.4	0.1
+ Residents' franking refund $(1-\tau^{d,h})FC^h$	2.1	2.1	0.4	2.1
+ Residents' capital gains tax	0.7	-0.5	0.1	0.1
+ Foreigners' dividend tax $\tau^{d,f}d^f$	0.7	-0.2	0.9	0.5
+ Foreigners' franking refund $(1-\tau^{d,f})FC^f$	0.0	0.0	-1.1	0.0
+ Foreigners' capital gains tax	0.0	0.0	-0.0	-0.0
+ Consumption tax	-0.1	-0.1	-0.0	-0.1
+ Labor tax	0.0	-0.0	0.0	-0.6
Equity Value (EV): Total	-9.1	14	24	-64
+ Equity Value: Resident owned	-46	-33	-13	-32
+ Equity Value: Foreign owned	37	46	37	-32
+ Equity Value: Resident capital volume	-40	-39	-26	-4.3
+ Equity Value: Foreign capital volume	43	34	26	-25
+ Equity Value: Resident equity price	-5.6	5.9	13	-27
+ Equity Value: Foreign equity price	-6.7	12	11	-7.3
Welfare: Aggregate	0.6	-0.4	-0.6	0.3
+ Welfare: Low income	1	-0.1	-0.4	0.8
+ Welfare: Middle income	0.7	-0.3	-0.5	0.4
+ Welfare: High income	0.1	-0.9	-0.8	-0.4
+ Welfare: Wages w	0.5	-0.2	-0.1	-1.6
+ Welfare: capital returns r^h	-0.7	-0.5	-0.2	-0.2
+ Welfare: Bequests BQ	-0.4	-0.3	-0.1	-0.3
+ Welfare: Government transfers T	1.2	0.5	-0.1	2.3

Table 14: **Impacts of policy changes with standard deviation of firm productivity shocks, σ, divided by ten.** Note that, changes are in percentage of initial output. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET: Equal Treatment scenario and ETNF: Equal Treatment and No Franking scenario.

			Initial	NRF	NRFLD	ET	ETNF
Mass of firms	Resident	EI	3	1	5	5	0
		LC	0	58	0	0	35
		PI	3	1	11	3	15
		FF	49	0	0	51	0
		FI	5	11	46	19	45
	Foreign	EI	5	0	18	1	0
		LC	14	0	20	0	2
		PI	1	3	0	1	1
		FF	0	0	0	15	0
		FI	20	26	0	5	3
Capital	Resident	EI	3	1	6	3	0
		LC	0	50	0	0	27
		PI	4	2	16	3	19
		FF	56	0	0	52	0
		FI	6	8	51	18	48
	Foreign	EI	3	0	13	1	0
		LC	9	1	14	0	2
		PI	1	5	0	1	1
		FF	0	0	0	15	0
		FI	18	34	0	5	3
Investment	Resident	EI	11	3	14	10	0
		LC	0	84	0	0	55
		PI	5	2	23	4	28
		FF	56	0	0	52	0
		FI	4	5	6	11	11
	Foreign	EI	7	0	36	3	0
		LC	11	1	20	0	3
		PI	1	7	0	1	2
		FF	0	0	0	15	0
		FI	4	-2	0	3	1
Output	Resident	EI	6	2	9	5	0
		LC	0	59	0	0	38
		PI	8	1	21	7	23
		FF	62	0	0	56	0
		FI	3	4	36	9	33
	Foreign	EI	4	0	21	2	0
		LC	7	1	13	0	2
		PI	1	7	0	2	1
		FF	0	0	0	16	0
		FI	9	25	0	3	2
Coefficient of variance: capital			0.43	0.61	0.69	0.38	0.67
Correlation: capital, productivity			0.34	0.39	0.42	0.29	0.38

Table 15: **Distribution of firms by policy scenario with standard deviation of firm productivity shocks, σ, halved.** Note that, EI is Equity issuing, LC is Liquidity constrained, PI is Partially imputed, FF is Fully franked, and FI is Fully imputed. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET Equal Treatment scenario; and ETNF: Equal Treatment and No Franking scenario.

			Initial	NRF	NRFLD	ET	ETNF
Mass of firms	Resident	EI	0	0	0	0	0
		LC	0	57	0	0	0
		PI	0	0	1	0	37
		FF	68	0	0	61	0
		FI	0	0	54	0	38
	Foreign	EI	0	0	0	0	0
		LC	1	0	45	0	0
		PI	13	0	0	0	12
		FF	0	0	0	39	0
		FI	17	43	0	0	12
Capital	Resident	EI	0	0	0	0	0
		LC	0	55	0	0	0
		PI	0	0	1	0	37
		FF	70	0	0	61	0
		FI	0	0	56	0	39
		EI	0	0	0	0	0
	Foreign	LC	1	0	43	0	0
		PI	13	0	0	0	12
		FF	0	0	0	39	0
		FI	17	45	0	0	12
Investment	Resident	EI	0	0	0	0	0
		LC	0	79	0	0	0
		PI	0	1	1	0	44
		FF	70	0	0	61	0
		FI	0	0	35	0	31
	Foreign	EI	0	0	0	0	0
		LC	2	0	64	0	0
		PI	15	0	0	0	14
		FF	0	0	0	39	0
		FI	14	20	0	0	10
Output	Resident	EI	0	0	0	0	0
		LC	0	56	0	0	0
		PI	0	0	1	0	40
		FF	72	0	0	61	0
		FI	0	0	54	0	36
	Foreign	EI	0	0	0	0	0
		LC	1	0	44	0	0
		PI	12	0	0	0	13
		FF	0	0	0	39	0
		FI	15	43	0	0	12
Coefficient of variance: capital			0.05	0.16	0.16	0.05	0.14
Correlation: capital, productivity			0.32	0.50	0.50	0.00	0.46

Table 16: **Distribution of firms by policy scenario with standard deviation of firm productivity shocks, σ, divided by ten.** Note that, EI is Equity issuing, LC is Liquidity constrained, PI is Partially imputed, FF is Fully franked, and FI is Fully imputed. NRF: No Resident Franking scenario; NRFLD: No Residents Franking credits and Lower Dividend rate scenario; ET: Equal Treatment scenario; and ETNF: Equal Treatment and No Franking scenario.

Scenario	RD	RF	RG	FD	FF	FG	CT	DD	ID
Output: total Y	7.3	-2	-0.9	0.5	2.6	-0.7	7.6	-8.4	5.8
+ Output: resident capital K^h	7.4	-4.8	-0.4	-2.9	-4.3	-1.6	-3.2	-0.9	7.3
+ Output: foreign capital K^h	-2.6	2.9	-0.4	2.7	6.5	0.4	9.1	-7.7	-2.3
+ Output: labor N	4	-0.9	-0.4	0.4	0.8	0.1	1.7	-1.3	1
+ Output: TFP Z	3.2	0.2	-0.2	1.3	0.0	1.2	-0.2	2	-0.6
+ Output: adjustment costs AC	-5.2	0.5	0.5	-0.9	-0.4	-0.8	0.0	-0.6	0.4
Investment	2.9	-1.1	-0.5	-0.1	1.3	-0.7	3.7	-4.5	3
Consumption	3	-1	0.3	0.2	-0.1	0.3	1.9	-2.9	2
Net exports	1.4	0.0	-0.7	0.5	1.5	-0.3	2	-1	0.8
Government revenue (GR)	-6.8	1.5	0.4	-0.4	-0.8	-0.2	-2.2	1.2	-1.4
+ Corporate tax TAK^k	-0.7	0.1	0.1	-0.1	-0.1	-0.0	-5.4	3.4	-1
+ Residents' dividend tax $\tau^{d,h}d^h$	-2.7	-2.4	-1.1	-0.6	-1.9	-0.5	-2.5	1.1	0.4
+ R' franking refund $(1-\tau^{d,h})FC^h$	-1.6	2.3	0.8	0.3	1.9	0.2	2.3	-1.2	-0.7
+ R' capital gains tax	-2.8	1.2	0.5	0.3	1.0	0.3	1.5	-0.7	-0.2
+ Foreigners' dividend tax $\tau^{d,f}d^f$	-0.5	0.5	0.2	-0.5	0.7	0.3	1.0	-0.4	-0.5
+ F' franking refund $(1-\tau^{d,f})FC^f$	0.0	0.0	0.0	0.0	-2.7	0.0	0.0	0.0	0.0
+ F' capital gains tax	0.0	0.0	0.0	0.0	0.0	-0.5	0.0	0.0	0.0
+ Consumption tax	0.1	-0.0	0.0	0.0	-0.0	0.0	0.1	-0.1	0.1
+ Labor tax	1.3	-0.3	-0.2	0.1	0.3	0.0	0.8	-0.8	0.6
Equity Value (EV): Total	127	-24	-15	16	39	-1.8	84	-48	46
+ EV: resident owned	82	-26	8.8	0.4	-9.9	8	18	-14	20
+ EV: foreign owned	46	1.3	-24	16	48	-9.8	66	-34	26
+ EV: resident: capital volume	78	-47	-3.9	-29	-44	-16	-34	-7.8	77
+ EV: foreign: capital volume	-24	25	-3.5	23	58	3.4	85	-61	-21
+ EV: resident: equity price	4.1	21	13	30	35	24	52	-6.7	-57
+ EV: foreign: equity price	69	-23	-20	-7.6	-9.4	-13	-19	27	47
Welfare (W): aggregate	-1.6	0.2	0.2	0.0	-0.1	-0.0	0.9	-2.6	1.3
+ W: low income	-2.7	0.6	0.2	-0.0	-0.2	-0.1	0.3	-1.9	0.8
+ W: middle income	-1.9	0.3	0.2	0.0	-0.1	-0.0	0.8	-2.4	1.2
+ W: high income	-0.1	-0.2	0.2	0.1	-0.1	0.1	1.8	-3.6	2.1
+ W: wages w	3.9	-0.8	-0.5	0.5	1.1	-0.0	3.2	-3.9	2.5
+ W: capital returns r^h	0.4	-0.3	0.2	-0.1	-0.4	0.1	-0.2	0.2	0.0
+ W: bequests BQ	0.7	-0.2	0.1	0.0	-0.1	0.1	0.1	-0.1	0.2
+ W: Transfers	-6.1	1.3	0.4	-0.4	-0.9	-0.1	-2.1	1.1	-1.2

Table 17: **Impacts of changing capital taxes**. Note that, changes are in percentage of initial output. W: Welfare; R': Residents'; F': Foreigners'; and EV: equity value. RD: setting resident's dividend tax rate to zero, $\tau^{d,h}=0$; RFC: setting resident's franking deductibility to zero, $\chi^{FC,h}=0$; RCG: setting resident's capital gains tax rate to zero, $\tau^{g,h}=0$; FD: setting foreigner's dividend tax rate to zero,$\tau^{d,f}=0$; FFC: setting resident's franking deductibility to one,$\chi^{FC,f}=1$; FCG: setting foreigner's capital gains tax rate to their dividend rate, $\tau^{g,f}=0.1$; DWT: Dividend Withholding Tax; FC: Franking Credit; DD: Depreciation deductibility; ID: Investment deductibility.

Scenario	RD	RF	RG	FD	FF	FG	CT	DD	ID
Output: total Y	1.1	1.4	2.4	1.2	3.2	-3.5	3.4	6.9	4.3
+ Output: resident capital K^h	1.1	3.2	1.1	-6.9	-5.3	-7.9	-1.4	0.7	5.3
+ Output: foreign capital K^h	-0.4	-2	1.1	6.3	8	2	4.1	6.3	-1.7
+ Output: labor N	0.6	0.6	1.2	0.9	1	0.3	0.8	1	0.7
+ Output: TFP Z	0.5	-0.2	0.5	3	0.0	6	-0.1	-1.7	-0.4
+ Output: adjustment costs AC	-0.8	-0.4	-1.4	-2.1	-0.5	-3.8	0.0	0.5	0.3
Investment	0.4	0.7	1.2	-0.3	1.6	-3.4	1.7	3.7	2.2
Consumption	0.4	0.7	-0.8	0.4	-0.2	1.3	0.9	2.4	1.5
Net exports	0.2	-0.0	1.9	1.1	1.8	-1.5	0.9	0.8	0.6
Government revenue (GR)	-1	-1	-1	-1	-1	-1	-1	-1	-1
+ Corporate tax TAK^k	-0.1	-0.1	-0.3	-0.1	-0.1	-0.2	-2.4	-2.8	-0.7
+ Residents' dividend tax $\tau^{d,h}d^h$	-0.4	1.6	3	-1.5	-2.4	-2.6	-1.1	-0.9	0.3
+ R' franking refund $(1-\tau^{d,h})FC^h$	-0.2	-1.6	-2.1	0.8	2.3	1.2	1	1	-0.5
+ R' capital gains tax	-0.4	-0.8	-1.4	0.7	1.2	1.7	0.7	0.6	-0.1
+ Foreigners' dividend tax $\tau^{d,f}d^f$	-0.1	-0.4	-0.5	-1.2	0.9	1.5	0.4	0.3	-0.4
+ F' franking refund $(1-\tau^{d,f})FC^f$	0.0	0.0	0.0	0.0	-3.3	0.0	0.0	0.0	0.0
+ F' capital gains tax	0.0	0.0	0.0	0.0	0.0	-2.7	0.0	0.0	0.0
+ Consumption tax	0.0	0.0	-0.0	0.0	-0.0	0.1	0.0	0.1	0.1
+ Labor tax	0.2	0.2	0.4	0.4	0.4	0.0	0.4	0.7	0.4
Equity Value (EV): total	19	17	41	38	47	-8.7	38	39	33
+ EV: resident owned	12	17	-24	1.0	-12	39	8.1	12	14
+ EV: foreign owned	6.7	-0.9	64	37	60	-48	30	28	19
+ EV: resident: capital volume	11	32	11	-69	-55	-78	-15	6.4	56
+ EV: foreign: capital volume	-3.5	-17	9.4	55	71	17	38	50	-16
+ EV: resident: equity price	0.6	-14	-34	70	43	117	23	5.5	-42
+ EV: foreign: equity price	10	16	55	-18	-12	-65	-8.6	-22	35
Welfare (W): aggregate	-0.2	-0.2	-0.5	0.1	-0.2	-0.1	0.4	2.1	1.0
+ W: low income	-0.4	-0.4	-0.5	-0.1	-0.2	-0.5	0.1	1.5	0.6
+ W: middle income	-0.3	-0.2	-0.5	0.0	-0.2	-0.2	0.3	1.9	0.9
+ W: high income	-0.0	0.2	-0.6	0.3	-0.1	0.4	0.8	3	1.6
+ W: wages w	0.6	0.5	1.3	1.3	1.4	-0.1	1.4	3.1	1.9
+ W: capital returns r^h	0.1	0.2	-0.6	-0.2	-0.4	0.6	-0.1	-0.2	0.0
+ W: bequests BQ	0.1	0.1	-0.2	0.0	-0.1	0.3	0.1	0.1	0.1
+ W: government transfers T	-1	-1	-1	-1	-1	-1	-1	-1	-1

Table 18: **Impacts of changing capital taxes normalized for revenue**. Note that, changes are in percentage of initial output.

Scenario			Base	RD	RF	RG	FD	FF	FG	CT	DD	ID
Mass of firms	Resident	EI	15	3	20	38	35	28	35	25	9	12
		LC	0	0	45	0	0	0	0	42	0	0
		PI	2	0	0	7	1	0	1	0	5	0
		FF	25	6	0	17	19	24	22	0	40	0
		FI	11	39	15	17	8	30	13	9	5	0
	Foreign	EI	8	39	0	0	4	1	2	0	21	33
		LC	12	12	1	1	0	0	0	2	9	55
		PI	0	0	2	1	1	0	1	3	1	0
		FF	0	0	0	0	0	6	0	0	0	0
		FI	26	1	17	19	32	11	26	20	9	0
Capital	Resident	EI	10	5	10	19	16	12	16	10	10	19
		LC	0	0	33	0	0	0	0	30	0	0
		PI	6	0	1	12	5	0	6	0	15	0
		FF	35	16	0	25	29	20	32	0	51	0
		FI	16	58	11	12	8	17	11	6	9	0
	Foreign	EI	2	17	0	0	3	2	1	0	7	23
		LC	4	4	2	1	0	0	0	2	2	58
		PI	1	0	7	2	2	3	2	11	1	0
		FF	0	0	0	0	0	18	0	0	0	0
		FI	26	0	36	29	37	27	32	40	5	0
Investment	Resident	EI	52	38	41	57	70	48	70	35	59	20
		LC	0	0	56	0	0	0	0	50	0	0
		PI	12	1	2	25	11	0	11	1	17	0
		FF	35	16	0	25	29	20	32	0	-0	0
		FI	6	-30	1	7	5	3	7	1	-5	0
		EI	6	72	1	1	8	13	4	0	33	36
	Foreign	LC	5	2	5	3	0	0	0	5	1	44
		PI	1	0	13	3	4	6	3	24	0	0
		FF	0	0	0	0	0	18	0	0	0	0
		FI	-16	-0	-19	-21	-26	-10	-27	-15	-7	0
Output	Resident	EI	24	13	21	30	29	20	29	17	24	22
		LC	0	0	35	0	0	0	0	31	0	0
		PI	17	3	2	25	15	0	15	0	30	0
		FF	35	27	0	21	28	16	30	0	31	0
		FI	10	37	4	8	8	4	8	2	2	0
		EI	2	20	0	0	3	7	2	0	11	31
	Foreign	LC	3	1	3	2	0	0	0	3	1	47
		PI	1	0	13	2	3	11	2	22	0	0
		FF	0	0	0	0	0	25	0	0	0	0
		FI	8	0	22	12	14	15	12	24	1	0
C.V. capital			1.29	1.35	1.30	1.29	1.37	1.21	1.38	1.20	1.48	1.23
Cor. capital, productivity			0.36	0.44	0.37	0.36	0.38	0.38	0.38	0.38	0.37	0.36

Table 19: **Distribution of firms by ownership and financial regime.** Note that, EI is Equity issuing, LC is Liquidity constrained, PI is Partially imputed, FF is Fully franked, FI is Fully imputed, C.V. is Coefficient of variance, and Cor is Correlation.

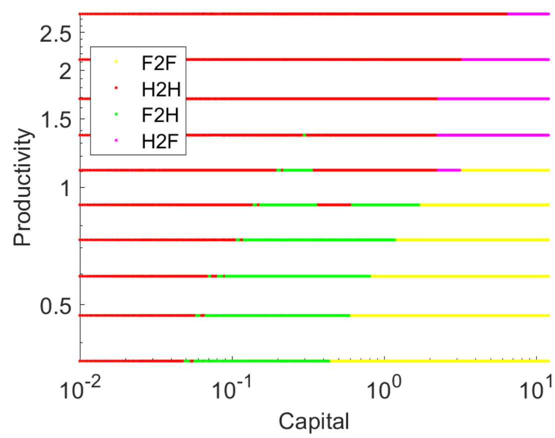

Figure 16: **Changes in firm ownership after allowing franking deductions for foreigners.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

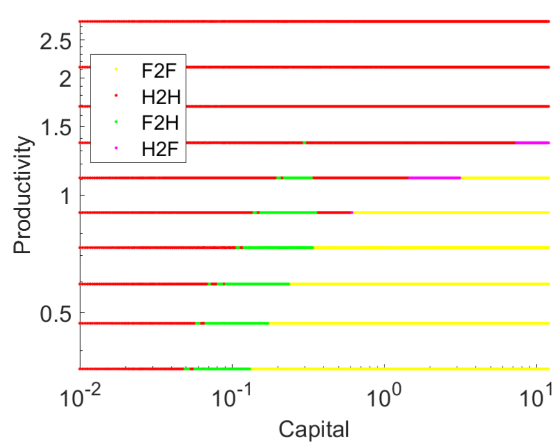

Figure 17: **Changes in firm ownership from increasing foreigner's capital gains tax rate.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

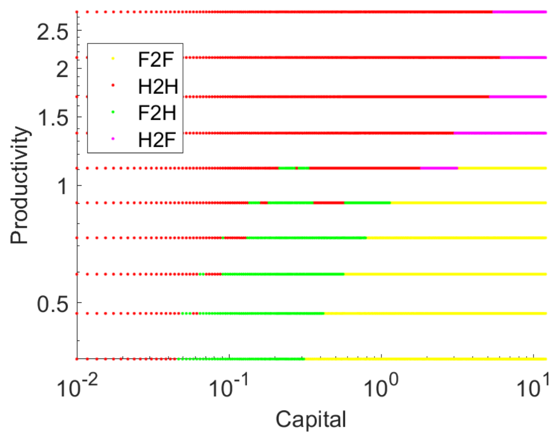

Figure 18: **Changes in firm ownership after corporate income tax cut.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to resident ownership (F2H).

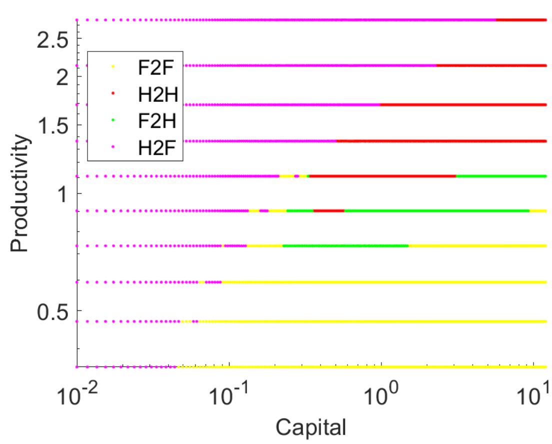

Figure 19: **Changes in firm ownership after removing depreciation allowance.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).

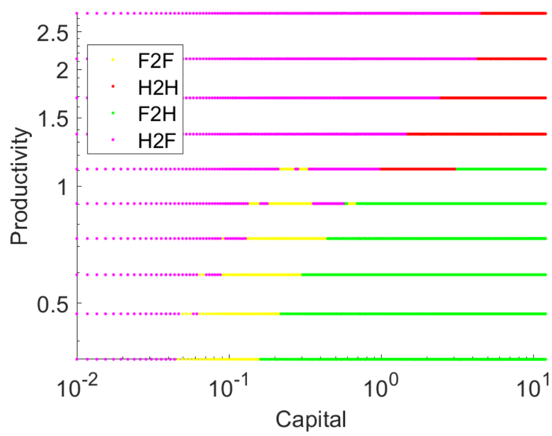

Figure 20: **Changes in firm ownership after switching to investment tax credits.** Change in end of period ownership by next period capital and current productivity. Yellow indicates firms that remain foreign owned (F2F); Red remain resident owned (H2H); Magenta transition from domestic to foreign ownership (H2F); and Green transition from foreign to domestic ownership (F2H).